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

A New Survey of Universal Knowledge

ENCYCLOPÆDIA BRITANNICA

Volume 14

LIBIDO TO MARY, DUCHESS OF BURGUNDY

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Volume *14*

LIBIDO *TO* MARY, DUCHESS OF BURGUNDY

LIBIDO, defined by Freud as "the energy of those instincts which have to do with all that may be comprised under the word 'Love."' Jung enlarged the concept so that for him it describes the energy resident in all instincts. Libido is usually considered to be synonymous with other such vague concepts as *élan* vital and psycho-physiological energy.

It is claimed that the energy of intellectual processes is measured by intelligence tests in terms of clearness and speed; but the measurement of the conative energy of a "uish" is more difficult, because the wish, which may be considered to be the inner feeling of need together with motor sets appropriate to its appeasement, may fail to find expression in measurable overt conduct because of opposing repressive (unconscious) and suppressive (conscious) forces.

See PSYCHOANALYSIS; MOTIVATION.

LIBITINA, Roman goddess of funerals. She had a sanctuary in a sacred grove (perhaps on the Esquiline). where by an ordinance of the legendary Roman king Servius Tullius a piece of money nas deposited whenever a death took place. There the undertakers (libitinarii), uho carried out all funeral arrangements by contract, had their offices, and everything necessary was kept for sale or hire; there all deaths were registered for statistical purposes. The word Libitina then came to be used for the business of an undertaker, funeral requisites and, by poets. for death itself. By antiquarians Libitina was sometimes identified nith Persephone. but more commonly (partly or completely) with Venus Lubentia or Lubentina, an Italian goddess of gardens—a mere confusion. The similarity of name and the fact that Venus Lubentia had a sanctuary in the grove of Libitina favoured this idea. Further, Plutarch mentions a small statue at Delphi of Aphrodite Epitymbia (Aphrodite of Tombs = Venus Libitina), to which the spirits of the dead were summoned. Libitina may have been originally an earth goddess, connected with luxuriant nature and the enjoyments of life; then, all such deities being connected with the underuorld, she also became the goddess of death, and that side of her character predominated in the later conceptions.

LIBO, in ancient Rome, the name of a family belonging to the Scribonian gens. It is chiefly interesting for its connection with the Puteal Scribonianum or Puteal Libonis in the forum at Rome, dedicated or restored by one of its members, perhaps the praetor of 204 B.C., or the tribune of the people in 149.

Puteal was the name given to an erection or enclosure on a spot which had been struck by lightning; it was so called from its resemblance to the stone curb or low enclosure round a well (*puteus*). In the vicinity of the Puteal Libonis the praetor's tribunal, removed from the comitium in the 2nd century B.C., held its sittings, nhich led to the place becoming the haunt of litigants and business people.

LIBON, a Greek architect, born at Elis, who was employed to build the great temple of Zeus at Olympia (*q.v.*) about 460 B.C. (Pausanias, v, 10, 3).

LIBOURNE, a town of southwestern France, capital of an *arrondissement* of the *département* of Gironde, at the confluence of the isle with the Dordogne, 22 mi. E N.E. of Bordeaux on the railway to Angoulême. Pop. (1954) 14,581. The river is tidal and vessels drawing 14 ft. can reach the town at the highest tides. Libourne stands on an ancient site. Under the Romans Condate stood a mile to the south of the present Libourne; it was destroyed in the 5th century. Resuscitated by Charlemagne, it was rebuilt in 1269, under its present name and on the site and plan it still retains, by Roger de Leybourne (of Leybourne in Kent), seneschal of Guienne, acting under the authority of King Edward I of England.

It suffered considerably in the struggles of the French and English in the 14th century. The church of St. Jean, restored 15th-century Gothic, has a stone spire 232 ft. high. On the quay a 14th-century clock tower survives from the old ramparts, and the *hôtel* de ville is a quaint relic of the 16th century. Libourne is the seat of a subprefecture and of tribunals of first instance and of commerce.

Trade is in local wines and brandies. Printing and cooperage are carried on.

LIBRA (the "Balance"), in astronomy, a constellation and sign of the zodiac (*q.v.*). The constellation was pictured as a pair of scales; its stars are faint and present little of interest to the naked eye. The name suggests the equality of day and night when the sun arrives at the autumnal equinox and enters the sign Libra. The sign itself has been shifted westward into the adjoining constellation Virgo by the earth's precessional motion.

(R. H. BR.)

LIBRARIES. A library (from Lat. liber, book) is a collection of printed or written material arranged and organized for the purpose of study and research or of general reading or both. Many libraries also include collections of films, microfilms, phonograph records, lantern slides and the like within the term "written or printed material." Libraries may be roughly classified in two ways: by ownership or use; *e.g.*, national, municipal, county, university, research, school, industrial, club, private, etc.; or by contents; *e.g.*, general, special (including medical, legal, theological, scientific, engineering, etc.). General libraries frequently contain special collections. The organization ranges from a system of great complexity, with catalogues and indexes and other records, a binding department, a secretariat and a large staff, to the simple arrangement with perhaps a list of his books which suffice for the owner of the smaller private library.

ANCIENT LIBRARIES

The earliest libraries probably consisted of archive collections preserved in temples and palaces. In the course of his excavations at Nineveh in 1850, Sir Austen Layard came upon tablets of clay, covered with cuneiform characters. These varied in size from 1 in. to 12 in. square. It is estimated that this library consisted of about 10,000 distinct works and documents. The tablets appear to have been methodically arranged and catalogued, and the library seems to have been public. (See BABYLONIA AND ASSYRIA; NIPPUR.)

Egypt.—At an early date Heliopolis was a literary centre of great importance, with a culture akin to the Babylonian. Attached to every temple were professional scribes. There is a record relating to "the land of the collected works (library) of Khufu," a monarch of the 4th dynasty, and a similar inscription relating to the library of Khafra, the builder of the second pyramid. At Edfu the library was a small chamber in the temple, on the wall of which is a list of books (Brugsch, *History of Egypt,* i, 240 [1881]). The exact position of Ikhnaton's library (or archives) of clay tablets was found. A library of charred books was found at Mendes (Egypt Expl. fund, *Two Hieroglyphic Papyri),* and there are references to temple libraries on the Silsileh "Nile" stelae and, perhaps, in the Harris papyri. The most famous of the early Egyptian libraries, that of King Osymandyas (Rameses II, 1300–1236 B.C.), described by Diodorus Siculus, was probably in the Ramessaeum at western Thebes.

Greece.—Among known collèctors of books were Pisistratus, Polycrates of Samos, Euclid the Athenian, Nicocrates of Cyprus and Euripides. At Cnidus there is said to have been a special collection of works upon medicine. Plato is known to have been a collector, and Xenophon tells us of the library of Euthydemus. The earliest recorded collection worthy of the name of "library" was that of Aristotle, who is described by Strabo as having been "the first man known to have collected a library" and is, moreover, credited by the same authority as having "taught the kings of Egypt to do likewise." Aristotle bequeathed his collection to his disciple Theophrastus, and it is known that Demetrius of Phalerum, a pupil of Theophrastus, had great influence on Ptolemy I, the founder of the library of Alexandria.

Alexandria.—Under Ptolemy I's son, Ptolemy Philadelphus, the Alexandrine library rapidly became the intellectual centre of Hellenistic culture. Manuscripts were collected from all parts of the then known world and scholars flocked in ever-increasing numbers to work on them. The main library, with the museum, was situated in the Brucheum; in Roman times the collection overflowed into another building in the Serapeum.

The number of volumes was very large, although it is difficult to attain any certainty among varying accounts, such as those of Tzetzes (42,800 in the Serapeum and 490,000 in the Brucheum), Aulus Gellius (700,000) and Seneca (400,000). It should be observed that, as the ancient roll or volume usually contained less matter than a modern book, these numbers must be discounted for comparison with modern collections. The first five librarians appear to have been Zenodotus, Callimachus, Eratosthenes, Apollonius and Aristophanes; they cover about a century. The catalogues of the Alexandrine libraries were among the earliest experiments in bibliography. Among other lists, two were prepared by order of Ptolemy Philadelphus, one of tragedies, the other of comedies. The *pinakes* (tablets) of Callimachus formed a catalogue of all the principal books, arranged in 120 classes. After the time of Aurelian, the Serapeum became the principal library. The importance of the libraries decreased with the political decline of Alexandria itself, and the usual statement that the libraries continued to flourish until they were destroyed in A.D. 640 can hardly be supported.

The **Pergamum.**—German researches in the acropolis of Pergamum (1878–86) revealed four of the rooms of the Attalid library (Alexander Conze, *Die pergamen. Bibliothek* [1884]). Despite the embargo, reported by Pliny, placed by the Ptolemies upon the export of papyrus, the library, when it was transported to Egypt, numbered 200,000 volumes. We learn from Suidas that in 221 B.C. Xntiochus the Great summoned the poet and grammarian Euphorion of Chalcis to be his librarian.

Rome.—It is not until the last century of the republic that we hear of libraries in Rome, with the exception of the writings of Mago upon agriculture. The first considerable collections of which we hear in Rome were brought there as the spoils of war. The library of Perseus was all that Aemilius Paulus reserved from the prizes of victory (167 B.C.) for himself and his sons. Next came the library of Apellicon the Teian, brought from Athens by Sulla (83 B.C.). The zeal of Cicero and Titus Pomponius Xtticus in adding to their collections is well known. Tyrannion is said to have had 30,000 volumes of his own, and Cicero wrote to M. Terentius Varro: *"Si hortum* in *bibliotheca habes, nikil deerit"* (If you have a garden in the library. nothing will be lacking). Julius Caesar is recorded as having proposed to establish a public library in Rome, but the honour of being the first actually to dedicate a library to the public is said by Pliny and Ovid to have fallen to G. Asinius Pollio, who erected a library in the Atrium Libertatis on Mount Aventine. Augustus erected two libraries, the Octavian and the Palatine. The forrner was founded (33 B.C.) in honour of his sister, the charge of the books being committed to C. Melissus. The Octavian and Palatine libraries perished by fire; the story that the Palatine was destroyed by order of Pope Gregory the Great in the 6th century is now generally rejected. Tiberius, the immediate successor of Augustus, established on the Palatine what Gellius refers to as the "Tiberian library." Vespasian established a library in the Temple of Peace erected after the burning of the city under Nero. Domitian restored the libraries then destroyed, and he, or Hadrian, founded the Capitoline library. The most famous and important of the imperial libraries was that created by Ulpius Trajanus, known as the Ulpian library, afterward moved to the baths of Diocletian. The library of Domitian, which had been destroyed by fire in the reign of Commodus, was restored by Gordian, who added to it the 62,000 books bequeathed to him by Serenus Sammonicus. In the 4th century there are said to have been 28 public libraries in Rome.

Roman Provincial Libraries.—The library which the younger Pliny gave to Comum cost 1,000,000 sesterces; Hadrian established one at Athens, described by Pausanias, and in modern times identified with the Stoa of Hadrian. At Ephesus and at Timgad in Algeria, the structural plan of the library buildings is clear (R. Cagnat, "Les Bibliotheques municipales dans l'Empire Romain," *Mém.* de *l'Acad. des Insc.*, tom. 38, pt. 1 [1906]). A private library discovered at Herculaneum contained 1,756 rolls on shelves to a height of about 6 ft. around a room approximately 12 ft. square, with a central press, or shelved case.

The names of several librarians (generally slaves or freedmen) are preserved to us in inscriptions, including that of C. Hymenaeus, physician and librarian to Augustus.

Constantinople.—When the seat of empire was removed by Constantine to his new capital upon the Bosporus, the emperor established a collection there. Constantine's library, which contained 6,900 volumes, was perhaps mainly intended as a repository of Christian literature; it was greatly enlarged by Julian and Theodosius, at whose death it is said to have increased to 100,000 volumes. Julian not only augmented the library at Constantinople, but founded others.

As Christian literature grew, libraries became part of the ecclesiastical organization, and it became the rule to attach one to every church. The largest of these libraries, that founded by St. Pamphilus (d. A D. 309) at Caesarea, and said to have been increased by Eusebius to 30,000 volumes, is frequently mentioned by St. Jerome. St Augustine bequeathed his collection to the library of the church at Hippo, which was fortunate enough to escape destruction at the hands of the Vandals. Even the hermit communities of the Egyptian deserts, out of which developed the later monastic orders, accumulated books.

With the removal of the capital to Byzantium the libraries of Rome ceased to collect the writings of the Greeks, while the Greek libraries had never cared much to collect Latin literature. The church became increasingly hostile to pagan letters. The repeated irruptions of the barbarians soon snept the old learning and libraries alike from the soil of Italy. With the close of the western empire in 476 the ancient history of libraries ceased.

MEDIAEVAL PERIOD

Learning had little place in a barbaric Europe. Nevertheless, in spite of persecutions, Christians all over the Roman world quietly went on amassing in their churches and monasteries collections of their own literature, and scriptoria began to be established in which the monks produced their own books. The use of vellum instead of papyrus resulted in the supersession of the roll of classical antiquity by the bound book as we know it today.

Monastic Libraries.— It is to St. Benedict that we owe the development of the monastic library. The abbey of Monte Cassino, founded *c.* 529, mas the first of a long line of houses in which the establishment of a library of religious works was obligatory and daily reading and study were enjoined upon the monks. and the influence of this wise and simple rule rapidly spread throughout all Christendom.

Of the reformed Benedictine orders the Carthusians and the Cistercians were those most devoted to literary pursuits. The abbeys of Fleury, of Melk and of St. Gall were remarkable for the splendour of their libraries. The Augustininns and the Dominicans were scarcely less active than the Benedictines! the libraries of Ste. Geneviève and St. Victor, belonging to the former order, being among the largest of the monastic collections.

Independently of the Benedictine influence! the monasteries of Ireland and of Anglo-Saxon England were amassing noteworthy collections, and the missionary zeal of the monks spread their influence to northern Gaul and to the Rhineland while that of St. Benedict was spreading northward from Italy to meet it. Even in Italy itself. the monastery of Bobbio owed its foundation to an Irish monk. Columban *(c.* 613). The greatest name of the period is that of Alcuin of York, the English monk who went to the court of Charleinagne in the late 8th century and did so much to develop, in his monastery at Tours. the Carolingian minuscule hand which forms the basis of modern European writing and printing. Among the few private collectors of this period, Louis I the Pious, son of Charlemagne. Charles II the Bald and Gerbert (afterward Pope Sylvester II) may be mentioned here.

Of the other monastic libraries of France the principal were those of Cluny, St. Riquier, Corbie. Bec and St. Martial (Limoges). The library of St. Riquier, in the time of Louis the Pious, contained 2 j6 manuscripts, with more than 500 works. Of the collection at Corbie in Picardy we have two catalogues dating from the 12th and from the 17th centuries. In 1638, 400 of its choicest manuscripts were removed to St. Germain-des-Prés. The remainder were removed after 1794, partly to the national library at Paris, partly to the town library of Amiens.

The chief monastic libraries of Germany were at Fulda, Corvey, Reichenau and Sponheim. The library of Corvey on the Weser, after being despoiled in the Reformation, was presented to the University of Marburg in 1811. The library at St. Gall, formed as early as 816 by its second abbot, still exists. Reference: to monastic libraries occur throughout the sections on various countries.

England.— In England, the principal collections were those of Canterbury. York, Wearmouth, Jarrow, Whitby, Glastonbury, Crowland. Peterborough and Durham. The library of Christchurch, Canterbury, originally founded by Augustine and Theodore and destroyed by the Danes about 867, contained, in the 13th or 14th century. about 5,000 works. Sir Richard Whittington built a library for the Grey Friars in London. and this order possessed considerable libraries at Oxford. Of Whitby there is a catalogue of the 12th century. The catalogue of Glastonbury was printed by Thomas Hearne in his edition of John of Glastonbury. The library of Crowland perished by fire in 1091; Peterborough, from a catalogue of about the end of the 14th century. had 344 volumes, with nearly 1,joo titles. The catalogues of Durham were printed by the Surtees society. (The oldest catalogue of a western library is that of the monastery of Fontanelle in Normandy [8th century].) Many catalogues may be found in the collections of D'Achery, Edmond Martène and Ursin Durand. and Bernhard and Hieronymus Pez, in the bibliographical periodicals of Robert Naumann and Julius Petzholdt and the *Zentralblatt für Bibliothekswesen.* Joseph Hunter collected some particulars as to the contents of the English monastic libraries; E. Edwards printed a list of the catalogues *(Libraries and Founders of Libraries,* pp. 448–454 [1865]. *See* also G. Becker, *Catalogi Bibliothecarum Antiqui* [1885].) In the 14th century the Franciscans compiled a general catalogue of the manuscripts in 160 English libraries, and about 1400 John Boston, a Benedictine monk of Bury, catalogued the libraries of 19j religious houses in England and part of Scotland (Thomas 'Tanner, *Bibliotheca Britannico-Hibernica* [1748]). John Leland's list of the books he found during his visitation of the houses in 1539–45 is printed in his *Collectanea.*

The identification of the early provenance of mediaeval manuscripts was greatly advanced in modern times, especially by the works of M. R. James, both by catalogues of existing collections and by publications of surviving monastic catalogues; *e.g.,* those of Canterbury and Dover (1909). *(See,* generally, J. W. Clark, *The Cave of Books* [1909], and E. A. Savage, *Old English Libraries* [1911].) These catalogues. with many others. afford abundant evidence of the limited size and character of the monkish collections.

The Development of Library **Arrangements.**—Modern library methods began with the Rule of St. Benedict. early in the 6th century. In the 48th chapter the monks were ordered. for their daily reading. to borrow a book apiece and to read it straight through. The Carthusians and Cistercians. among others, had a system of interlibrary loans; the Cluniacs had an annual stocktaking; and some of the Benedictine houses had, by the end of the 11th century. separate reference and lending divisions. In some monasteries the books were housed in a press located in the cloisters, as at Worcester; elsewhere they were in the treasury. Books used by the reader in the refectory might be kept in a press near the infirmary. By the end of the 15th century the larger monasteries found it necessary to establish a separate library apartment.

Libraries were specially built at Canterbury, Durham, Citeaux, Clairvaux and elsewhere. and there grew up increased liberality in the use of books. During this period, collegiate and monastic libraries were on the same plan. the books being laid on desks or lecterns and chained to a horizontal bar. As the books increased the accommodation was augmented by one or two shelves erected above the desks, each bay being lighted by its own window. The library at Cesena is still in its original condition and that of Merton college, Oxford, is nearly so. The Laurentian library at Florence was designed by Michelangelo on the monastic model. There were no chains in the library of the Escorial, erected in 1584, which was the first library to dispense with bays and arrange its books in cases lining the walls of a great hall. Chains continued to be used in England in church libraries down to the early part of the 18th century, as at Wimborne. Triple desks and revolving lecterns: raised by a wooden screw, formed part of the library furniture. The English cathedral libraries were fashioned after the same principle. By the end of the 17th century the type of public library developed from collegiate and monastic prototypes became fixed in Europe. (H. R. Tedder, "Evolution of the Public Library," *Trans. of 2nd Int. Library Conference* [1897, 1898].)

Islam. — Greek manuscripts were eagerly sought for and translated into Arabic, and colleges and libraries arose everywhere, notably at Baghdad, Cordova, Cairo and Tripoli. The royal library of the Fatimites in Africa and that collected by the Omayyads of Spain are reported, perhaps with exaggeration, to have contained, respectively, 100,000 and 600,000 manuscripts. It is said that there were no fewer than 70 libraries established in the cities of Andalusia.

Renaissance. — In the 9th century, under Leo the Philosopher and Constantine Porphyrogenitus, the libraries of Constantinople awoke into renewed life. Meanwhile, in the west we find arising outside the monasteries a taste for collecting books and within them a gradual broadening of the intellectual horizon. Charles V of France formed a considerable library of 910 volumes, including much newer literature, and had a catalogue of them prepared in 1373. Guy, earl of Warwick, formed a collection of French romances, which he bequeathed to Bordesley abbey in 1315. Richard of Bury, the doubtful author of the *Plzilobiblon,* amassed a noble collection. A reviving taste for secular literature and for the classics gave a fresh direction to collectors, and a disposition to encourage literature began to show itself. Cosimo de' Medici formed a library at Venice while living there in exile in 1433, and on his return to Florence laid the foundations of the great Medicean library. Niccolo Niccoli had already, in 1436, left his library of more than 800 volumes for the use of the public. Frederick, duke of Urbino, and Poggio Bracciolini were among the chief collectors of the Latin manuscripts buried in monastic libraries. Beyond the Alps, Matthias Corvinus, king of Hungary, formed a great collection of splendid manuscripts.

When the fall of Constantinople in 1453 converted into a full stream the former trickle of Greek scholars into western Europe, the impact of Greek learning and philosophy upon Latin Christianity produced a vast surge of intellectual activity and scientific inquiry and a pressing demand for books—a demand satisfied by one of the miracles of history, the invention of printing almost within the same year. From the enormous increase in library stocks. and the new catholicity of subject interest: resulted the substitution already described above of the new plan of a large hall, with bookcases all round it, for the old arrangement of a library in bays. The modern history of libraries had begun.

MODERN BRITISH LIBRARIES

State Libraries, British **Museum.**—The British museum ranks in importance before all the great libraries of the world, except the National library of France, and excels in the arrangement and accessibility of its contents. The library at mid-20th century consisted of about 6,000,000 printed volumes (including 10,000 incunabula) and 75,000 manuscripts. Its expansion was mainly the result of the energy of Sir Anthony Panizzi (*q.v.*).

The foundation of the British museum dates from 1753, when effect was given to the bequest (in exchange for £20,000 to be paid to his executors) by Sir Hans Sloane, of his books, manuscripts, curiosities, etc., to be held by trustees for the use of the nation. A bill was passed through parliament for the purchase of the Sloane collections and of the Harleian manuscripts, costing £10,000. To these, with the Cottonian manuscripts, acquired by the country in 1700, was added by George II. in 1757, the royal library of the former kings of England, coupled with the privilege of obtaining a copy of every publication entered at Stationers' hall. A lottery having been authorized to defray the expenses of purchases, as well as for providing suitable accommodation, the museum and library were established in Montague house, and opened to the public on Jan. 15, 1759. In 1763 George III presented the Thomason collection (in 2,220 volumes) of Civil War and Commonwealth tracts. C. M. Cracherode bequeathed his collection of choice books in 1799, and Sir Joseph Banks his library (16,000 volumes) of natural history and travels in 1820. Of other libraries subsequently incorporated in the museum, the most valuable were George III's collection, 15,000 volumes of tracts and 65,259 volumes of printed books, which was transferred (for a pecuniary consideration) by George IV in 1823, and that of Thomas Grenville (20,240 volumes of rare books, bequeathed in 1846). The Cracherode, Banksian. King's and Grenville libraries are preserved as separate collections. Among notable later accessions are the Ashley library of original editions of the English poets from about 1625 onward, formed by T. J. Wise (1937), and the Hirsch library of musical scores and literature (1946).

The newspaper collections are housed in a large repository at Hendon. The Burney and Thomason collections of early British newspapers are almost complete. Many of the British provincial newspapers (30,000 bound volumes) were lost when the repository was bombed during World War II.

A General Catalogue of Printed Books was printed in 108 volumes between 1881 and 1905; a second edition was begun in 1931 (vol. 1–51 [A-Dez] had appeared by mid-century). Monthly lists of accessions are issued. A *Subject-Index of Modern Works* (3 vol., covering accessions during the years 1881–1900) was followed by quinquennial supplements. Large numbers of special catalogues (*e.g.,* of incunabula and of early English printed books) have been published, and there are interleaved working catalogues of maps and music. For a full account of the British Museum catalogues of printed books and manuscripts *see* articles by F. C. Francis in *Journal of Documentation,* vol. 4 (1948) and by T. C. Skeat in *Journal of Documentation,* vol. 7 (1951).

The department of manuscripts is equal in importance to that of the printed books. The collection of European manuscripts at mid-20th century contained 57,000 volumes, more than 100,000 rolls, a rich series of charters, etc., and a vast quantity of papers, ranging from the 3rd century B.C. down to modern times and including the old historical chronicles of England, the charters of the Anglo-Saxon kings, the Xrthurian romances and also unprinted works by English writers. To the *Codex Alexandrinus* of the Bible, which came to the museum along with the old Royal library, was added in 1933 the *Codex Sinaiticus,* purchased from the soviet government for £100,000 (partly raised by private subscriptions and partly contributed by the government). The famous collections of manuscripts made by Sir Robert Cotton and Robert Harley, earl of Oxford, have already been mentioned, and from these and other sources the museum became rich in early Anglo-Saxon and Latin codices, such as that containing *Beowulf;* the charters of King Edgar and Henry I to Hyde abbey, which are written in gold letters; and the Lindisfarne Gospels (A.D. 700), containing the earliest extant Anglo-Saxon version of the Latin gospels. The museum can boast of an eariy copy of the *Iliad,* and one of the earliest known codices of the *Odyssey.* Arnong the unrivalled collection of Greek papyri are the unique manuscripts of several works of ancient literature, such as Aristotle, *On the Constitution of Athens,* the *Mimes* of Herodas and the *Odes* of Bacchylides. Irish, French and Italian manuscripts are well represented. For illuminated manuscripts special reference may be made to the Lindisfarne Gospels, the Bedford Hours: the Sforza Book of Hours and Queen Mary's Psalter. The Luttrell and Bedford Psalters were bought for £64,000 in 1931. The collections of local and family history, of maps and of music are also very rich.

Oriental printed books (130,000) and manuscripts (18,000) formed, from 1892, a separate department. The collection includes the library formed by C. J. Rich (resident in Baghdad in the early part of the 19th century); the Chambers collection of Sanskrit manuscripts; and a library of Hebrew manuscripts, including that of the orientalist H. J. Michael, of Hamburg, and codices of great age brought from Yemen. The collection of Syriac manuscripts is important.

The building in which the library is housed was designed by Panizzi and opened in 1857. The circular reading room is surrounded by book stores placed in iron stacks, the origin of the more modern steel stacks; in these are fitted hanging and rolling auxiliary bookcases. The presses inside the reading room contain approximately 60,000 volumes; to those on the ground floor (20,000) readers have direct access. The maps and music and certain other sections of the library were transferred in 1914 to the new King Edward building; in 1923 one quadrant of the iron stacks received an extra story; and a reconstruction designed to double the stack-room capacity was begun as a result of the report of the Royal Commission on National Museums and Galleries (3 vol. [1928–30]). This work was interrupted by World War II. Serious air raid damage was suffered by the museum library during the war, the loss of books amountihg to 150,000 volumes, of which a large number were later replaced. The reading room was damaged. but was reopened in 1946. a service having been maintained in the meantime in the north library.

The Natural History museum, Soufh Kensington, a division of the British museum now under separate management. had books on the natural sciences numbering more than 300,000 volumes at mid-century.

Other State Libraries.— One of the largest technical libraries in the country is that of the patent office in Southampton buildings, London, with 325,000 volumes at mid-century. The Science library in the Science museum at South Kensington (founded 1857) has 400,000 volumes and 20,000 sets of periodicals. It publishes weekly accessions lists and specialized bibliographies, and runs an interlibrary loan service and a photocopying service. The Kational Art library in the Victoria and Albert museum contained about 300.000 volumes and 325,000 photographs in the mid-1950s. Among other state libraries in London may be noted those of the India office (260,000 volumes and 25.000 manuscripts) and of the admiralty. the two houses of parliament, the foreign office, the war office and the ministries of education and of health (each having between 80.000 and 150,000 volumes). The library of the Royal Botanic gardens at Kew (1853) had 50,000 volumes in 1954.

Outside London the most important state libraries are the national libraries of Scotland, Wales and Ireland. Sir George Mackenzie of Rosehaugh may be regarded as the founder of the Faculty of Advocates' library, afterward the National Library of Scotland. The first librarian was appointed in 1684. The library retains the copyright privilege conferred upon it in 1709. Of the special collections the most important are the Astorga (Spanish), purchased in 1824; the Thorkelin collection, relating chiefly to the history and antiquities of the northern nations: the Dietrich collection of German pamphlets and dissertations; and the Barnbougle Scottish collection. presented in 1928 by Lord Rosebery. hlanuscripts numbered more than 8,000 at mid-century. There are 13 monastic chartularies which escaped the destruction of the religious houses to which they belonged. The manuscripts relating to Scottish church history include the collections of Spottiswoode, Wodrow and Calderwood. Sir James Balfour's collection and the Balcarres papers consist largely of original state papers of James V, Queen Mary and James VI. The most important manuscripts of old poetry are the Bannatyne manuscript. written by George Bannatyne in 1568, and the Auchinleck manuscript.

In 1922 the faculty, finding the maintenance of the general library increasingly onerous. offered it to the government as a national library of Scotland. The government accepted the offer in 1923. when an institution toward which movements had been made in Scotland since 1870 received a gift of £100.000 from Sir Alexander Grant, and the necessary act was passed and the library transferred in 192j. The library at mid-century contained more than 1.500,000 volumes. The Advocates retain the law section.

The National Library of Wales at Aberystwyth, founded in 1907, was opened in 1915. It enjoys the copyright privilege, and in 1954 contained about 1,500,000 volumes and 160.000 manuscripts and documents, largely of Welsh interest. Francis Bourdillon's Romances, and C. Thomas-Stanford's Euclids are among special collections of printed books. The National Library of Ireland! Dublin, was founded in 1877, and incorporates the library of the Royal Dublin society. It had *c.* 700,000 volumes in 1950.

University **and** Collegiate **Libraries.**—*Oxford.*—The earliest library of the University of Oxford was in existence in 1337; the second was founded by Humphrey, duke of Gloucester (d. 1447) and refounded in 1598 and endowed in 1611 by Sir Thomas Bodley (*q.v.*). He opened the library in 1603 with about 2.000 volumes. In 1610 he obtained a grant from the Stationers' company of a copy of every work printed in the country, a privilege still enjoyed under the Copyright acts. Other chief benefactors were Archbishop William Laud. John Selden, Richard Gough, Francis Douce, Lord Sunderlin (brother of Edmund Malone) and Richard Rawlinson. The library at mid-century had about 2,000,000 printed volumes and about 40,000 manuscripts (other than charters, rolls, etc.). In oriental manuscripts it is. perhaps. superior to any other European library. and it is exceedingly rich in other manuscripts. especially in English literary and local history, and in early printing. A new building to house 5,000,000 volumes, with underground book stacks, designed by Sir Giles Gilbert Scott (*q.v.*), was opened in 1946.

The Radcliffe library of natural science. founded by John Radcliffe (d. 1714) and opened in 1749 in the domed building known as the "Radcliffe Camera." was transferred to the University museum and laboratories in 1860. when the trustees offered the use of the Camera to the curators of the Bodleian; the building was transferred absolutely in 1927. In the Camera are the modern books. and it also serves as a reading room, especially for undergraduates. The Indian institute, the Law library, the Maitland library (social and legal history) and Rhodes house (colonial history) are administered by the Bodleian.

The Taylor institution for modern languages is due to the benefaction of Sir Robert Taylor, an architect (d. 1788). The Finch collection (bequeathed in 1830) is kept with it.

The library of All Souls was established in 1443 by Archbishop Henry Chicheley; it possessed 40,000 printed volumes and 300 manuscripts at mid-century. and is rich in law. The library of Christ Church is rich in divinity and topography. Corpus possesses a fine collection of Aldines, with about 400 manuscripts. Keble college has the manuscripts of many of John Keble's works. Magdalen college has about 50,000 volumes and a50 manuscripts with scientific and topographical collections.

Merton college possesses the earliest surviving college library building. St. John's college library is largely composed of theology and law before 1750, and medical books of the 16th and 17th centuries. Wadham college has the botanical books bequeathed by Richard Warner (1775) and Benjamin Wiffen's collection on the Spanish reformers.

Cambridge.—The University library at Cambridge dates from the earlier part of the 15th century. Two early catalogues are preserved, the first embracing 52 volumes and dating from about 1425, the second a shelf list, apparently of 330 volumes, made in 1473. The library, with about 2.000.000 volumes, has the copyright privilege. It includes a fine series of *editiones principes* of the classics and of the early productions of English and Netherlandish presses. The manuscripts number more than 12,000, in which are included a considerable number of adversaria or printed books with manuscript notes, which form a leading feature in the collection. The most famous of the manuscripts is the Codex *Bezae* of the four Gospels and the Acts. which was presented to the university by Theodore Beza himself. A new building: with bookstacks on 12 floors in the tower, was opened in 1934.

There is a library attached to the Fitzwilliam museum; bequeathed to the university in 1816. It contains printed and manuscript music and a collection of illuminated manuscripts, chiefly French and Flemish. Catalogues and reprints have been published.

The library of Trinity college at mid-century had more than 120,000 printed and nearly 2,000 manuscript volumes. Among special collections are the Capell collection of early dramatic and especially Shakespearean literature, German theology and philosophy. and the Grylls bequest in 1863 of 9.600 volumes. including many early printed books. There are printed catalogues of the Sanskrit and other oriental manuscripts by S. T. Aufrecht and E. H. Palmer. of the incunabula by Robert Sinker and of the Capell collection by W. W. Greg. 1903.

The library of Corpus Christi college is famous for the bequest of Anglo-Saxon and illuminated manuscripts made by Archbishop Matthew Parker in 1575. Magdalene college possesses the library of Samuel Pepys (*q.v.*). The library of Peterhouse. the oldest in Cambridge, possesses a catalogue dating from 1418 of 600 or 700 books. It has a unique collection of manuscript music. The library of St. John's college is rich in early printed books and English history.

Other British Universities.—The library of the University of London, founded in 1837, had more than 600,000 volumes in the mid-1950s and included the Goldsmiths' library of economic literature (60,000 volumes). University College library, Gower street, established in 1824, had about 550,000 volumes before World War II, including Jeremy Bentham's library, G. E. Morrison's Chinese library and H. C. Barlow's Dante library. Approximately 70,000 volumes were destroyed when the library was bombed.

In close association with the University of London is the London School of Economics and Political Science (1896). in mhich is housed the British Library of Political and Economic Science, with 350,000 books and 150,000 pamphlets and official reports. The School of Oriental and African Studies library was established in 1916 in the building of the Royal institution.

Among other English university and college libraries may be mentioned the following: Birmingham, Leeds, Liverpool and Manchester (350,000–500,000 volumes each); and Bristol. King's college (Newcastle) and Nottingham (150,000–200,000 volumes each). The oldest university library in Scotland is that of St. Andrews (14j6); Glasgow and Aberdeen mere founded in the late 15th century and Edinburgh in 1580. All are large libraries. having between 250,000 and 500,000 volumes each at mid-century and containing valuable special collections. The combined libraries of the several colleges of the University of Wales (Aberystwyth, Bangor, Cardiff and Swansea) hold about 750,000 volumes. In Ireland, the Queen's University of Belfast has an important library of nearly 240,000 volumes; the library of the University of Dublin. possessing 750,000 volumes at mid-20th century. was founded in 1601 by a subscription raised by the English army to commemorate their victory at Kinsale. This library continued to enjoy the copyright privilege after the establishment of the Irish Free State.

In 1946 the University and Research section of the Library association published a report, *University and Research Libraries of Great Britain: Their Post-War Development.*

The most important theological college library is that of Sion college (1635, 300.000 volumes), which is rich in liturgiology; of public school libraries, those of Eton and Winchester are outstanding, while that of Shrewsbury, though small: has an exceptional collection of bindings.

Cathedral and Church Libraries.—Nearly all cathedrals possess libraries of interest. Intended for the cathedral or diocesan clergy, they are in most cases open to persons suitably introduced. Many have valuable manuscripts, but most were ravaged in the Great Rebellion, and the printed collections are the work of antiquarian deans of the 18th century. That of St. Paul's cathedral was founded in very early times. and by the mid-1950s numbered about 25,000 volumes and pamphlets, with a good collection of early Bibles and Testaments, Paul's Cross sermons and works connected with the cathedral (catalogue 1893).

The library of Christ Church, Oxford, which belongs alike to the college and the cathedral, has been mentioned above. That of Durham, 20.000 volumes, dates from monastic times, and possesses many of the books which belonged to the monastery. The collection is fairly general, and is kept up to date. It is especially rich in very early manuscripts, written at Durham. The library at York is open to the public, and has many valuable manuscripts and early printed books. J. Raine in *Testamenta Eboracensia* (1836) quotes many bequests to this library. The foundation of the library at Canterbury dates probably from the time of Augustine, but nothing of the pre-Conquest library survives. Many of the manuscripts originally here were transferred by Archbishop Parker to Corpus Christi college, Cambridge (catalogue 1743 and 1802, of manuscripts 1911).

The Lincoln cathedral library (catalogue 1859, of incunabula 192j. of manuscripts 1927) was refounded by Dean Michael Honywood, at the Restoration, in a building by Sir Christopher Wren. Chichester dates from the Restoration only. Ely is rich in the literature of the nonjurors. Exeter possesses many Saxon manuscripts, including *The Exeter Book* of Old English poetry, the gift of Leoiric, the first bishop. At Lichfield the library is post-Restoration, but includes the famous Evangelistary of St. Chad. The collection at Norwich is chiefly modern. The earlier library at Peterborough being almost destroyed in the Great Rebellion, Bishop White Kennett refounded it, but many of his books were lost. Salisbury is rich in incunabula (catalogue 1880). Winchester cathedral library is mainly the bequest of Bishop George Morley (17th centuryj. The library at Bristol was burned and pillaged in the riots of 1831. At Chester in 1691 Dean James Arderne bequeathed his books and part of his estate "as the beginning of a public library for the clergy and city." The library of Hereford (catalogue of manuscripts 1927) is a good specimen of an old monastic chained library; Worcester has fine manuscripts (catalogue 1906, and of incunabula 1910).

The four Welsh cathedrals were supplied with libraries by a deed of settlement in 1709. All are small. That founded by Archbishop Robert Leighton in 1654 in Dunblane cathedral is the only cathedral library in Scotland of any historic interest. The public library established about 1699 at St. Sepulchre's, close to St. Patrick's cathedral, Dublin, by Archbishop Narcissus Marsh, was incorporated in 1707, and endowed by its founder at his death in 1713. The books are chiefly theological and include the libraries of Bishop Edward Stillingfleet and of Elias Bouhereau, the first librarian. In 1849 Beriah Botfield published *Notes on the Cathedral Libraries of England.* A union catalogue of English cathedral libraries was begun under the auspices of the Bibliographical society.

The best Catholic libraries in London are those of Brompton Oratory and Westminster cathedral. The archiepiscopal library at Lambeth palace (damaged in World War II) was enriched by the gifts of Archbishops William Laud, Thomas Tenison, Charles Manners-Sutton and others of his successors. It is rich in theology and Church history. Of illuminated manuscripts and early printed books, catalogues were issued by S. R. Maitland (1792–1866). The manuscripts were described in H. J. Todd's catalogue. 1812, and the older volumes by M. R. James, 1900. The Jews' college has an important library of Judaica.

Endowed Libraries.—In London the Bishopsgate institute (1891), founded out of City charities, contains about 50,000 volumes and a fine collection of prints, drawings and maps of London. The Cripplegate institute (1896) in Golden lane was also founded out of charity moneys. The St. Bride Institute Technical Reference library (1895) is a very complete collection of about 40,000 volumes on printing and allied arts. Dr. Williams' library (more than 90,000 volumes in 195j), founded in 1716 by the will of Daniel Williams, is primarily theological, and has been enlarged to include philosophy, history and literature, with collections of theosophy and of the works of Jakob Boehme, William Law and other mystics. The manuscripts include the original minutes of the Restminster assembly, letters and treatises of Richard Baxter and the journals of Henry Crabb Robinson.

Forerunners of the modern public library were established during the first half of the 17th century at Coventry, Norwich, Bristol, Leicester and elsewhere; but the most notable of the English provincial endowed libraries are those of Manchester. That founded by Humphrey Chetham in 1653 is still housed in its old collegiate buildings (100,000 volumes and manuscripts). More important is the John Rylands, founded in 1899 by the widow of a cotton merchant in memory of her husband. By mid-20th century the John Rylands had 500,000 volumes and 12,000 manuscripts, including the 6,000 Crawford manuscripts from Haigh hall, bought in 1901, and 20,000 French Revolution broadsides, etc., presented by the earl of Crawford in 1924. Other considerable endowed libraries are the William Salt, Stafford (Staffordshire history), opened 1874; the Solon Ceramic library, Stoke-on-Trent (20,000 volumes); St. Deiniol's (1894), Hawarden, founded by W. E. Gladstone; and the Shakespeare Memorial (1881), Stratford-on-Avon.

The oldest endowed library in Scotland is the Innerpeffray, Perthshire (1680), founded by David Drummond, 3rd Lord Madertie. The most important is the Mitchell in Glasgow, founded by Stephen Mitchell (1874), opened in 1877. It contains valuable collections of Scottish poetry, Robert Burns's works, Glasgow printing, and art. It contained more than 600,000 volumes in 1954, and is the reference library for the Glasgow public library system.

Libraries of Societies and Learned Bodies.—Of the law libraries, that at Lincoln's Inn; London! is the oldest and the largest (75,000 volumes). That of the Middle Temple contained 70,000 volumes before it was bombed during World War II. The library of the Inner Temple is known to have existed in 1540. Its chief collections are William Petyt's manuscripts, received in 1708, John Adolphus' historical pamphlets and the Crawford collection on crime. There were 90,000 volumes before the bombing, in which half the stock was lost. Gray's Inn library was established before 1555; it was completely destroyed in 1941. The Law society (1828) has 75,000 volumes. The Royal Institution of Great Britain (1803), possessing a general reference subscription library of about 150,000 volumes, was closed in 1916, its oriental section remaining to help found the London University School of Oriental and African Studies. while its western books went to the university and college libraries.

The best library of arcbaeoiogy is the Society of Antiquaries, Burlington house. 100,000 volumes, many manuscripts and early prinrcd books. For natural sciences there are the libraries of the Koyal society (1667) in Burlington house, with more than 145,000 volumes, mainly publications of scientific bodies (the celebrated Arundel bequest, dating rrom the society's infancy. was dispersed); the Geological society (1807); the Linnean society (1788); and the Zoological society (1829).

Medicine and allied sciences are served by the libraries of the Royal Society of Medicine (1805); the Royal College of Physicians (1525); the British Medical association; the Royal College of Surgeons of England (1800); the Chemical society (1841); and the Pharmaceutical society. Other important London society libraries are the Royal Geographical society (1830), open to the public for reference; the Royal Empire society (1868), 280,000 volumes of British colonial literature; and the Royal United Service institution, Whitehall (1831), 32.000 volumes, belles-lettres, politics and history. Libraries are owned by the British and Foreign Bible society (largest existing collection of printed Bibles—catalogue 1903–11), the Institution of Civil Engineers, the Institution of Electrical Engineers, the Royal Academy of Arts, Royal Institute of British Architects. etc.

The library of the Society of Writers to His Majesty's Signet (1722), Edinburgh, contained about 160,000 volumes in the mid-1950s, with early prints and other rare books, especially in British topography. The library of the Royal Irish academy at Dublin (1785, 50,000 volumes and more than 2,000 Irish manuscripts) is partly supported by a government grant and is freely open.

Among subscription libraries, the London library (600,000) stands first in order of importance. It was founded in 1841 as a lending library for the use of scholars, largely at the instance of Thomas Carlyle. Author and subject catalogues have been printed, the latter of great value. Severe damage was suffered by this library in World War II.

The first circulating library in Birmingham was opened in 1757, and was followed by Liverpool Lyceum (1758) and Warrington's (1760), both merged in the museum, and by Leeds (1768).

Other proprietary libraries were established at Leicester. Liverpool (Athenaeum, 1798), Manchester, Newcastle, Belfast (the Linen Hall library), Nottingham and elsewhere. In Scotland the first subscription library was started by Allan Ramsay, the poet, at Edinburgh in 172j. Commercial subscription libraries increased greatly, W. H. Smith's, Boots' and the *Times* Book club being typical modern examples.

Many of the principal clubs possess libraries. That of the Athenaeum (London) is by far the most important. It numbered about 80,000 volumes of choice books in the mid-1950s. The pamphlets (of which also there is a complete printed catalogue) include those collected by Edward Gibbon and Sir James Mackintosh. The Reform club had about 45,000 volumes at mid-20th century. The Gladstone library of the National Liberal club may be used occasionally by nonmembers. The Carlton club also has an important library. Libraries on international affairs were established by the Royal Institute of International Affairs and by the United Nations association.

Public Libraries— The earliest public libraries have already been referred to in the description of endowed libraries. The first act of parliament authorizing the establishment of rate-supported public libraries by local authorities was passed in 1850 and was largely a result of the efforts of William Ewart, M.P., and Edward Edwards. later first librarian at Manchester. Norwich was the first city to adopt the act; Manchester and Liverpool, though adopting the act later, were first in the field with actual libraries (1852). In 1853 the act was extended to Scotland and Ireland. Rapid progress was made after the formation of the Library association in 1877. Various amending acts were passed, one of which (1919) removed the rate limitation of one penny in the pound for England and Wales and permitted local authorities to spend as much as they wished on their public libraries. The same act empowered county councils also to provide a library service (see below, *County Libraries*). In Ireland, the rate limitation was abolished in 1947; in Scotland it was continued until 19jj.

The main points in British library legislation are as follows: (1) The acts are permissive and not compulsory. (2) Municipal libraries are managed by committees appointed by the iocal authorities, who may delegate to them all their powers and duties. Glasgow has contracted them out by a special act. In Ireland, committees are appointed much as in England. (3) Power is given to provide libraries, museums, schools for science, art galleries and schools for art. (4) The regulation and management of public libraries are entrusted to the library authority: which may either be the local authority or a committee with a full or partial delegation of powers.

An immense stimulus to progress was given from about 1900 by Andrew Carnegie (*q.v.*), who began to present library buildings to towns in England as well as in Scotland and the United States. All local authorities possessing power to adopt the 1850 act did so. In the year 1955–56 more than 500 municipal and approximately go county library authorities in Great Britain and Northern Ireland were operating about 2,000 library buildings and 30,000 rural service points (*e.g.*, in schools). Total book stocks amounted to about 63,500,000 volumes and total issues to about 399,000,000, or rather more than 7.8 per person (compared nith 5.3 per per-son in 1938). At approximately £13,870,000 the total ccst represented about js. $5\frac{1}{2}$*d*. per person (against 1*s*. 4*d*. in 1938).

The first library to adopt the open access system was that of Clerkenwell in 1894, and, largely under the influence of the Carnegie trust, this system became universal in British public libraries. Lster developments included the provision of children's and hospital libraries and commercial and technical divisions or departments (notably those of Birmingham. Manchester, Sheffield and Glasgow). Many Iibraries publish reading lists and bibliographies and arrange exhibitions and courses of lectures. Great attention has been paid to local collections and to the preservation of archive material.

The Dewey decimal system of classification was largely adopted in public libraries (though many learned libraries still preferred the Library of Congress method and scientific libraries turned toward the universal decimal classification). Catalogues are almost invariably compiled on cards, but some libraries use slips bound in adjustable binders (the "sheaf" system). Issues of books to borroners are registered by various systems of slips, forms and cards. Some libraries (*e.g.*, Bristol and Hull) have their onn binding departments, while others prefer to have their binding done by commercial firms.

A departmental committee on public Iibraries published in 1927 a valuable report, aimed at stimulating backward authorities by showing mhat could be done in more enlightened places. An authoritative survey was that done for the Library association by L. R. McColvin in 1942 (*The Public* Library System of Great *Britain*) which proposed the merging of smaller units in the interests of greater efficiency. Later, the question of nationalizing the public library service was raised.

There is one important municipal library which is not tax-'supported under the Public Libraries acts. This is the Guildhall reference library of the Corporation of the City of London. A library was established for London by Sir Richard Whittington between 1421 and 1426. But it did not remain without accident; about 1549 the lord protector Edward Seymour, duke of Somerset, carried off three cartloads of books, and during the great fire of 1666 the remainder together with the buildings were destroyed. The loss was unrepaired until a new library was opened in 1828.

The library (nearly 130,000 printed volumes and nearly 21,000 manuscriptsj includes a special collection of books, prints and drawings about London, the Solomons Hebrew and rabbinical library, the National Dickens library. etc., and the libraries of the Clockmakers' and Gardeners' companies and of the Old Dutch church in Austin Friars. It was severely damaged during World War II and in the immediate postwar years only about 35,000 volumes were available for use.

County **Libraries.**—While the library movement made notable headway in the towns during the last quarter of the 19th century, largely through the generous financial encouragement of Andrew Carnegie, the half century that followed witnessed a greater, and, after 1918, a much more rapid advance in the smaller centres of population and in rural areas. Before this date the service was severely handicapped by two restrictions: the one penny rate limit, which, except in the largest cities, precluded anything like adequate expenditure on books and salaries, and the almost total impossibility of applying the Public Libraries acts outside the big towns. An admirable statistical report, setting forth in detail the anomalies and difficulties of the situation, was prepared by W. G. S. Xdams and published by the Carnegie United Kingdom trust in 1915. From this it was manifest that the position in the towns could not be remedied without the removal of the rate limit, and the only hope for the rural areas was in some broad scheme of co-operation. The Library association had persistently agitated for new legislation, with the former object as the most urgent item. Pending action by the government, the Carnegie trustees set up a number of circulating systems on a regional basis, as an experiment and an object lesson to show how the rural problem should be solved.

Legislation. — The position of these rural systems was regularized in Scotland by the Education (Scotland) act of 1918, empowering county education authorities to make book provision for children and young persons attending schools or classes: and for adults. The subject was also dealt with in an interim report by the adult education committee of the ministry of reconstruction; and, almost immediately, the Public Libraries act of 1919 was passed, authorizing county councils to adopt the acts, to levy a rate and provide a library service through their education committees. Similar powers were granted in Northern Ireland by the Public Libraries act of 1924, and in the Irish Free State by the Local Government act of 1925.

Success of the County Library System. — Hitherto, such rural library systems as had been established were financed by the Carnegie trustees, who continued to offer to defray the capital expenditure of county councils which were willing to adopt the acts. During the period 1915–27, the grants made by the trustees for this purpose in Great Britain totalled £263,78j, with some supplementary grants for the period ending in 1930. In their report issued in March 1928, the trustees showed that 22 English, 3 Welsh and 6 Scottish counties were already independent of their assistance. The rate of this expansion is indicated by the figures given in the report of the Public Libraries committee set up by C. P. Trevelyan, then president of the board of education, in 1924, which completed its proceedings in 1927. In 1911 the population in England and Wales resident in library areas amounted to 62.5% of the total. The percentage rose to 68.8 by 1921, to 90.4 by 1924 and by 1926 to 96.3. Of this last figure, the urban library service accounted for 64.1%, and the county systems for 32.2%. By the mid-1950s scarcely any area remained without some kind of public library service. Admittedly, however, facilities varied, from the excellent to the ineffectual.

The system began with the periodical supply of boxes of books to village centres, usually in schools, and the boxes were sent by railway or other carriers. An increasing number of counties acquired their own motor vans, fitted with shelves to form small travelling libraries and thus afford the local volunteer librarian some opportunity of choosing books on the spot. Other vans, in charge of driver-librarians, make regular visits to individual farms and cottages. Here and there, local interest or the philanthropy of some well-wisher resulted in the formation of small stocks of reference books, and even the opening of a village reading room. Special provision is usually made, so far as resources permit, for adult classes. and special collections are formed for teachers. Middlesex provided an excellent example of the policy of co-ordinating the municipal library and the rural system. In Cornwall, seven borough and two urban district libraries were brought into a co-operative scheme for the whole county. The Belfast library was encouraged by a liberal grant from the Carnegie trustees to become the centre of a regional scheme of co-operation for the whole of Northern Ireland. Merely fractional rates, as low as one-tenth to one-fourth of a penny, were raised by the county authorities in the first instance. In some places these rose to threepence or fourpence or even more. By the mid-1950s. some counties were spending 5s. per person on the service, though some were still spending less than 1*s.*

Public Library Developments after 1919.—The main provisions and effects of the 1919 act have already been referred to. Prominent among other developments were the persistent endeavours made to obtain more satisfactory scales of pay for library staffs. Salaries at mid-century were still inconsistent with the fact that librarianship is a learned profession—though much improved by the establishment of a national scale. The effects! however, both of the increased amount of money obtainable from the rates and of the improved salary scales: were largely offset by the vast increase in the cost of living during and after the 1920s.

During World War II hundreds of libraries of all kinds were hit by bombs and rockets, 60 being completely destroyed. Municipal and county libraries lost nearly 1,000,000 volumes, particularly at Coventry. Exeter, Liverpool, Manchester, Plymouth. Portsmouth and Southampton. Nevertheless, no public library ever completely suspended its services; indeed, they issued more books than ever before and many of them provided air-raid shelter libraries and emergency services of all kinds. Sheffield and others established advice and information services, and many contributed in one way or another to the needs of research for war purposes. Moreover, the public libraries did much work in supervising collection of books for the fighting forces and for the restocking of war-damaged libraries, and rendered invaluable service in preventing the indiscriminate pulping of books collected as "salvage" for papermaking.

Special Libraries. — Many special libraries (*e.g.,* those of the Science museum and other government departments and those of learned societies) have already been mentioned. The term "special libraries" came to include in particular the libraries of scientific and research institutions and of industrial undertakings, which began as a group to evolve a technique of their own, based upon their function as suppliers of information to inquirers rather than as places where inquirers seek it for themselves. Great use is made of indexes, filing systems, photocopying equipment and microfilms for the storage of information likely to be required at a moment's notice, and experiments were made with punched-card systems. The Association of Special Libraries and Information Bureaux (Aslib), established in 192j, published a directory of special libraries in 1928 (new ed. in preparation, 1955).

Library Co-operation: The National Central Library. — A central library for students was started in London in 1917, largely to provide books for adult classes. This grew into an organization for interlibrary lending covering the whole country and including libraries of all types. The country was divided into ten regions, each with its own lending organization and most with regional union catalogues in various stages of development. The National Central library in London, as the headquarters institution, had a combined union catalogue of 4,800,000 entries at mid-century. It handles a large volume of direct inquiries and in addition passes on to other regions inquiries which cannot be satisfied within the region where they originate. Scotland and Ireland have their own central libraries for students linked with the National Central library. In 1954–55 the whole system supplied about 305,000 volumes to readers. The system includes about 250 "outlier'! libraries, most of them special or research libraries, which are willing to lend specialized material for advanced research. The contribution of the university libraries to this work is noteworthy. The National Central library is financed by a treasury grant (£34,000 for 1954–55), small grants from the British Council and other bodies and subscriptions from libraries (£5,000); libraries' subscriptions provided an acldditional £8,000 for the upkeep of the regional bureaus. An international interlibrary loan service was resumed on a small scale after the end of World War II. The National Central library's building was damaged in an air raid: and 110,000 of its reserve stock of books were destroyed.

Other aspects of library co-operation included the furnishing by individual libraries of material for such co-operative enterprises as the *British Union Catalogue of Periodicals,* the *World List of Scientific Periodicals,* the *Union Catalogue of Periodicals in British Universities* and A. W. Pollard and G. R. Redgrave's *Short-Title Catalogue of Books Printed in England, Scotland and Ireland and of English Books Printed Abroad, 1475–1640* (London, 1946). The metropolitan borough libraries of London adopted a scheme for co-ordinating their purchases of books whereby each library tried to cover one or more special subjects in addition to building up its general stock. A scheme propounded by the University and Research section of the Library association for a nationwide survey of research library resources was held up for lack of funds. Co-operation in the buying of foreign books on the lines of the U.S. "Farmington plan" was studied, with a view to achieving a wider coverage xi-ithout excessive duplication, and many surveys of resources in special branches of literature were produced. The London Uni 'ersity School of Librarianship conducted an inquiry into co-(peration in April 1949 the results of which were published in the *Journal of Documentation,* vol. 5 (1949), and R. F. Vollans made a detailed survey of the National Central librsry and the regional systems in *Library Co-operation in Great Britain* (1952). The resumption of international contacts after 1945 led to much activity in the field of international standardization of bibliographical terms and library practice.

Other Developments.—World War II witnessed the establishment of large numbers of libraries in government research institutions directly concerned with the conduct of the war, such as the ministriesof information and of economic warfare. Many thousands of books were collected for the recreational reading of men and women in the fighting forces, and the value was seen of providing libraries for study as well. Toward the end of the war courses were instituted for the education and training of those about to be demobilized and the Army Library service in particular grew rapidly.

An army library advisory committee was formed in 1949 by the Library association and the Institute of Army Education to assist the war office in the efficient carrying on of this service. Libraries continued to be provided for the mercantile marine by the British Sailors' society and for the blind by the National Library for the Blind: both services had already been developed greatly after World War I.

Much attention was paid to the provision of libraries in schools, hospitals, prisons and other types of institutions, and for the use of adult education classes. The universities and the National. Central library took a prominent part in adult education library work.

The building and equipping of new libraries was hampered after World War II by high costs and shortages of materials, and research was stimulated in substitute materials, prefabrication and standardization. Staff shortages led to re-examination of administration and routine.

A central bibliographical and cataloguing service had long been desired by British librarians, and in 1950 appeared the first issue of a meekly *British National Bibliography,* published under the joint auspices of the British museum, the Library association. Aslib and bodies representing publishers, booksellers and other interests.

'BRITISH COMMONWEALTE

The majority of the dominions have permissive library laws. In Africa, Australia and Canada the governments make grants to public libraries. The Canadian and Australian libraries are administered more or less on U.S. and those of the Union of South Africa, India. etc.. on English lines.

Africa. — There are several important libraries in the Union of South Africa. The oldest library is the South African Public library at Cape Town, established in 1818, which enjoys the copyright privilege for the Cape (310,000 volumes). This library contains the collection of colonial books bequeathed by Sir George Grey. This and the Pretoria state library (200,000 volumes) form together the National Library, the Pretoria library serving as the national centre for interlibrary lending. The Library of Parliament. Cape Town. is the reference library of the Union legislature; it includes the Mendelssohn collection of Africana. At Cape Town also is the University of Cape Town library (275,000 volumes), which doubled in size in the decade 1940–50. There were nearly 300 public libraries in Cape province at mid-century, all receiving state financial aid, and another 80 in other parts of the Union, Johannesburg having the largest and most valuable' collection (600,000 volumes). The University of the Witwatersrand, Johannesburg. has large collections of Africana and medicine. Cape province and Transvaal had established rural library systems.

The university colleges of Makerere (Kenya), Ibadan (Nigeria) and Achimota (Ghana), and Gordon college. Khartoum, all have rapidly growing collections, and employ a high proportion of native staff.

Australia, — The various states legislate for libraries independently, and maintain libraries. The Commonwealth library at Canberra was founded in 1927. The state public libraries circulate books to institutes, etc., in the country. The local public libraries are those of Victoria at Melbourne (1853) (760,000 volumes); of New South Wales at Sydney (1867) (650,000 volumes, including the Mitchell library; this was an old subscription library bought by the government); of South Australia at Adelaide (253,000 volumes); of Queensland at Brisbane (1896) (173,000 volumes); and of Western Australia at Perth (1860) (196,000 volumes). The university libraries are those of Sydney (350,000 volumes, including the fine Fisher collection, 1885), Adelaide, which assists in control of the public library. Melbourne and Brisbane.

Tasmania. — Only Hobart (State Library of Tasmania, 1849) had in 1925 used the large powers given by the act of 1867. A new Library act of 1943, however, stimulated considerable activity. The University of Tasmania has collected a library of about 80,000 volumes.

New Zealand. — There are more than 400 public libraries in New Zealand, some of them operating on a free lending basis. The National Library service co-ordinates a supply of books and reference material to most libraries in the dominion, as well as to schools. The four universities and university colleges have good libraries, as do the agricultural colleges. For historical and cultural research the Alexander Turnbull library at Wellington is pre-eminent. and good New Zealand historical collections are in the Grey collection at Auckland and the Hocken and McNab collections at Dunedin. The general assembly library at Wellington is a copyright depository and one of the best all-round libraries in the country (220,000 volumes).

India and the East. — The chief library in India is the National library at Calcutta (760,000 volumes). Of 17 university libraries, three (Sind. Punjab and Dacca', passed to Pakistan in 1947; a new Pakistan university was founded at Peshawar in 1950. The library of the Asiatic Society of Bengal was founded in 1784, and the Bombay branch in 1804. Another early library of importance is that of the Madras Literary society (1812).

A remarkable library in India is that of the raja of Tanjore, which dates from the end of the 16th or beginning of the 17th century. There are about 18,000 manuscripts written in a wide variety of languages.

The Indian Library association initiated a plan for a comprehensive public library system, of which the first unit, a public library at Delhi. was established by the Indian government and UNESCO in 19jo.

At Rangoon there are several good libraries. The Raffles library at Singapore (now the library of the University of Malaya) has special collections of books relating to the Malayan peninsula and archipelago. In Ceylon there is the Museum library at Colombo and the library of University college. Colombo.

Canada. — The Jesuit college at Quebec had a library as-early as 1632. The most important public library is that of Toronto (1883), which had nearly 860.000 volumes in the mid-1950s, and includes a notable children's department in a separate building. The other most important libraries in Ontario are: Queen's university, Kingston (1841) (295.000 volumes, rich in Canadian history); Legislative library of Ontario! Toronto (1867); University of Toronto (1856) (595,000 volumes and 160,000 pamphlets) ; Library of Parliament, Ottawa (about 500.000 volumes). A national bibliographical centre was established in 1950 and a national library in 1953. By 1956 a union catalogue of 115 important Canadian libraries had been compiled, containing 3,300,000 cards.

In the province of Quebec there are several notable libraries among which are the Fraser institute, Montreal (188j) ; McGill university, Montreal (1855) (650,000 volumes comprising many important collections): the Seminary at St. Sulpice, Montreal; Laval university, Quebec; and the library of the legislature.

British Columbia has important provincial and university libraries in Vancouver.

In Nova Scotia there is a system of circulating books among the school libraries. The Legislative library at Halifax incorporates that of the Nova Scotia Historical society (1878). The school law of New Brunswick provides for grants to school libraries.

The vast distances and sparse population of most of Canada produced highly developed travelling lihrary services.

West Indies. — The Trinidad public library (1851) is the oldest library in the West Indies. The library of the University College of the West Indies in Jamaica is a copyright repository of West Indian official publications.

FRANCE

The great expansion of French libraries was a direct result of the French Revolution. On Nov. 2, 1789, all ecclesiastical libraries were seized by the state and transferred to *dépôts littéraires* (literary depositories). The libraries of the nobility suffered the same fate in 1792. Though many precious volumes and manuscripts mere burned, the total number of volumes seized in Paris and the provinces is estimated at about 7,000,000.

While the *dépôts* were originally intended to be used for the creation of libraries in places not already possessing them! in the end it was the largest existing libraries that benefited most. State control extended. through the minister of public instruction, to nearly all libraries during the 19th century, a decree of 1878 going so far as to establish a procedure in cataloguing and classifying university libraries. Most municipal libraries were subordinated to national authority by a decree of 1897, and school libraries came under the same ministry.

Bibliothèque Nationale. — The Bibliothkque Nationale (formerly Bibliothkque du Roi, Royale or Impériale) is one of the finest libraries in the world. The real foundation of the institution may be said to date from the reign of King John, the Black Prince's captive, who bequeathed his "royal library" to his successor, Charles V in 1364. Charles V removed the library from the Palais de la Cité to the Louvre, where it was arranged on desks in a large hall of three stories by the first librarian and cataloguer, Claude Mallet, the king's *valet de chambre.* His *Inventaire des Livres du Roy nostre Seigneur estans nu chastel du Louvre* is extant. as well as the inventories made by Jean Blanchet in 1380, and by Jean le Bègue in 1411 and 1424. Charles VI added several hundred manuscripts to the library, which, however, was sold to the regent, duke of Bedford, transferred to England and finally dispersed at the regent's death in 1435. Charles VII did little to repair the loss. but under Louis XI another library was created; the first librarian mas Laurent Paulmier, and Jean Foucquet of Tours was named the king's illuminator. Charles VIII enriched it with many fine manuscripts executed by his order, and also with most of the library of the kings of Aragon, seized by him at Naples. Louis XII incorporated into the Bibliothkque du Roi the fine Orleans library at Blois, and further enriched it by plunder from Pavia, and by the purchase of the Gruthuyse collection; it was described at this time as one of the four marvels of France. Francis I enlarged and removed it to Fontainebleau in 1534. He set the fashion of fine bindings. which was still more cultivated by Henry II, and which has never died out in France. During the librarianship of Jacques Amyot the library was transferred from Fontainebleau to Paris. Henry IV removed it to the Collège de Clermont, but in 1604 another change was made, and in 1622 it was installed in the Rue de la Harpe. Under J. A, de Thou it acquired the library of Catherine de Medici, and the Bible of Charles the Bald. In 1617 a decree ordered the deposit of two copies of every new publication, but this was not enforced till Louis XIV's time. The first catalogue worthy of the name was finished in 1622. describing about 6.000 volumes, chiefly manuscripts. Many additions were made during Louis XIII's reign. notably that of the Dupuy collection, but a new era dawned under Louis XIV. J. B. Colbert. one of the greatest of collectors, so enlarged the library that it became necessary to make another removal. It was therefore, in 1666, installed in the Rue Vivien (later Vivienne). The departments of engravings and medals were then created, and were soon important. Nicolas Clément made a catalogue in 1684 according to the arrangement still used (in 23 classes, each designated by a letter of the alphabet), with an alphabetical index. After Colbert's death the marquis de Louvois employed John Mabillon, M. Thévenot and others to procure books, etc., from all parts of the world, and a new catalogue was compiled in 1688 in eight volumes by several scholars. Toward the end of Louis XIV's reign the library contained more than 70,000 volumes. Under the Abbé Bignon the library was moved to its present home in the Rue Richelieu. Between 173j and 1739 a catalogue in 11 volumes was printed, and duplicates were sold. In Louis XVI's reign the La Vallière sale yielded many valuable accessions. A few years before the Revolution the printed books numbered more than 300,000 volumes and pamphlets. Following the Revolution. the library, renamed the Bibliothkque Nationale, and the other state libraries received large accessions, the forfeited collections of those who fled abroad at the Revolution, as well as of the suppressed religious communities, which by enactments of 1789–92 were gathered into the *dépôts littéraires* mentioned above. Napoleon increased the government grant, and by the strict enforcement of the law of deposits, as well as by the acquisition of collections, the library progressed under him toward his idea of universality. At the beginning of the 19th century it held 250,000 printed volumes, 83,000 manuscripts and 1,500,000 engravings. though after 181j the library had to send back many manuscripts plundered by him from conquered capitals.

After World War I the fall in the value of the franc seriously diminished the library's resources. Under P. Roland-Marcel a reorganization took place of which the following mere the main features: (1j a consortium was set up, under a joint council, of the library with the other chief Parisian national libraries (*i.e.,* the Mazarine [which became the fifth department of the Nationale], the Sainte-Genevikve and the Arsenal and. later. the University of Paris). by decrees of Aug. 29, 1923, and Dec. 28, 1926, purchases of books and periodicals being divided between them; (2) the library, and then the group. were by laws of April 28. 1927, and March j, 1928. given the status of "civil personality." carrying the right to hold funds; (3) the law of copyright was amended, with the result of greatly enlarging the receipts of current French books; the weekly catalogue of accessions of new French books was amalgamated with the list of new publications issued by the trade (*Bibliographie de* la *France);* (4) the oval public reading room, rendered less important by the development of the public libraries of the *arrondissements* of Paris. was converted into a periodical room, equipped with a bureau of information the main feature of nhich is an index of the special collections in all French libraries; (5) a central exchange for loans of books between libraries, whether in France or between France and other countries. nas established in 1927; (6) an office of documentation and bibliographical research was established by the Society of Friends of the Bibliothkque Nationale. These developments greatly increased the library's effectiveness. But the sum available for purchases of printed books remained totally inadequate. In 1954 the Bibliothkque Nationale contained more than 6,000,000 printed volumes (apart from maps, music, periodicals, etc.), 155,000 manuscripts, 5,000,000 engravings and 450,000 medals.

Admittance to use of the library is obtained through a card procured from the secretarial office. The slip catalogue bound in volumes dates from 1882, and gives a list of all accessions since that date; it is divided into two parts, one for the names of authors and the other for subjects. Of the *Catalogue général des livres imprimés* (authors only), begun in 1897, 183 volumes, A-Tendil, had appeared by the end of 1955. Anonyma, periodicals, etc.. are reserved for later treatment. The preface to vol. i, by L. Delisle, is a valuable historical account of the library. The place of the unpublished volumes was, from 1925, supplied by a photographic issue of the manuscript slips of the classed catalogue.

Two other exceptionally important catalogues, out of many, are *Catalogue de l'histoire de France,* 11 vol. (1885–89), and H. Omont's *Catalogue général des manuscrits français,* 13 vol. (1895–1918; index, 1928). For the Greek collection important catalogues were made by Omont. and for the Latin by Delisle, Omont and others. For many oriental languages catalogues have been compiled, and those of manuscripts in modern languages are nearly all completed. The Bibliothkque Nationale began publication in 1885 of a *Catalogue général des manuscrits des bibliothèques publiques de France;* this is still not finished. The departments of medals and of engravings possess excellent catalogues. The former department includes vases! bronzes and gems; the catalogues of the Greek and early French series are remarkable. The department of engravings has been described in the vicomte H. Delaborde's *Le Département des Estampes à la Bibliothdque Nationale* (1875); it includes drawings. F. Courboin's *Catalogue sommaire des gravures et lithographies composant la Re'serve* (1900–01) is supported by many fine special catalogues.

A list of works on and of the catalogues of the Bibliothkque Nationale, and most other French libraries, may be found in A. Vidier, *Annuaire des Bibliothèques et des Archives,* 1927, pp. 13–38. Of the two copies of every new French publication deposited by the printer, one is kept by the Bibliothkque Nationale and the other is allotted by the Council of the National Libraries to one of the other institutions represented upon it.

Other National Libraries. — The Bibliothkque de l'Arsenal, administered from 1935 by the Bibliothkque Nationale, was founded by the marquis de Paulmy (Antoine-René d'Argenson) in the 18th century; in 1786 it received 80,000 volumes from the duc de la Vallikre's library. By mid-20th century it contained more than 1,000,000 volumes and 12,000 manuscripts, with the Bastille collection (2,500 fortfolios) of which the inventory is complete, and 120,000 prints; it is the richest library for the literary history of France, with more than 130,000 theatrical pieces, including the Auguste Rondel collection, added in 1925; accordingly, it receives belles-lettres in the allotment of deposited books.

The Bibliothkque Mazarine owes its origin to the great cardinal, who confided the direction to Gabriel Naudé; it was open to the public in 1642. Dispersed during the Fronde, it was reconstituted with 40,000 volumes after Mazarin's death in 1661 and left to the Collège des Quatre-Nations, which, in 1691, made it again public. It was made one of the libraries of the national consortium and the fifth department of the Nationale; in the mid-1950s it had more than 350,000 printed volumes, includicg incunabula, and 6,000 manuscripts.

The first library of the Genovéfains had nearly disappeared when François Cardinal de la Rochefoucauld, who had charge of the reformation of that order, constituted. in 1642, a new library with his own books. The Bibliothkque Ste.-Geneviève, in 1716, possessed 45,000 volumes. It became national property in 1791, and was called the Bibliothkque du Panthéon and added to the Lycée Henri IV under the Empire. It had 1,000,000 printed volumes, 1,500 incunabula, 4,000 manuscripts, 40,000 prints and 4,000 maps and plans in the mid-1950s.

Official Libraries. — The Bibliothkque du Ministkre des hffaires Étrangères at mid-century contained 400,000 volumes; the Bibliothkque du Ministkre de la Guerre, formed by Louvois, more than 200,000; and that of the Ministkre des Finances 150,000. The Bibliothkque de Documentation Internationale Contemporaire, founded in 1917, had 250,000 volumes, apart from periodicals, documents, maps. etc. The Bibliothkque du Ministkre de la Marine is of old formation (catalogue 1838–43). The Bibliothkque de la Chambre des Députés (1796) possesses 900,000 printed books and 1,600 manuscripts (printed catalogue of law and political economy 1883, and of manuscripts 1907). The Bibliothkque du Sénat (1818) contains 175,000 volumes and 1,400 manuscripts. There are also the following law libraries: Office de Législation Étrangère; Faculté de Droit of the university; Ordre des Avocats (1871, printed catalogue 1880–82); Avocats à la Cour d'Appel; and Cour de Cassation. The City of Paris owns, among other libraries, the Bibliothkque Historique de la Ville de Paris, destroyed in 1871 but restored in 1872 (500,000 volumes); the Forney (industrial art); and those of prefectures, hospitals and schools.

Educational Libraries. — The library of the university is that of the Sorbonne (1762), originally including only arts and theology. In 1800 it was the Bibliothkque du Prytanée, in 1808 des Quatres Lycées and in 1812 de l'Université de France. The faculty sections are: (1) sciences and letters, (2) medicine, (3) jurisprudence and (4) pharmacy. Before the separation of church and state there was also (5) Protestant theology. After the Bibliothkque Nationale it is the richest, and it is superior to all in the fields of classics, archaeology and literature, philosophy, mathematics and physics, possessing in all 2,500,000 volumes. Installed since the year 1897 in the New Sorbonne, it is a library of the very first rsnk. The section of sciences and letters has 900,000 volumes. Among important bequests are those of J. V. Leclerc, E. Lavisse, H. Derenbourg and A. Beljame (the last including an important Shakespearean library).

At the Sorbonne are also to be found the libraries of the laboratories, notably the geological. The section relating to medicine, housed since 1891 in the new buildings of the faculty of medicine, includes 490,000 volumes. The library of the faculty of jurisprudence (1772) contains 300,000 volumes. The fourth section, the faculty (formerly Bcole supérieure) of pharmacy, greatly developed since 1882, contains 120,000 volumes. The library of art and archaeology contains 200,000 volumes and 150,000 photographs.

The other libraries connected with higher education include that of the École des Beaux-Arts, 85,000 volumes, 100,000 reproductions, 14,000 drawings; Bcole Normale Supérieure (1794), 600,000 volumes; École Nationale des Chartes, 80,000 volumes. The library of the Muséum National d'Histoire Naturelle (18th century) has 400.000 volumes, 2,300 manuscripts and 19,joo original drawings. The Bibliothkque du Musée Pédagogique (1880) has 200,000 volumes. The other principal museums (Louvre. Cluny, Guimet, etc.) have large working libraries for the curators and students.

In 1760 was founded the Bibliothèque de l'Institut de France, which is very rich; its acquisitions come particularly from gifts and exchanges (1,500,000 volumes, 5,000 manuscripts). Among other libraries may be mentioned those of the Conservatoire National de Musique (1775); Observatoire; Institut Catholique (400,000 volumes); Conservatoire National des Arts et Métiers; Polonaise (attached to the Académie Polonaise des Sciences et Lettres) containing the Musée Adam Mickiewicz; and Comédie Française. The learned societies of Paris possess valuable collections; the Société de Géographie, for instance, has a library of 300,000 volumes and 100,000 maps.

Old **Municipal** Libraries. — In most towns there are, besides the learned and historical "bibliothkque de la ville," popular lending libraries, privately founded, but since 1874 subsidize supplied with books and inspected by the ministry. In one or two departments there is the beginning of a rural circulating system. Many of the municipal libraries owe the greater part of their collections to the *dépôts littéraires,* but some are of older foundation. Thus, Angers owes its first collection to Alain de la Rue about 1376, and that of Bourges dates from 1466. The libr y of Carpentras was established by Michel Anglici between 1452 and 1474. Mathieu de la Porte is said to have been the founder of the library at Clermont-Ferrand, at the end of the 15th century; it contained more than 49,000 volumes at the time of its union with the Bibliothkque Universitaire.

Among libraries dating from the 16th century must be mentioned that at Lyons, founded by François I in 1527; it possesses 700,000 volumes. 900 incunabula and 10,000 manuscripts (many catalogues printed).

In the 17th century were established the following libraries: Abbeville, by Charles Sanson in 1685; Besanqon, by Abbé Boisot in 1694; La Rochelle, by the Consistoire Réformé in 1604; Vesoul, by Antoine Villeque (died 1665).

The principal libraries founded during the 18th century are the following: Xix-en-Provence (1786). Bordeaux (1736), Chambéry (1780), Dijon (1701), Grenoble (1772), Marseilles (1799), Nancy (1750), Nantes (1753), Nice (1786), Nimes (1778), Niort (1771), Perpignan (1759), Rennes (1790) and Toulouse (1782).

Nearly all the other municipal libraries date from the distribution of the *dépôts littéraires* in 1803. Those of Avignon. Montpellier. Caen, Rouen, Tours and Versailles are specially important; in the second rank come Amiens, Auxerre, Beaune, Brest, Douai, le Havre le Mans, Orleans, Pau. Poitiers and Toulon.

The Association des Bibliothécaires Français in 1928 urged a development of popular public libraries in France generally.

The old university libraries, scattered and thrown into the *dépôts* at the Revolution, were re-established by acts of 1875, 1879 and 1882; civic personality, carrying financial autonomy, followed in 1896. The Bibliothkque Nationale et Universitaire, formerly the Universitats- und Landesbibliothek, of Strasbourg, founded in 1871 to replace that burned in the Franco-German war, is the largest provincial university library, with a fine collection of material relating to Xlsace and Lorraine. Others are: Aix, Algiers, Besanqon. Bordeaux, Caen, Clermont, Dijon, Grenoble, Lille, Lyons, Marseilles, Montpellier, Poitiers, Rennes and Toulouse.

Administrative control of the libraries of France is vested in the *direction des bibliothèques,* under the ministry of education (established 1945).

In the French overseas territories the most considerable library centre is Algiers, with national. university and city libraries.

GERMANY, AUSTRIA, HUNGARY, SWITZERLAND

Germany. — By the mid-1950s much of the damage caused to Germany's library system during World War II had been made good. Buildings and collections had been to a large extent restored, in both eastern and western Germany.

There was no law of deposit in Germany covering any area wider than that of individual states, and some states had no law of deposit at all for a long time. The Deutsche Rucherei at Leipzig, founded by the German book-trade association (Borsenverein der deulschen Buchhandler) in 1912 to supply the need for a copyright library for all Germany, had 2,000,000 volumes at the time of the destruction of its building (with 400 000 of its books) in 1943. It operated a central cataloguing service and issued the German national bibliographies. The most important co-operative cataloguing enterprise of Germany was the *Gesamtkatalog der preussischen Bibliotheken* (of which the first volume appeared in 1931), undertaken by a special department of the Preussische Staatsbibliothek. Fourteen volumes of this work had appeared by 1939, but it was then discontinued, perhaps permanently.

In 1924 was promulgated the Leihverkehrsordnung fur die Deutschen Bibliotheken, which authorized and organized mutual lending betneen all libraries in the country.

The state and university libraries are under state control. The earlier distinction between these two classes has become less and less marked, and together they form a great assemblage of learned (*wissenschaftlich*) libraries.

There has always been a sharp distinction between the learned and the popular libraries (Volksbuchereien), which exist in most towns. Karl Preusker formed a plan for setting them up in 1839, and four were founded in Berlin in 1850. After 1890 a number of popular libraries were established, some by municipalities, but many by associations and firms. Most of the states had a consultative office for popular libraries, and the Deutsche Zentralstelle fur Volkstümliches Buchereiwesen acted as a centre. The Verband Deutscher Volksbibliothekare publishes an annual directory (vol 36, 1955). Sometimes these popular libraries were under the supervision of a scientifically administered town library, as in Berlin; elsewhere, as at Magdeburg, an ancient foundation assumed the obligations of a public library. The National Socialist party made great use of the Volksbüchereien for propaganda purposes.

Berlin and Prussia.—The largest of the Berlin libraries is the Deutsche Staatsbibliothek in East Berlin (prior to World War II the State library), which was founded and made public by the "Great Elector," Frederick William, in 1661. From 1699 the library became entitled to a copy of every book published nithin the royal territories, and it received many valuable accessions by purchase and otherwise. It included 2,850,000 printed volumes before World War II and 68,500 manuscripts, 300,000 maps and 6,500 incunabula. The building, erected about 1780 by Frederick the Great, was rebuilt in 1909 and again after 1945, following severe damage in World War II. The State library lost 350,000 volumes in the bombing. Part of its collections, dispersed for safety during the war, was assembled at the Westdeutsche Bibliothek, Marburg, the national library of the German Federal Republic, which had nearly 2,000 000 volumes in the mid-1950s; by that time the Staatsbibliothek also had restored its stock to about 2,000,000. There is a regular system of mutual lending, established by ministerial edict of Jan. 27, 1893, between the State library and a great number of Prussian libraries. The same is true of Bavaria, Wurttemberg and Baden.

Conducted by the Staatsbibliothek were the *Gesamtkatalog der preussischen Bibliotheken* already described, the Auskunftsburo der Deutschen Bibliotheken (founded in 1905 to give information as to where any particular book might be consulted) and the Kommission fur den *Gesamtkatalog der Wiegendrucke* (a complete catalogue of books printed before 1500), of which vol. 1–8, pt. i, had appeared by 1939. After World War II it undertook extensive bibliographical work with particular emphasis on the publications of eastern Europe.

The University library (1831) had about 875,000 volumes and a collection of 560,000 dissertations in the mid-1950s. Its building was damaged during World War II but not more than 20,000 books were lost.

Some of the governmental libraries in Berlin were important; the administrative partition of Berlin has led to the establishment of many new governmental libraries and the splitting of others between Berlin and Bonn.

The former Prussian university libraries outside Berlin include Bonn (59,000 printed volumes, 2,000 manuscripts), Gottingen, from its foundation in 1736–37 the best-administered library of the 18th century (1,100,000 volumes, 9,000 manuscripts), Kiel, Konigsberg, Marburg and Miinster. Largely in consequence of the impoverishment of the years after 1918 the university libraries divided the field of knowledge among them by means of a cooperative purchase scheme. Bonn collected Romance, Gottingen English, Kiel Scandinavian, Heidelberg art and archaeology, Konigsberg philosophy, Leipzig Italian and oriental, Tübingen theology and oriental, Berlin German and foreign academica and Griefswald Low German. Breslau was ceded to Poland and renamed Wroclaw. The buildings of Bonn, Gottingen, Münster and others were destroyed or seriously damaged, but evacuation saved the greater part of the collections in many cases.

Munich and Bavaria. — *The* libraries of Munich include two of great importance. The State library was founded by Duke Albrecht V of Bavaria (1550–79), who made numerous purchases from Italy, and incorporated the libraries of the Nuremberg physician and historian Hartmann Schedel, of J. A. Widmannstadt and of J. J. Fugger. The number of printed volumes was estimated at 2,000,000 and of manuscripts at 50,000 in the mid-1950s. The library had 16,000 incunabula, many from the monastic libraries closed in 1803. The oriental manuscripts are numerous and valuable, and include the library of Martin Haug. The catalogue of the printed books is in manuscript; a printed catalogue of manuscripts was issued in 1858. The University library (700,000 volumes, 2,500 incunabula, 4,000 manuscripts) was founded at Ingolstadt in 1472, and moved with the university to Munich in 1826. Both libraries were severely damaged in World War II.

The chief Bavarian libraries outside Munich are the State library at Bamberg (200,000 volumes. 4,500 manuscripts) and the University library at Würzburg (formerly 600.000 volumes, 1.750 manuscripts); this building, catalogues and 200,000 volumes were destroyed in World War II. The universities of Erlangen, Augsburg and Nuremberg have large libraries (Erlangen and Augsburg undamaged; Nuremberg building destroyed, collections saved).

Other German Libraries. — *In* Dresden the Sachsische (formerly Ronigliche Öffentliche) Landesbibliothek was founded in the 16th century; it specializes in history and literature, and had 710,000 volumes in the mid-1950s of which only 90,000 were organized for use, 250,000 having been destroyed in World War II.

Leipzig University library had 1,600,000 volumes in the mid-19 jos (building severely damaged); the Comeniusbücherei (Pädagogische Zentralbibliothek) was one of the largest educational libraries in the world. The Deutsche Biicherei has already been mentioned. The University library of Tiibingen is the largest library in Württemberg. The Württembergische Landesbibliothek at Stuttgart (1 765) had in the mid-1950s 660,000 volumes. 348,000 pamphlets and 10,000 manuscripts, with a famous collection of Bibles. Half the original collection was destroyed in 1944.

The former grand-ducal library of Darmstadt. the Hessische Landesbibliothek, was established by the grand duke Louis I in 1819, on the basis of a 17th-century library, and included 760,000 volumes and 4,500 manuscripts at the time of its destruction in 1944 with the loss of two-thirds of the collection.

Among the other libraries of Hesse the chief are the Cniversity library at Giessen (destroyed with nearly all its contents) and the Stadtbibliothek at Mainz, including the Gutenberg museum (damaged but restored).

In Baden are the Badische Landesbibliothek at Carlsruhe (156,000 volumes in 1954 after almost complete destruction), and the university libraries at Freiburg (700,000 volumes. 1.800 manuscripts) and Heidelberg (1386), the oldest of the German university libraries. In 1623 the whole collection of the last named was given to the pope, and only the German manuscripts were returned. The library was re-established in 1703, and after 1800 was enriched with monastic spoils; in the mid-I950s it contained 820.000 volumes, apart from dissertations, etc., and manuscripts and papyri, for the most part of great value. Heidelberg was untouched by the destruction of war; Freiburg suffered considerable damage to its building but little to its collections.

In other German states should be mentioned Jena, Rostock, Schwerin and Weimar (all little damaged), possessing rich collections of manuscripts.

The ducal library of Gotha, now the Thiiringische Landesbibliothek, was established by Duke Ernest the Pious in the 17th century. and contained many valuable books and manuscripts from monastic collections. It numbered about 400.000 volumes, with 7,800 manuscripts. The catalogue of the oriental manuscripts, chiefly collected by Ulrich Seetzen and forming one-half of the collection, is one of the best in existence. The greater part of the collection was moved to Moscow by the soviet occupation authorities in 1946. In the mid-1950s there were 120.000 volumes.

The Herzog-August (formerly Landes-) Bibliothek at Wolfenbiittel, founded in the second half of the 16th century by Duke Julius, was made over to the University of Helmstedt in 1614. whence the most important treasures were returned to Wolfenbiittel in the 19th century; in 1954 it numbered 400,000 volumes and 8,400 manuscripts and was exceptionally rich in incunabula.

The chief libraries of the Hanse towns are those of Bremen, Liibeck and Hamburg (Staats- und Cniversitatsbibliothek. formerly Stadtbibliothek). made public since 1648. Of its 850,000 volumes, Hamburg lost 710,000 by bombing in World War II; by 1951 the collection had already been restored to between 500,000 and 600,000. Liibeck was virtually undamaged at the end of World War II, though its evacuated collections were not returned to it from the soviet zone. Bremen (severely damaged) had 250,000 volumes in the mid-19 jos.

Austria. — The *Adressbuch der Bibliotheken der Oesterreich-ungarischen Monarchie,* by Hanns Bohatta and Michel Holzmann (1900), described the libraries of the Austro-Hungarian empire. The largest library in Austria, and one of the chief in Europe, is the Nationalbibliothek (before 1920 Hofbihliothek) (1526), including a portion of the library of Matthias Corvinus. Since 1808 the library has been entitled to the copyright privilege. The number of printed volumes was 1.500,000 (including y.000 incunabula). The manuscripts amounted to 35,000 (2.360 oriental), with 100,000 papyri of the collection of Archduke Rainer. The collection of prints was separated from the books in 1921 and annexed to the Alhertina. The University library of Vienna (1365) (1,360,000 volumes) was established by Maria Theresa.

The number of monastic libraries in Austria is very considerable. They possess altogether more than 2,500,000 printed volumes, 25,000 incunabula and 25,000 manuscripts. The oldest library in Austria is that of the monastery of St. Peter at Salzburg (785–821), with 70,000 volumes and nearly 1,500 incunabula. Kremsmiinster (100,000) dates from the 8th century, Admont (86,000) and Melk (70,000) from the 11th. Accounts of their manuscripts appear from time to time in *Zentralblatt jiir Bibliothekswesen.* Rlany of their librarians are trained in the great Vienna libraries.

While the financial crisis which followed World War I forced a few of these libraries to sell some of their treasures, World War II left them unscathed.

Hungary. — Information about the chief libraries in Hungary under the dual monarchy was given annually up to 1911 in the Hungarian *Statistical Year Book.* The largest library in Hungary is the National Széchenyi library at Budapest, founded in 1802 by the gift of the library of Count Franz Széchenyi. It contained 1,330,000 printed volumes and 20,000 manuscripts*at mid-20th century and had 11 lending and 4 reference branches. The University library of Budapest (1585) included 900,000 printed books and 3,400 manuscripts. Other important university libraries are at Szeged, Pécs and Debrecen.

The central bureau of public libraries produces a general catalogue of accessions (which serves as a current national bibliography).

The library of the Benedictines at Pannonhalma (11th century) was the central library of the order in Hungary. and contained nearly 280,000 volumes in 1951. Its principal treasures nere, on the secularization of the monasteries, distributed among the state libraries in Budapest.

Switzerland. — The University library at Basle (1460), the Cantonal library at Lausanne and the Stadtbibliothek at Berne, which, in 1903, was united to the University library of that city, the Landesbibliothek (Bibliothèque Nationale) at Berne and the City and University library of Geneva are considerable. All Sniss literature since 1848 is collected by the Landesbibliothek at Berne. established in 1895 for this special object (1,000,000 volumes). There is no legal. but only a voluntary, deposit of Swiss books. The monastic libraries of St. Gall (816) and Einsiedeln are of great historical interest. The former League of Nations library at Geneva became the property of the United Nations. Switzerland has a highly developed system of cantonal, communal and travelling libraries, and of interlibrary loans.

ITALY

Italy is the home of the oldest libraries. The Vatican at Rome and the Laurentian at Florence are sufficient in themselves to give Italy prımacy in respect of rare and valuable manuscripts. The local rights which so long impeded the unification of Italy created and preserved many libraries which would hdve been lost under a central state. Italy is still in spite of nars and collectors, rich in books. The destruction and damage during World War II were assessed by the ministry of public instruction in 1946 at a total of 3,480,000,000 lire. Many libraries sent their treasures to the

Vatican for safekeeping.

Governmental Libraries.—Governmental libraries (biblioteche *governative*) are under the minister of public instruction. The prefascist regulation controlling them was issued in the *Bollettino Ufficiale,* Dec. 5, 1907. They consisted of the national central libraries of Rome (Vittorio Emanuele) and Florence; the national libraries of Milan (Braidense), Naples, Palermo, Turin and Venice (Marciana); the government library at Cremona; the Marucelliana. the Mediceo-Laurenziana and the Riccardiana at Florence; the government library at Lucca; the Estense at Modena; the Brancacciana and that of San Giacomo at Naples; the Palatina at Parma; the Angelica. the Casanatense and the Lancisiana at Rome; the university libraries of Bologna, Cagliari, Catania, Genoa, Messina. Modena, Naples, Padua, Pavia, Pisa, Rome and Sassari; the Ventimiliana (with the university library) at Catania; the Vallicelliana and the musical library of the Conservatorio di Musica "Santa Cecilia" at Rome; the musical section of the Palatine at Parma; and the Lucchesi-Palli (added to the national library) at Naples. Each library was to possess a general inventory, an accessions register, an alphabetical author catalogue and a subject catalogue. Catalogues of the special collections mere next to be compiled. A general catalogue of the manuscripts was issued together with catalogues of oriental codices and incunabula.

The general lines of this structure. operating under government supervision, were maintained after World War II, though certain changes were necessitated by the destruction of many libraries and the dispersal of their contents. Rebuilding, however, was pushed forward energetically.

Two publications. the *Bollettino* delle *pubblicazioni* italiane and *Bollettino* delle *opere moderne straniere acquistate dalle* biblio*teche governative,* for many years issued from the national libraries of Florence and Rome. respectively, have taken the place of a collective catalogue of accessions. The former is the current national bibliography.

Vatican.—The Biblioteca Vaticana stands in the very first rank among European libraries as regards antiquity and wealth of manuscripts. We can trace it back to the earliest records of the *Scrinium* Sedis *Apostolicae* (Archive of the Apostolic See). There still survives an inventory made under Boniface VIII. The old library was moved to Avignon, where it was renewed and increased, but this collection has only in part, and in later times. been taken into the library of the Vatican. The latter is a new creation of the I jth century. Eugenius IV planted the first seed, but Nicholas V was the real founder of the library, to which Sixtus IV consecrated an ornate abode, in the Court of the Pappagallo. Sixtus V erected the present magnificent building in 1588, and greatly augmented the collection.

The most noteworthy librarians were Marcello Cervini (the first Cardinale Bibliotecario, later Pope Marcel II), Sirleto and A. Carafa. In 1600 the library was further enriched by the acquisition of the library of Fulvio Orsini. Pope Paul V (1605–21) separated the library from the archives and added the two "Pauline" halls for the new codices. Under him and under Urban VIII many manuscripts were purchased from the Convent of Assisi. the Minerva at Rome, the Capranica college and, above all, the library at Bobbio (see section on *Mediaeval* Period above). Gregory XV (1622) received from Maximilian I, duke of Bavaria, the valuable library of the Elector Palatine, seized by Count Tilly at the capture of Heidelberg. Alexander VII (1658) added the manuscripts of the dukes of Urbino.

The *Libreria* della Regina (*i.e.,* of Christina of Sweden) of ancient manuscripts—some from French monasteries, from St. Gall and elsewhere, and others of importance for French literature from the collection of Petau—was in great part presented by Alexander VIII in 1689. Under Clement XI were purchased 54 Greek manuscripts which had belonged to Pius II. and also oriental manuscripts. In the time of Benedict XIV was bequeathed the Capponi library, rich in Italian books; and by purchase was acquired the Biblioteca Ottoboniana, which. in Greek, Latin and Hebrew manuscripts, mas after the Vatican the richest in Rome. Clement XIII in 1758, Clement XIV in 1769 and Pius VI in 1775 were also benefactors.

After three centuries of uninterrupted growth the Vaticana was to undergo a severe blow. In 1798, after the treaty of Tolentino, 500 picked manuscripts were sent to Paris. These. however, were chiefly restored in 1815, though most of the Palatine manuscripts found their way, not back to Rome, but to Heidelberg. Pius VII acquired the library of Cardinal Zelada in 1800, and among important purchases of the 19th century were the splendid Cicognara (archaeology and art, 1823). Cardinal A. Mai, 40,000 volumes (1856), about 300 Borghese manuscripts from the papal library of Avignon, the Barberini library and the Borgia collection, De Propaganda Fide.

The printed books in the Vaticana numbered about 700,000 at mid-20th century, the manuscripts about 53,000 and the incunabula about 7.000 with many vellum copies; there are 500 Xldines and a great number of bibliographical rarities, including many presentation copies. Among the Greek and Latin manuscripts are some of the most ancient and valuable in the world; *e.g.,* the famous biblical Codex *Vaticanus* of the 4th century, the two Virgils of the 4th and 5th centuries, the Bembo Terence and the palimpsest De *Republica* of Cicero.

Many important catalogues of special classes of manuscripts and important single volumes have been published in facsimile. A new catalogue of the printed books was made in 1927–29 to make easily available the library's rich treasures. This catalogue, made possible by the aid of the Carnegie endowment, was worked out mainly according to the code of the American Lihrary association by four Vatican librarians and four U.S. librarians.

Other Roman Libraries.—The most important library in Italy for modern requirements is the Biblioteca Nazionale Centrale (1875) (more than 1,900,000 volumes, 300,000 pamphlets and 5,200 manuscripts in 1954). This contains the Biblioteca Maior o Secrets of the Jesuit college of Rome and the cloister libraries of the Provincia Romana, and has the right to copies of new Italian books. Noteworthy among the manuscripts are the Farfensi and the Sessoriani of Santa Croce in Jerusalem: some of these last being of the 6th to the 8th centuries. The library was reorganized in 1910. It is rich in the Renaissance, in Roman topography and generally in books of reference and in journals. A monthly *Bollettino* is issued of modern foreign literature received by the libraries of Italy. The library acts as the central bureau of bibliographical information for Italy.

The Biblioteca Casanatense, founded by Cardinal G. Casanata in I joo (280,000 printed volumes, 2.000 incunabula, with many Roman and Venetian editions, and 6,000 manuscripts, some of the 8th–10th centuries), is rich in theology, mediaeval history, law and the social sciences. An incomplete catalogue of the printed books by A. Audiffredi (1761–88) still remains a model.

The Biblioteca Angelica, founded in 1614 by Angelo Rocca (129,000 printed volumes and 3,000 manuscripts), was the first library in Rome to be opened to the public. The Alessandrina, founded by Alexander VII in 1661, with the greater part of the printed books belonging to the dukes of Urbino, is the library of the University of Rome. In 181j Pius VII granted to it the right to receive a copy of every book printed in the states of the church, which grant was continued by Italian law but limited to the province of Rome. The library possessed 800,000 printed books in 1954.

The library of the senate, first established at Turin in 1848, contains 350,000 volumes and is rich in the history and statutes of Italian cities. That of the chamber of deputies (1848) contains 400.000 volumes and specializes in more modern history, law and politics. The Vallicelliana (1581), controlled by the Regia Società Romana di Storia Patria has some important manuscripts, including one attributed to Alcuin; the Lancisiana (1711) is valuable for its medical collections; the Accademia di San Luca possesses a good art library; the Biblioteca Militare Centrale (1893) has 100,000 printed volumes and 72.000 maps; the Bibliotera della Conservatorio di Musica "Santa Cecilia" (1875) has a musical collection of 150,000 volumes and 6.000 manuscripts; the Corsiniana, founded by Clement XII and from 1884 part of the Accademia Nazionale dei Lincei, is rich in incunabula and prints. The Deutsches Institut, École Française and British and U.S. schools may be mentioned. All these and many other Roman libraries are open, at least to advanced students.

Subiaco.—At Subiaco, about 40 mi. from Rome, the Benedictine monastery of Santa Scolastica has only 6,000 printed volumes and 400 manuscripts, but it is remarkable as having been, in 1465, the first seat of typography in Italy, and students may inspect the series of Conrad Sweynheim and Arnold Pannartz's original editions preserved in their first home.

Florence.—The Biblioteca Nazionale Centrale of Florence was formed from the union of A. da M. Magliabechi's library with the Palatina. The Magliabechiana became public in 1714, and in 1861 the Palatina (formed by Ferdinand III, grand duke of Tuscany) was joined with it. It had long had a right to a copy of every work printed in Tuscany. a right maintained more rigorously from 1860. Since 1870 the Nazionale has received, by law, a copy of every book published in Italy. Its monthly *Bollettino* is the current bibliography of the national literature. The manuscripts include the most important extant codices of Dante and later Italian poets and historians. The Galileo collection numbers 308 manuscripts. Of the 2j manuscript portolani, the oldest is dated 1417, and several seem to be the original charts executed for Sir Robert Dudley (duke of Northumberland) in the preparation of his *Arcano del Mare*. Among the early printed books are a great number of 16th-century *Rappresentazioni* (books printed on vellum). municipal histories and statutes. authoritative texts and maps. The library contained 1.500,000 printed volumes in the mid-1950s, more than 1,000,000 pamphlets, and manuscripts, incunabula, prints and maps. A new building was completed on the Corso dei Tintori in 1929.

The world-famed Biblioteca Mediceo-Laurenziana at Florence was formed from the collections of Cosimo the Elder, Pietro de' Nedici and Lorenzo the Magnificent. It mas made public by Clement VII. who charged Michelangelo to construct a suitable edifice for its reception. Opened by Cosimo I in 1571, it grew steadily. The accessions in the 18th century alone were enough to double it. Its printed books number probably only 50,000, and though almost all of them are of the highest rarity and interest. it is the 10,000 manuscripts which give the chief importance to this library. More than joo are earlier than the 11th century. Some of them are the most valuable codices in the world—the famous Virgil of the 4th or 5th century, Justinian's *Pandects* of the 6th, a Homer of the 10th and several other very early Greek and Latin classical and biblical texts, as well as copies in the handwriting of Petrarch, about 100 codices of Dante, a *Decameron* copied by a contemporary from Boccaccio's own manuscript, and Benvenuto Cellini's manuscript of his, autobiography. Administered with the Laurentian is the Riccardiana, rich in manuscripts of Italian, and especially the Florentine, literature.

The Biblioteca Marucelliana (founded 1jog, opened 1753) is remarkable for its early woodcuts and engravings; the printed volumes number 340,000 and the manuscripts 2.000.

Milan.—The Biblioteca Nazionale of Milan, better known as the Braidense. founded in 1770 by Maria Theresa, had 570,000 printed volumes in 1950. Among the manuscripts are letters of Galileo, poems in Tasso's autograph and a fine series of Italian illuminated service books. 12th to 16th centuries.

Among the great libraries not under government control, the most important at Milan is the Ambrosiana, founded in 1609 by Cardinal Federigo Borromeo. It contained 600.000 printed volumes: 2,000 incunabula and 25,000 manuscripts in 1954. Among the manuscripts are a Greek Pentateuch of the jth century, the famous Peshito and Syro-Hexaplar, a Josephus on papyrus. supposed to be of the 5th century. several palimpsest texts and a 7th-century copy of St. Jerome's commentary on the Psalms. full of contemporary glosses in Irish. Gothic fragments of Clfilas and a Virgil with notes in Petrarch's handwriting. Cardinal Mai and Pope Pius XI were former custodians here. The building was damaged during World War II. but the collections remained intact.

Naples.—The oldest library at Naples is the Brancacciana, founded in 1647 by Cardinal F. M. Brancaccio, and opened by his heirs in 1675. The Biblioteca Nazionale at Naples (founded in 1734 and opened in 1804) is the largest library of that city, and was rehoused in 1927 in the Palazzo Keale. To the collection of Cardinal G. Seripando were added, especially in 1848 and 1860, many private and conventual libraries. The biblical section is rich. Other features are the collections of authoritative texts and of books on volcanoes, the best in existence of the publications of Italian learned societies and a nearly complete set of the Bodoni press. The manuscripts include many illuminated books, the autographs of G. Leopardi, and books about the ports of the world. The library in 1954 contained about. 1,400,000 printed volumes. Annexed to it is the Officina dei Papiri Ercolanesi. The Biblioteca della Università at Naples, established by Joachim Murat in 1812 in the buildings of Monte Oliveto, and thence sometimes called the Eiblioteca Gioacchimo, was transferred to the Royal university and opened in 1827. It is strongest in medicine and science; its chief manuscripts and early printed books were transferred about the middle of the 19th century to the Xazionale. The library of the University of Naples was destroyed in World War II; its stock had been restored to 700,000 volumes by 1954.

Palermo.—The Biblioteca Nazionale of Palermo, founded from the Jesuits' libraries, is rich in 15th-century books (catalogue printed in 1875), in Aldines and in Sicilian 16th-century books, many being unique.

Turin.—The Biblioteca Nazionale Universitaria of Turin took its origin in the private library of the house of Savoy, given in 1720 to the university by Vittorio Amedeo II. The fire of 1904 destroyed about 24,000 out of 300.000 volumes, and of the 4,138 manuscripts there survive but 1,500, and those in a damaged condition. Among those that perished were the palimpsests of Cicero, Cassiodorus, the Codex Theodosianus and the famous *Livre d'Heures*. The 1,09j incunabula escaped. After the fire the library was enriched by new gifts, notably Baron A. Lumbroso's of 30,000 volumes, principally on the French Revolution and Empire. The library was in 1910 transferred to a set of rooms in the offices of the Debito Pubblico. It possessed 600,000 volumes in 1954.

Venice.—The Biblioteca Nazionale Marciana, or library of St. Mark, at Venice, was traditionally founded in 1362 by Petrarch's gift of manuscripts (all subsequently lost) and opened by Cardinal J. Bcssarion in 1468. It had 550,000 printed books in 1954, manuscripts of great value (more than 1,000 Greek codices given by Johannes Bessarion), collections on Venetian history, music and theatre, and on early geographical research, a codex of the laws of the Lombards and the autograph manuscript of Paolo Sarpi's History *of the* Council *of* Trent. Many private and conventual libraries were incorporated in the Libreria del Sansovino, from which the library was transferred in 1812 to the Palazzo Ducale. and in 1904 to the Palazzo della Zecca (the mint).

Other Italian Libraries.—First in historical importance among the university libraries comes that of Bologna! founded by U. Xldrovandi (1605). Count Luigi F. Marsili in 1712 increased the library and established an Istituto delle Scienze, reconstituted as a public library by Benedict XIV in 1756. The printed books numbered 270,000 in 1954; the oriental manuscripts are noteworthy. The grand hall, with its fine furniture in walnut wood, merits particular attention. The library escaped damage in World War I Other important university libraries are those of Catania (1755), Genoa (1773), Pavia (1763), Padua (1629) (390,000 volumes). Cagliari (175j) and Sassari (c. 1j50). Messina was destroyed in the earthquake of 1908, but the more important part of the furniture was saved, and two years later the library was restored to active work.

At Modena is the Eiblioteca Estense, founded by the Este family at Ferrara in 1393; it was transferred to Modena by Cesare d'Este in 1598. L. A. Muratori, F. A. Zaccaria and G. Tiraboschi were librarians here. The printed volumes numbered about 300.000 in 19jo. besides incunabula, manuscripts and the Campori collection (5,000 manuscripts and 100,000 autographs).

The Biblioteca Palatina di Parma was founded in 1769 by the grand duke Philip. who employed Paolo M. Paciaudi to organize it. It contained 400,000 volumes in 1950 and several thousand manuscripts, including Giovanni Bernardo de Rossi's biblical and rabbinical manuscripts. Xlso worthy of note are the Biblioteca Governativa or Pubblica of Lucca. and that of Cremona.

At Genoa the Biblioteca Franzoniana (40,000 volumes), founded about 1770 for the instruction of the poorer classes, is noteworthy as being the first European library lighted at night for the use of readers.

The foundation of the monastery of Monte Cassino (529) was a result of the efforts of St. Benedict, and became the prototype of all western religious houses. The library extended to about 70.000 volumes and that belonging to the monks contains about the same number. But the chief glory of the library is the archive, which is quite apart; this includes more than 30.000 bulls, diplomas, charters and other documents, besides 1.000 manuscripts dating from the 6th century on. There are good written catalogues, and descriptions with extracts are published in the *Bibliotheca Casinensis*. The monastery was declared a national monument in 1866. It was completely destroyed in World War II but its collections, which had been moved for safety to the Vatican, survived. At Ravenna the Biblioteca Communale Classense has a 10th-century codex of Aristophanes. At Vercelli the Biblioteca dell' Archivio Capitolare comprises nothing but manuscripts, all of great antiquity and value, among them an evangelarium of St. Eusebius, supposed to be of the 4th century, and a famous codex of Anglo-Saxon homilies.

The Monastero della S. Trinita, at La Cava dei Tirreni, in the province of Salerno (beginning of the 11th century), has only about 10,000 volumes. but these include manuscripts from the 8th to the 14th centuries, among them a codex of the laws of the Lombards, dated 1004, besides a well-known geographical chart of the 12th century, more than 100 Greek manuscripts and about 1,000 charters beginning with the year 840, more than 200 of which belong to the Lombard and Xorman periods. The library is national property, the abbot holding the office of keeper of the archives.

Not a few of the communal and municipal libraries are of great extent and interest: Bologna (1801); Brescia, the Civica Quiriniana (1747); Ferrara (1; 53); Macerata. the Mozzi-Borgetti (1783–1835, united 1855); Mantua; Novara, the Negroni e Civica (1847 and 1890); Padua; Palermo (1760); Perugia (18j2), founded by P. Podiani; Siena (1; 58), founded by S. Uandini. fine art collection; Venice, the Museo Civico Correr (1830); Verona (1792, public since 1802—badly damaged in World War II); Bertoliana (1708). The postwar reconstruction plan of the Federation of Italian Libraries. operated in conjunction with the government, included proposals for co-operative book buying.

SPAIN, PORTUGAL AND LATIN AMERICA

Spain and **Portugal.**—Most of the royal, state and university libraries of Spain and Portugal have government control and support.

The chief library in Spain is the Biblioteca Nacional (formerly Real) at Madrid (1712), with 1,500,000 printed books. Theology, canon law, history, etc.. are very strong. The collection of prints was principally bought from Don Valentin Carderera in 1865. Also in Madrid is the Biblioteca de la Real Academia de la Historia (1738) (50,000 volumes and 8.400 manuscripts), which contains Spanish books of great value, including the Salazar collection. The University of Madrid (550,000 volumes) serves as a central information bureau for the whole country. The Escorial, rich in manuscripts, has the earliest Renaissance library building (1584). The Biblioteca Provincial y Universitaria of Barcelona (1841) contains about 350,000 volumes, and that of Seville (1767j has 200,000 volumes. Among other provincial and university libraries is that of Salamanca (1254). Rural public library systems are being developed throughout Spain.

Among the libraries of Portugal the Biblioteca Nacional at Lisbon (1796) takes first place. In 1841 it was largely increased from the monastic collections, and it has 850,000 volumes of printed books. largely on theology, canon law. history and Portuguese and Spanish literature, 16.000 manuscripts and 40,000 coins and medals. The Academia das Ciências (1779), in the convent of the Ordem Terceira da Penitencia, in 1836 acquired the library of that suppressed convent (210,000 volumes). The University library of Coimbra (1591) (850,000 volumes) is the second largest in Portugal.

The Biblioteca Pública Municipal at Oporto, founded during the siege of 1833, and till 1874 styled the Real Biblioteca do Pôrto, has about 400,000 volumes. The regent gave to the town the libraries of the suppressed convents in the northern provinces. The important Luis de Camoens collection is described in a printed catalogue (1880), as are the manuscripts by H. da Cunha Rivara (1850–70). Most of the other large towns have municipal libraries.

Latin America. — Many of the older libraries of Latin America derive their original collections from monastic and other religious libraries. The republics created their own national libraries! which act as national bibliographical centres. Universities tend to have separate faculty or departmental collections without a general library. The public library system, still generally in an early stage of development, was making steady progress by mid-20th century under the influence of the United Nations Educational, Scientific and Cultural organization (UNESCO) and the United States.

The National library of Mexico was established in 1857 by a decree which suppressed the University of Mexico and transferred its library to the state. The university subsequently accumulated many departmental collections. The National library, which absorbed also the ecclesiastical libraries of Mexico City, possessed 420,000 volumes at mid-century. There are important special libraries, notably those of the National Museum of Anthropology and of the Academy of Sciences. A public library service n-as established in 1921 under the Libraries department of the ministry of education.

Cuba has a National library (1901) at Havana (256,000 volumes) and Havana university has a good library of moderate size. The ministry of education set up a Library office in 1940. The libraries of the other Middle American states were still small at mid-century, that of Panama having been founded as late as 1942.

The oldest national libraries in South America are those of Argentina and Brazil, both founded in 1810 and each having about 700,000 volumes. Argentina was early in the field with its public library system (1870), controlled arid subsidized by a national commission. Brazil possesses in Rio de Janeiro and São Paulo important general and special libraries in addition to the Biblioteca Nacional, among which may be noted the Marine library, the library of the National museum and the Municipal library at Rio de Janeiro and the University and Municipal libraries of São Paulo. At mid-century there were more than 250 municipal libraries in various parts of the country. The National library of Chile at Santiago (1813) contains 500,000 volumes; Chile has an extensive system of public libraries. In Colombia the government and UNESCO established a model public library at Medellín in 1954. in Peru. the National library in Lima (1821) was destroyed by fire with nearly all of its 120,000 volumes in 1943; the opportunity was taken to inaugurate a modern library organization for the whole country. Uruguay established in 1942 a Xational library in Montevideo, where there is also a municipal library system; Venezuela has a National library of 200.000 volumes at Caracas. Bolivia and Paraguay have no libraries of great size; the Bolivian Xational Library and Archives at Sucre, however, is of early foundation (1836).

BELGIUM, NETHERLANDS AND SCANDINAVIA

In Belgium, the older libraries derived their collections largely from the sequestration of monasteries after the French Revolution. In Holland, most of the earlier libraries were destroyed during the religious wars and the war with Spain. The outstanding example is that of the Benedictine monastery of Egmond, which mas completely destroyed. World Wars I and II caused further severe damage.

After 1900 there was considerable progress in both Belgium and the Netherlands in the development of public libraries, and many towns in the latter country established popular libraries after the fashion of the municipal libraries of the United Kingdom and the U.S.

The library systems of Scandinavia also bear close resemblances to those of the English-speaking peoples.

Belgium. — The national library of Belgium is the Bibliothkque Royale at Brussels. based on the Bibliothkque des ducs de Bourgogne, the library of the Austrian sovereigns of the Low Countries in 1772. In 1794 a number of volumes were transferred to Paris, the majority being returned in 1815; in 179j the remainder were formed into a public library under the care of La Serna Santander, who was also town librarian, and who was followed by Van Hulthem. At the end of the administration of Van Hulthem a large part of the precious collections of the Bollandists was acquired. In 1830 the Bibliothkque de Bourgogne was added to the state archives. Van Hulthem died in 1832; his private library (catalogue printed in 1836), mostly relating to Belgian history, was purchased in 1837, and together with the Bibliothkque de Bourgogne and the Bibliothkque de la Ville (open since 1794), formed the Bibliothèque Royale de Belgique. The printed volumes numbered more than 1,600,000 in the mid-1950s, with 32,000 manuscripts and maps, many prints. coins and medals. There are printed catalogues of special collections of manuscripts, of accessions, etc., and entries for books and periodicals acquired by university libraries are incorporated in a union catalogue on cards. There is no free legal deposit of books in Belgium; the government purchases new books from the publishers and deposits them in the Royal library. There are libraries attached to most of the departments of the government.. Other important libraries in Brussels are the Bibliothkque Collective des Sociétés Savantes (1906), with a union catalogue on cards, and the Bibliothkque du Conservatoire Royal de Musique (1832) with 40,000 volumes in 1950. The Bibliothkque de la Société des Bollandistes (1640) (300,000 volumes) is one of the world's outstanding theological libraries. At Antwerp the town library (1505) has 350,000 volumes. The valuable collection of books in the Musée Plantin-Moretus (1640) should also be mentioned. It contains several hundred manuscripts and 2,000 printed books, comprising the works issued by the Plantin family and many 15th-century books, besides the archives of the firm.

The University library of Ghent (declared public in 1797, opened in 1798), was known successively as the Bibliothkque de l'École Centrale and Bibliothkque Publique de la Ville. On the foundation of the university in 1817 the town placed the collection at its disposal, but it remained under state control. The printed volumes amounted to 870,000 and the manuscripts to 7,000 in 1954. The Bibliothkque de l'Université Catholique of Louvain (1636) was based upon the collections of Laurent Beyerlinck, bequeathed in 1627, and of Jacques Romain, professor of medicine. There were more than 211,000 volumes in 1914, when the library was totally destroyed by fire during the German occupation. By 1940, when the library was destroyed for the second time. the collection had been built up to nearly 1,000,000 volumes. In 1954 there were 650,000 volumes. On the foundation of the University of Liége (181;) the old Bibliothèque de la Ville was added to its library (1,100,000 printed volumes and 3.600 manuscripts). The Bibliotheque de la Ville of Bruges (1798) contains 60.000 printed books and manuscripts housed in the old Tonlieu (1477). Every town has a communal library, mostly small and open only part of the day; the chief are those of Alost, Arlon (1842), Ath (1842), Courtrai, Malines (1864), Mons (1797), Namur (1800), Ostend (1861; burned in 1940), Tournai (1794, housed in the Hôtel des Anciens Prêtres. 1755), Verviers (1843j and Ypres (1939). Public libraries receive state subsidies and there is an interlibrary lending system. They are regulated by an act of 1921 for which Jules Destrée was largely responsible.

Netherlands. — The national library of the Netherlands is the Koninklijke Bibliotheek at The Hague (1797). In 1848 the Baron W. Y. H. van Westreenen van Tiellandt bequeathed his library and antiquities to be presen-ed in his former residence as a branch of the royal library. There were more than 1,000,000 printed books and 7,000 manuscripts in 1953. Books are lent all over the country. The library is the richest in the world in books on chess, Dutch incunabula, Elzevirs and Spinozana. In 1800–11 a printed catalogue was issued, and beginning in 1866 a yearly list of additions.

The next most important library is that of the Academia Lugduno-Batava, dating from the foundation of the State University of Leyden in 157j. Valuable additions include those from the libraries of Jacobus Golius, Joseph Scaliger. Isaac Voss, David Ruhnken and Tiberius Hemsterhuis. The library of the Society of Netherlands Literature. placed here in 1877, the Legatum Warnerianum of oriental manuscripts, and the collection of maps bequeathed in 1870 by J. J. Bodel Nyenhuis are noteworthy. Published catalogues are: books and manuscripts, 1716; supplements of books added in 1814–47, and of manuscripts, 1850; and oriental manuscripts, 1851–77. The library in 1954 contained about 1,500,000 volumes and 16,000 manuscripts.

The State University library at Utrecht (800,000 volumes) is based on conventual collections brought together in 1581. The public library thus formed was soon enriched by books bequeathed by the historian Arnoldus Buchelius and transferred to the university on its foundation in 1636. Among the manuscripts is the famous Utrecht Psalter, which contains the oldest text of the Athanasian creed. Printed catalogues are of printed books, 1834 (supplement 1845, index from 1845–55 and additions 1856–70), and of manuscripts, 1887. Titles of accessions are printed.

The University library at Amsterdam began in the 16th century as a city library. In 1881 it was moved to a building modelled on the British Museum library. It includes the best mediaeval collection in the Netherlands and the Bibliotheca Rosenthaliana of Hebraica (30,000 volumes, catalogue 1875). The libraries of the Dutch Geographical and other societies are preserved here. The library contained about 1,500,000 volumes in 1954. Dutch library development has long been hampered by political and religious disagreement. There are, however, popular subscription libraries with reading rooms in all parts of the country, and in Rotterdam there is a society for the encouragement of social culture which has a large library. An advisory board created by the ministry of education in 1921 co-ordinates library services.

The library of the Palace of Peace at The Hague had more than 100,000 volumes of works on international law in 1954.

Since Indonesia achieved independence from the Netherlands, a national library service has been under development with assistance from USESCO, with a National library in Jakarta.

Denmark and Iceland. — The beginning of the great Royal library (Kongelige Bibliotek) at Copenhagen may be credited to Christian III (1535–59); but to Frederick III (1648–70) was mainly due the collection of Icelandic literature and the acquisition of Tycho Brahe's manuscripts, and also the building in the Christiansborg castle, begun in 1667. In 1793 the library was opened as the national library. Two copies of every book published in Denmark must be deposited here. The incunabula and block books form an important series. In foreign literature it specializes in the humanities. There are printed catalogues of the De Thott collection (1789–9j); French manuscripts; Oriental manuscripts (1846); the Danish collection (1875), etc. There were 1,200,000 printed books and 48,000 manuscripts in 1954.

The University library (1382). destroyed by fire in 1728, but soon re-established, has received. since 1894, a copy of every Danish publication, and has 590.000 volumes and 10,000 manuscripts including the Arne-Magnean Icelandic collection. The State and University library of Aarhus (1894) possesses about 500,000 volumes. A state library commission supervises the state-supported libraries which cover the entire population. The Landsbókasafn Islands (National library) of Reykjavik. Iceland, has about 180,000 printed books and several thousand Icelandic manuscripts.

Norway. — The chief library in Norway is the University library at Oslo (Christiania), founded in 1811 by Frederick VI with a large donation of duplicates from the Royal library at Copenhagen. There are about 1,200,000 volumes in the collection, and it is the copyright collection for Norwegian publications.

The Deichmanske Bibliotek at Oslo was founded by Carl Deichmann in 1780 as a free library, and is maintained by endowments and by the city. It now contains about 470,000 volumes. The University library at Bergen (1948) incorporates the Bergen Museum library and has 350,000 volumes. The Kongelige Norske Videnskabers Selskabs Bibliotek at Trondhjem has also a large library. The public library system has a central book-buying agency supported by the state, a travelling library service and a service for ships.

Sweden. — The first Royal library at Stockholm was given to the University of Uppsala in 1576 by Gustavus II. A second Royal library was presented to Uppsala in 1620, and yet a third was begun. This was burned in 1697, and the present library was organized shortly afterward. The Renzelstjerna-Engestrom library (rich in Swedish history) was annexed to it. Among the manuscripts the *Codex Aureus* of the 6th or 7th century. with an Anglo-Saxon inscription, is noteworthy. The library contained 850,000 printed books and about 12,000 manuscripts in 1952. The Royal Academy of Science. Stockholm (founded in 1739 by Linnaeus and others), has a first-rate library of 200,000 volumes.

The University library at Uppsala, originally established in 1477, is the oldest university library in Sweden. The manuscripts chiefly relate to the history oi the country, but include the *Codex Argenteus* of the Gothic gospels of Ulfilas. also published in facsimile. Printed catalogues are: general (1814), foreign accession lists (annually from 1850) and Arabic, Turkish and Persian manuscripts (1846). The library contains about 1,000,000 printed books and manuscripts. The University library at Lund (1668) was based upon the old cathedral library. There are about 900,000 volumes in the library. The Stadsbihliotek of Goteborg (1890) has about 580,000 volumes! and a printed catalogue.

A well-organized public library service covers the country and provides special facilities for adult education and for seamen.

U.S.S.R.

The Saltykov-Shchedrin public library at Leningrad, formerly the Imperial public library at St. Petersburg, the State library of the Union of Soviet Socialist Republics, is one of the largest libraries in the world. It should be noted. however, that the statistics for libraries in the U.S.S.R. may be swollen by the operation of copyright deposit laws. which provide for the deposit of more than one copy of each book. In 1954 it was said to contain 10,000,000 printed books and 260,000 manuscripts and autographs. It originated in the books seized by Peter the Great in Courland in 1714; the library, however, attained to the first rank in 1795, with the acquisition of the famous collection formed by the Polish count ,Joseph Zaluski, who collected 200.000 volumes which were added to by his brother Andrew, bishop of Cracow. At his death it was left to the Jesuit college at Warsaw; on the suppression of the order it was taken by the commission of education; and in 1795 it was transferred by Alexander Suvorov to St. Petersburg as a trophy of war. It then had 260,000 printed volumes and 10,000 manuscripts, but in consequence of the dispersal of many works among other institutions, hardly 238,000 volumes remained in 1810. After World War I part of the Zaluski collection was returned to Poland. By a law passed in 1810 t\\-o copies of every Russian publication must be deposited in the library. Very many valuable special collections have been added, such as the Tolstoy Slavonic collection (1830), L. F. K. von Tischendorf's manuscripts (1858), the Dolgorousky oriental manuscripts (1859), the Abraham Firkovitch Hebrew (Karaite) collection (1862–63) and the national manuscripts of N. M. Karamzin (1867). Some departments are thus exceedingly rich, while others are comparatively meagre.

The *Codex Sinaiticus* of the Greek Bible, brought from the convent of St. Catherine on Mount Sinai by Lobegott Tischendorf in 1859, was sold to the British inuseum by the soviet government in 1933. Other important biblical and patristic codices are to be found among the Greek and Latin manuscripts; the Hebrew include some of the oldest extant: and the Samaritan collection is one of the largest; the oriental manuscripts and the French manuscripts (notably the historical) are of great value.

The library of the Academy of Sciences in Leningrad (1725) is the oldest and largest scientific library of the U.S.S.R. (8,000,000 volumes). The library at the Hermitage was founded by the empress Catherine II's purchase of Voltaire's and Diderot's books and manuscripts. In 1861 it possessed 150,000 volumes. of which nearly all but those on the history of art were then transferred to the Imperial library. There are many large and valuable libraries attached to the government departments, academies and colleges in Leningrad. The library of the university had more than 1,000,000 volumes in 1939.

The largest library in the U.S.S.R. and probably in the world is the Lenin State library in Moscow (formerly Rumyantzov museum collection, renamed after Lenin's death in 1924). At mid-20th century it had more than 14,000,000 volumes, and it is rich in early printed books, Russian history and manuscripts. The latter number 46,000, including many ancient Slavonic codices: historical documents and the archives of the Masonic lodges in Russia between 1816 and 1821; catalogues of the manuscripts and of some special collections are printed. Its enormous growth began after the Revolution of 1917, when confiscated libraries in great numbers were added; a new building was begun in 1930. Moscow has many other large libraries, notably those of the university, the Academy of Sciences, the army, the State Historical museum, the ministry of health (Central Medical library), the foreign office and other government departments.

The Ukrainian National library of the Ukrainian Academy of Sciences at Kiev had 10,000,000 volumes in 1950, and there are large state libraries at Baku, Minsk, Tashkent, Tiflis and other centres. Most of these are copyright deposit libraries. Among the university libraries may be noted those of Baku. Kazan, Kharkov. Kiev and Odessa. The development of "mass libraries," the equivalent of British public libraries, was very rapid after the Revolution, these institutions having been set up in great numbers in towns and rural areas and having school, factory and travelling services. National. research and "mass" libraries are all expected to conform with governmental policy and doctrine. The All-Union Book chamber controls the distribution of soviet publications to the copyright libraries.

Losses of libraries and books during World War II reached enormous proportions, and a central fund was formed for library restoration. The All-Union Book chamber acted as an exchange for duplicates.

EASTERN EUROPE, NEAR EAST

Poland. — Many of the libraries described under this heading were destroyed during World War II. The Germans set up a library administration on German lines at Cracow in 1940, with state libraries in that city and in Warsaw, Lwów, Lublin and Poznan. The subsequent fighting and the ultimate rearrangement of frontiers completely destroyed the former library system of Poland, on which much effort had been expended in the period between World Wars I and II. Poland did, however, gain the important libraries of Breslau (Wroclaw) and Danzig.

A famous group of libraries was established in the late 18th and early 19th centuries, among them the Zaluski at Warsaw (later the basis of the Imperial library at St. Petersburg but partly restored to Poland in 1921), the Czartoryski at Cracow, the Krasiński at Warsaw, the Raczyhski at Poznań and the Ossoliński at Lwów. Warsaw had, in addition, a large university library and a public library of importance, and a national library was founded there in 1928 (opened 1935). The nucleus of this was the material, including part of the Zaluski collection, carried off to Russia from Poiish libraries in 1795 and 1831 and restored under the treaty of Riga of 1921. The National library at Warsaw became a copyright deposit library. The Jagiellon library at Cracow (1400), the oldest in Poland. served as a national library until 1918. There were university libraries at Lwów. Lublin, Poznan and Vilnius. The German administration formed a Warsaw State library by amalgamating the University library with the Krasiński and the National; at Cracow the university libraries were combined with the Jagiellon and the library of the Polish Academy of Science and Letters. Many books from other

Polish collections were carried off to Germany, and important collections of Hebraica at Lublin and elsewhere were destroyed altogether by German governmental order.

After the end of World War II, the National library at Warsaw was re-established (1,300,000 volumes in 1954), and publication of the monthly Polish bibliography was resumed. By the end of 1946, a public library service had been restored in 1,800 centres out of the 9,000 in service in 1939.

Czechoslovakia.—The most considerable libraries in Czechoslovakia are the National and University library. Prague (1773), with 1,530,000 volumes in 1951, and the university libraries at Brno and Bratislava.

During the 19th century, free libraries mere founded by the clergy and school teachers, while the library periodical, *Česká Osvěta* (1904), helped to spread a knowledge of Anglo-American popular library methods. Local authorities were obliged by law to establish public libraries, including special libraries for minorities. under the general supervision of the ministry of education. Damage and dislocation during World War II were very severe (the National and University library lost about 500.000 volumes).

Elsewhere in Eastern Europe.—The chief libraries of the Baltic states were, before World War II: in Lithuania. Kaunas (state and university librariesj; in Latvia, Riga (state, university and municipal libraries); in Estonia, Tartu (state and university libraries) and Tallinn (city library). Finland had the parliament. university and city libraries at Helsinki and those of the Finnish university and the Swedish academy at Turku (Åbo).

In Rumania. Bucharest has the library of the Rumanian academy (now the National library) and Jassy a university library. After World War I Rumania acquired, in Transylvania and Bukovina, the university libraries of Cluj and Czernowitz (Cernăuti). The largest libraries in Bulgaria are the national and university libraries at Sofia. Yugoslavia's National library of 500,000 volumes was destroyed in an air raid on Belgrade in 1941, but the Gniversity library fortunately remained almost undamaged. Other large libraries include the State (formerly University) library at Ljubljana and the library of the University of Zagreb. Albania has a national library at Tirana. The National library of Greece at Athens includes the university library and contains about 600.000 volumes.

The Near East.—Turkey has a national library at Ankara, founded in 1946 and opened in 1948, which possessed more than 200.000 volumes in 1954. Istanbul has a university library of about 140,000 volumes and a number of important mosque, libraries containing enormous collections of Arabic manuscripts. The chief library of Israel is at Jerusalem. the Jewish National and University library. containing the largest collection of Hebraica in the world. Egypt has a national library in Cairo of 600.000 volumes and 500,000 manuscripts, The (Fund I) university at Cairo and the (Farouk I) university at Alexandria have important libraries, the latter founded as late as 1943. The Moslem university at Cairo has a fine collection of manuscripts. The National library of Iran was established in Tehran in 1937. In Ethiopia, a national library was opened at Addis Ababa in 1944.

THE FAR EAST

China.—The earliest notice of a library in China is that of the imperial Chou dynasty whose capital was at Loyang in the modern province of Honan. According to a tradition preserved in Ssu-ma Ch'ien's "Historical Record." the philosopher Lao-tse, who lived in the 7th century before Christ, was keeper of books in this library National collections of books in the modern sense, however, originated with the attempts made to recover the books scattered or destroyed by the so-called "First Emperor" in 220 B.C. Hence. the earliest catalogue of Chinese books is preserved in the "History of the Former Han Dynasty" (206 B.C.–A.D. 23) and written in the 1st century of our era. The histories of nearly all succeeding dynasties have likewise left catalogues of books preserved in their libraries or knonn to their times. After the invention of printing in China private libraries became increasingly numerous. From time to time these were destroyed or dispersed, but catalogues of many of them remain. At mid-20th century there were still about 14 large private libraries in various parts of China, several containing as many as 200.000 volumes each.

The first public library in China was established in Hunan in 1905. According to a survey made by the Library association of China in 1927 there were then 503 public and private libraries in China proper and Manchuria. The National library at Peking (1909) had. in 1954, over 2,500,000 volumes, including the original Ming and Ching collections. Each provincial capital also has its own library. The following universities have large collections of both Chinese and western books: Peking university (formerly the Peking. Tsinghua and Yenching universities)! Canton university (formerly Sun Yat-sen), Amoy university and Nanking university. The most common classification of books in Chinese libraries—the so-called *Ssu-K'u* system in vogue for 15 centuries—divides all Chinese literature into four classes: classics, history. philosophy and belles-lettres. A few of the modern Chinese libraries discarded this system entirely, but most of them combined with it a modified Dewey or Library of Congress classification.

Important libraries were established in Formosa after 1945, including that of the Taiwan university (620.000 volumes in 1953).

Japan.—The ancient history of libraries in Japan is analogous to that of China. The former Imperial library (1872) at Tokyo was reconstituted after World War II as the National Diet library (1948); it acts as a bibliographical centre for Japan and in 1954 possessed about 1,500,000 volumes. Tokyo Cniversity library has 1.800.000 volumes and the library of the Kyoto university (1899) contains more than 1,500,000 volumes, of which a large proportion are in European languages. Kyoto and other towns have considerable municipal libraries.

LIBRARY ASSOCIATIONS AND TRAINING

The first and largest association established for the study of librarianship was the American Library association (1876), which includes Canada (*see* below). The Library association of the United Kingdom was formed in 1877. as an outcome of the first International Library conference, held at London. and in 1898 it received a royal charter "to unite all persons engaged or interested in library work." At mid-20th century it had a membership of 10,000, of which nearly 1,000 were institutional members. A yearbook and the monthly *Library Association* Record are published, and there are an annual general conference and a number of sectional and branch conferences and meetings. The Library Assistants' association, formed in 1895, became a section of the Library association. publishing the *Assistant Librarian.* An Irish Library association was formed in 1928. The Library association is the recognized British examining body in librarianship; revisions in its syllabus went far to meet criticisms from university and research librarians that the association was paying undue regard to the needs of public librarians. The study of archives was added to the syllabus in 1927.

In 1917 the Library association, having for many years held lectures and correspondence classes in librarianship. appealed for the establishment of a day school within the University of London for the regular training of librarians. The Carnegie trustees undertook to provide £1,500 a year for the first five years and the school of librarianship was opened at University college, London. The school provides a one-year postgraduate course and awards a diploma. The study of archive administration was added to its curriculum. Easter and summer schools are held both in Britain and abroad.

The school had great influence in raising the educational standard of librarianship. and the *Report on Public Libraries in England and Wales* produced by an interdepartmental committee in 1927 urged that it should be maintained and considered it to have a strong claim on the funds received by the university from the state. Schools of librarianship were also established at Brighton, Leeds. Loughborough. Manchester. Newcastle-upon-Tyne and Glasgow and at the City Literary institute, London; and evening classes are held in a number of other centres.

In the British Commonwealth, library associations or institutions exist in the Union of South Africa (1930), Australia (1937), New Zealand, India and the provinces of Canada. Schools of librarianship are to be found at Capetown, Pretoria, Achimota (Ghana), Sydney, New Zealand, several Indian universities and a number of centres in Canada.

Aslib (the Association of Special Libraries and Information Bureaux) was formed in 1925 to meet the special needs of technical and industrial libraries. Its scope was later widened to include all special libraries, both in the sciences and in the humanities, and many university and public libraries acquired institutional membership in Aslib. The association has paid special attention to documentation and information work. It has commonwealth and foreign as well as British members.

The Association des Bibliothécaires Français was founded in 1906 to promote library reform. It was particularly active in 1928 in urging the development of a system of popular libraries in France. The French library profession is organized by central legislation, beginning with a royal ordinance of 1839 which assigned one-third of the higher posts to trained "archivistes-paléographes." The École Nationale des Chartes issues a diploma in librarianship, with special emphasis on archive work and historical bibliography. The American Library association ran a library school in Paris from 1924 to 1929, with a curriculum based on C.S. methods.

The professional association of German learned librarians is the Verein Deutscher Bibliothekare, founded early in the 20th century. The Verband Deutscher Volksbibliothekare is the corresponding body for popular libraries. Prussia regulated professional training for service in learned libraries by a decree of 1893, which was followed by similar legislation in other states. Library training institutions were established in Berlin, Munich, Dresden, Leipzig and other centres. Volkesbiichereischulen at Berlin, Cologne and Leipzig gave training for entry into the popular libraries.

Austria had no comprehensive system of training in librarianship before World War II. Many Austrian librarians belonged to the Verein Deutscher Bibliothekare. Hungary has an association of Hungarian librarians and archivists, which began after the mar to organize courses of instruction. Switzerland has an association of Swiss librarians and an association of special libraries; there is a library school at Geneva.

Italy has a federation of Italian libraries, founded in 1908 and refounded in 1948, but little attention appears to have been paid to the formal training of librarians. In Spain, the University of Madrid holds a seminar in librarianship.

In the Netherlands, training is controlled by the Central Society for Public Libraries; there is a four-year course, and no public library in receipt of government money may employ unqualified assistants. There is a professional association of librarians. The Netherlands Institute for Documentation has been very active in the field of international standardization, as has also the corresponding body in Belgium. The Belgian Society of Archivists and Librarians was formed at Brussels in 1907. Large numbers of Scandinavian librarians have received training in U.S. libraries, though Denmark has a system of professional training and certification and an association for promoting public libraries (1905).

The U.S.S.R. has a highly developed system for training library staffs. In the mid-1950s there were more than 50 library schools in the Soviet Union and an elaborate system of grading according to the qualifications was in force. In Poland. library examinations are controlled by the ministry of education. Czechoslovakia has a professional association and also a society of learned libraries; library qualifications are regulated by law and there are two or three library schools. Turkey established a library school at Ankara in 1940. In China, training in librarianship was begun at Boone university, Wuchang, in 1910. In Latin America! Brazil, Mexico, Cuba, Peru and Uruguay have library training schools.

INTERNATIONAL ORGANIZATIONS

The International Library committee was established in 1927 and held annual meetings up to 1939 and after 1948. From 1929 it administered the affairs of the International Federation of Library Associations, its membership being composed of representatives of library associations which were members of the federation. The activities of the International federation were resumed in 1948 International Library congresses were held in Rome (1929), Madrid (1935) and Brussels (1955).

The International Federation for Documentation had held 15 congresses before World War II and resumed its activities with a 16th in Paris in 1946. With the International Standards organization it made much progress toward the establishment of internationally agreed standards in such fields as the terminology of documentary reproduction, the abbreviation of titles of periodicals, the transliteration of Cyrillic characters, the format of periodicals and the development of the universal decimal classification devised by the Institut International de Bibliographie in Brussels in 1927–29.

The Institut International de Bibliographie. founded in 1897, began the compilation of a universal card catalogue of the world's great libraries. About 14,500,000 cards had been compiled by 1934, but little has been done since then.

The work of the International Institute for Intellectual Co-operation set up by the League of Nations was in part revived by UNESCO, with headquarters in Paris. The program of the libraries division of this body included the preparation, in conjunction with the Library of Congress, of a world bibliographical survey, leading to a development program of national bibliographical services. UNESCO's work also included projects in public and learned library improvement; "book coupons" enabling libraries to buy foreign books in spite of exchange restrictions; and the promotion of international conventions facilitating the free flow of all forms of information. Much was also done to restock war-damaged libraries and to encourage the international exchange of publications.

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THE UNITED STATES

The earliest libraries of the American colonial period were private; among the more notable were those of William Brewster of Plymouth. Gov. John Winthrop of Connecticut, Cotton Mather of Boston, Col. Ralph Warmeley of Virginia and John Harvard. Toward the end of the 17th century the so-called Bray Parish libraries began to appear. These were collections mainly of religious books sent to America through the efforts of Thomas Bray of London, designed particularly for the use of the clergy, though open to the public. The first subscription library in the colonies was projected by Benjamin Franklin in 1731 in Philadelphia. Many of the early subscription and proprietary libraries became the foundations of public libraries, and a few of them still flourished in the mid-20th century. The Boston Athenaeum (1807) at mid-century had a collection of about 375,000 volumes and was especially rich in historical material. The Providence Athenaeum (1753) had about 135,000 volumes. The New York Society library (1754) had a general collection of 200,000 volumes, with special strength in fine arts. early fiction and Americana.

Throughout the pears libraries increased, and in the 1954 *American Library Directory* 12,478 U.S. libraries were listed, including 6,925 public, 1,920 college and junior college, 293 law, 393 medical. 64 institutional. 309 government, 1,923 special. and 6j1 armed services. In addition, the directory listed 74 libraries of all types in the U.S. territories and dependencies and 1,305 in Canada and Newfoundland.

Endowed Libraries. — The gift or bequest of great private libraries or large sums of money for the erection of library buildings and the organization and maintenance of libraries for free public use became a frequent object of philanthropy in America. John Jacob Astor and James Lenox were the founders of libraries bearing their names! which later became the New York Public library. It was established May 23, 1895, by a consolidation of the Astor (1849) and Lenox (1870) libraries, supplemented by an endowment of $2,000,000 from Samuel J. Tilden. In 1901 Andrew Carnegie gave $5,200,000 for the erection of circulating libraries throughout the city. One of the great libraries of the world. it operates more than 50 branches and contains almost 6.000,000 volumes. The Enoch Pratt Free library (1886) of Baltimore. Md., and the Providence (R.I.) Public library (1878) are typical of the numerous endowed public libraries, many of which are supported in part by municipal appropriations.

At the head of the list of library benefactors stands the name of Andrew Carnegie, whose first library gift was made in 1881 to Dunfermline, his native town in Scotland. His second gift was made in 1890 to Allegheny, Pa. Pittsburgh received a large central building in 1895 and later eight branches. The total amount given by Carnegie and the Carnegie corporation for library buildings in the United States and Canada was $43,665,000. Other philanthropists and the recipients of their gifts were Joshua Bates, Boston Public library; Thomas Jefferson, University of Virginia; B. Rush, Philadelphia Public library; and James Lick, San Francisco libraries. Famous libraries, open to the public, which were also established by individuals include the Pierpont Morgan library and Frick Art Reference library. New York city; John Crerar and Newberry libraries, Chicago; Henry E. Huntington Library and art gallery, San Marino, Calif.; Hoover Library on War, Revolution and Peace, Stanford university; and Folger Shakespeare library, Washington. D.C.

In addition to the Carnegie corporation, several other foundations, including the General Education board, the Rockefeller foundation and the Julius Rosenwald fund, gave generously through endowments and special grants for the furtherance of libraries.

College and University Libraries.—The history of U.S. college and university libraries is also a record of generous gifts from private collectors and friends of education. Their origins can he traced in the early history of the nine colonial institutions of higher learning (Harvard. Yale. Brown. Dartmouth, Princeton, Columbia, Pennsylvania. Rutgers and William and Mary). Harvard university dates its library from 1638. when John Haryard bequeathed his collection of 330 volumes, and by 1800 eight of the institutions had libraries. Two of them, the University of Pennsylvania and Dartmouth college, had libraries that antedate their founding. Most oi the early collections were small, with theology largely represented among the books. Modern college libraries are composed of well-diversified collections and are provided principally through purchase with college funds.

In tbc mid-1950s the approximate number of volumes in leading university libraries were: California (Berkeley), 1,900,000; Chicago, 1,900,000; Columbia, 2~000.000; Cornell. 1,600,000; Duke, 1,125,000; Harvard, 5,700,000; Illinois, 2,600,000; Michigan, 1,500,000; Minnesota, 1,700,000; Northwestern, 1,100,000; Pennsylvania, 1,300,000; Princeton, 1,250,000; and Yale, 4,215,-000.

Particularly after World War I, college libraries developed as instruments of teaching. The Lamont library (1948) of Harvard was probably the best example. Many large university libraries opened their bookstacks to all students and introduced divisional reading rooms providing basic collections in academic subjects.

Library of Congress and Other Governmental Libraries.—Founded in Washington, D.C., on April 24, 1800. the Library cf Congress became in fact if not in name the national library of the U.S. and one of the greatest libraries in the world. It was moved in 1897 from the capitol into an ornate building which, with the ground. cost about $7,000,000. On April 5, 1939, a five-story annex was completed at a cost of about $9.000,000, with ground. In addition to serving members of congress and other officers of the government, it developed into an institution unique among the learned institutions of the world, with magnificent collections of books. manuscripts, music, prints and maps. It provides lectures and concerts. legislative reference service! service for the blind, a union catalogue and catalogue cards for subscribing libraries and institutions, bibliographical, reference and photo-duplication facilities; interlibrary loans and exhibits. By the mid-1950s it had a total of about 35,000,000 books, pamphlets, manuscripts, microfilms, recordings, music, photographic prints, etc.: of this number, about 10,500,000 were volumes and pamphlets. Yearly, it was adding about 500.000 volumes to its collections. many through deposits of the copyright law and exchanges of official publications with foreign governments and learned societies. It had a staff of about 2,400. Among its publications, the library issues a weekly *Information Bulletin*.

Other governmental libraries in Washington include those of the coast and geodetic survey, geological survey, weather bureau, Bureau of American Ethnology. fish and wildlife service, department of agriculture, forest service, Interstate Commerce commission. bureau of foreign and domestic commerce. bureau of labour statistics, department of commerce. treasury department, department of defense (including army medical), Veterans administration. superintendent of documents, supreme court. department of state and Smithsonian institution. In 1938 the Library Service division of the U.S. office of education was established.

Public Libraries.—The modern public library, maintained by the municipality or some other unit of local government from the proceeds of taxation, was scarcely knoivn before 1850 and developed for the most part after the iormation of the American Library Association in 1876. J. H. Shera in *Foundations of the Public Library* (1949) pointed out that "there have been many claimants to the distinction of having created the first truly public library in the United States, but this antiquarian controversy is rooted not in ignorance of historical fact but in uncertainty as to the precise definition of terms . . . If the custodianship of a common collection of books by public authorities be the criterion, then the institution may truthfully he said to have begun in 1629 when the Massachusetts Bay Company authorized the shipment to Salem of those bcoks assembled by the Rev. Samuel Skelton." However. the Bingham Library for Youth. established in 1803 at Salisbury, Conn., represented the first instance in which a municipal governing body contributed active financial assistance to public library service. This was the earliest real recognition by a municipality that aid to library development was a proper function of the town. In the mid-1950s the oldest existing public institution comparable to the modern public library was at Peterborough, N.H., established in 1833. Nevertheless, the real impetus to the expansion of the public library movement was the establishment of the Boston Public library in 1852.

With its law for the "Establishment of Public Libraries" (1849), New Hampshire was probably the first state to enact public library legislation. By the mid-1950s, library legislation was coinmon in all states and federal aid was being sought through congressional legislation for library extension and demonstration controlled by legislation. Each state had its state library and library commission or similar body located in the capital city, to assist public libraries, and every city likewise controlled and supported its library through powers given it by state enabling laws. The governing body of the city public library is generally the board of trustees, appointed by city authorities. Under the board is the chief librarian, who supervises and administers the library or library system and its activities.

Public libraries in the Cnited States are characterized by great similarities in function and basic services. and by wide differences in size, structure, and variety of activities in which they engage. Most of them derive their support. entirely or overwhelmingly, from local taxes; they provide a book stock which is diversified and selected to appeal to the interests of their patrons; the books are classified by subject matter and are listed in a comprehensive catalog arranged to show authors, titles, and subjects. The service is free to all local residents and to others at a slight charge. The differences among them spring largely from the size of the community or area served. and reflect the unique character of each community. Thus, one library may be unusually strong in its technological collection, another in its commercial or industrial or professional holdings. The large city or county library, in addition to its main stock of books: numbering hundreds of thousands of volumes, maintains numerous branches, each of which is a smaller replica of the central library, as well as dozens of smaller book installations in community centers, factories, schools, hospitals, prisons, etc. It may also operate one or more "bookmobiles" to distribute books to areas where such branches do not exist. Through a well-organized system of loans between the central library and its outlets, anyone may borrow any book that the library owns. or he may even obtain books on interlibrary loan from other cities.

Beyond making books available for ccnsulting and borrowing, the large libraries carry on extensive programs to encourage reading. They issue book lists on special topics and publish monthly lists of selected additions to the collections. They sponsor book talks, discussion groups. film showings and record concerts. Staff members visit schools, clubs and business groups to describe the library services, and they review books over the radio; they set up book exhibits at local and county fairs.

Though the library is still primarily concerned with the preservation and distribution of books, it has increasingly recognized an obligation to provide important non-book materials, such as phonograph records for home playing and films for projection in homes and clubrooms. In 1950 the Louisville (Ky.) public library opened the first library frequency modulation (FM) radio station. WFPL, and Is on the air eleven hours a day, broadcasting to schools and homes and carrying programs of particular interest to the residents of its area. It also maintains teievision sets in the library branches.

Since the end of World War II there has been a tremendous resurgence of library building in the United States. The new structures have taken many forms, capitalizing on the latest technical improvements in architecture and engineering. One such building, the new Donnell Regional branch of the New York Public library, opened in Dec. 1955. This library maintains 60.000 volumes for adults on open shelves, lends phonograph records without charge, and arranges film bookings. In addition there is a children's library of 7,000 volumes and one for teenagers with 13,000. A foreign-language center containing books in twenty languages occupies a prominent area, with specialists in charge of the Russian, Italian. French and German collections. Since this regional library serves as headquarters for the branch libraries in Manhattan, it contains a union catalog showing the holdings of 80 New York branches. A basement auditorium with 278 seats is used for concerts, puppet shows, lectures, and similar attractions. This library's close relationship to the New York residents is typical of the American public library as a community-centered institution.

According to statistics on public libraries published by the U.S. office of education! there were 7,477 public library systems operating in the U.S.in 1950. To the 6,028 systems reporting, 9,327,000 volumes were added during that year with a total of 142,931,000 volumes owned (1.24 volumes per capita of population served). A total of 25,361,000 registered borrowers was reported by 5,162 library systems; of these approximately two-thirds were adults. Loan privileges indicated a home circulation of 384,606,-000 volumes from 5,783 systems, to approximately 53% of the adults: 41% of the children, with 6% of circulation unknown. The total income for 5,773 systems reporting was $102,350,000 (87.4% derived from local funds), while operating cxpcnsc was $109,777,-000, or 96 cents per capita of the population served by the libraries reporting. The total personnel employed by 6,028 systems reporting was 44,415—33% professional librarians, 19% subprofessional librarians. 35% clerical and 13% building and maintenance. About 27% of the population, more than 35,000,000 people (mostly in rural areas), was without library service. Only Massachusetts and the District of Columbia provided library service for 100% of their population, although several other states almost reached that goal.

Statistics for 1954 for public libraries in cities with populations of 100,000 or more showed that there were 55,565,923 volumes owned; 163,887,844 volumes circulated, and expenditures amounting to $77,507,482. According to the A.L.A. standards for public libraries, $1.50 per capita was the minimum support recommended for public libraries, $2.25 for good service, and $3.00 for superior service. with $37,500 the minimum budget (for libraries in areas of at least 25,000 population).

Standards and plans for libraries were prepared during the 1940s, and further planning was made possible through a two-year study in 1949 and 1950, the Public Library Inquiry, the findings of which were published in seven volumes. The salaries and working conditions of public library employees were surveyed in 1948–49 by the U.S. department of labour and the A.L.A. The published report showed that $2,350 was the average yearly salary for all public library employees; the average professional employee received $2,825 and the average nonprofessional $1,925. Though no further study was made by the mid-1950s it is safe to assume that these figures would require considerable upward revision. In fact, the entering salary for professionally trained librarians is frequently not less than $3,800.

Increased financial support to provide more adequate personnel, materials and facilities remains the most pressing need of libraries. A second urgent need is recruiting and training of librarians in order to overcome shortages of personnel. Equally importaxit long-term needs are: further development and application of library standards. closer co-operation among libraries and among librarians, more effective enlistment of public interest and speedier enactment of legislation necessary for strengthening library service to all areas and communities.

Children's **Libraries.**—A special library for children was established in New York city as early as 1885. In 1890 a separate room for children was opened in the public library at Brookline, Mass., and in the next few years public libraries began generally to provide special rooms or other facilities for children. By 1900 a separate children's room with specially trained children's librarians to give skilled and sympathetic guidance in the use of books and periodicals, had come to be considered an essential part of every well-conducted public library.

In public libraries with organized work for children, the juvenile circulation amounts to more than one-third of the total. There has been a noticeable increase in work with preschool children and parents and in specialized effort with adolescents.

School Libraries.—In their modern form, U.S. school libraries were a development of the 20th century. Curriculums were changed to require a wide variety of books, pamphlets and magazines. Secondary school libraries, especially those in schools with enrolments of 200 or more, usually include a carefully selected collection of printed materials chosen with the needs of the specific group and community in mind. Some school libraries include film strips, films and recordings among their materials. The library is the school's materials centre.

Growth in elementary school library service has been marked in such cities as Chicago, Detroit: Oakland and Denver and in many suburban and medium-sized communities. Trained school librarians or teacher librarians are assigned to direct the school library service, usually assisted by student library assistants.

Although some rural schools have excellently equipped libraries, the typical pattern is for such schools to receive library services from the county library or directly from the state library. Books may be placed on depcsit in the school for the entire year, to be supplemented by periodic visits by a bookmobile.

Many states have enacted legislation providing that school librarians be certified, just as teachers are certified. an action that has undoubtedly had the effect of improving the quality of school library personnel at the same time that it has aggravated the problem of personnel shortages.

Although remarkable progress had been made in this field, the majority of rural children are still without school library service (as well as public library service) and the quality of that service in at least half of the urban schools is considerably below accepted standards.

Special Libraries.—Specialization in all fields necessarily has its counterpart in library service and, while public libraries built up many special collections in various fields, there was a growing need for the library covering a specific area. After about 1910 there was a rapid development in collections of library materials in special fields. By the 1950s, about 2,000 libraries served special groups such as banks, corporations. manufacturing concerns, newspapers, law firms, advertising and insurance agencies, transportation companies, research organizations, museums, hospitals, governmental bureaus and associations, and organizations in the fields of medicine, business, technology, social welfare, art and science. In 1909 the Special Libraries association was founded; and by the mid-1950s had approximately 5,000 members with headquarters at 31 E. Tenth St.. New York 3, N.Y., and chapters in most large cities. Its official magazine is titled *Special Libraries.*

Library Schools.—The first U.S. library school was established at Columbia college in 1887 by Melvil Dewey, an eminent librarian and educator; by the mid-1950s, 35 were accredited by the A.L.X. and; in addition, library instruction was being offered in hundreds of other institutions. The progress of library education received great impetus over a period of years through grants to library schools and the X.L.A. from the Carnegie Corporation of New York, the General Education board and the Julius Rosenwald fund.

Completion of the first professional curriculum and the general education necessary in preparation for library service usually requires a minimum of five years of study following high school graduation. At most library schools this program leads to a master's degree. It opens with a group of courses which may often bc taken for undergraduate credit, and in the fifth year it combines graduate study in library science and related subject fields. In the mid-1950s study for a doctoral degree was offered by the library schools of Columbia and Western Reserve universities and the Universities of California, Chicago, Illinois and Michigan. Library school enrolments were comparable with figures prior to World War II, but the number of graduates in postwar years fell below the 1940 total. A serious shortage of librarians was in prospect.

American Library Association.—Founded in 1876, from which modern librarianship generally dates, the A.L.A. is the national organization of librarianship, the agency through which the profession speaks with the most authority. In the mid-1950s it maintained headquarters at 50 East Huron St., Chicago 11, Ill., and carried on its activities with a paid staff of 96, assisted by 700 volunteer members of boards and committees. It had more than 20,000 members and an endowment capital of $2,460,000. It is financed by membership dues, endowment income and occasional grants for special projects.

Whether serving as a centre of information on all library subjects, holding conferences, issuing library publications, combating the effects of financial stress on libraries, helping in war or peace or planning for the future of school, college and public libraries, the A.L.A. has the same objective—to increase the use and usefulness of books through improving and extending library service. Continuously the association has concerned itself also with the raising of standards for the library profession. Its international activities are concerned with the interchange of librarians and publications; importation of foreign books and journals in scholarly fields; and preparations for rehabilitating devastated libraries in war areas. In addition to having published about 250 books the A.L.A. issues the following periodicals: *A.L.A. Bulletin, Booklist and Subscription Books Bulletin* and *Hospital Book Guide*. Its divisions publish *Public Libraries, Top of the News, College and Research Libraries, Library Resources and Technical Services,* and the *Public Library Division Reporter*.

One area in which the association has been particularly outspoken is that of preserving the right of free access to reading materials, whether or not of a controversial nature. In 1939, following the imposition of restrictions on reading matter in nazi Germany, the A.L.A. adopted a strong statement known as the Library Bill of Rights, which affirmed belief in the principles of free inquiry. Later on, when pressures were being exerted in the United States on libraries to prevent them from providing books which might prove offensive to certain groups or individuals because of the political views of their authors or for other reasons, the association reinforced its conviction that the library was obligated to present materials reflecting varying points of view. The major elements in the Library Bill of Rights are:

"1. As a responsibility of library service, books and other reading matter selected should be chosen for values of interest, information and enlightenment of all the people of the community. In no case should any book be excluded because of the race or nationality, or the political or religious views of the writer.

"2. There should be the fullest practicable provision of material presenting all points of view concerning the problems and issues of our times, international, national, and local; and books or other reading matter of sound factual authority should not be proscribed or removed from library shelves because of partisan or doctrinal disapproval.

"3. Censorship of books, urged or practiced by volunteer arbiters of morals or political opinion or by organizations that would establish a coercive concept of Americanism, must be challenged by libraries in maintenance of their responsibility to provide public information and enlightenment through the printed word."

Since 1935 the A.L.A. has been active in working for a greater degree of state and federal participation in providing funds for local library operation. It has been instrumental in having bills introduced in congress looking toward financial grants for improvement in library service, especially in areas where local financing is difficult because of lack of population density or of economic resources. It has rallied considerable interest in the problem, and the time may yet come when library service, with its potentialities for contributing to an informed public opinion, will be regarded as a matter transcending the concern of the locality or even of the individual states.

The A.L.A. in the mid-1950s was affiliated with many national library organizations, among them the American Association of Law libraries, American Merchant Marine Library association, the American Theological Library association, the Association of American Library schools, the Association of Research libraries, and the National Association of State libraries. It was also a member of or closely co-operated with the Canadian Library association, the Cuban Library association, International Federation of Library associations, the American Documentation institute, the Catholic Library association, the Educational Film Library association, the Council of National Library associations, the Medical Library association, the Music Library association, the Special Libraries association and the Theater Library association. It works closely with numerous cultural, educational and social agencies throughout the world. The diversity and specialization of library interests are attested by the large number of local and state library clubs and associations to be found all over the U.S.; and many libraries, public and academic, receive support and assistance from groups known as Friends of Libraries.

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LIBRARY ARCHITECTURE is concerned with bringing together in agreeable, convenient and practical surroundings, great numbers of books and readers, efficiently served by a library staff. It is a modern problem. The world has long had library materials to use and store, but it was not until after the development of the rotary press in the mid-19th century that the vast quantities of books made new methods essential.

Prior to this time, it was practical to have one large room or gallery for both books and readers. Books were kept in shelves or cupboards with suitable furniture on which the heavy volumes could be rested. Aesthetically the treatment of these rooms was often masterful, as in the Vatican or the Biblioteca Laurenziana in Florence. To meet the challenge of the printing press, reading rooms were. at first. made larger with added tiers of books and galleries. but limits of expansion for a single gallery were soon reached, and some method had to be devised for separating the public in reading rooms from the room for storing books.

As early as 1835, the French architect. Benjamin Delessert. suggested for the Bibliothkque Nationale in Paris a circular reading room with bookstacks surrounding it. This circular reading room allowed librarians (installed on a raised platform in the centre) easier supervision of the readers. Delessert's plan probably suggested that of the reading room of the British museum (R. & S. Smirke. architects. 1852).

When Henri Labrouste was appointed architect of the new Ste. Genevieve library in Paris (1843) the site selected, being long and narrow, almost forced the solution. A reading room occupied the entire upper floor of the building and contained many of the books, as in the old libraries. but other spaces were made for books on the floor beneath. a scheme that in subsequent years was used in many important libraries. Significant was the separation of books and readers.

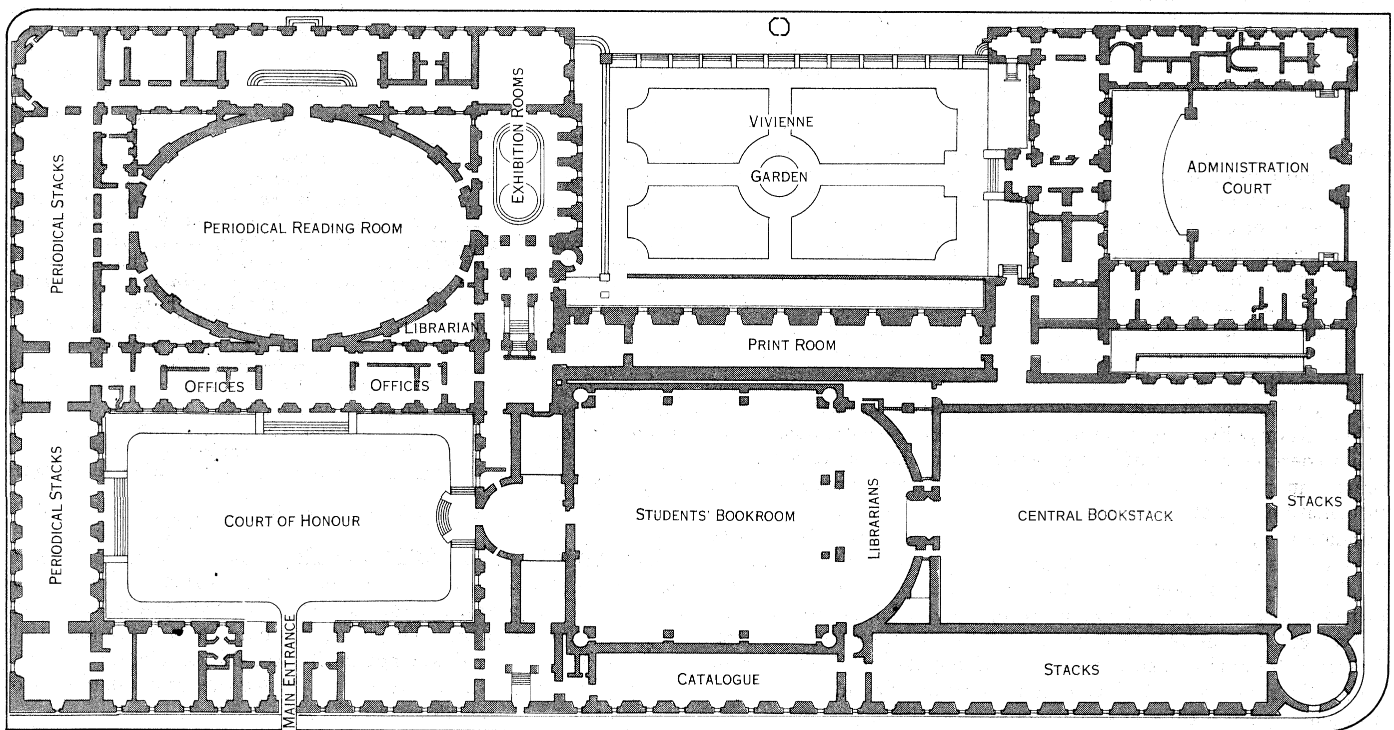
Later. in the plans for the Bibliothkque Nationale in Paris (1854), where he was less hampered by the exigencies of space. Labrouste designed another remarkable building. The main reading room is square. with an apse where the librarians are installed facing its entrance and commanding that to the stacks. The reading room is surrounded by three tiers of shelves. The light comes through a large opening on the north side. and from nine domes, each of which rests on four light steel columns. The atmosphere of the room is quiet and restful and the light is excellent. The most remarkable part of the composition, however, is the bookstack. a huge room. 90 ft. x 120 ft. Here the principle of the modern bookstack first evolved. The shell of masonry is covered by a glass skylight which allows daylight to penetrate every corner, while inside this shell the metal framework of the book tiers and the passages between are entirely independent construction resting on the basement floor.

Library Planning. — The three types of library plans, represented by the Ste. Genevikve, the Bibliothkque Nationale of Labrouste and the British museum, furnished the patterns for most large libraries of the late 19th and early 20th centuries. To the type of Ste. Genevikve; *i.e.*, with a reading room lighted on both sides. with books along the walls or in alcoves and with storage under the reading room, belongs the New Tork Public library (Carrère and Hastings, architects. 1897). To the type of the Bibliothèque Nationale: *i.e.*, with a reading room parallel or perpendicular to the stacks. belongs the Widener Memorial library at Harvard. To the type of the British museum: *i.e.*, with a circular reading room. surrounded by the bookstacks and lighted by high windows or skylights, belong the old Columbia University library. New York (McKim, Mead & White, architects. 1897), and the Library of Congress. Washington! D.C. (Smithmeyer, Pelz & Casey, architects. 1886–97).

A marked progress in library design was noticeable around 1930. In particular, the Municipal library at Viipuri (Viborg) (1934, Alvar Aalto, architect) incorporated many of the newer ideas in a relatively small building. Here the technical requirements for shadowless lighting, mechanical ventilation and acoustical treatment influenced the shape of rooms and contributed the interest in the wall and ceiling surfaces formerly supplied by surface decoration.

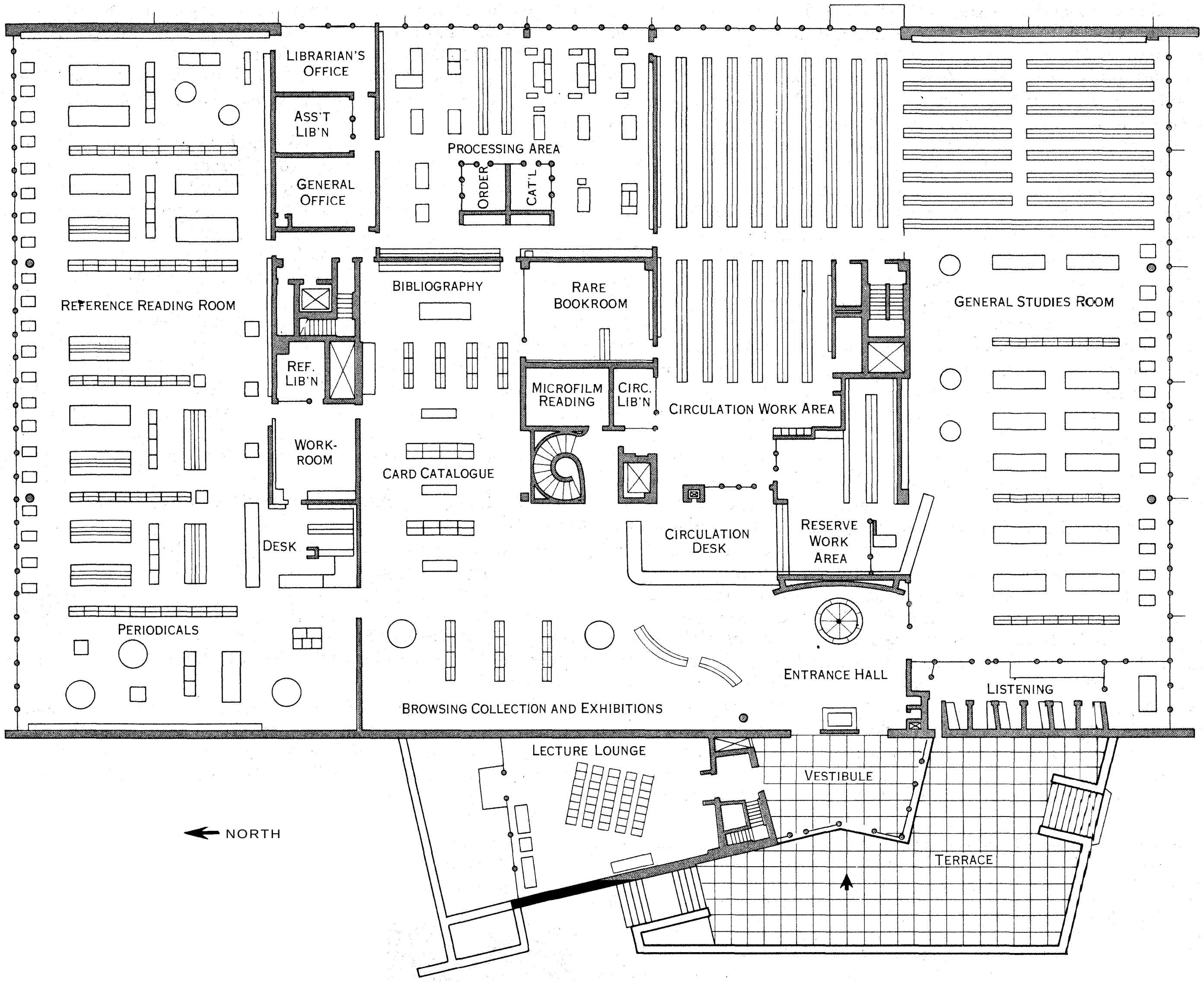
The storage annex at Versailles of the Bibliothkque Nationale in Paris provided one solution to the problem caused by the accumulation and growth of material to be stored by libraries, in this case a separate building outside the city. Discussions at the library congress held in Paris in 1937 led to the system of reduction of certain material by photography (newspapers for example) onto 35 mm. film as a method of saving space. Microprinting is a further development of this idea. Branch libraries and reference libraries specializing in particular fields tend to overcome the unwieldiness of huge central libraries.

U.S. Libraries. — In the United States numbers of people began to borrow books for home reading. This gave rise to a further service, the essential feature of which was the delivery room with its desk in direct communication with the stacks, and its catalogues and open shelves so arranged that readers in the reading rooms were not disturbed by users. In the larger libraries, the increased size of the card catalogue required a special room. In the New York Public library, for example, the catalogue room is on the third floor and readers pass through it on the way to the



FROM GAUDET, "ÉLÉMENTS ET THÉORIE DE L'ARCHITECTURE" (LIBRAIRIE DE LA CONSTRUCTION MODERNE)

FIG. 1.—FIRST FLOOR PLAN OF THE BIBLIOTHÈQUE NATIONALE, PARIS



BY COURTESY OF O'CONNOR & KILHAM & NEVIN & MORGAN, ASSOCIATED ARCHITECTS

FIG. 2.— MAIN FLOOR PLAN OF THE UNIVERSITY OF LOUISVILLE (KY.) LIBRARY

reading room. The influential University of California library (John Galen Howard. architect, 1911), emphasized a single entrance (for control) and a second-floor reading room with a desk betneen it and the stacks. The Baker Memorial library at Dartmouth (Jens Fredrick Larson, architect, 1928) brought forward the principle of the "open stack" where students were free to select their own books from the shelves. At the same time, they got a realistic idea of other material available to them. As the proportion of the stacks to the rest of the library increased. many interesting new plans were devised. In the Sterling library at Yale (James Gamble Rogers, architect, 1931), the tower stack permitted the facilities most used by the students to be available on the ground floor, with the books stored in the tower. In addition seminars were arranged in this tower adjacent to related areas of stack material. This idea of seminar rooms related to the stacks was carried further in the new Columbia University library (James Gamble Rogers, architect. 1934), where an air-conditioned core of books, in several tiers, was surrounded by rooms of normal floor height. (A great disadvantage of this type of enclosed stack is that it cannot be enlarged.) It exemplified the new willingness to depend on artificial light and ventilation.

A still further development was the attempt to break down the size of the large centralized libraries by dividing them into departments which were separately staffed, as in the case of the Cleveland library (Walker and Weeks, architects, 1926). The Enoch Pratt Free library (Clyde Friz and Tilton and Githens, architects, 1933), in Baltimore, was designed primarily for the circulation of hooks rather than their storage. Service was improved and expert staffs were organized to provide the books quickiy.

Another phase of development took place after World War II, particularly in the university libraries. Large enrollments, the extent and variety of the curriculum offered, the emphasis on research, the number of departments to be served, as well as the preservation of the materials, brought recognition of the necessity for flexibility. With the "open stack" principle widely accepted, individual places for the scholar to study, called carrels, were included in the stacks, as well as small reading areas throughout, rather than a concentration of seating in a remote central reading room. To achieve the flexibility that permitted carrels, seminar rooms or stacks to be on the same floor, the multiple tier stacks tended to give way to the loft-type open floor to permit the interchangeable use of the standard dimension stacks or movable partitions. Planning was more frequently modular wherein the uniform spacing of the columns was determined by a unit of space which permitted the efficient use of standard metal shelving units or rooms of reasonable size between the columns. With the perfection of electric lighting, ventilation and air conditioning, dependence on exterior windows was eliminated and solid-block libraries became practical. The student, the book and the teacher could then be brought together as in the Firestone library at

Princeton university (1948, O'Connor and Kilham, architects).

New types of stacks based on sliding or swinging units. known as compact storage, made it possible to recapture some of the storage space lost in aisles between the stacks. A further development was the storage library, shared by several institutions where the least-used books could be stored, yet be available on short notice. The New England Deposit library (1942) was perhaps the first. This idea was expanded in the Midwest Inter-Library centre (1951, Shaw, Metz & Dolio. architects). where the books of several institutions are shared. and certain new acquisitions are co-ordinated. alleviating much duplication.

In the past. libraries have been divided according to types of materials, such as books, films, maps or periodicals, etc. Since the war there has been a tendency toward division by subject bringing various materials from the same field together. With the increasing cost of services, there has been, in planning. increased attention to the efficient disposition of the staff. With the growth of modern audio-visual materials and equipment. libraries also became depositories for slides, tapes, films, discs, etc., with equipment for utilizing them.

The basic relationships of a library are illustrated in the plan of the library of the University of Louisville (1956, architects O'Connor and Kilham). Coming through the library entrance the user finds the circalation desk, and to the left is the catalogue and bibliography area, which is used equally by the readers and the staff. The entrance and desk of the reference room are close to the catalogues. Back of the catalogue area is the processing section where the staff members concerned with the acquisition, cataloguing and shelving of books are located. To the right is the general studies room, a reading room where books are kept on reserve for beginning students who are. generally, in large classes. It also includes listening rooms where audio tapes and discs may be used. Opposite the circulation desk is a top lighted gallery for the exhibition of pictures and sculpture. A lecture lounge is located oft' the vestibule so that its traffic will not disturb the rest of the library and so that the room can be used when the library is closed.

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LIBYA, a kingdom of North Africa, bounded on the north by the Mediterranean. on the east by Egypt. on the southeast by the Sudan, on the south by the French African Kepublics of Chad and Niger, on the west and northwest by Algeria and Tunisia. For the geography of Libya *see* the articles on its constituent parts: CYRENAICA; FEZZAN; and TRIPOLITANIA. Total area is 679,3j8 sq.mi.; population (1954) 1,091,830.

The ancient Greek name *Libye* designated northern Africa west of Egypt but was given more precise connotation when the Roman emperor Diocletian divided Cyrenaica into Libya Inferior (Marmarica) and Libya Superior (farther west). Long understood as a geographical expression for what is now the kingdom, Libya became the official name of the Italian colony formed on Jan. 1, 1934, by the union of Cyrenaica and Tripolitania (*qq.v.*), and was incorporated into the metropolitan kingdom of Italy on Jan. 9, 1939. During World War II Italian administration ended in 1942–43, whereupon Cyrenaica and Tripolitania passed under separate British military administrations and Fezzan under a French.

On Nov. 21, 1949, the United Nations general assembly decided that an independent sovereign state'of Libya should be formed by Jan. 1, 1952; the inhabitants, in a national assembly, were to determine its constitution. Adriaan Pelt, a Dutch assistant secretary-general of the United Nations. was appointed UN commissioner, with an advisory council on which Egypt, France, Italy, Pakistan, the United Kingdom, the United States and the three territories of Libya and the local minorities (46,000 Italians and about 22,000 native Jews) were represented. The national assembly, comprising representatives in equal numbers from Cyrenaica, Tripolitania and Fezzan. met in Tripoli on Dec. 2, 1950, and decided that Libya should have a democratic representative, constitutional monarchy. Mohammed Idris as-Sanusi (es-Senussii. whose amirate of Cyrenaica had been recognized by Great Britain since 1946, became King Idris I of the United Kingdom of Libya, created on Dec. 24, 1951.

Libya was admitted to the Arab league on March 28. 19j3. By the 20-year treaty of July 29, 1953, Great Britain was to pay annually a £1.000.000 development grant and a £2.750,000 budget subvention and maintain military bases. A similar treaty with the United States was signed on Sept. 9, 1954. On Dec. 15, 1955, Libya became a member of the United Nations.

LICATA, seaport, Sicily, province of Xgrigento, 24 mi. S.E. of Agrigento direct; 54 mi. by rail. Pop. (1951) 36,570. The river Salso. east of the town. is the ancient *Himera meridionalis*. On the promontory. which has the town at its foot, and is called the Poggio di Sant' Angelo, the Ecnomus of the Greeks, is the site of the town Phintias of Aeragas built after the Mamertines destroyed Gela (281 B.C.). It was off this promontory that the Romans defeated the Carthaginian fleet in the spring of 2j6 B.C., while in the plain to the north, Hamilcar defeated Agathocles in 310 B.C.

The modern port refines and exports sulfur. It was bombed by the Allies in World War II.

LICENCE, permission, leave, liberty! hence an abuse of liberty; in particular, a formal authority to do some lawful act. Such authority may be either verbal or written; when written, the document containing the authority is called a "licence." Many acts: lawful in themselves, are regulated by statutory authority, and licences must be obtained. *See* LIQUOR LAWS AND LIQUOR CONTROL. etc.

LICHENS, a group of plants which are unique in being a combination of plants from two entirely different groups. This is quite unlike the situation in the mosses, ferns, wild flowers or trees, which are single plants. Each of the combinations in the lichens produces a plant body which appears as a distinct "species" despite its dual origin. The plants which unite to produce this combination are an alga and a fungus. These live together in an intimate relationship called symbiosis (*q.v.*) by most biologists and parasitism by others. Although lichens are commonly thought of in connection with the mosses, there is no relationship between these plants.

F. H. BRIGHTMAN

FIG. 1.— LICHENS GROWING ON AN OAK TREE

(A) Fruticose lichen, *Evernia prunastri;* (B) foliose lichen, *Parmelia caperata;* (C) crustose lichen, *Pertusaria* **amara**

Lichens are found throughout the world, often occupying niches in which no other plants can become established. They are most conspicuous in the alpine and arctic tundras, where they are dominant forms of vegetation. The rock outcrops of the world are usually clothed with an abundance of these plants. Lichens are almost the only plants able to survive the severe conditions of life found at high altitudes and latitudes.

In Antarctica, where there are very few flowering plants and perhaps 60 mosses, there are over 400 species of lichens. In more temperate regions the lichens are common in undisturbed habitats in old fields, in bogs and in forests, on the soil and old rotting logs, on tree trunks and branches. In tropical regions lichens are abundant. with different species occupying the ecological niches occupied by other species in other parts of the world. Few species survive in the vicinity of large cities, nhere they are killed by smoke and gases. The higher temperatures and consequent drier conditions of cities may also reduce lichen populations.

USES AND VALUES

Soil Formation. — Lichens are well known as pioneers on bare rock surfaces. Here some of them act by secreting acids which dissolve the material that cements the particles together. On limestone some species of *Verrucaria* and *Caloplaca* may dissolve pits in the rock surface. Other lichens help to fragment the rock by expanding nhen wet, attaching to the rock, then contracting when dry, thereby plucking away particles of the rock Still others may act by a process of chemical binding to remove some of the mineral elements from the crystals of the rock. As the rock becomes broken up by the action of the lichens and by weathering, the debris furnishes a lodging for the growth of mosses and eventually higher plants.

Erosion Control. — Some species of lichen thrive on very sandy soil. Here the undifferentiated plant body or thallus of a species such as *Lecidea uliginosa* will help materially in binding the surface of the soil against the action of the wind. On clay soils in old abandoned roadbeds in the eastern United States, *Baeomyces roseus* helps to protect against water erosion by binding the soil surface.

Food. — In the arctic and subarctic regions lichens are important as forage for reindeer, caribou, musk ox and moose. Lichens of the so-called reindeer moss group, *Cladonia mitis,* C. *sylvatica,* *C. alpestris* and Iceland moss *(Cetraria islandica),* are the most important species. Because growth in these northern climates is so slow 35 to 38 years are required for an area to recover from grazing. The area required to support a herd thus is enormous, and the Laplanders whose reindeer herds subsist mainly on lichens are forced to be a nomadic people. Iceland moss is used in Greenland and Iceland as a supplement in the food of sheep and cattle as well as of human beings. For use as food, the lichen is soaked in soda solution to neutralize the lichen acids, dried and powdered, and then mixed with potatoes. Some of the rock tripes (leafy or foliose forms), *Umbilicaria* species, have been used as emergency foods by explorers, but the action of the lichen substances on the body is generally unpleasant. One of the plants credited with being the manna of the children of Israel is a lichen, *Lecanora esculenta,* of north Africa and Asia Minor. This species sometimes rolls before the desert ninds in great quantities. Numerous small animals feed to a limited extent on lichen thalli; slugs, snails, mites, caterpillars and termites all are reported to feed upon lichens.

Medicine. — The fancied resemblance of lichens to parts of man's body led in earlier times to their use in the treatment of various ailments. For example, the lungwort, *Lobaria pulmonaria,* has the appearance of the surface of the lungs, hence was used to treat tuberculosis, pneumonia and similar afflictions; the yellow *Xanthoria parietina* was deemed valuable in cases of jaundice; the dog lichen, *Peltigera canina,* with its fruits resembling teeth in a jaw, mas used in the treatment of rabies. The skull lichen, *Parmelia saxatilis,* was considered excellent for epilepsy if found on old skulls instead of its usual habitat on tree trunks and rocks; its value was greatly enhanced if the skull happened to be that of an executed criminal. These fanciful treatments — based on the "doctrine of signature" *(see* SIGNATURE), by which nature was believed to have placed a sign indicating the value of the plant to man — have given way to more scientific remedies. Many of the lichens contain usnic acid and other lichen acids which have been shonn to have antibacterial properties. In Scandinavia the reindeer lichens have been used in the manufacture of alcohol, but difficulties in obtaining raw materials for this industry arise because the regronth of the lichen supplies is so slow. The wolf lichen, *Letharia vulpina,* has been used in Russia for poisoning wolves. One of the lichens of the plains of western North America, *Parmelia chlorochroa,* accumulates selenium and is therefore poisonous to livestock.

Perfumes. — The oak moss lichen. *Evernia prunastri,* and related species, is gathered in southern Europe and used in perfumes; it functions as a fixative to assist in controlling the uniform evaporation of the many varied ingredients of the perfumes.

Dyes. — Probably the most familiar use of dyes derived from lichens is in the litmus paper (paper saturated with litmus solution) of the chemist. This reddish-violet dye, litmus, used as an acid-base indicator, is prepared from a purple or reddish-purple dyestuff called orchil, archil or cudbear. In Europe, cudbear, *Ochrolechia tartarea,* a crustose (having a thin flat crusty aspect) lichen, is scraped from the rocks and used in the preparation of the dyestuff. In the Canary Islands, Madagascar, the coast of South America and formerly along the coast of California, various species of orchil lichens, *Roccella tinctoria* and other species of *Roccella,* are gathered, prepared with sodium or ammonium hydroxide solutions and used for dyeing wool and silk. Rock tripes, *Umbilicaria* sp., *Parmelia* sp. and other lichens are used in northern countries as sources of other dyestuffs, giving soft browns, yellows and other colours to wool.

NATURE OF LICHENS

The unusual structure of the lichens (*i.e.,* a composite plant body or thallus composed of two interdependent plants) was not discovered until after the development of the microscope. The name of this group of plants first appears in the writings of Theophrastus, a disciple of Aristotle, about the 4th century B.C. At that time, and for many centuries thereafter, lichens were confused with the mosses (*q.v.*) and the hepatics. The early students of lichens thought that the green cells (now known to be alga) were specialized structures produced by the fungus and probably of reproductive function. Wallroth *(1825)* coined the term gonidia to indicate this reproductive function, but also mentioned the resemblance to some of the well-known free-living algae. It was not until *1867* that Simon Schwendener announced that the green cells were indeed algae, and that the fungi were parasitic upon them. After the introduction of pure culture techniques, the constituents of numerous lichens were isolated and grown apart from each other and then recombined. The resulting lichen, however, appears somewhat different from the original, and the experimental demonstration of the complete life cycle presents difficulties.

Because the lichen appears as a healthy organism which thrives in very severe environments, the interpretation of the relationship as a simple case of parasitism did not satisfy many of the workers in this field. The term consortium (a union or fellowship) was proposed by Johannes Reinke *(1873)* to explain the relationship; then H. A. de Bary *(1873)* suggested that symbiosis would be a more satisfactory term to describe the relationship. Experimentation shows that there is not only manufacture of the food by the alga in the process of photosynthesis and absorption of water from the atmosphere by the fungus, but that there is also an exchange of complex organic compounds between the components of the lichen.

The constancy of the algal host in the lichen relationship is undetermined. Although the same genus of alga is present in a given species of lichen, there are indications that different species or races of the alga may be present. In some lichens there may be two groups of algae represented in the thallus. In *Peltigera aphthosa* and *P. venosa,* for example, the alga in the thallus is one of the green algae, *Coccomyxa,* while the blue-green alga, *Nostoc,* is found in special gall-like growths called cephalodia. In *Solorina crocea* there may be two layers of the two types of algae. The algae of the lichen are often considerably different from free-living algae of the same genus, and only by pure culture can they be definitely identified. Some of the algae may change their colour. Others which normally grow in chains of cells may be broken up into cell units scattered throughout the thallus.

Algal Member. — The algae in the lichens belong to one of two groups, the Cyanophyta or blue-green algae, or the Chlorophyta or green algae. In the case of the association with the blye-green algae, the shape of the lichen is usually determined by that of the alga, and the fungal threads or hyphae are usually nithin the gelatinous sheath of the alga. When the algal component is a branched filamentous type, such as *Rivularia,* *Stigonema* or *Scytonema,* the lichen is of the same form, and the filaments of the fungus grow in a sheathing mass around the algal cells. If the blue-green alga normally forms flat colonies containing threads scattered through a gelatinous layer, the lichen will have the same shape, the threads of the fungus being intermixed with those of the alga, or the algal threads may be broken into single-celled units by the growth of the lichen thallus; *Nostoc* and Gloecapsa are common blue-green algae with such a distribution in the thallus. Lichens formed with such a uniform distribution of the two components are said to have

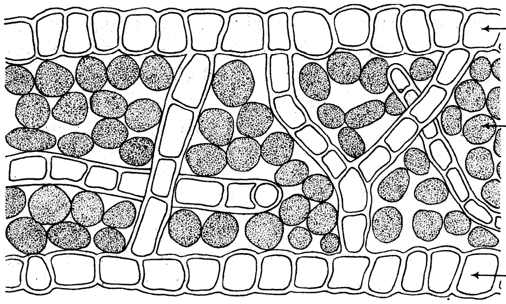


FIG. 2.— SECTION OF THALLUS OF LEPTOGIUM CYANESCENS SHOWING HOMOEOMEROUS TYPE OF THALLUS. (ENLARGED)

a homoeomerous thallus. Collema is a typical lichen of this type. In *Leptogium* the fungus produces a definite layer on either side of the thallus but the internal structure is similar to that of Collenza.

A wide variety of green algae can be associated with the fungi of lichens; Protococcus, *Trentepohlia* and *Trebouxia* (*Cystococcus*) are the commonest, but other genera may also be involved. One of the filamentous types, Cladophora (alga), is involved in *Racodium* (lichen), and in this case the shape of the lichen is influenced by the shape of the alga. In most lichens in which the alga is a member of the Chlorophyta, the fungus determines the shape of the lichen; in the case of flat thalli the algal cells are in a definite layer within the upper part of the thallus, whereas in cylindrical thalli the algal cells are in a layer around the thallus but under the surface. The lichens with layered structure are termed heteromerous. In only a few of the lichens does there appear to be a penetration of the algal cells by special bodies of the fungus called haustoria. In most there is only a close application of the fungal filaments to the algal cells.

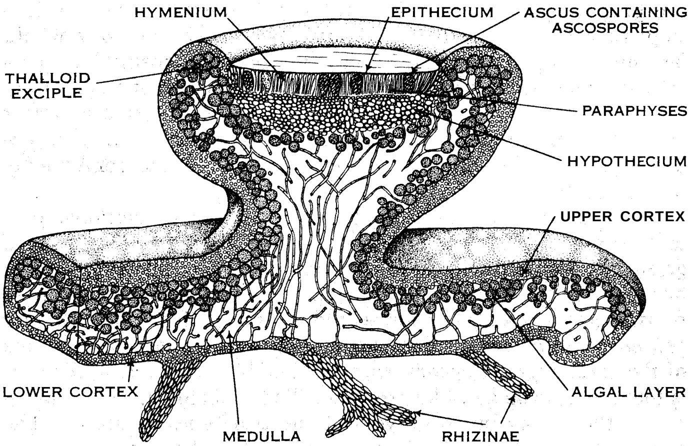


FIG. 3 — SECTION OF PHYSCIA LICHEN SHOWING HETEROMEROUS TYPE OF THALLUS AND LECANORINE APOTHECIUM WITH THALLOID EXCIPLE. (ENLARGED)

Fungal Member. — The lichen fungi belong to a wide variety of groups of the fungi. In a very few tropical lichens such as Cora pavonin and Dictyonenza the fungal symbionts are members of the Basidiomycetes. In most of the lichens, however, the fungal symbionts are members of the Ascomycetes. There are four main groups of Ascomycete fungi involved, with the fruiting structures being the basis of the classification. The Pyrenulales form a fruiting body called a perithecium, a small round enclosed body containing many spore sacs (asci) containing spores and opening by a pore at the tip. The Caliciales form a fruiting body nithin which the asci break down at maturity to release a mass of dry, powdery spores. The Hysteriales form oblong, more or less linear apothecia which open by slits along the top. The largest group of lichen fungi belongs to the Lecanorales, in which the open disklike apothecia are either flat, convex or cuplike.

Evolution. — There is no record in the rocks as to the antiquity of the lichens, but it is obvious that this symbiotic organism must be more recent than its components. It is also obvious that lichens are not primitive but highly developed structures. Both the symbiont are polyphyletic; that is, the algae come from several groups, and the fungi, likewise, are of several widely different origins. Presumably the earliest lichens were a loose association of fungal hyphae with free-living algae. Some lichens are still on this borderline. In Calcium and *Mycocalicium* it is sometimes difficult to be certain of the presence of the alga. Some fungi such as Leotia may contain algal cells in their fruiting bodies. Evolution probably developed from these loose associations to a definite crustose structure, then to the leafy (foliose) structure and finally to the intricate fruticose (shrubby or bushy) type of thallus.

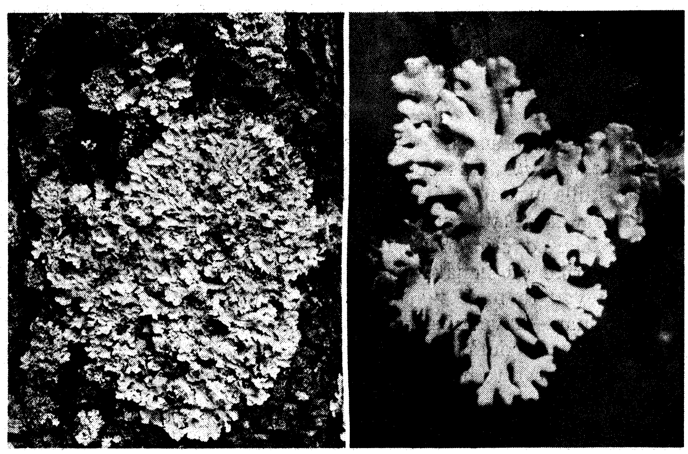
STRUCTURE

General Form and Growth Habit. — There are four general types of growth habit among the lichens: crustose, squamulose, foliose and fruticose.

Crustose.—In the crustose lichens there may be but a thin layer of fungal hyphae with the algal cells scattered among them. This grades into definitely layered structures with an upper cortex of hyphal cells, an algal layer and then an inner layer of loose hyphae, the medulla. The crustose thallus may be granular or smooth, and, if thick may become divided into small, marked-off, angular pieces or elongate lobes; these in appearance approach those of the foliose lichens but are more closely attached to the substratum. If the thallus of the crustose lichen is over the bark surface it is termed epiphloeodal; if it penetrates the bark, only forming the fruits on the surface, it is termed hypophloeodal. Similarly the rock lichens may be epilithic or endolithic. Sometimes the crustose lichens on rocks penetrate them to surprising depths; Biatorella simplex penetrates its rock substrate to a depth of almost half an inch.

Squamulose.—In the squamulose lichens there is a small, leafy, layered thallus which, unlike the crustose type, is more loosely attached, usually toward one edge. *Dermatocarpon*, Lecidea and Cladonia form this type of thallus.

Foliose. — The foliose type of thallus is one of the most conspicuous types of growth of lichens. It is a large leafy type, sometimes in smaller lobes as in Physcia or *Parmelia*, sometimes forming

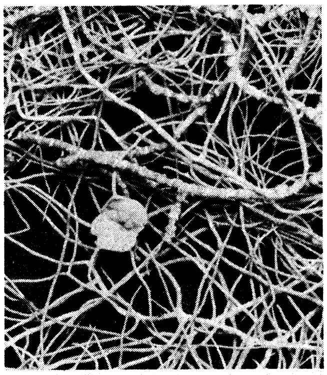


(LEFT) BY COURTESY OF JOHN W THOMSON, (RIGHT) RUTHERFORD PLATT

FIG. 4 — (LEFT) LICHENS GROWING ON AN OAK TREE SHOWING PARMELIA WITH BROAD LOBES AND STAR LICHEN (PHYSCIA STELLARIS) WITH TINY LOBES. (RIGHT) CLOSE-UP OF PARMELIA

huge plates attached at the centre as in the rock tripes, Unzbilicaria. The typical foliose thallus is definitely layered. The upper layer is of either fibrous or cellular appearance; next below this layer is the algal layer with some of the fungal hyphae running through it; then follows a loose inner layer, and finally the lower layer or lower cortex, which may be cellular or loose, and from which project the rootlike structure or rhizinae which attach this type of thallus to the substratum. The rhizinae are sometimes quite abundant as in some of the *Parmelias*. Growth of these lichens is from the margins, which are oiten lighter in colour as they have not yet accumulated the substances which will darken them.

Fruticose.—The upright shrubby or fruticose forms, rarely exceeding six inches in height, usuaily arise irom a primary thallus of a different growth form, sometimes crustose and sometimes squamulose. The fruticose lichens may be quite simple nith club-shaped, pointed or cup-shaped structures, or they may form intricately branching stalklike structures as in the reindeer lichen *Cladonia rangiferina*. This species in turn forms large mats on the soil. The internal structure of the fruticose lichens is similar to that of the foliose types, except that it is based on the cylinder. There is an outer cortex. an algal layer which is more or less continuous, then an inner medullary layer. In Cladonia and *Dactylina* the stalks are hollow. In some of the fruticose lichens as *Roccella* and *Ramalina* there are longitudinal thick-walled strands This tendency reaches its peak in the *Usneas*, nhich have a central strand of great toughness and strength. enabling the hanging thallus to reach a recorded length of 11 yd. in the case of *Usnea longissima* which hangs from tropical trees.



BY COURTESY OF NEW YORK STATE MUSEUM ''' SCIENCE SERVICE

FIG. 5.—CLOSE-UP OF A PORTION OF THE FRUTICOSE THALLUS OF OLD- .,,, ,,,,, LICHEN ,,,,,,, TRICHODEA), SHOWING NUMEROUS FIBRILS AT RIGHT ANGLES TO THE MAIN BRANCHES AND THE JOINTED APPEARANCE OF THE MAIN BRANCHES. ONE APOTHECIUM IS SEEN IN THE CENTRE

Special **Structures.**—*Cyphellae*.—Replacing the stomata of the flonering plants are the cyphellae and pseudocyphellae of the lichens. which are reputed to be organs of gaseous exchange. The cyphellae have a definite margin and occur as small pores on the underside of some of the Stictaceae. The pseudocyphellae lack the definite cup margins and occur more widely among the lichens, in the Stictaceae, in *Nephroma, Cetraria* and some *Parmelias*.

Cephalodia.—These occur only in lichens with green algae. They contain algae of a blue-green type, different from those of the host. They may originate from algae which land on the surface of the lichen and become the centre of the gall-like growth of the cephalodium. Cephalodia occur on the upper surface of *Lecanora gelida* and Peltigera *aphthosa*, on the underside of Pcltigera cenosa and within the thallus in *Solorina saccata*. In *Stereocaulon* they contain the algae Stigonema or *Scytonema* instead of the commoner *Nostoc*. Cephalodia occur quite widely among the lichens.

Soredia.—These consist of a few algal cells enveloped by a weft of iungal hyphae to form a powdery granule which serves in the reproduction of lichens of many species. In the more primitive lichens the soredia are formed over the surface of the thallus. In the more advanced lichens they are formed in special structures termed soralia. The soralia are sometimes head-shaped and are then commonly found upon the surface of the thallus. In other cases they may be lip-shaped and located at the tips oi the lobes or along the sides of the lobes of the thallus. In some cases. as in *Parmelia sulcata*, they may be formed along ridges on the tops of the lobes. Still other soralia may be iormed on the underside of the thallus.

Isidin.—These are outgrowths on the upper surface or the margins of the lobes of many lichens. They are corallike extensions of the thallus; the internal structure usually includes a central medulla. an algal layer and an outer cortex. Their iunction is usually supposed to be that of increasing the area of the thallus devoted to photosynthesis. They are also usually quite brittle and may serve as organs oi vegetative reproduction.

Rhizinae and Cilia.—Rhizinae are groups of the fungal hyphae which anchor most of the foliose lichens to the substratum of rock. bark or soil. They do not appear to play an important role in transfer of water or minerals to the lichen. The cilia are long hairlike structures which ornament the margins of the lobes of species of *Parmelia, Anaptychia,* Physcia and *Umbilicaria*. Their function is unknown although occasionally they may serve to attach the lobes to each other, thereby strengthening the mass of the plant.

REPRODUCTION AND GROWTH

Probably the commonest means of reproduction of this dual organism, the lichen, is vegetative reproduction. Dry lichens are very brittle and smali bits are readily fragmented from the thallus to blow away, anchor and give rise to new thalli. Special organs which contain both components of the thallus (*i.e.*, soredia, isidia or other small lobes) may also be widely distributed by the wind, by water, or over the surface of the snow.

Rigorous proof of the sexual reproduction of the fungal member of lichens remains to be shown. The difficulties of carrying out experimental culture have limited the studies to examination of the structures present in the lichens and to analogy with the methods of reproduction of similar nonlichen-forming fungi. In *Collema* there is a coiled egg-bearing structure which bears a trichogyne (receptive filament) which may or may not reach the surface of the lichen. Male sex cells (spermatia or pycnoconidia) have been observed attached to the trichogyne and suggest the possibility of sexual union. But the pycnoconidia have also been shown experimentally to be able to germinate into fungal hyphae and there is a distinct possibility that the association of the structures is merely accidental. In Peltigera there is formation of a hook or crozier similar to that in Pezizales, which suggests fusion of nuclei. Asexual reproduction has also been suggested for many lichen fungi in which the sexual process has considerably degenerated. Yet the majority of the lichen fungi produce an abundance of apothecia containing ascospores which suggests that these are important.

The lichen fungi form ascocarps (fruiting bodies) of a variety of types depending on the Xscomycete involved in the lichen. In the Lecanorales there is a disk—or cup-shaped apothecium borne on the upper surface or margins of the thallus. The typical structure of the apothecium consists of a layer of tissue called the hymenium, which contains sterile hpphae (paraphyses) interspersed among the saclike asci containing the ascospores. The usual number of ascospores per ascus is eight, but there may be only one or two as in some of the *Pertusaria* and up to hundreds of tiny spores in *Acarospora*. Below the hymenial layer is a layer oi iungal tissue, the hypothecium, which is extended up the sides of the cup to form the proper margin or proper exciple of the

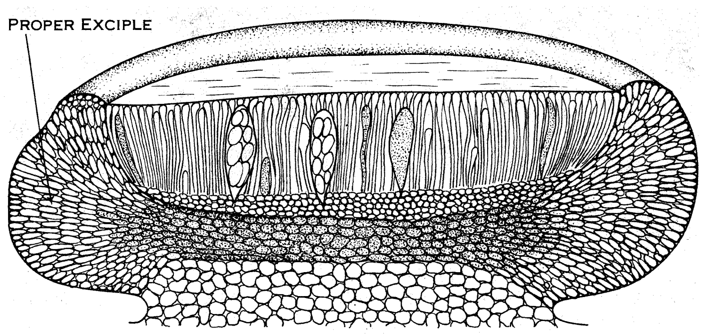


FIG 6 — SECTIONOF APOTHECIUM OF LECIDEA STERIZA SHOWING LECIDEINE APOTHECIUM WITH PROPER EXCIPLE. (ENLARGED)

apothecium, as in the genus Lecidea. Below this layer may be another which is an extension of the thallus usually containing the algae. This grows up in some of the lichens (as *Lecanora*) to form another margin. the thalloid margin or thalloid exciple around the apotheciurn. The tips oi the paraphyses are more or less enlarged and form a layer (epithecium) over the tips of the asci. In the lichen fungi belonging to the Sphaeriales, the asci are formed in a layer inside the flask-shaped perithecium, which is partly, or wholly embedded in the thallus. The outer tissue is usually partly black and carbonized; it may extend entirely around the fruit except for the tiny ostiole or opening, or it may extend only over the upper part of the perithecium. In many species the paraphyses may become gelatinized and disappear as the asci mature. In certain types of lichen fungi belonging to the Hysteriales there is a long, narrow ascocarp with the sides carbonized and the asci and paraphyses in a furrow down the middle. In still other lichen fungi belonging to the Caliciales the asci disintegrate to leave the spores free in a threadlike mass. the mazaedium.

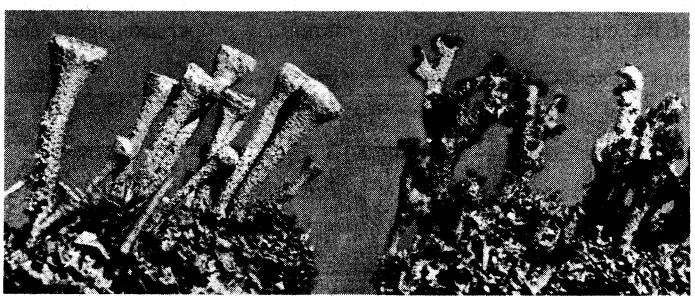
The life of the apothecia and perithecia in the lichens, unlike that of the ascocarp in the nonlichen-forming fungi, may extend over a period of many years. The spores may be shed from the same hymenial layer as in most of the lichens, or there may be an added layer as in the concentric layers of the rock tripes, *Umbilicaria*. When the thallus is moist the spores are ejected from the asci into the wind for distribution. Although there seems to be a greater formation of ripe spores in the spring by some lichens, there are usually some spores present in the apothecium at all times of year.

Among the lichen fungi which belong to the Basidiomycetes the spores, called basidiospores, are borne on the underside of the bracket-shaped thallus.

The spores of lichens are exceedingly varied, and this variability is helpful in the classification of lichens. The spores may be brown or clear, one celled or two celled. or there may be a number of square- or lens-shaped cells placed either lengthwise, or lengthwise and crossnise. The spores may have very thick nalls and the tiny cell cavities joined by a canal as in *Caloplaca*. Spores vary from very small (1 micron, or $\frac{.4}{100,000}$ in) as in *Acarospora* to very large (250 microns, or $\frac{1}{100}$ in.) as in *Pertusaria* and *Thelotrema*. The wall may be smooth or sculptured, and the shape varies from spherical or elliptical to fusiform or needlelike. Most spore cells appear to be uninucleate, but in the large simple spores of *Pertusaria* they are multinucleate

Most lichens produce pycnidia, flask-shaped structures. in addition to the apothecia. The pycnidia may be within the surface of the thallus as in *Parmelia* and *Physcia* or marginal, somewhat barrel-shaped structures as in *Cladonia* and *Cetraria*. They produce spores called pycnoconidia within the pycnidia. These spores can germinate to produce fungal hyphae and possibly represent one additional means of reproduction. The possibility of their being spermatia is uncertain.

Reproduction of the algae in the lichens is usually by ordinary division. In pure cultures the algae may form zoospores or autospores, depending upon the type of alga.



BY COURTESY OF JOHN W. THOMSON

FIG. 7.—PYXIE-CUPS LICHEN (CLADONIA CHLOROPHAEA) SHOWING (LEFT) SIMPLE CUPS AND (RIGHT) CUPS WHICH HAVE SIDE BRANCHES BEARING APOTHECIA

The fungal spore may germinate and form a tiny prothallus which goes into a resting stage. A new lichen thallus may be initiated when an appropriate algal cell or the soredium of the same lichen species alights by chance upon or very close to the resting prothallus stage.

Growth of the thallus of the lichens occurs mainly at the periphery. Sometimes the algal cells are carried out at the edge of the thallus by special fungal hyphae. The fungal hyphae may grow out farther than the rest of the thallus, and algal cells carried on the winds anchor upon the hyphae giving rise to nea parts of the thallus. The rate of growth of a given lobe of a lichen tends to be exceedingly slow, especially among the crustose lichens. Figures of fractions of a millimetre a year are usual. and some single thalli may be estimated to be centuries old. The foliose and fruticose lichens grow more rapidly, one or two centimetres a year being common growth rates for these. Frequently, as the thallus reaches large size, the centre portion will die out leaving a bare area, while the periphery continues to grow. In the centre new thalli may colonize and thus form concentric rings of lichens.

PHYSIOLOGY

Lichens obtain part of their water supply from rains, part from the atmosphere directly, and part from dews and fogs. In desert regions the dews are of special importance. Water can be absorbed by lichens to the extent of 1 to 35 times their own neight. When growing on damp mossy surfaces, the lichens can obtain much of their water from the substratum Although water is easily taken up by the thallus, it is also quickly lost; it has no special ability to retain the moisture. Lichens are able to withstand extreme drying, especially those species growing on the hot dry rocks of deserts. However, they show correspondingly reduced assimilation and respiration.

Respiration of the lichen thallus is of course dependent upon the two components of the lichen. In the dark the CO_2 output rises and O_2 utilization increases; in the light the reverse occurs. The balance of these two measures of respiration depends on the kind of lichen, the temperature and the availability of water. The lichens of shade achieve a balance sooner during the day under loner intensities of light than do the lichens which grow in higher light intensities. The rate of respiration drops rapidly with lowering temperatures until at $-10°$ C. it becomes immeasurable, although the lichens still survive much lower temperatures. Respiration is at a maximum at from 15° to 25° C., then drops as the temperature is raised over 25°. In lichens in the dry condition the gaseous exchange is very slight. With increase in moisture content of the thallus up to a point just short of saturation the gas exchanges increase. They then diminish as saturation is reached. A moist lichen will carry on about five times as rapid a gaseous exchange as a dry lichen. The carbon dioxide and oxygen ratio is not much influenced by the moisture content of the lichen.

Light requirements of lichens are dependent upon the kind of lichen being studied There appear to be two maxima in the rate of assimilation, one at from 7j to 400 lux and another in the more moderate range of 2,000 to 3,500 lux.

Lichens are sensitive to gaseous compounds of sulfur and to ozonated hydrocarbons. This probably accounts for their scarcity in areas around cities nhere such compounds are abundant. Some species as *Xanthoria parietina*, *Evernia prunastri* and *Anaptychia ciliaris* have been suggested as indicators of air pollution.

Because of the difficulty of growing the lichen fungi in pure culture, comparatively little is known about their requirements. They are like the nonlichenized fungi in a preference for common hexose and disaccharide sugars. A deficiency of thiamine has been shown for six species. Ammonium salts are readily utilized by a number of species, but amino acids are apparently poor sources of nitrogen for these fungi. Mineral nutrition is poorly understood. An exchange of organic compounds between the two symbiotic members of the lichen was suggested by the work of Quispel.

CHEMISTRY

The fungal tissues of lichens produce a uide variety of substances. The hyphal walls in many lichens are composed mainly of the polysaccharide lichenin. which does not react with iodine, whereas in other lichens, isolichenin is found. which has a blue reaction nith iodine. Chitin, hemicelluloses. pentosan, dextran and a glucan may also be formed. Lipoid substances are very commonly formed. A number of other types of sugars such as arabitose. sucrose and trehalose and polyhydric alcohols such as mannitol and volemitol, have been reported in lichens. Sixteen amino acids, growth substances and a number of vitamins have also been found in lichens. The constituents of the algal member of the lichens are presumably the same as in the free-living algae of the corresponding genera.

The most interesting of the substances produced by lichens are those which are produced on the exterior of the fungal hyphae. In addition to calcium oxalate, there are formed a large number of peculiar chemical substances with a very wide range of chemical formulas and an interesting variety of crystalline structure. Lichen substances are in some cases formed without the algal partner's being present. Many of the lichen substances are of bright colours, red. yellow or orange. and give the clear colours to the common lichens. They are in most cases unique to the lichens, but in some cases are also formed by independent fungi'. The exact function of these substances in the life processes of lichens was unknown in the late 19jos. Various ideas include: *(1)* they provide protection against animals as a result of the bitter flavour of the substances; *(2)* they give protection against transpirational loss of water; and (3) they are end products of cell metabolism, excretory substances. Some, like usnic acid, have an antibacterial effect. Although commonly called lichen acids, these include a wide series of other types of chemicals.

CLASSIFICATION

Long before the true nature of the lichen thallus was understood, there had been attempts to classify the lichens. Usually they were placed among the mosses, the hepatics and the algae. Even Linnaeus (1753) added other plants to his genus *Liclzen,* which contained all the lichens then known to him.

Modern systems of classification of the lichens show an increasing emphasis upon the fungi which are associated in the lichen relationship. There is an increasing tendency toward distributing the groups which are associated with the blue-green algae among those associated with the green algae according to the type of fungus present. The names are based on the fungus member of the partnership in order to avoid the naming difficulties which would result from basing them on the combination. One system, quoted by M. E. Hale (1956), includes the following:

Class Ascomycetes
- Subclass Bitunicatae (Xscoloculares)
  - Order Hysteriales (Opegraphaceae, Dirinaceae, etc.)
- Subclass Unitunicatae (Ascohymeniales)
  - Order Sphaeriales (Pyrenulaceae, Verrucariaceae, Dermatocarpaceae)
  - Order Pezizales (Graphidaceae, Pannariaceae, Lecideaceae, and nearly all ioliose and iruticose genera)
  - Order Caliciales (Caliciaceae, Cypheliaceae, Sphaerophoraceae)

Class Basidiomycetes
  - Order Thelephorales (Cora, Dictyonema)

Class Fungi Imperiecti (Crocynia, Lepraria)

These larger groups are divided into a large number of families and over 200 genera. There are over 18.000 species of lichens in the world. In North America over 2,200 species have been listed.

PHYTOGEOGRAPHY AND ECOLOGY

Distribution. — So much remains to be done in the collection and study of lichens that only the general outlines of the distribution patterns can be described. For those which have been studied, patterns matching those of the better-known flonering plants can be shown. but some unique patterns have been found. In the arctic there is a circumpolar distribution type containing many widespread species such as *Alectoria ochroleuca, Cetraria nivalis, C. cucullata* and *Parmelia centrifuga.* An Arcto-Pacific distribution type contains species which are found in Siberia and in the western American arctic; *e.g., Cetraria richardsonii* and *Cetraria chrysantha.* A lichen occurring in both arctic and antarctic regions is *Usnea (Neuropogon) sulphureus. A* very large number of lichens of the temperate zone occur around the world, so that manuals of European lichens are of great help in studying North American lichens and vice versa. Such genera as *Alectoria, Cladonia, Caloplaca, Lecidea, Lecanora, Parmelia, Physcia* and *Rinodina* provide many examples of such wide distribution. A few species such as *Lecidea olivacea, Alectoria fremontii, Cavernularia hultenii* and *Lobaria hallii* are found in the western parts of both North America and Europe. Some species such as *Cetraria oakesiana* and *Baeomyces roseus* are found in eastern North America and in Europe. Mediterranean desert lichens such as *Physcia biziana* are also found in the arid regions of western North America. Along the coastal regions of western North America are a number of lichens which also occur in Japan.

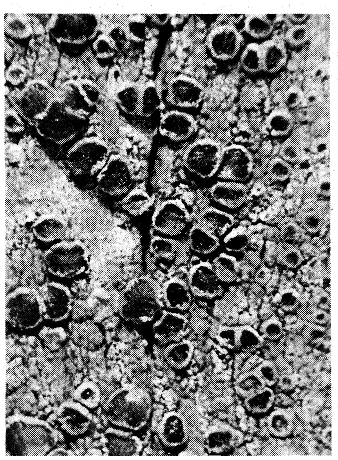
Tropical lichens tend to be represented strongly by lichen fungi associated with the algal genus *Trentepohlia.* Although many of the same genera that occur in temperate regions are present, the predominant lichens are different. The families Graphidaceae, Pyrenulaceae, Astrotheliaceae, Paratheliaceae, Coenogoniaceae, Thelotremaceae, Stictaceae and Parmeliaceae are conspicuous among the tropical groups.

In antarctic regions the most conspicuous lichens are the Stictaceae, the Cladoniae and members of the subgenus *Neuropogon* of the genus *Csnea.* In Antarctica there are over 400 lichens, the bulk of them being crustose; the genus *Buellia* is best represented.

Ecology. — Although lichens are to be found in many kinds of habitats in the world, the balance between the two components in each species of lichen is so delicate that any given kind is likely to show a very marked response to the external conditions under which it grows. Thus, lichens make very good indicator plants to deduce the nature of the environment. The substratum, light, temperature, moisture and winds all may play a part in the limitation of a given lichen-to a specific ecological niche.

In Europe and to a lesser extent in North America there is a broad intertidal zone along the coastal rocks in which species such as *Verrucaria maura* and *Caloplaca marina* can grow between the seaweeds in the periodic salt-water bath.

In North America there is one species *Hydrothyria venosa,* which is completely aquatic in fresh-water streams in the eastern mountains and in California. Another species. *Dermatocarpon aquaticum,* occurs along streams of the northern hemisphere in places which are periodically flooded. Just as in the case of the higher plants. lichens may be tolerant of a wider variety of habitats to\\-ard the centres of their ranges, whereas on the periphery of their ranges they may show a stronger limitation to a certain habitat. Some species are indicative of limestone soil or rocks (calcicolous lichens); these include *Cetraria tilesii* and *Dactylina arctica* in the arctic, and *Lecanora crassa* and some species of *Collema, Caloplaca* and *Verrucaria* in more temperate regions. Some prefer acidic rocks (silicicolous lichens); *e.g.,* most of the *Umbilicarias, Rhizocarpon, Lecidea, Stereocaulon* and many *Lecanoras.* Although many lichens grow in very dry habitats, others prefer higher atmospheric humidity; the lace-lichen, *Ramalina reticulata,* for example, festoons the foggy redwood forests of western North America. Studies of tree bark, or corticolous, communities of mosses and lichens show that although such lichens may grow on many kinds of trees there is a marked preference for certain species. The type of bark (rough or smooth), the bark acidity, the amount of shade of a given tree — these are some of the factors determining this selectivity. Because many lichens have very similar habitat requirements, they can be grouped into communitiks of species which frequently occur together. Such studies of lichen communities, or lichen sociology, show them to be quite specific for various parts of the world.



BY COURTESY OF NEW YORK STATE MUSEUM AND SCIENCE SERVICE

FIG 8.—MAGNIFIED VIEW OF A TINY CRUSTOSE LICHEN. LECANORA SUBFUSCA, GROWING ON A PIECE OF WOOD. VARIOUS STAGES OF GROWTH OF APOTHECIA ARE SHOWN

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LICHFIELD, a city, county of a city, and municipal borough in the Lichfield and Tamworth parliamentary division of Staffordshire, Eng., 17 mi. N. of Birmingham. Pop. (1951) 10,619. Area 5.6 sq.mi.

The town is on a stream with low hills to the east and south. There is a tradition that "Christianfield" nearby was the site of the martyrdom of 1,000 Christians during the persecutions of Maximian about 286. At Wall, 3 mi. distant, there was a Romano-British village called Letocetum ("gray wood"), from which the first half of the name Lichfield is derived. The first authentic notice of Lichfield occurs in Bede's history, where it is mentioned as the place where St. Chad fixed the episcopal see of the Mercians. At the time of the Domesday survey Lichfield was held by the bishop of Chester, who held the lordship and manor of the town until the reign of Edward VI, when they were leased to the corporation. Richard II gave a charter (1387) for the foundation of the guild of St. Mary and St. John the Baptist; this guild obtained the whole local government, which it exercised until its dissolution by Edward VI, who incorporated the town (1548). The only existing fair is a small pleasure fair of ancient origin held on Shrove Tuesday; the annual fete on Whit Monday claims to date from the time of Alfred. King Edward VI's grammar school was founded in 1495. The cathedral, one of the smallest in England, dates from the 13th and early 14th centuries. Built mainly of red sandstone, its fine exterior has a lofty central and two lesser western spires, of which the central, 252 ft. high. is a restoration attributed to Sir Christopher Wren after its destruction during the Civil Wars. Among numerous monuments are memorials to Samuel Johnson (born in Bread Market street, 1709) and to David Garrick, who spent his early life and was educated in Lichfield. The city has also been the home of some famous men and women, among them Elias Ashmole, Joseph Addison and Erasmus Darwin. It possesses many houses of historic interest and architectural merit. It is well planned, with extensive housing schemes and a remarkable variety of crafts and industries, varying from the production of essences to a wide variety of plastics and light engineering works. The borough was extended in 1934. There is a general museum and two regimental museums.

LICHTENBERG, formerly a small German principality on the Rhine, now belonging to the district of Trier, Rhineland-Palatinate. The principality included parts of the electorate of Trier, and Nassau-Saarbrucken. Originally called the lordship of Baumholder, it owed the name of Lichtenberg and its elevation in 1819 to a principality to Ernest, duke of Saxe-Coburg, to whom it was ceded by Prussia in 1816. The duke restored it to Prussia in 1834.

The area is about 210 sq.mi.

LICINIUS (FLAVIUS GALERIUS VALERIUS LICINIANUS), Roman emperor, A.D. 307–324, of Illyrian peasant origin, was born probably about 250. He was elevated to the rank of Augustus by Galerius, his former friend and companion in arms, on Nov. 11, 307, receiving as his immediate command the provinces of Illyricum. On the death of Galerius, in May 311, he shared the entire empire with Maximinus, the Hellespont and the Thracian Bosporus being the dividing line. In April 313 he inflicted a decisive defeat on Maximinus at Heraclea Pontica, and established himself master of the east while his brother-in-law, Constantine, was supreme in the west. In 314 his jealousy led him to encourage a treasonable enterprise against Constantine. When his perfidy became known a civil war ensued, in which he was twice severely defeated. The outward reconciliation left Licinius in possession of Thrace, Asia Minor, Syria and Egypt, but added numerous provinces to the western empire. In 323 Constantine again declared war against him, and, having defeated his army at Adrianople, succeeded in shutting him up within the walls of Byzantium. The defeat of Licinius' fleet compelled his withdrawal to Bithynia, where a last stand was made; the battle of Chrysopolis, near Chalcedon, resulted in his submission. He was executed in the following year.

LICORICE: *see* LIQUORICE.

LICTORS (Lat. *lictores),* in Roman antiquities, a class of the attendants (*apparitores*) upon certain Roman and provincial magistrates. As an institution they went back to the regal period and continued to exist till imperial times. The majority of the city lictors were freedmen; they formed a corporation divided into decuries, from which the lictors of the magistrates in office were drawn; provincial officials had the nomination of their own. In Rome they wore the toga; on a campaign and at the celebration of a triumph, the red military cloak (*sagulum*); at funerals, black. As representatives of magistrates who possessed the *imperium,* they carried the fasces *(see* FASCES). They were exempt from military service and received a fixed salary; theoretically they were nominated for a year, but really for life. They were the constant attendants of the magistrate to whom they were attached. They cleared a passage for him *(summovere)* through the crowd, and saw that he was received with the marks of respect due to his rank. They stood by him when he took his seat on the tribunal; mounted guard before his house, against the wall of which they stood the fasces; summoned offenders before him, seized, bound and scourged them and (in early times) carried out the death sentence. Directly a magistrate entered an allied, independent state, he was obliged to dispense with his lictors. Each of the consuls had 12 lictors; the dictator, as representing both consuls, 24; the emperors 12, until the time of Domitian, who had 24. The Flamen Dialis and each of the Vestals were also accompanied by lictors. These lictors were probably supplied from the *lictores curiatii,* 30 in number, whose functions were specially religious, one of them being in attendance on the *pontifex maximus.* They originally summoned the *comitia curiata,* and when its meetings became merely a formality acted as the representatives of that assembly.

For the fullest account of the lictors, *see* Theodor Mommsen, *Romisches Staatsrecht,* vol. i, 355, 374, 3rd ed. (1887); *cf.* J. E. Sandys, *Companion to Latin Studies* (1921).

LIDDELL, HENRY GEORGE (1811–1898), English lexicographer, co-editor of *A Greek-English Lexicon,* was born at Binchester, near Bishop Auckland, on Feb. 6, 1811. He was educated at Charterhouse and Christ Church, Oxford, became a college tutor and was ordained in 1838. In 1846 he became headmaster of Westminster school. Early in 1834 Liddell and Robert Scott began the great *Lexicon* (based on the German work of F. Passow) which became his life work, and the first edition was published in 1843. It is still the standard Greek-English dictionary (revised ed. by H. S. Jones and others, 1940). In 1855 he became dean of Christ Church and took an active part in the first Oxford University commission. He resigned the deanery in 1891 and retired to Ascot, where he died on Jan. 18, 1898. It was for Liddell's daughter Alice that Lewis Carroll wrote *Alice in Wonderland.*

See H. L. Thompson, *Henry George Liddell* (1899).

LIDDESDALE or LIDDISDALE is the valley of Liddel water, Roxburgh, Scot., extending 21 mi. from the Peel fell to the Esk, its head being crossed by the Catrail, or Picts' dyke. For 7 mi. it forms the border between England and Scotland. At one period points on the river were occupied with freebooters' peel towers, but many have disappeared. Hermitage castle, a massive H-shaped fortress and one of the oldest baronial buildings in Scotland, stands on a hill overlooking Hermitage water, a tributary of the Liddel. It was built in 1244 and captured by the English in David II's reign. It was retaken by Sir William Douglas, who received a grant of it from the king *(c.* 1353). In 1492 Archibald Douglas, 5th earl of Angus, exchanged it for Bothwell castle on the Clyde with Patrick Hepburn, 1st earl of Bothwell. It passed to the duke of Buccleuch. It was there that Sir Alexander Ramsay of Dalhousie was starved to death by Sir William Douglas in 1342, and that James Hepburn, 4th earl of Bothwell, was visited in 1566 by Mary, queen of Scots, after being severely wounded by the outlaw Little Jock Elliot.

LIDDON, HENRY PARRY (1829–1890), English divine, was the son of a naval captain and was born at North Stoneham, Hampshire, on Aug. 20, 1829. He was educated at King's College school, London, and at Christ Church, Oxford. As vice-principal of the theological college at Cuddesdon (1854–59) and as vice-principal of St. Edmund's Hall, Oxford, he withstood the liberal reaction against Tractarianism, which had set in after Newman's secession in 1845. In 1864 he became prebendary of Salisbury cathedral. In 1866 he delivered his Bampton lectures on the *Divinity of Our Lord* (13th ed., 1889), which established his fame. In 1870 he was made canon of St. Paul's cathedral, London, where his preaching attracted vast crowds. In 1870 he had also been made Ireland professor of exegesis at Oxford. The combination of the two appointments gave him extensive influence over the Church of England. With Dean Richard Church he may be said to have restored the waning influence of the Tractarian school, and he succeeded in popularizing the opinions which, in the hands of Edward Pusey and John Keble, had appealed to thinkers and scholars. His forceful spirit was equally conspicuous in his opposition to the Church Discipline Act of 1874, and in his denunciation of the Bulgarian atrocities of 1876. In 1882 he resigned his professorship and utilized his thus increased leisure by travelling in Palestine and Egypt, and showed his interest in the Old Catholic movement by visiting Johann von Dollinger at Munich. In 1866 he became chancellor of St. Paul's, and it is said that he declined more than one offer of a bishopric. He died on Sept. g, 1890, in the full vigour of his intellect and at the zenith of his reputation. He had undertaken and nearly completed an elaborate life of Dr. Pusey, for whom his admiration was unbounded; and this work was completed after his death by Johnston and Wilson. Liddon's great influence during his life was caused by his personal fascination and the beauty of his pulpit oratory rather than by any high qualities of intellect. As a theologian his outlook was that of the 16th rather than the 19th century; and, reading his Bampton lectures now, it is difficult to realize how they could ever have been hailed as a great contribution to Christian apologetics. To the last he maintained the narrow standpoint of Pusey and Keble, in defiance of all the developments of modern thought and modern scholarship; and his latter years were embittered by the consciousness that the younger generation of the disciples of his school were beginning to make friends of the mammon of scientific unrighteousness. The publication in 1889 of *Lux Mundi*, a series of essays attempting to harmonize Anglican Catholic doctrine with modern thought, was a severe blow to him, for it showed that even at Oxford, the principles of Pusey were being departed from. Liddon's importance is now mainly historical. He was the last great popular exponent of the traditional Anglican orthodoxy. Beside the works mentioned, Liddon published several volumes of *Sermons*, a volume of Lent lectures entitled *Some Elements of Religion* (1870) and a collection of *Essays and Addresses* on such themes as Buddhism, Dante Alighieri, etc.

See J. Johnston, *Life and Letters of Dean Liddon.*

LIDICE, a mining village in Czechoslovakia, near the coal fields of Kladno. This unknown village sprang into world fame at the very day of its complete destruction, announced officially by the Germans on June 10, 1942. The Germans suspected that some inhabitants had supported the patriots who killed the German police general, Reinhard Heydrich, reichsprotektor for Bohemia and Moravia. According to official German statements, all the male inhabitants, irrespective of age. and j6 women mere immediately executed. The other women uere put into concentration camps; the children were carried off to correction schools, "all buildings of the village were levelled to the ground and the name of the village was immediately abolished." These actions aroused world-wide sympathy and protest. Towns in several countries were renamed to commemorate the Czech village. among them Lidice, Ill., near Joliet, U.S., inaugurated July 12, 1942, and Lidice, Mexico, formerly known as San Geronimo, near Mexico City.

LIDNER, BENGT (1757–1793), Swedish poet of the 18th-century romantic movement, was born at Goteborg on March 16, 1757. He studied at Lund, 1774–75, and spent three years in Germany and one in Paris. He died at Stockholm, Jan. 4, 1793.

Lidner's best works were written between 1783 and 1787. His subjects are spectacular. *Spastaras Dod* (1783), the text for a cantata, deals with a woman who attempts to rescue her son during an earthquake. Both are killed, and the poem follows the mother to heaven, where she meets Lidner's own mother, who had died when Lidner was a boy. In the operatic libretto *Medea* (1784), a deceived wife kills her sons on the stage. The heroine of the epic *Yttersta Domen* ("The Last Judgement"; 1788) is Eve: its opening. in which images of sound and light combine to evoke an intense atmosphere of death, is famous. Lidner's motto *"In lacrimis voluptas"* ("there is pleasure in tears") points to the pathetic element in his poetry and in his emotional life. He was musical, and his verse is melodious.

Lidner's *Samlade arbeten,* in 2 vol.. were published in 1788; there is an incomplete critical ed. (1930–39).

See also K. J. Warburg, *Lidner* (1887); *M.* Lamm, *Lidnerstudier,* in *Samlaren* (1909). *(S. E.)*

LIE, JONAS LAURITZ EDEMIL (1833–1908), Norwegian novelist, was born on Nov. 6, 1833, close to Hougsund (Eker), near Drammen. In 1838 his father being appointed sheriff of Tromso, the family moved to that arctic town. There he gained acquaintance with the wild seafaring life which he was afterward to describe. He went to the University of Christiania (Oslo), where Henrik Ibsen and Bjornstjerne Bjornson were among his fellow students. On completing his studies he began to practise as a solicitor in Kongsvinger. In 1860 he married his cousin, Thomasine Lie. who collaborated with him in his work.

In 1866 he published his first book. a volume of poems. Financial embarrassment drove him to Christiania to try his luck as a man of letters. As a journalist he had no success, but in 1870 he published a melancholy little romance, *Den Fremsynte* (Eng. trans., *The Visionary,* 1894), which made him famous. Lie proceeded to Rome and published *Tales* in 1871 and *Tremasteren "Fremtiden"* (Eng. trans., *The Barque "Future,"* 1879), a novel, in 1872. *Lodsen og hans Hustru (The Pilot and His Wife,* 1874), placed him at the head of Norwegian novelists, and brought him a small government stipend. Lie spent the next few years partly in Dresden, partly in Stuttgart. Back in Norway, he began a series of novels of life in Christiania. He returned to Germany, then moved to Paris (1882–91), and, after a year in Rome, returned to Norway. He died at Christiania on July 5, 1908. Two of his most successful novels were *The Commodore's Daughters* (1886) and *Niobe* (1894). In 1891–92 he wrote. under the influence of the new romantic impulse, 24 folk tales! 2 volumes entitled *Trold.* Some were translated by R. N. Bain in *Weird Tales* (1893), illustrated by L. Housman. His *Samlede Vaerker* were published at Copenhagen in 14 volumes (1902–04).

As a novelist he stands with those minute and unobtrusive painters of contemporary manners who defy arrangement in this or that school. (E. *G.;* X.)

LIE, (MARIUS) SOPHUS (1842–1899), Norwegian mathematician, who made significant contributions to the theories of algebraic invariants and differential equations, was born at Nordfjordeid, near Bergen, on Dec. 17, 1842. Educated at the University of Christiania (now Oslo), in 1869 he went to Berlin and there met Felix Klein. in conjunction with whom he afterward published several papers. In 1871 he was appointed assistant tutor in Christiania university, in the same year submitting for his doctor's degree his famous memoir *Geber Complexe, insbesondere Linien- und Kugel-Complexe, mit Anwendung auf die Theorie partieller Differential-Gleichungen,* in which he advanced the theory of tangential transformations. He was appointed extraordinary professor in 1872, and the following year began his researches on continuous transformation groups and discovered his transformation. making a sphere correspond to a straight line. In 1884 Ernst Engel went to assist Lie, and after nine years' work was published *Theorie der Transformationsgruppen* (3 vol., Leipzig, 1893), a work of wide range and great originality. It was followed by joint works with G. Scheffers *Geometrie der Berührungstransformationen* (1896). In 1886 Lie succeeded Klein in the chair of mathematics at Leipzig, Engel being appointed his assistant. In 1898 he returned to Christiania to accept a special post created for him, but his health was already broken and he died on Feb. 18, 1899. Besides his development of transformations, Lie made contributions to differential geometry; but his primary aim was the advancement of the theory of differential equations.

An analysis of Lie's works is given in the *Bibliotheca Mathematica* (1900); his collected works are contained in *Gesammelte Abhandlungen*, 6 vol. (1922–1937). (O. OE.; X.)

LIE, TRYGVE HALVDAN (1896–), Norwegian statesman, was the first secretary-general of the United Nations. He was born in Oslo, Norway, July 16, 1896. Educated at Oslo university, he became a leading Labour party lawyer and politician, and in 1940 became foreign minister of the Norwegian government-in-exile. On Feb. 1, 1946, he was elected UN secretary-general for a term of five years.

As secretary-general, Lie exercised and developed the political authority of his untried office in the Iran, Palestine and other cases, and, in 1950, undertook a "peace mission" to great power capitals designed to end the Soviet boycott over Chinese representation and to advance his "Twenty Year Peace program."

His important support of the UN police action in Korea led to his denunciation by the Soviet bloc, whose opposition to his renomination was overridden in 1951 by extending his term for three years. The barrier to his mediatorial activities raised by continuing Soviet refusal to recognize him as secretary-general was a principal cause of Lie's submitting his resignation in November, 1952, in a context of criticism of his personnel policies.

See, Trygve Lie, *In the Cause of Peace* (1954) and Stephen M. Schwebel, *The Secretary-General of the United Nations* (1952). (S. M. S.)

LIEBER, FRANCIS (1800–1872), U.S. political philosopher whose code of military regulations for the conduct of the federal troops in the Civil War became the basis of the Hague conventions of 1899 and 1907, was born in Berlin. Ger., on March 18, 1800. After studying mathematics at the universities of Jena, Halle and Dresden in 1820–21, he joined an expedition to free Greece from Turkish rule. On returning to Berlin in 1823, he was soon, as on a previous occasion, imprisoned without trial by the Prussian police on suspicion of being a revolutionary; he emigrated to the United States in 1827.

His first important venture in his new home was the *Encyclopaedia Americana* (13 vol., 1829–33). In 1835 he obtained the professorship of history and political economy at South Carolina college, where he made his reputation as a political theorist with his *Manual of Political Ethics* (2 vol., 1838–39), *Legal and Political Hermeneutics* (1839) and *On Civil Liberty and Self-Government* (1853). In 18j7, when Columbia college in New York city began to expand into a university, Lieber was appointed to the new chair of history and political science, and in 1865 he became professor of constitutional history and public law in the Columbia law school. During the Civil War, while a member of a war department board, he prepared the codified *Instructions for the Government of the Armies of the United States in the Field*, which was issued by the adjutant general's office as *General Orders No. 100* (1863). This codification became international law through embodiment in the Hague conventions of 1899 and 1907.

To Lieber, the national polity was the normal type of government in modern civilization. However, he deprecated "centralization," which he described as the converging of all the "rays of power into one central point"; whereas nationalization was the "diffusion of the same life blood through a system of arteries, throughout the body politic." His most distinctive contribution was the view that civil liberty could be realized only through the development of a "vast system of (self-governing) institutions, where number supports the whole, as the many pillars support the rotunda of our capitol." Lieber died on Oct. 2, 1872.

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LIEBERMANN, MAX (1847–1935), painter and etcher, who became a leader of the German Impressionist school, was born in Berlin on July 20, 1847. After studying under Steffeck, he entered the school of art at Weimar in 1869. Though the straightforward simplicity of his first exhibited picture, "Women Plucking Geese" (Berlin, National gallery) in 1872, presented already a striking contrast to the art then in vogue, it was heavy and bituminous in colour. In his course he was confirmed by Michael von Munkacsy's influence in Paris in 1872. A summer spent at Barbizon in 1873, where he became acquainted with Jean François Millet and studied the works of Jean Baptiste Corot, Constant Troyon and Charles Daubigny, resulted in the brightening of his palette. He subsequently went to the Netherlands, where the example of Josef Israels confirmed him in the method he had adopted at Barbizon; on his return to Munich in 1878 he caused much unfavourable criticism by his realistic painting of "Christ in the Temple," which was condemned by the clergy as irreverent. His later work showed the influence of French and German Impressionism, overlaid with his personal style. He devoted himself exclusively to the study of light and to the painting of the life of humble folk. He found his best subjects in the orphanages and asylums for the old in Amsterdam, among the peasants of the Netherlands, and in the beer gardens, factories and workrooms of his own country.

Liebermann did for his country what Millet did for France. His pictures hold the fragrance of the soil. His people move in their proper atmosphere and their life is stated in all its monotonous simplicity. His work being at variance with the academic tradition he became the leader of the *Berliner Sezession (see* PAINTING: *Expressionism and the German school)*. His first success was a medal awarded him for "An Asylum for Old Men" at the 1881 salon. Then followed "The Cobbler's Shop" (1881) and "The Flax Spinners" (1887). In 1884 he settled in Berlin, where he became president of the academy. Liebermann's painting and etchings are represented in many of the leading continental galleries. He died in 1935.

LIEBIG, JUSTUS VON, BARON (1803–1873), German chemist and biochemist, who synthesized chloroform and with Friedrich Wohler established the existence of organic radicals, was born at Darmstadt on May 12, 1803. His father, a dealer in chemicals and colours, occasionally made experiments in the hope of improving his processes and, thus the son early acquired familiarity with practical chemistry. For the theoretical side he read all the textbooks which he could find, somewhat to the detriment of his ordinary school studies. Having determined to make chemistry his profession, at the age of 15 he entered the shop of an apothecary at Appenheim, near Darmstadt; but he soon found how great is the difference between pharmacy and scientific chemistry, and the explosions and other incidents that accompanied his private efforts to increase his chemical knowledge disposed his master to view without regret his departure at the end of ten months. In 1820 he entered the University of Bonn, but migrated to Erlangen when the professor of chemistry, K. W. G. Kastner (1783–1857), was appointed in 1821 to the chair of physics and chemistry at the latter university. He followed this professor to learn how to analyze certain minerals, but in the end he found that the teacher himself was ignorant of the process. Indeed, as he himself said afterward, it was a wretched time for chemistry in Germany. No laboratories were accessible to ordinary students, who had to content themselves with what the universities could give in the lecture room and the library, and though both at Bonn and Erlangen Liebig endeavoured to make up for the deficiencies of the official instruction by founding a students' physical and chemical society for the discussion of new discoveries and speculations, he felt that he could never become a chemist in his own country. Therefore, having been graduated as Ph.D. in 1822, he left Erlangen—where he subsequently complained that the contagion of the "greatest philosopher and metaphysician of the century" (Friedrich von Schelling), in a period "rich in words and ideas, but poor in true knowledge and genuine studies," had cost him two precious years of his life—and by the liberality of Louis I, grand duke of Hesse-Darmstadt, was enabled to go to Paris.

There by the help of Louis J. Thénard he gained admission to the private laboratory of H. F. Gaultier de Claubry (1792–1873), professor of chemistry at the École de Pharmacie, and soon afterard. by the influence of Alexander von Humboldt. to that of Joseph Gay-Lussac. He attended lectures of Gay-Lussac, Thénard, Pierre Dulong, Alexis Petit, Pierre Laplace and Georges Cuvier. There he concluded, in 1824, his investigations of the fulminates. It was on Humboldt's advice that he determined to become a teacher of chemistry, but difficulties stood in his way. As a native of Hesse-Darmstadt he ought, according to the academical rules of the time, to have studied at and been graduated from the University of Giessen, and it was only through the influence of Humboldt that the authorities forgave him for straying to the foreign University of Erlangen. After examination, his Erlangen degree was recognized, and in 1824 he was appointed extraordinary professor of chemistry at Giessen, becoming ordinary professor two years later. In this small town his most important work was accomplished. His first care was to persuade the Darmstadt government to provide a chemical laboratory in which the students might obtain a proper practical training. The laboratory, unique of its kind at the time, in conjunction with Liebig's unrivaled gifts as a teacher, soon rendered Giessen the most famous chemical school in the world; men flocked from every country to enjoy its advantages, and many of the most accomplished chemists of the 19th century (*e.g.*, August W. von Hofmann, Charles A. Wurtz, Sir Edward Frankland, Friedrich A. Kekulé von Stradonitz, Charles F. Gerhardt, *qq.v.*) had it to thank for their early training. Further, it gave a great impetus to the progress of chemical education throughout Germany, for the continued admonitions of Liebig combined with the influence of his pupils induced many other universities to build laboratories modeled on the same plan. Ennobled in 1845, Liebig remained at Giessen for 28 years, until in 1852 he became professor of chemistry at Munich university, and this office he held, although he was offered the chair of chemistry at Berlin in 1865, until his death, which occurred at Munich on April 18, 1873. His grave is in the Alt Süd Friedhof.

Pure Chemistry.—Here Liebig's work includes improvements in technique of organic analysis, his method for determining the natural alkaloids and for ascertaining the molecular weights of organic bases by means of their chloroplatinates, his process for determining the quantity of urea in a solution, and his invention of the potash bulb, formerly known in every laboratory. He did not invent the condenser commonly known as the "Liebig" condenser, but popularized its use. His contributions to inorganic chemistry were numerous, including investigations on the compounds of antimony, aluminum, silicon, etc., on the separation of nickel and cobalt and on the analysis of mineral waters; but they are outweighed in importance by his work on organic substances. In this domain his first research was on the fulminates of mercury and silver, and study of these substances led him to the discovery of the isomerism of cyanic and fulminic acids. Further work on cyanogen and related substances yielded a great number of interesting derivatives. He also described an improved method for the manufacture of potassium cyanide and for the analysis of cyanides by titration with silver nitrate.

In 1832 he published, jointly with Friedrich Wohler (*q.v.*), one of the most famous papers in the history of chemistry, that on the oil of bitter almonds (benzaldehyde), wherein it was shown that the radical benzoyl might be regarded as forming an unchanging constituent of a long series of compounds. Jöns J. Berzelius hailed this discovery as marking the dawn of a new era in organic chemistry. A continuation of their work on bitter almond oil by Liebig and Wohler resulted in the elucidation of the mode of formation of that substance and in the discovery of the ferment emulsin as well as the recognition of the first glucoside, amygdalin. Another and not less important and far-reaching inquiry in which they collaborated was that on uric acid, published in 1837. About 1832 he began his investigations into the constitution of ether and alcohol and their derivatives. These on the one hand resulted in the enunciation of his ethyl theory, by the light of which he looked upon those substances as compounds of the radical ethyl; on the other they yielded chloroform, chloral and aldehyde, as well as other compounds, and also the method of forming mirrors by depositing silver from a slightly ammoniacal solution by acetaldehyde. In 1837, with J. B. A. Dumas, he published a note on the constitution of organic acids, and in the following year an elaborate paper on the same subject appeared under his name alone; by this work Thomas Graham's doctrine of polybasicity was extended to the organic acids. Liebig also did much to further the hydrogen theory of acids.

Animal and Vegetable Physiology.—These and other studies in pure chemistry mainly occupied his attention until about 1838, but the last 35 years of his life were devoted more particularly to the chemistry of the processes of life, both animal and vegetable. In animal physiology he attempted to trace out the operation of chemical and physical laws in the maintenance of life and health. To this end he examined such vital products as blood, bile and urine; he analyzed the juices of flesh, establishing the composition of creatine and investigating its decomposition products, creatinine and sarcosine; he classified the various articles of food in accordance with the special function performed by each in the animal economy and expounded the philosophy of cooking. In opposition to many of the medical opinions of his time he taught that the heat of the body is the result of the processes of combustion and oxidation performed within the organism. A secondary result of this line of study was the preparation of his food for infants and of his world-famous extract of meat.

Vegetable physiology he pursued with special reference to agriculture. His first publication on this subject was *Die Chemie in ihrer Anwendung auf Agricultur und Physiologie* in 1840, which was at once translated into English by Lyon Playfair. Rejecting the old notion that plants derive their nourishment from humus, he taught that they get carbon and nitrogen from the carbon dioxide and ammonia present in the atmosphere, these compounds being returned by them to the atmosphere by the processes of putrefaction and fermentation, while their potash, soda, lime, sulfur, phosphorus, etc., come from the soil. Of the carbon dioxide and ammonia no exhaustion can take place, but of the mineral constituents the supply is limited because the soil can not afford an indefinite amount of them; hence, the chief care of the farmer, and the function of manures, is to restore to the soil those minerals which each crop is found, by the analysis of its ashes, to take up in its growth. On this theory he prepared artificial manures containing the essential mineral substances together with a small quantity of ammoniacal salts, because he held that the air does not supply ammonia fast enough in certain cases, and carried out systematic experiments on ten acres of poor sandy land which he obtained from the town of Giessen in 1845. But in practice the results were not wholly satisfactory, and it was a long time before he recognized one important reason for the failure in the fact that to prevent the alkalis from being washed away by the rain he had taken pains to add them in an insoluble form, whereas, as was ultimately suggested to him by experiments performed by J. T. Way about 1850, this precaution was not only superfluous but harmful, because the soil possesses a power of absorbing the soluble saline matters required by plants and of retaining them, in spite of rain, for assimilation by the roots.

Liebig's literary activity was very great. The Royal society's *Catalogue of Scientific Papers* enumerates 318 memoirs under his name, exclusive of many others published in collaboration with other investigators. In 1832 he founded the *Annalen der Pharmazie*, which became the *Annalen der Chemie und Pharmazie* in 1840 when Wohler became joint editor with him, and *Annalen der Chemie* in 1874. In 1837 with Wohler and Johann Poggendorff he established the *Handworterbuch der reinen und angewandten Chemie*. After the death of Berzelius he continued the *Jahresbericht* with H. F. M. Kopp.

The following are his most important separate publications, many of which were translated into English and French almost as soon as they appeared: *Anleitung zur Analyse der organischen Körper* (1837); *Die Chemic in ihrer Anwendung auf Agrikultur und Physiologie* (1840); *Die Thier-Chemie* (1842); *Handbuch der organischen Chemie* (1843); *Chemische Briefe* (1844); *Chemische Cntersuchungen über das Fleisch* (1847); *Die Grundsatze der Agrikultur-Chemie* (1855); *Über Theorie und Praxis in der Landwirthschaft* (1856); *Naturwissenschaftliche Briefe* (1859). A posthumous collection of his miscellaneous addresses and publications appeared in 1874 as *Reden und Abhandlungen,* edited by his son George (b. 1827). His criticism of Francis Bacon, *Über Francis von Verulam,* was first published in 1863 in the *Augsburger allgemeine Zeitung,* where also most of his letters on chemistry made their first appearance. His autobiographical notes appeared in *Berichte der deutschen chemischen Gesellschaft* (1890).

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LIEBKNECHT, KARL (1871–1919), German socialist, was born in Leipzig on Aug. 13, 1871. The son of Wilhelm Liebknecht (*q.v.*), he qualified as a lawyer, and became a prominent member of the extreme left wing of the Social Democrat party. After serving a sentence of 18 months' imprisonment for high treason, in 1908 he was elected to the Prussian chamber of deputies and in 1912 entered the reichstag as a Social Democrat. He was one of a small group who refused to vote war credits in 1914. He violently opposed the war and the successive votes of credit. He organized antiwar demonstrations, and in 1916 gave the police the desired opportunity for arresting him by shouting "down with the war" to some troops passing through the Potsdamer Platz. He was condemned to two years' penal servitude, and was released only on Oct. 22, 1918. Before his imprisonment he had founded the international group, later the Spartacus Union, the policy of which was based on the full execution of the Erfurt program. Liebknecht's condemnation was the signal for a strike of the metalworkers in Berlin organized by the Spartacists independently of the trade unions. On his release in 1918 he placed himself at the head of the Spartacists and demanded a "free socialist republic," but the independent socialists had joined hands with the Ebert party, and Liebknecht's efforts failed. During the insurrection of the Spartacists in Jan. 1919 Liebknecht was arrested; while being conveyed from military headquarters in the west end of Berlin to the prison at Moabit on Jan. 15, he was brutally murdered, on the usual pretext of attempted escape. His comrade, Rosa Luxemburg, perished the same night. Their bodies were thrown into the canal; Liebknecht's was recovered and received a public funeral.

See his *Militarismus und Antimilitarismus* (1908, Eng. trans. 1918); *Briefe aus dem Felde, aus der Untersuchungschaft und aus dem Zuchthaus* (1919); H. Schumann, *Karl Liebknecht, ein unpolitisches Bild* (1919).

LIEBKNECHT, WILHELM (1826–1900), German socialist, was born at Giessen on March 29, 1826. Left an orphan at an early age, he was educated at the *gymnasium* in his native town, and attended the universities of Giessen, Bonn and Marburg. Before he left school he had become affected by the political discontent then general in Germany; he had already studied the writings of St. Simon, from which he gained his first interest in communism, and had been converted to the extreme republican theories of which Giessen was a centre. He soon came into conflict with the authorities, and was expelled from Berlin apparently in consequence of the strong sympathy he displayed for some Poles, who were being tried for high treason. He proposed in 1846 to migrate to America, but went instead to Switzerland, where he earned his living as a teacher. As soon as the revolution of 1848 broke out he hastened to Paris, but the attempt to organize a republican corps for the invasion of Germany mas prevented by the government. In September, however, in concert with Gustav von Struve, he crossed the Rhine from Switzerland at the head of a band of volunteers, and proclaimed a republic in Baden. The attempt collapsed; he was captured, and, after suffering eight months' imprisonment, was brought to trial. Fortunately for him, a new rising had just broken out, the mob burst into the court, and he was acquitted. During the short duration of the revolutionary government he was an active member of the most extreme party, but on the arrival of the Prussian troops he succeeded in escaping to France. Thence he went to Geneva, where he came into intercourse with Giuseppe Mazzini; but, unlike most of the German exiles, he was already an adherent of the socialist creed, which at that time was more strongly held in France. Expelled from Switzerland he went to London, where he lived for 13 years in close association with Karl Marx. He endured great hardships, but secured a livelihood by teaching and writing; he was a correspondent of the *Augsburger Allgemeine Zeitung.* The amnesty of 1861 opened for him the way back to Germany, and in 1862 he accepted the post of editor of the *Norddeutsche Allgemeine Zeitung,* the founder of which was an old revolutionist. Only a few months elapsed before the paper passed under Bismarck's influence. There is no more curious episode in German history than the success with which Bismarck acquired the services of many of the men of 1848, but Liebknecht remained faithful to his principles and resigned his editorship. He became a member of the *Arbeiterverein,* and after the death of Ferdinand Lasalle he was the chief mouthpiece in Germany of Karl Marx, and was instrumental in spreading the influence of the newly-founded *International.* Expelled from Prussia in 1865, he settled at Leipzig, and it is primarily to his activity in Saxony among the newly-formed unions of workers that the modern Social Democrat party owes its origin. Here he conducted the *Demokratisches Wochenblatt.* In 1867 he was elected a member of the north German reichstag, but in opposition to Lasalle's followers he refused all compromise with the "capitalists," and avowedly used his position merely for purposes of agitation while taking every opportunity for making the parliament ridiculous. He was strongly influenced by the "great German" traditions of the democrats of 1848, and, violently anti-Prussian, he distinguished himself by his attacks on the policy of 1866 and the "revolution from above," and by his opposition to every form of militarism. His adherence to the traditions of 1848 are also seen in his dread of Russia, which he maintained to his death. His opposition to the war of 1870 exposed him to insults and violence, and in 1872 he was condemned to two years' imprisonment in a fortress for treasonable intentions. The union of the German Socialists in 1874 at the congress of Gotha was really a triumph of his influence, and from that time he was regarded as founder and leader of the party. From 1874 till his death he was a member of the German *Reichstag,* and for many years of the Saxon diet. In 1881 he was expelled from Leipzig, but took up his residence in a neighbouring village. Liebknecht was the author of: *Robert Blum und seine Zeit* (Nuremberg, 1892); *Geschichte der Französischen Revolution* (Dresden, 1890); *Die Emser Depesche* (Nuremberg, 1899) and *Robert Owen* (Nuremberg, 1892). He died at Charlottenburg on Aug. 7, 1900.

See Kurt Eisner, *Wilhelm Liebknecht, sein Leben und Wirken* (1900).

LIECHTENSTEIN, one of the smallest independent sovereign states of Europe, 60 6 sq.mi. in extent. Separated on the west by the Rhine a few miles below Lake Constance from the Swiss canton of St. Gallen, it is bounded on the east by Austrian Vorarlberg, and on the south by the western crests of the Rhatikon, between Liechtenstein and Graubiinden. Snitz. The major physical divisions are (1) a small narron strip along the Rhine valley, widening northnard into the triangular lonland of the confluence of the Rhine and the tributary Ill; (2) the larger upland area, practically bisected by the Samina which feeds the Ill. The highest peaks lie southward, with Falknis (8,399 ft.), central south, and Naafkopf (8,432 ft.), southeast, at the meeting points of the three frontiers. The chief settlements are at the western foot of the uplands and not on the Rhine itself. In order from the south, they are Balzers. Triesen, Vaduz (capital and seat of government, pop. 1960, 3,398), Schaan and Nendeln. They are linked by the road joining Ragaz, Switz.. with Feldkirch, Aus. Two small settlements, Eschen and Mauern, lie in the northern triangular lowland. Liechtenstein's only railway crosses the centre of the western frontier from Buchs, Switz., and then parallels the road through Schaan and Nendeln. The population in 1960 was 16,628. largely German in origin and speech, Roman Catholic in religion and agricultural in interest. Corn, wine and fruit are grown and cattle are reared. There are also small manufactures of cotton, leather and false teeth.

The principality, founded in 1719, consisted of the lordships of Schellenburg and Vaduz, and formed part of the Holy Roman empire. It was included from 1806 to 1815 in the Rhine confederation, and from 1815 to 1866 in the German confederation. In 1866 it became independent. Prince John II (1840–1929) succeeded his father in 1858. The constitution, after 1921, provided a *Landtag* of 1 j members elected by direct vote; suffrage is universal The standing army was abolished in 1868. Until 1919 Liechtenstein was closely allied with Austria; in 1921 it adopted Swiss currency, and after 1924 it was included in the Swiss customs union. Switzerland administers its telegraph and postal services Francis I (1853–1938) succeeded his brother in 1929, and was in turn succeeded by his great-nephew, Francis Joseph II. in 1938.

The principality, not a member of the Cnited Nations. expressed the wish in 1949 to become a party to the statute of the International Court of Justice. On July 27 the Security council agreed by nine votes with two abstentions to grant this request and a similar resolution was adopted in December by the general assembly.

In the early 1960s the yearly average budget revenue exceeded 11,000,000 fr. Most of the revenue comes from taxes, but about one-fourth is derived from the sale of stamps.

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LIÈGE,[1] one of the nine provinces of Belgium, the successor of the old prince-bishopric, touching on the east Dutch Limburg and Germany. Its towns are Likge. Herstal, Verviers. Spa, Seraing, Huy, etc. The Meuse flows through the centre. and its valley from Huy to Herstal is one of the most productive mineral districts in Belgium. Agriculture in the Condroz district south of the Meuse has been much developed.

There are four administrative *arrondissements,* 28 cantons and 373 communes. The districts of Eupen, Malmédy, St. Vith and the former neutral district of Moresnet after 1919 became part of the province. Area 1,521 sq.mi. Pop. (1955 est.) 994,185 or 654 per square mile.

LIÈGE[1] (Flemish LUIK, German LÜTTICH), the chief town of the province of Likge, Belg., and between c. 1000 and 1795 the capital of the principality of Liège, lies on the Meuse at its confluence nith the Ourthe. Pop. (1947) 156,208, (195j) 154,924.

Likge is the largest French-speaking city in Belgium and the third most important river port of western Europe. The Meuse, which is deep enough to take Rhenish boats of more than 2.000 tons and some seagoing ships, connects the city with other Belgian industrial districts and with those of northern and eastern France and of the Netherlands. There is a heliport in the town. After Antwerp the most important rail centre of Belgium, Likge is also the meeting place of the great Paris-Berlin and Amsterdam-Basel roads. The Meuse flows through the centre of the town. The old part on the left bank, comprising the residential quarter, is the largest part of the city. There are several parks, one of which, the Square d'Avroy, is close to the large boulevard which runs through the city. To the west of this park are the botanic gardens.

The cathedral, which stands to the north of the Square d'Avroy, is one of many Romanesque and Gothic churches; others include St. Bartholomew's. St. Denis's, St. James's. St. John's. St. Cross and St. Martin's. The city has concert halls. theatres and an opera house. The museums of fine art and of Walloon art have a particularly fine collection of French painting from Ingres to Picasso. The Curtius and Ansembourg museums for archaeology and decorative arts house important examples of Mosan art (artifacts of the Meuse valley) and an international collection of glass. Liège has a university (1816) with well-known faculties in the fields of engineering. philology and history. The Royal Academy of Music nas founded in 188; and is famous for its violin school established by Eugene Isaye. The most important modern building in the city is the Palais des Congres (1957–58); the central university building was finished in the 20th century.

There are also several research laboratories and technical schools associated with the major industries of Liege. such as the Belgian centre for the study of water. the national centre for metallurgical research. the coal industry's national institute and a section of the nuclear sciences interuniversity institute. Liege has been an important industrial centre for many years, due, in great part. to its easy accessibility by water and road and to the presence of coal. The largest finished product is steel and of that almost one half is in the form of rolled steel. The manufacture of weapons is still an important industry.

Men have lived in the area of Liège in Paleolithic. Neolithic, Roman and Frankish times. The city. which came into being during the 8th century nhen a bishopric was established, took advantage of its favourable geographic position near the Carolingian settlements of Jupille, Herstal and Aix-la-Chapelle. About the year 1000, under the ponerful bishop Notger. it grew greatly in importance; it was the centre of Mosan art and it became one of the most famous intellectual cities of the west.

In 1131 Pope Innocent II met King Lothair (later emperor) at Liège at a council attended by St. Bernard. Its status nas that of an independent principality ruled by the prince-bishops. under the Holy Roman emperor. It was given a communal magistracy in 1185 and the strengthening of its municipal power was accompanied in the 13th and 14th centuries by sociopolitical struggles in which the town council, the cathedral chapter and the trade guilds took part.

On June 3. 1208, Philip. duke of Swabia and king of the Romans. confirmed the charter of Bishop Albert de Cuyck (1195–1200) which granted important rights to the citizens. The night of Aug. 3–4, 1312, was disastrous for the nobles and other members of the upper class and on Feb. 14, 1313, a peace was made granting political equality to the labourers and a preponderance of the trades. In the 1 jth century. during the Burgundian domination of the Netherlands, Liege was attacked by Charles the Bold and the city was ruthlessly sacked (1468). After the fall of the Burgundian power in Liège in 1477 the city was rebuilt. In the first part of the 16th century, under the prince-bishop Erard de la Marck, there was a vigorous movement in the arts deriving from the medieval rather than the Italian style. In the 17th century, when industrialization started, internal strife between the Chiroux (the pro-prince party) and the Grignoux was aggravated by the intervention of Richelieu and Mazarin. In 1684, after hard fighting. the prince-bishop Maximilian Henry of Bavaria destroyed all democratic institutions. In 1691 Liege was bombarded by the French artillery. For a century the nobles and upper classes flourished undisturbed. but their rule was ended in 1789 by a bloodless revolution. In 1795, Likge was formally joined to France, becoming chief town of the *département* of the Ourthe, and so remained until 1814 when the first treaty of Paris detached it. In 181j, the whole of the *département* of Meuse-et-Ourthe (created in 1814) was awarded to the kingdom of the Netherlands by the Congress of Vienna.

In the Belgian revolution of 1830, the Liegois under Charles Rogier played an important part: and, on Oct. 28, Liege became

[1] Liege was always spelled with a grave accent until after World War I, when the spelling with the acute accent prevailed. The grave accent was again officially decided upon in 1951.

part of Belgium. From this time, the city expanded, and its arms industry became one of the foremost in Europe. In World War I the battle of Liège (Aug. 4–16: 1914) delayed the advance of the Germans and it was only after fierce fighting that the city fell. During World War II, when Liège was the centre of the Belgian resistance, the city was heavily bombarded but the historic buildings were not badly damaged.

Jean le Bel, the 14th-century chronicler. was a native of Liège, which has numbered among its citizens many men who have made important contributions to industry, music (César Franck) and art. Three dignitaries of the ancient cathedral of Saint-Lambert became popes under the names of Crban IV, Gregory X and Innocent VI.

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LIEGE, an adjective of uncertain derivation which seems originally to have meant "simple," "unconditioned." The word is historically important because it was early used as a qualification of legal terms such as homage. In feudal law, liege homage is the homage due from a tenant to his chief lord. In course of time the idea prevailed that liege homage was due to the king. above and beyond the homage done to any immediate lords. From this idea is ultimately derived the employment of the abstract noun "allegiance." to denote the subject's duty to his sovereign.

See F. Pollock and F. W. Maitland, *History of English Law* (2nd ed., 1898). i, 298–300.

LIEGNITZ, a town of Poland, formerly in the Prussian province of Silesia. Ger., on the Katzbach, just above its junction with the Schwarzwasser. and 40 mi. W.N.W. of Breslau (Wroclaw), on the main line of railway to Berlin via Sommerfeld. Pop. (1950) 39,000. Liegnitz is first mentioned in a historical document in the year 1004. In 1163 it became the seat of the dukes of Liegnitz. who greatly improved and enlarged it. and who are buried in the church of St. John. On the death of the last duke of Liegnitz in 1675, the duchy came into the possession of the empire. which retained it until the Prussian conquest of Silesia in 1742. On Aug. 15, 1760, Frederick the Great gained a decisive victory near Liegnitz over the Austrians. It consists of an old town, and several suburbs. The palace. formerly the residence of the dukes of Liegnitz. and rebuilt after a fire in 1835, is used as the administrative offices of the district. The Ritter Akademie, founded by the Emperor Joseph I, was reconstructed as a gymnasium in 1810. The church of SS. Peter and Paul (restored in 1892–94) dates from the 14th century. The manufactures are considerable. the chief articles made being cloth, wool, leather, tobacco, pianos, clogs, sugar, and machinery. Its trade in grain and its cattle markets and market gardens are likewise important. Following World War II, Silesia was annexed by Poland and Liegnitz became Legnica, Wroclaw province.

LIEN. The word lien signifies the right of a person in possession of property belonging to another to detain such property until some debt or demand in connection with the property detained is satisfied. This right of lien arises either by implication of law or by express contract. Where, however, an express contract for security is made between parties such agreement excludes, to the extent of the express contract, any lien upon property to which it might otherwise have been subject. The possessory right conferred by lien is not a right ad rem, that is to say it does not convey to the person in possession of goods any property in them, it merely gives him a legal right to retain them until his demand is satisfied. Consequently, apart from statute or legal process authorizing him so to do, he is not entitled to sell the goods to recover what is due to him.

If the goods be not in possession of the claimant of lien, as in the case of the furniture of a tenant owing rent to a landlord, the law will indeed assist the landlord to seize the property and enable him to sell it in due course in order to pay himself out of the proceeds, but it will not give him any property in the furniture itself.

There are two descriptions of lien recognized by the English law: particular and general. Particular liens exist where persons have a right to retain possession of property in respect of labour or money expended by them on the identical chattel which constitutes the res gestae or subject matter of the dispute. Liens of this description are usually favourably regarded by the court. General liens are claims made in respect of a general balance of account between the parties.

Liens are created in three ways, either (1) by express contract, (2) by usage of trade or (3) by some legal relation between the parties, where there is no express contract, nor any usage of trade. The term legal relation applies either to those persons on whom the law throws an obligation to perform certain services whenever required so to do by any member of the public, such as an innkeeper or a common carrier, or else to a person who usefully expends time, work or money on the reparation of the chattel of another, such as a jobbing tailor, a boot repairer, a furrier, a calico printer, or indeed any person to whom goods are delivered in order to have some service performed in connection with them for which such delivery is necessary. But the mere safeguarding of the article, apart from work done upon it, will convey no right to lien in this particular form of deposit.

Again, a shipmaster (on behalf of the ouner) has a lien upon cargo for freight; and if, upon landing, notice of such lien is given to the wharfinger or narehouseman, the cargo is bound thereby in his hands, and may be subsequently sold by him upon compliance with statutory conditions (Merchant Shipping act, 1894, secs. 494–498). And a like rule applies to passengers' luggage (except wearing apparel actually in use) for unpaid passage money.

A claim to general lien, though, as already stated, not regarded with favour by the courts, may be established by special or necessarily implied agreement, or by the custom of a certain trade. By virtue of accepted custom of trade or profession, wharfingers, bankers, insurance brokers and solicitors have a lien upon the property of their employers, not only for debts arising out of the particular transaction for which the property was delivered to them, but also for a general balance of account between the parties, and this rule has been held to apply to statute barred debts (*Courtenay* v. *Williams*, 3 Hare at p. 552).

A similar principle as to general balance of account has been held applicable to the lien of calico printers and packers and locally (by the custom of Exeter) to fullers. The right to general lien is, however, incapable of transference.

Maritime Lien differs from all other forms of lien in that it neither includes nor requires actual physical possession of the ship in respect of which a maritime lien arises. It presupposes the giving of a credit coupled with a postponement intentionally made of the right to enforce it. It follows as a necessary consequence that unless the creditor has forfeited the right because of his own laches he can take legal proceedings against the ship notwithstanding any change there may have been in the ownership, and he has priority over all other titles to the ship which are not based on superior or equal liens, including mortgages already existing. It is otherwise with an existing possessory lien of a ship repairer. (Carver's Carriage by Sea, 55. 320, 692.)

The principal instances in which the law recognizes maritime liens are bottomry (*q.v.*) (*i.e.,* mortgage of ship's keel), salvage wages, master's wages, disbursements, liabilities, damage from collision, in which case the lien attaches to the wrong-doing ship.

Right of Sale or Transference of Lien.—Apart from statute a mere lien confers no right of sale on the party entitled to retain the chattels against the true owner, even if the detention be attended with trouble and expense (Thames Iron Company v. Patent Derrick *Company,* 1860, 29 L.J., ch. 714). A statutory right of sale, however, of any goods left by a guest in his custody enures, after six weeks, to an innkeeper for the amount of his bill, by virtue of the Innkeepers act, 1878 (sec. 1). By the Merchant Shipping act, 1894 (secs. 497–498), a wharfinger or warehouseman, at the expiration of 90 days from the time when goods are placed in his custody (or a shorter time if the goods be perishable) is entitled to sell them by public auction; and sec. 97 of the Railway Clauses act, 1845, authorizes railway companies to detain and sell any goods delivered to them for carriage upon default of payment of their tolls. Neither the custody of the chattel nor the accompanying lien is capable of legal transference to a third party, who is consequently, after demand and refusal, liable in trover to the true owner of the goods.

The lien of an unpaid vendor for the price of the article which he has sold to an insolvent purchaser subsists until the chattel has either been actually or constructively delivered into the hands of the latter. This lien for the price of specific goods is not determined by the mere delivery of the chattels to a carrier for the purpose of conveyance. Consequently, if the vendor can arrest the goods at any stage of the transit before they reach the hands of the purchaser or his agent the vendor reverts to the same position as if he had not parted with the possession of the goods.

The right is not devested by the purchaser endorsing over a bill of lading of the goods by way of security or for valuable consideration to a third party, with notice of the consignee's insolvency, or by a purchaser's subsale of the goods before the termination of the *transitus*, without delivery of the documents of title to an innocent third party.

Waiver and Determination of Lien.—A lien may be waived, and the right to assert the claim lost, by conduct on the part of the holder of the goods obviously inconsistent with the existence of such a right. A lien is determined by actual payment or tender of the full amount of the legal claim for which the goods are detained, but part payment of such demand is not sufficient, neither is a general tender or offer to discharge the claim without actual tender or what, in point of law, is equivalent thereto. (W. W -P.)

U.S. Differences.—In the United States, speaking generally, the law relating to liens is that of England, but there are some considerable differences occasioned by three principal causes. (1) Some of the southern states, notably Louisiana, have never adopted the common law of England. When that state became one of the United States of North America it had (and still preserves) its own system of law. In this respect the law is practically identical with the Code Napoleon, which, again speaking generally, substitutes privileges for liens, *i.e.,* gives certain claims a prior right to others against particular property. These privileges being *strictissimae interpretationis*, can not be extended by any principle analogous to the English doctrine of equitable liens. (2) Probably in consequence of the United States and the several states composing it having had a more democratic government than Great Britain, in their earlier years at all events, certain liens have been created by statute in several states in the interest of the working classes which have no parallel in Great Britain, *e.g.,* in some states workmen employed in building a house or a ship have a lien upon the building or structure itself for their unpaid wages. This statutory lien partakes rather of the nature of an equitable than of a common-law lien, as the property is not in the possession of the workman, and it may be doubted whether the right thus conferred is more beneficial to the workman than the priority his wages have in bankruptcy proceedings in England. Some of the states have also practically extended the maritime lien to matters over which it was never contended for in England. (3) By the constitution of the United States the admiralty and interstate jurisdiction is vested in the federal as distinguished from the state courts, and these federal courts have not been liable to have their jurisdiction curtailed by prohibition from courts of common law, as the court of admiralty had in England up to the time of the Judicature acts; consequently the maritime lien in the United States extends further than it does in England, even after recent enlargements; it covers claims for necessaries and by materialmen, as well as collision, salvage, wages, bottomry and damage to cargo.

Difficulties connected with lien occasionally arise in the federal courts in admiralty cases, from a conflict on the subject between the municipal law of the state where the court happens to sit and the admiralty law; but as there is no power to prohibit the federal court, its view of the admiralty law based on the civil law prevails. More serious difficulties arise where a federal court has to try interstate questions, where the two states have different laws on the subject of lien; one for example, like Louisiana, following the civil law, and the other the common law and equitable practice of Great Britain. The question as to which law is to govern in such a case can hardly be said to be decided. "The question whether equitable liens can exist to be enforced in Louisiana by the federal courts, notwithstanding its restrictive law of privileges, is still an open one" (Derris, *Contracts* of *Pledge*, 517; and see *Burdon Sugar Refining Co.* v. *Payne*, 167 U.S. 127).

LIEPĀJA (LIPAYA; Russian LIVAVA), a seaport of Latvia in 56° 32′ N., 21° 2′ E., at the northern extremity of a narrow sandy peninsula which separates Lake Libau (12 mi. long and 2 mi. wide) from the Baltic sea. Pop. (1959) 71,000. There are four harbours: the Commercial, with stone quays. storehouses for merchandise and three grain elevators; the Winter, with numerous timber yards round the quays; the Avant pier or New harbour, where regular passenger steamers berth; and the War harbour (closed shortly after the start of World War II) with two dry docks, each 600 ft. Vessels drawing more than 28 ft. can not enter the port. It is open practically the year round with the help of icebreakers.

The chief imports are coal, iron, salt, herring, grain, cotton, machinery, chemical manure and phosphates. The exports include rye, barley, oats, wool, linseed, sleepers, deals, pitprops, pulpwood, skins and hides, wheat and eggs. The port also serves as a coaling and oiling station.

Primarily because of the loss of Russian commerce, trade fell in 1920 to approximately 20% of the 1913 level. Industries before 1913 included iron and steel works and engineering yards, veneering, flour-milling, bacon-curing, tobacco manufacture, the extraction of vegetable oils, the making of colours and varnishes, brewing, distilling and leather work. Many of the factories ruined during World War I were never repaired and put into production. An immense state-owned factory, dominating the water front, produces agricultural and other heavy machines.

The port of Libau, Lyra portus, is mentioned in 1263, when it belonged to the Livonian order or Brothers of the Sword. In 1418 it was burned by the Lithuanians and in 1560 mortgaged by the grand master of the Teutonic order, to which it had passed, to the Prussian Duke Albert. In 1701 it was captured by Charles XII of Sweden, and in 1795 annexed to Russia. After 1872, when it was brought into railway connection with Moscow, Orel and Kharkov. Liepāja became an important port and developed rapidly. The Russians constructed an extensive naval port, protected by moles and breakwaters in 1893–1906. The Latvian government removed here when Riga was in German occupation in 1917–19, and Liepāja itself was occupied by German troops in 1919.

Certain areas were still in ruins in 1941, when the Germans again reoccupied the town, following the Russian occupation of 1940–41. Liepāja served as a German naval base from 1941 to 1945.

LIERNE: *see* ARCH AND VAULT.

LIERRE (French for LIER), a town in the province of Antwerp. Belg., 9 mi. S.E. of Antwerp. Its church of St. Gommarus was completed in 1557; three fine windows were given by Archduke Maximilian to celebrate his wedding with Mary of Burgundy. The cutlery and beads industries became important.

The population in 1955 was 28,9jo.

Midsummer Eve Tradition.—In the community of Lierre, according to Sir James Frazer in The *Golden Bough*, it became customary for the people to take precautionary measures to protect themselves from the "nefarious pursuits" of witches and warlocks on Midsummer eve, or St. John's eve, the day before Midsummer day (June 24), near the summer solstice.

Frazer reported that it was thought that supernatural creatures convened on that night at a designated field, where they conducted rites and were imbued with fresh powers. Hence it was necessary to secure doors and windows and seal all openings in houses, since the witches might be anxious to experiment with their newly acquired powers on the inhabitants.

LIETZMANN, HANS (1875–1942), German Protestant theologian and church historian, who combined the disciplines of classical philology and theology in order to show the connection of the Christian faith with its historical foundation, was born at Dusseldorf, on March 2, 1875. He studied at the universities of Jena and Bonn, where he became a lecturer in church history in 1900. From 1905 he was professor at the University of Jena and in 1924 was appointed professor at the University of Berlin, succeeding Adolf von Harnack. He died at Locarno, Switz., on June 25, 1942.

Lietzmann's works include *Der Menschensohn* (1896); *Catenen* (1897); *Apollinaris von Laodicea und seine Schule*, vol. i (1904); *Das Leben des heiligen Symeon Stylites* (1908); *Petrus und Paulus in Rom* (1915; 2nd ed., 1927); *Messe und Herrenmahl* (1926; Eng. ed., 1953–57); *Geschichte der alten Kirche*, 4 vol. (1932–44; Eng. ed., 1937–52), and many other books and articles. He edited *Kleine Texte für theologische Vorlesungen und Übungen* (1902 *et seq.*); *Handbuch zum Neuen Testament* (1906 *et seq.*); and *Zeitschrift fur die neutestamentliclze Wissenschaft und die Kunde der älteren Kirche* (1920 *et seq.*).

Lietzmann's autobiography to 1924 is in *Die Religionswissenschaft der Gegenwart in Selbstdarstellungen*, vol. ii (1926); a bibliography of his writings may be found in *Zeitschrift fur die neutestamentliclze Wissenschaft und die Kunde der älteren Kirche*, vol. xli, pp. 12–33 (1942). (JK. F.)

LIEUTENANT. In general use, a lieutenant is an assistant, a deputy, or one who acts in lieu of another. The term appears in this sense in the title of Douglas Southall Freeman's classic work on the American Civil War, *Lee's Lieutenants*. More specifically, in most armies of the world, a lieutenant is the lowest rank of commissioned officer; he normally commands a small tactical unit such as a platoon. The modern British pronunciation, "leftenant," stems from various Old English spellings such as *lie ftenant.*

In the British army and in the U.S. army, air force and marine corps, a *second* lieutenant is the lowest ranking commissioned officer. Above him in the U.S. services comes a *first* lieutenant (lieutenant in the British army), then a captain. In the Soviet army there is still another rank, *senior* lieutenant. The term has a somewhat different meaning in the U.S. and British navies where the lowest ranking commissioned officer is an ensign (U.S.) or commissioned officer (British). The next higher rank is lieutenant junior grade (U.S.) and sublieutenant (British) folloned by lieutenant and lieutenant commander. A navy lieutenant (U.S.) is thus equal in rank to an army, air force or marine corps captain; a navy ensign (U.S.) is equal in rank to a second lieutenant in the other services. In the Royal Air Force a flight lieutenant ranks below a squadron leader and above a flying officer.

The word also appears in combination with other military and civilian titles to denote a second-in-command or one of lower rank. A lieutenant colonel, for example, ranks below a colonel and above a major. This use of the term stems from the period of English history when colonels raised and literally owned regiments but turned over their administration to lieutenant colonels. A lieutenant general ranks below a general and above a major general. In the U.S. and British navies a lieutenant commander, as noted above, ranks between a lieutenant and a commander. The term lieutenant governor in the United States describes an elected state official who may act for the governor or take his place if the governor dies or is incapacitated. In Canada the governors of provinces bear the title of lieutenant governor. The same term in British usage describes a governor who represents the sovereign in a given area. In similar fashion the lord lieutenant of a county in England or a province in France was originally the sovereign's deputy in that area for military affairs. *See* also INSIGNIA, MILITARY; OFFICEKS.

LIEVENS (LIVENS, LIEVENSZ), **JAN** (1607–1674), versatile Dutch painter and etcher, was born in Leyden on Oct. 24, 1607. A contemporary of Rembrandt, he was a pupil of Joris van Schooten in Leyden (1615–18) and of Rembrandt's teacher Pieter Lastman in Amsterdam (1619–21). In Leyden Prince Frederick Henry bought one of Lievens' paintings and gave it to the British ambassador Sir Dudley Carleton; this probably was the cause of Lievens' stay in England (1632–35). From 163j to 1644 he lived in Antwerp. In 1644 he returned to Amsterdam, where he received important commissions and was greatly admired. Yet his last years were troubled by debts, loneliness and wandering. He was buried in Amsterdam on June 4, 1674,

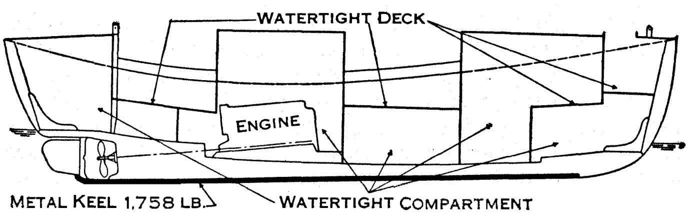
Lievens is remembered primarily for the works of his Leyden period; they derived occasional greatness from the influence of, and the competition with, his friend Rembrandt. The diary of the connoisseur Constantijn Huygens, who visited the young men about 1629, contains a fascinating estimate of their respective abilities; while he correctly sensed a certain grandiloquence in Lievens' works, some of them do approach Remhrandt's rather closely. and there were cases of collaboration. He painted biblical, allegorical and mythological subjects, figures of saints, old men and children. portraits and genre scenes. During his stay in Antwerp his art acquired a strong flavour of the style of Van Dyck. Some of his excellent landscapes were long attributed to his friend Adriaen Brouwer. During his later years in Holland, the Flemish element in his art recommended him to official circles, and he was commissioned to paint decorative canvases for the town hall in Amsterdam and other buildings. Some of his early etchings are worthy of Rembrandt. He also made eight woodcuts of surprising originality. (W. Sw.; X.)

LIF AND LIFTHRASIR. In Scandinavian mythology, Lif, a man, and Lifthrasir, a woman ("Life and Vitality"), are the human couple who survive the period of chaos when the world comes to an end. According to the myth, Lif and Lifthrasir are destined to become the progenitors of a new race on the earth. *See* RAGNAROK.

LIFE: *see* BIOLOGY; DEATH (BIOLOGICAL); LIFE EXPECTANCY; REPRODUCTION.

LIFEBOAT AND LIFESAVING. Lifeboats are specially constructed for the purpose of saving lives in peril on the water. They usually measure from 25 to 52 ft. in length. The type of lifeboat carried aboard a vessel for use in an emergency has special features for survival on the open sea, but it seldom has the characteristics which provide safety when proceeding through heavy surf to the shore. Shore-based lifeboats are designed to put out from land and aid persons in distress. They are used by governmentally supported lifesaving organizations and by privately sustained lifesaving institutions; they are constructed to stay afloat under adverse sea conditions in which other boats would be helpless. The ability to meet these conditions requires special characteristics such as sturdiness, self-righting ability, reserve buoyancy, and maneuverability in surf particularly in reversing direction.

Figures 1 and 2 illustrate the self-bailing, self-righting design



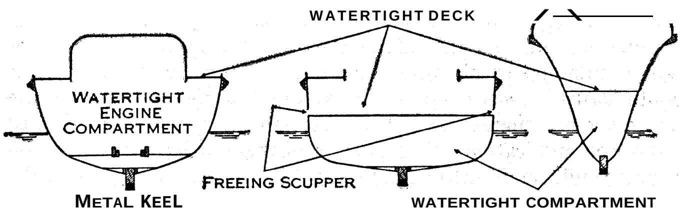
BY COURTESY OF THE UNITED STATES COAST GUARD

FIG. 1.—PROFILE OF SELF-BAILING AND SELF-RIGHTING MOTOR LIFEBOAT

of the motor lifeboat which accommodates survivors in watertight compartments. This U.S. version is 36 ft. 8 in. long, 9 ft. $5\frac{1}{4}$ in. wide, and has a draft of 3 ft. 5 in. and weighs about $10\frac{1}{2}$ tons. It is constructed of $1\frac{1}{8}''$ wood planking and has watertight decks and compartments. It is powered by an 85–110 h.p. diesel engine. The keel is bronze and weighs about one ton. It operates from sheltered inlets. Figure 3 shows a motor surfboat of smaller size than the lifeboat. It is self-bailing but not self-righting. The pulling surfboat illustrated in figure 4 can be hauled along the shore and launched directly into the surf.

British lifeboat design does not stress the self-righting feature. As most British lifeboats go well out to sea, they sacrifice self-righting ability for a broader beam and greater stability. They are built in the following lengths: 36, 42. 47, and 52 ft. They are powered by diesel engines, with the smaller boats having 20 h.p. and the larger boats having 60 and 72 h p. The speed varies from seven and one-half knots in the smaller boats to nine knots in the larger craft. The capacity of the 36-ft. boat is 37 persons; the 42-ft boat accommodates about 85 persons; the two larger boats can carry over 100 persons.

The term lifesaving, when considered in connection with lifeboats, refers to the organized efforts of specially trained groups of individuals for aiding persons in danger on the water, in the water and even over the water. (*See* also DROWNING AND LIFE-



BY COURTESY OF THE UNITED STATES COAST GUARD

FIG. 2.— SECTIONAL VIEWS OF 36-FT. SELF-BAILING, SELF-RIGHTING MOTOR LIFEBOAT

SAVING.) Before World War II the meaning of the term was limited to efforts to save life or render assistance by use of the lifeboat. the line-throwing and breeches-buoy apparatus and the application of resuscitation for the apparently drowned. During the war there were many mass flights of aircraft over water and airmen were frequently forced down offshore. Great Britain and the United States both recognized the importance of saving these highly trained men, as well as the crews of numerous torpedoed surface vessels. Great efforts were made to improve lifesaving techniques and equipment. "Air sea rescue" was the name originally applied to the highly co-ordinated system of a rescue direction centre controlling all communications, electronic devices, rescue ships. airplanes, lifeboats and other equipment capable of assisting in saving such lives. Following World War II when air transportation became a globe-encompassing industry, finding the exact location of a disaster scene in the vast ocean spaces became a paramount consideration, and the term for lifesaving throughout the world became "search and rescue."

HISTORICAL BACKGROUND

Records indicate that organized lifesaving was inaugurated by the Chinese centuries before its establishment in the occident. Certain Chinese benevolent institutions supported lifesaving services on the Yangtze and other large rivers. These services succoured those in danger. prevented casualties by ferrying passengers and accompanying junks across rivers in stormy weather, and provided rest houses where shipwrecked persons could find shelter and food. Special "red boats" were built and manned for rescue purposes. As a final service. arrangements were made with associated institutions to provide coffins and decent burials for persons found drowned.

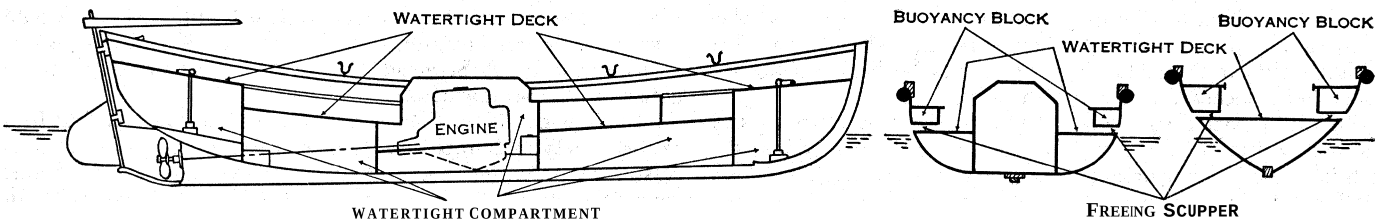
In the western world the need for action to prevent loss of life from drowning and shipwreck was recognized by several nations at about the same period. The French are credited with a number of original ideas which were not always put to practical use. In 1757 René de Réaumur sent a report to the Academy of Sciences at Paris regarding the resuscitation from drowning of several persons in Switzerland. The first "insubmergible" boat was constructed and tested on the Seine by M. Bernières in 1765. It was decked over at the bow and stern and contained airtight boxes under each deck for reserve buoyancy. Although the test found this boat to be practical it was not put into service at that time. About this same period M. Gelacy designed a life belt that would support its wearer in water. In 1796 M. La Fbre of France was a contemporary of Sergeant Bell of the royal artillery in the design of a line-throwing gun.

The Netherlands has the distinction of establishing the first lifesaving society in Europe shortly after Réaumur reported his successful resuscitation cases. Established at Amsterdam, it mas named Society for the Recovery of the Apparently Drowned. In 1773 the records of the Dutch society were translated into English and the following year a group of 32 prominent Londoners, headed by B. Hawes who had been paying rewards personally for saving life from drowning, founded the Royal Humane Society for Recovery of Persons Apparently Drowned or Dead. In the United States, similarly interested individuals founded the Massachusetts Humane society in 1785. The chief aim of these societies was the saving of life by swimming and resuscitation, but it is interesting to note that rescue from shipwreck quickly became part of their plan. As early as 1787 the Massachusetts Humane society launched a program which resulted in the construction of 17 huts for the shelter and succour of persons shipwrecked on the shores of that state. In England a comparatively early annual report of its society contains a short chapter describing a life raft, and a long chapter on Captain Manby's method of rescuing shipwrecked persons by means of his line-throwing gun. These early efforts by humane societies led to the establishment of the Royal National Life-boat institution operating in the British Isles and Ireland, and of the U.S. lifesaving service (now coast guard).

Great Britain.—Some of the first practical steps in both lifesaving and lifeboat construction were taken by Great Britain. The start was made in 1785 by a London coachbuilder, Lionel Lukin, who converted a Norway yawl into an "unimmergible" boat by adding airtight cases in the ends of the boat and along the inside above and below the thwarts (seats). He also added an iron keel for stability, and a thick layer of cork outside the gunwales for added buoyancy and protection against buffeting. This boat was stolen during tests, but the same principles of construction were used in rebuilding a Northumberland coble which became the first European boat used solely as a lifeboat; it was assigned to the first lifesaving station, established in 1786.

The activation of the first lifesaving station in England and the western world resulted from the philanthropic work of John Sharp, archdeacon of Northumberland, who administered the trust funds left for charitable purposes from the Bamburgh, Northumberland estates of Lord Crewe, bishop of Durham. Sharp instructed Lukin to convert the coble mentioned above into the first lifeboat. In order to get the most efficient use from his lifeboat Sharp placed a continuous watch in the tower of Bamburgh castle, and during bad weather he had two men patrol the coast on horseback for the purpose of locating and giving fast notice to his lifeboat crew of any shipwrecked vessel. Also, during fog, he had his men toll a bell and fire a cannon at intervals as a preventive warning signal. Thus, Archdeacon Sharp recognized and put into operation the basic duties of a lifesaving station—lookout watch, beach patrol, rescue by lifeboat, and preventive warnings.

Still other practical developments in the lifesaving field which originated in England are of interest. Following the tragic shipwreck in 1789 of the "Adventure" at the mouth of the Tyne, witnessed by helpless crowds on shore, a group of gentlemen from Newcastle sponsored a competition for the design of a boat that would right itself when capsized and would retain its buoyancy when manned and nearly full of water. William Wouldhave, a house painter, won half the prize for his model of the first English self-righting boat. Not fully satisfied with Wouldhave's design, the prize committee then drew up plans of its own and instructed Henry Greathead, uho had also entered the contest, to build the first boat designed solely for lifesaving. Greathead added to the design submitted by the committee by using a curved keel, but Wouldhave's self-righting principle was not included, probably because of the extra weight. When completed in the latter part of 1789, this go-ft., 10-oared, double-ended lifeboat was named the "Original." She remained in service in the vicinity of Newcastle



BY COURTESY OF THE UNITED STATES COAST GUARD

FIG. 3.—PROFILE AND SECTIONAL VIEWS OF 25-FT. SELF-BAILING MOTOR SURFBOAT

for 40 years, and because of her early successful rescues she became the prototype for 30 other lifeboats built by Greathead.

In 1807 Capt. George Manby, an artilleryman, developed the first practical line-thrcwing mortar with a range of from 250 to 320 yd. After firing a line to the wreck a life cot was hauled back and forth between the ship and the shore to bring the crew and passengers to safety. This mas the forerunner of the breeches buoy, and the completely enclosed life car. A similar line-throwing apparatus propelled by a rocket was invented in 1821 by Trengrouse. In addition to its greater range, it was much lighter than the mortar and could be transported along the shore with greater ease. This apparatus was further perfected in 1832 by John Dennett.

The most important development in the history of lifesaving in England took place in 1824 following a crusading campaign by Sir William Hillary of the Isle of Man for action to reduce the terrible loss of life from shipwreck occurring at that period. Chiefly through his efforts, prominent London citizens founded the National Institution for the Preservation of Life from Shipwreck. In 1854 this voluntarily supported society was named the Royal National Life-boat institution. It has served as a model for the formation of lifeboat societies in many other countries. In 1924, on the 100th anniversary of the founding of the institution, the first international lifeboat conference met in London; it was followed at four-year intervals by similar conferences in other cities.

During World War II, lifeboats of the institution were launched on service 3.760 times and rescued a total of 6,376 lives. By the end of the 1950s the institution controlled 151 lifeboat stations of which 78 were in England, the Scilly Isles and the Isle of Man; 31 in Scotland; 22 in Ireland; 18 in Wales; and two in the Channel Islands. The crews of the lifeboats consisted mainly of part-time volunteers, though the institution paid retaining fees to coxswains and other officers, and wages to part-time and full-time coxswains and mechanics.

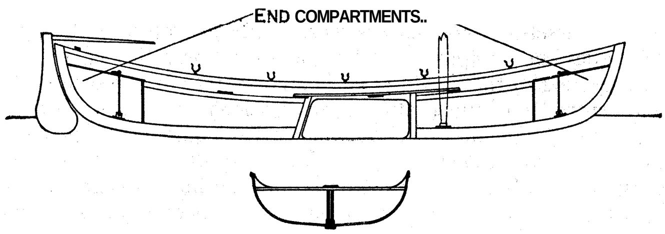
United States.—In tracing similar developments in the United States we must consider the difference in coastal topography and density of population in shore areas as compared mith that of Europe. In the United States during the 18th and 19th centuries most of the shore was a flat, uninhabited beach extending for miles and separated from the populated region by swamps and inlets. These conditions affected the development of lifesaving in three ways. First, there were fem people to witness a shipwreck and arouse public interest in remedial action. Second, because of the sparse coastal population there were only a few capable volunteers available for operating lifesaving equipment. Third, because rescue boats were usually launched from the beach. most surfmen preferred a lighter and more maneuverable boat than the heavier lifeboat with its self-righting and self-bailing characteristics. Because of these conditions, organized lifesaving lagged somewhat behind that in Europe. It is also noteworthy that when interest in rescue was aroused help had to be obtained from governmental sources.

The Massachusetts Humane society, as noted above: took the first step in 1787 with the construction of shelter huts on uninhabited beaches. This society next built and maintained a lifeboat, manned by volunteers, at Cohasset, a potentially dangerous spot on the approaches to Boston harbour. This boat was in service from 1807 to 1813. She was a 30-ft. whaleboat type of craft with a 10-ft. beam and considerable cork added for reserve buoyancy.

In 1816 a New York boatbuilder, Joseph Francis, built his first lifeboat. This boat's design was improved during the next few years when it became known as the "hydrogen lifeboat" because it obtained its reserve buoyancy from hydrogen tanks secured in the double bottom. The inner cockpit deck was made higher than the level of the sea so that water entering the cockpit would flow overboard through freeing ports in the boat's double bottom. It became popular as a lifeboat carried aboard ship.

In 1832 the national government showed its first interest in lifesaving when the secretary of the treasury ordered several revenue cutters to cruise along the Atlantic coast and give seaborne commerce special protection during the winter season. This winter cruising mas made a regular duty of the revenue marine by an act of congress passed in 1837, and it was continued until radio communication made such cruising unnecessary. Joseph Francis built his first life car in 1837, but it was ten years in development; when finally perfected it was a completely covered corrugated metal boat. This ten-foot life car held three or four people and was used in connection with a line-throwing mortar to haul shipwrecked crews and passengers through the surf from stranded vessels to the shore. Shortly after being put into service one of these life cars saved 201 persons from a ship wrecked on the New Jersey shore.

In 1840 the Massachusetts legislature appropriated $5,000 to assist the Massachusetts Humane society in the building of lifeboats. Of these ten were financed with state funds and one with funds from the society. A national humane organization known as

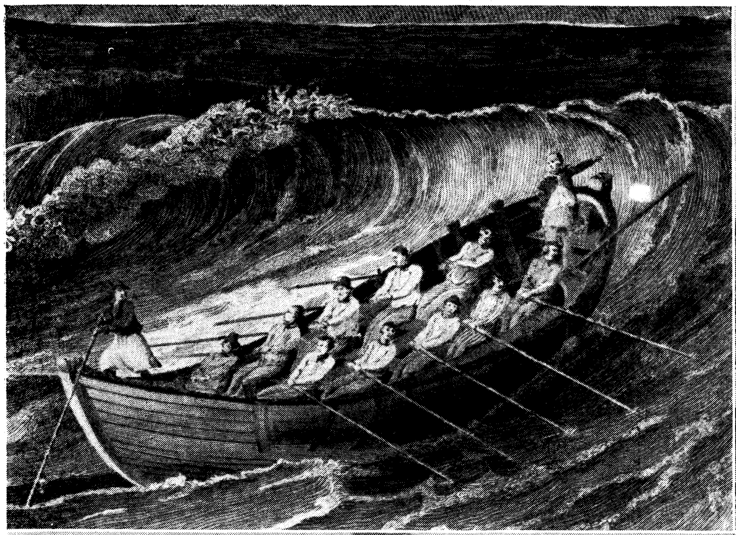


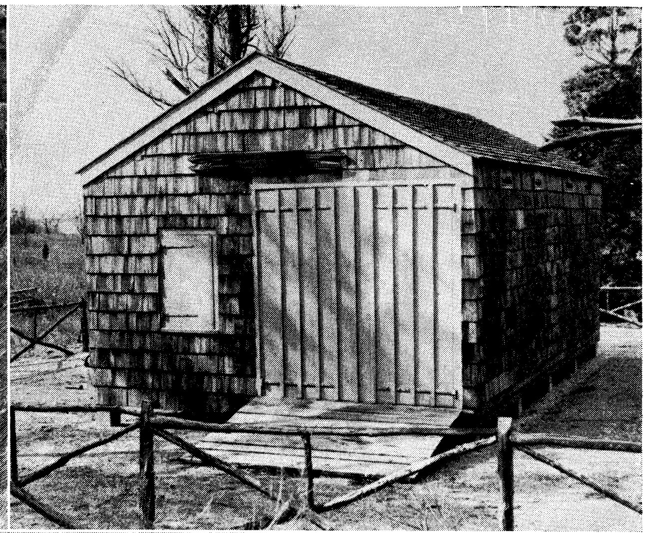
BY COURTESY OF THE UNITED STATES COAST GUARD

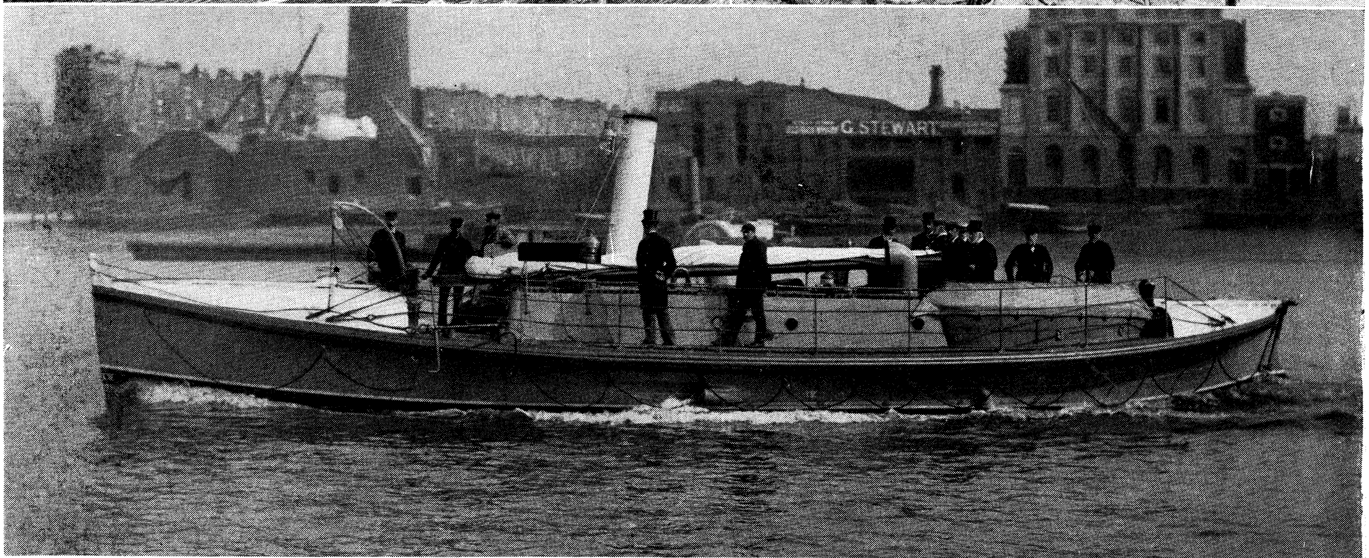
FIG. 4.— PROFILEAND MIDSHIP SECTION OF 26-FT. SURFBOAT

the American Shipwreck and Humane society was founded in 1843. Although James Fenimore Cooper and a number of other prominent New York men mere original board members: the society did not appear prominently in later lifesaving records. The federal government acted again in 1847 by appropriating $5,000 for furnishing lighthouses on the Atlantic coast mith means of rendering assistance to shipwrecked mariners, but because of a technicality in the law the money could not be spent as originally intended. The funds were later used to provide lifesaving equipment for the Massachusetts Humane society. More federal aid came from congress in 1848 with the appropriation of $10,000 for the purpose of placing lifesaving equipment along the New Jersey coast. These two appropriations were chiefly the result of efforts of congressman William A. Newell of Imlaystown, N.J., who was dedicated to the work of saving lives from drowning by shipwreck and who campaigned and was elected on such a platform.

Capt. D. Ottinger of the revenue marine was directed to put into effect the 1848 act of congress, and with the funds appropriated he built several small boathouses and equipped each with a fisherman type of surfboat, a line-throwing mortar, a metal life car, and necessary marine supplies. Similar boathouses mere built along the shores of Long Island in 1849, and another was established on the Rhode Island coast in 1850. Since no provision was







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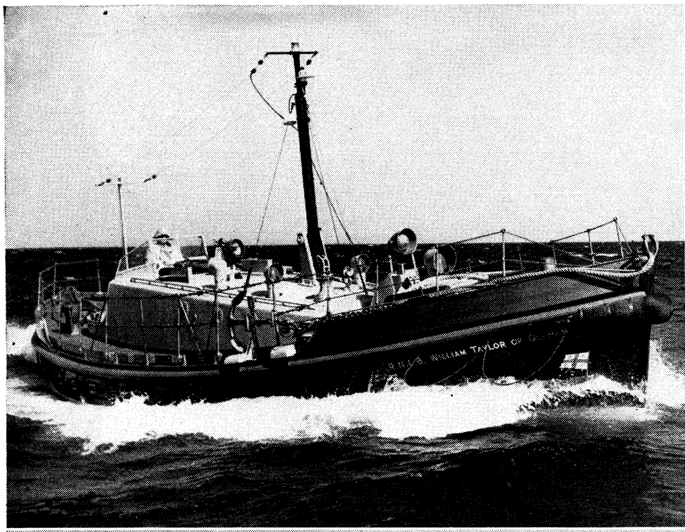
EARLY LIFESAVING STATION AND BOATS

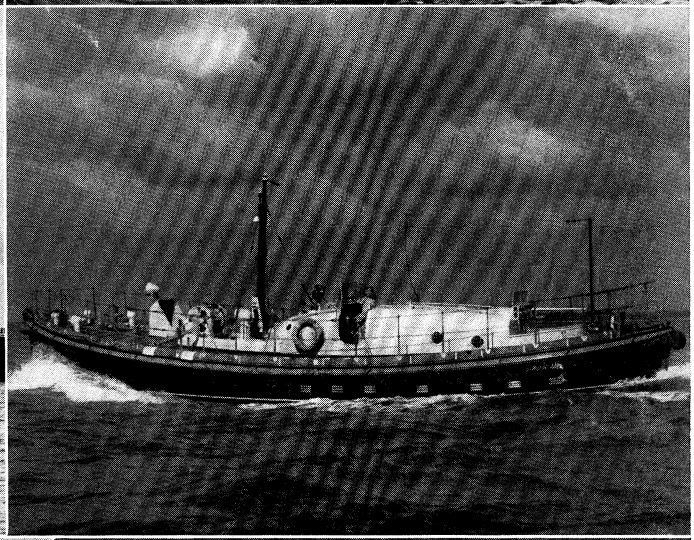
Top left: Engraving of the first English lifeboat built by Henry Greathead in 1789
Top right: Lifesaving station at Sandy Hook, N.J., the first to be authorized by U.S. congress, 1848
Centre: "Queen," 55 ft. steam turbine lifeboat built in England in 1897
Bottom: Early 20th-century U.S. coast guard surfboat and tractor used to haul it to the water

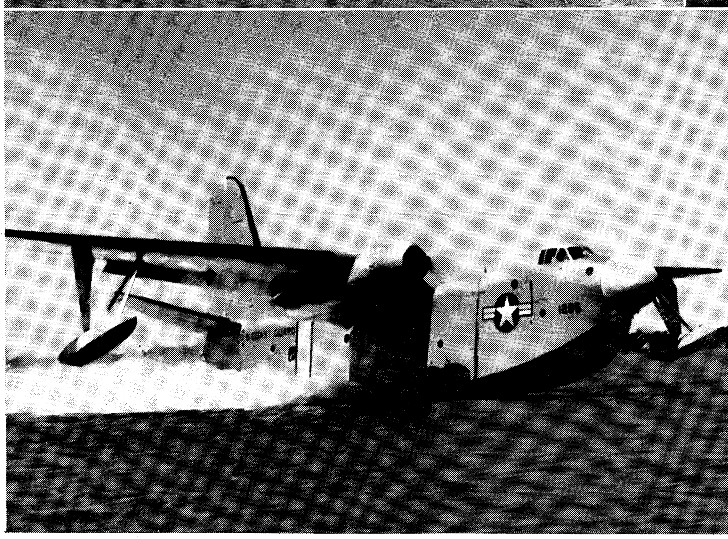
BY COURTESY CF (TOP LEFT, TCP RIGHT CENTRE LEFT) U 5. COAST GUARD, (CENTRE R GHT, BOTTOM) ROYAL NATIONAL LIFE-BOAT INSTITUTION; PHCTOGRAPHS, (CENTRE RIGHT) THE WESTERN MORNING NEWS CO. LIMITED, (BOTTOM) BEKEN & SON, COWLS

U.S. AND BRITISH LIFEBOATS

Top left: 30-ft. utility boat with diesel engine
Top right: DUKW, amphibious truck nicknamed "Duck," designed for use on roads, sand and in water
Centre left: Self-bailing and self-righting 36-ft. motor lifeboat used by U.S. coast guard
Centre right: "Exmouth," 35-ft. British lifeboat and tractor
Bottom: "Filey," "Liverpool" class lifeboat of the Royal National Life-boat institution







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LARGER TYPES OF RESCUE CRAFT AND A TYPICAL COAST GUARD STATION

Top left: 42-ft. "Watson" class lifeboat of the Royal National Life-boat institution

Top right: U.S. coast guard cutter, 95-ft. patrol boat used for port security, search and rescue. Carrying a crew of 15, the boat has a speed of 21 knots and a cruising range of 1,500 mi.

Centre left: 52-ft. motor lifeboat, self-bailing, self-righting and virtually unsinkable

Centre right: British 52-ft. motor lifeboat

Bottom left: Marlin P5M-1G seaplane used by the U.S. coast guard for open sea rescue work

Bottom right: Humboldt bay station of the U.S. coast guard, Samoa, Calif., showing boats and launching ways

LIFEBOAT AND LIFESAVING

RESCUE EQUIPMENT AND OPERATIONS

Top left: U.S. coast guard officer teaching civilian airline employees to use signal flare and other lifesaving equipment in survival raft
Top *right:* Helicopter equipped with hydraulic rope hoist
Second row left: Firing a Lyle line-throwing gun
Third row left: Coast guard cutter (left) preparing to remove survivors from broken tanker
Centre right: Flat-bottom boat used to assist flood victims
Bottom left: Transferring personnel from ship to ship with a breeches buoy. Inset shows close-up
Bottom right: Fully-equipped 24-ft. lifeboat capable of carrying 29 persons. This is typical of equipment aboard merchant vessels

made for crews or even caretakers this equipment rapidly deteriorated or was stolen. To remedy this situation congress made provision for paid keepers in 1854, but since the crews of these stations depended on volunteers from a sparsely settled coast. good surimen were not always available and the system was far from satisfactory. There was some change for the better in 1870 when congress authorized crews at each alternate station for the three winter months.

The real beginning of a modern lifesaving organization was established in 1871 by Sumner I. Kimball who had just been appointed chief of the revenue cutter service (coast guard). He secured appropriations to rebuild the boathouses to accommodate lifeboat crews. Inefficient keepers were replaced by men selected for their skill and experience. Additional stations were established; and all stations were manned by capable surfmen who were appointed and promoted under a merit system. A beach patrol was instituted and maintained during darkness and thick weather for the purpose of warning vessels and for the prompt discovery of wrecks or castaways. As a result of this efficient management only one life was recorded as being lost during the next two years within the area of responsibility of the service. Thus the era of groping for an efficient lifesaving organization in the United States came to an end.

Later Developments.—Following the establishment of the parent organizations in both England and the United States there have been only a few basic changes in administration and duties. In Great Britain the Royal National Life-boat institution experienced a period of diminishing interest in the 1840s. This decline was rectified in 1851 when the fourth duke of Northumberland was elected president. Under his able leadership there was an active revival of the service. other lifeboat societies joined the institution. and steps were taken to maintain a continuing public interest. It should be noted that this institution remained a voluntary service. supported and directed entirely by private individuals.

Complete search and rescue co-ordination depends upon co-operation of the Life-boat institution with the coast guard, the Royal Air Force and the Royal Navy.

In the United States the management of the service following its founding was under the direction of the chief of the revenue cutter service until 1878. at which time it was organized as a separate bureau under the treasury department and titled the U.S. lifesaving service. In 1915 this service was reunited with the revenue cutter service under a new name—the U.S. coast guard (*q.v.*). For further efficiency, congress joined the lighthouse service with the coast guard in 1939, and placed the bureau of marine inspection and navigation in this group of amalgamated bureaus in 1946 The addition of these latter two organizations to the coast guard stressed the modern concept of saving life through preventive measures.

hfodern science has vastly improved rescue facilities and lifesaving techniques throughout the world. The invention of radio communication, the airplane and helicopter, and amphibious vehicles now enable rescue forces to locate and reach persons in peril with greater speed and ease. When the helicopter cannot operate because of lack of range, darkness or high winds, rubber life rafts. food and survival gear may be dropped from planes until other assistance can arrive. Medical aid is sometimes parachuted where there is vital need at inaccessible locations.

The greatest advancement in lifesaving is the international trend to pool resources under the operational control of the most strategically located rescue co-ordination centre. where information is quickly evaluated and assistance directed to the scene. This aid may be the nearest merchant or naval vessel. air facility. weather station vessel, or the specially designed fast patrol craft and the modern lifeboat.

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(M. H. I.)

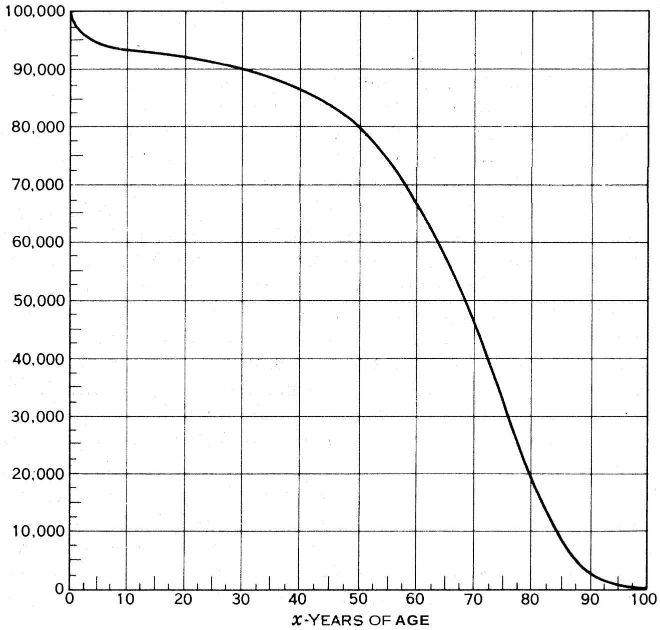
LIFE EXPECTANCY, or expectation of life, as used in actuarial work and vital statistics, means the average length of life after any given age; it is based on death rates shown in mortality tables.

Life expectancy statistics are related to an idealized conception or model. We consider hypothetically an indefinitely large number l_0 of individuals just born and observe their number as it is diminished by death with the passage of time. From birth until some years x later, a certain number of them will have died; those surviving will be aged x and their number is represented as I,. The time x just prior to which the last surviving individual has died (that is, the time at which $l_x = 0$) is represented as w. The value of l_x plotted against x is assumed to form a smooth curve, and this curve is called the survivorship function. A typical survivorship function is shown in the figure, to exhibit its general form. Between any age x and a small increment dx—that is, between ages x and (x + d~)— number of individuals dl, will have died, and if dx is taken as infinitesimally small dl, may be regarded as the number who die at exactly age x. The average age at death for all individuals who have survived to some specified age x—from which x, the age already attained, is subtracted—is the mean afterlifetime at age x, and is represented as $\mathring{e}_x$. The mean afterlifetime at birth, $\mathring{e}_0$, is the average age at death for the total l_0 births, and this is what is referred to as the expectation of life. The expectation of life as thus defined should not be confused with the age at which half the number beginning life at $x = 0$ have died (that is, the age x at which $l_x = \frac{l_0}{2}$); this is the median expectation of life.

An extension of the model just described of following some l_0 individuals just born. as they are diminished in time by death. is another model, referred to as a stationary population. In this model there is visualized not just one group of l_0 births but a succession of such births evenly occurring in time following the original set of births. From $x = 0$, when there are I, individuals, to an infinitesimally small time dx later: there will have died a certain number dl, individuals. The survivors, diminished to number $l_1 = l_0 -$ dl,, advance to age (o + dx). while the original group is replaced by l_0 new births. With the passage of the next small interval of time. the first group will have been diminished to a number I, — dl,, the second to the number $l_0 - dl_0$, and there will be a third group of births l_0 replacing the second. With the passage of time to $x =$ w, when the first group will have been reduced to $l_x = 0$, there will have accumulated at each age x just the number that had survived to this age from the first group. From this time forward the population will be stationary in respect to the distribution of the number of individuals present at each age, for as some individuals at any age die, the survivors grow older, while the entire group is replaced by the survivors from the just younger age. In this model of a stationary population, there is, at any time, the same number of persons living at any particular age x. The total population at any time is equal to the same number as the total number of person-years lived by any l_0 individuals as they pass from birth to x = w, when the last survivor is eliminated by death. In this way there is a mathematical identification between the model of following a particular cohort of l_0 individuals from birth to death. and the stationary population. The total number of person-years lived by any l_x individuals. who have survived to age x, as they pass in time from age x to age w, the final age of the life span, is equal to the total population, aged x and older, present at any time in the stationary population. This number is equal mathematically to the area under the curve representing the survivorship function shown in the figure, from age x forward. If this number is divided by the value of I, the number living at age x, it gives $\mathring{e}_x$. Accordingly $\mathring{e}_0$, the complete expectation of life at birth, is equal to the total area under the survivorship function divided by 1,.

The model of a stationary population brings one closer to the actualities of existing populations for which values of the expectation of life are regularly calculated than the model of following a particular group of I, births. but still there is a fundamental discrepancy. If a population such as that of England and Wales or that of the United States at a given time is considered, there is a particular age distribution which is the actual census of individuals at specified ages. This is not the age distribution of the model stationary population that defines the calculated expectation of life, and the calculated expectation of life is not the same as the actual mean age of death occurring in the population over a year. In order that a population become stationary, it is required that there be no immigration into and no emigration from the population, and that the age-specific death rates remain constant over a period at least equal to w, the total life span. Obviously, in modern times for countries of western civilization these conditions are not fulfilled. The age distribution actually obtaining in these populations is the resultant of just such changes, and the age distribution is therefore not that of a stationary population. It is then natural to ask the questions: Why should the expectation of life be calculated if it is bound up with a stationary population that is not that of the population in question? How is the expectation of life calculated? The answer to the question "why" is that although the expectation of life calculated for a specified population does not estimate the actual mean duration of life of that population as of that time, it does provide a defined index of the prevailing death rates, and so serves as a general measure of prevailing hygienic conditions, insofar as these are reflected in mortality. This is the chief use to which the calculated expectation of life has been put.

The calculation of the expectation of life in terms of the model described is effected by way of the construction of a life table for



THE NUMBERS OF PERSONS (l_x) SURVIVING TO AGE x OUT OF EVERY 100.000 BORN ALIVE

the population at hand. Only the essentials of the calculations, so far as they pertain to the evaluation of the expectation of life, will be referred to. The basic information required is the probability of dying within a year after the attainment of any age of life. That is, we wish to know for the population in hand how many individuals who have just attained, say, age 40 years die before the attainment of their 41st birthday, and we wish such information for every integral year of life. The probability of dying in the year from age x to the next year $(x + 1)$ is symbolized q_x, and its complement, the probability of surviving, is $p_x = 1 - q_x$. The data from which these required quantities are obtained are (1) the number of persons of various specified ages living at a given time and (2) the number of deaths occurring in a year by age at time of death. The sources of these data are the government enumerations made in censuses and death certificate reports. The figures as recorded in these reports must be adjusted to obtain the required values of q_x. The census figures are available only for census years and are subject to inaccuracies of reporting. Certain corrections must be made, and interpolation must be effected in available census figures, to obtain the population estimate for the required specific age, sex and year. If the number of deaths in the year which have occurred at, say, age 40 (that is, between the 40th and the 41st birthdays) is divided by the number of persons age 40 living in the middle of the year (that is. on July 1), we obtain m_x the central death rate for that year. This, it should be observed, is not quite q_x which has reference to the number of deaths in a year among individuals who had their xth birthday within a year before their death. Individuals who died in the year at age 40—that is, at an age between 40 and 41 years—were not necessarily 40 years old at the beginning of the year.

If the 40th birthday was on July 15 and the person died in August of the year, his death certificate would be marked age 40 years, but the census would have included him in the age group 39 since that was his age on July 1 when the census was estimated. The estimate of m_x can be converted to an estimate of q_x if it is assumed that the survivorship function between ages x and $(x + 1)$ is linear, by use of the formula

$$q_x = \frac{2\, m_x}{2 + m_x}$$

One then begins with a hypothetical number of births, usually taken as 100,000 and called the radix of the table. This is the value of the survivorship function l_x at age $x = 0$ and therefore is represented as l_0. Multiplying l_0 by q_0 yields d_0, the number of deaths, out of the 100,000 births, which occur in the first year of life, and these deaths subtracted from 100,000 give the number surviving to age one year. In this way l_1 is evaluated. In the same way l_2 is obtained by multiplying l_1 by q_1 to give d_1, the number of deaths among the l_1 who die between age one year and age two years. We may formulize this calculation by noting that

$$l_1 = l_0 - l_0\, q_0 = l_0\,(1 - q_0) = l_0\, p_0;\ l_2 = l_1\, p_1 = l_0\, p_0\, p_1$$

and so forth, so that in general

$$l_x = l_0\, p_0\, p_1\, p_2 \dots p_{x-1} \text{ or } l_x = l_0 \prod_{0}^{(x-1)} p$$

where Π represents the continued product of the p's. In this way is calculated, from the determined quantities q_x the value of l_x corresponding to each integral year of age x from $x = 0$ to $x = w$, the final year of the life span at which $l_w = 0$.

It will be remembered that the expectation of life after age x is given by the area under the survivorship function from x to w, divided by the initial value l_x. For purposes of calculating the area required, with the values of the survivorship function l_x calculated at each integral year of life, it is considered that a sufficiently good approximation is obtained if it is assumed that the survivorship function between each age year x and the next is linear.

On this assumption the area under the curve over a single year of age is half the sum of the values of the bounding l's. Thus the area from $x = 0$ to $x = 1$ is

$$\frac{l_0 + l_1}{2}$$

the area from $x = 1$ to $x = 2$ is

$$\frac{l_1 + l_2}{2}$$

and so forth. The total area from x to w is therefore

$$A = \frac{l_x}{2} + \sum_{x+1}^{w} l$$

where Σ represents the continued sum of l values from l_{x+1} on. The expectation of life from age x, or mean afterlifetime, is A divided by l_x; so

$$\mathring{e}_x = \frac{1}{2} + \left(\sum_{x+1}^{w} l\right) \Big/ l_x$$

and the expectation of life at birth is

$$\overset{\circ}{e}_0 = \frac{1}{2} + \left(\sum_{1}^{w} l\right) \Big/ l_0$$

From the development given, it is seen that the value of the expectation of life, as calculated, depends only on the values of the age-specific death rates obtaining in the population. It may be viewed as the actual mean age at death of a population in which these death rates prevailed indefinitely at the values they had in the year in question. It may thus be seen why it is regarded as a useful summary index of the mortality rates characteristic of existing conditions. This has been its chief usefulness.

Fairly reliable estimates of the expectation of life in western communities have been made for periods since the middle of the 19th century. Females are found always to have a longer expectation of life than males. For both, great progress has been made in its extension as general sanitary conditions have been improved, food has become more abundant and better in quality and advances in medical science have been achieved. The accompanying table gives some values of the expectation of life for England and Wales and for the United States. The period covered is roughly the 100 years extending from the middle of the 19th century to the middle of the 20th century. Values of the expectation are given at approximately ten-year intervals. The phenomenal extension of the duration of life is notable. Expectation of life in Roman times has been estimated to have been about 30 years. From that time to the middle of the 19th century it was increased to about 40 years. In the next century the increase in expectation of life was about 25 years, so that by 1950 the expectation of life was more than double that of ancient times. See DEATH RATE; LONGEVITY; POPULATION; see also Index references under "Life Expectancy" in vol 24. (JH. B)

Expectation of Life, in Years

United States			England and Wales		
Period	Male	Female	Period	Male	Female
1850	38.3	40.5	1838–54	39.9	41.9
1900–02	47.9	50.7	1901–10	48.5	52.4
1909–11	49.9	53.2	1910–12	51.5	55.3
1919–21	55.5	57.4	1920–22	55.6	59.6
1929–31	57.7	61.0	1930–32	58.7	62.9
1939–41	61.6	65.9	1937	60.2	64.4
1949–51	65.5	71.0	1952	67.1	72.3

LIFE INSURANCE, in the usual sense, means the business of issuing policies of insurance on human life. A policy on human life has been defined as any instrument by which the payment of money is assured on death (except death by accident only) or the happening of any contingency dependent on human life, or any instrument evidencing a contract that is subject to payment of premiums for a term dependent on human life.

In Great Britain the word "assurance" is in common use in connection with life contracts. In the United States the word "assurance" is rarely used, although it does appear in the names of a few life insurance companies.

Life insurance companies may be classified in two types: stock or proprietary. and mutual. Stock companies are controlled by the shareholders; mutual companies are without shareholders and are controlled by the policyholders.

A policy that shares in the profits of the company is called a participating policy. A policy that does not share in the profits of the company is called a nonparticipating policy. A stock company may issue both participating and nonparticipating policies. A mutual company's policies are usually participating, although there are some exceptions.

Mutual companies in Great Britain almost without exception issue both participating and nonparticipating policies. In the United States. for example, annuity contracts issued by mutual companies are likely to be nonparticipating.

Life insurance contracts map be classified as group or individual, the latter being further classified as ordinary or industrial. In an individual contract the policy is issued on an individual basis to the owner of the policy. The owner may or may not be the person whose life is insured. Before issuing an individual policy the company usually requires some evidence of insurability (see INSURANCE: *Risk* and *Insurance*). Under group insurance (*q.v.*) a large number of persons are insured under one blanket policy, the individuals insured receiving certificates and being called certificate-holders rather than policyholders. The commonest group contract is issued to an employer on the lives of the employees, although many contracts have been issued to labour unions, associations and other groups. Individual evidence of insurability is usually not required under a group contract.

The essential distinction between ordinary and industrial insurance (*q.v.*) is that, under industrial, the sum insured is comparatively small and premiums are payable at comparatively short intervals, the premium being commonly collected by the agent in the home of the insured.

In Great Britain the Industrial Assurance act (1923) defined industrial assurance as "assurances upon human life, premiums in respect of which are received by means of collectors and are payable at intervals of less than two months."

The New York state insurance law has defined industrial insurance as "that form of life insurance, either (a) under which the premiums are payable weekly, or (b) under which the premiums are payable monthly or oftener, but less often than weekly, if the face amount of insurance provided in the policy is less than $1,000, and if the words 'industrial policy' are printed upon the policy as a part of the descriptive matter."

The Ontario Insurance act defined industrial insurance in the following language: " 'Industrial contract' means a contract of life insurance for an amount not exceeding $2,000, exclusive of any benefit, surplus, profit, dividend or bonus also payable under the contract, and which provides for payment of premiums at fortnightly or shorter intervals, or, if the premiums are usually collected at the home of the insured, at monthly intervals."

This article is divided into the following sections and subsections:

I. TYPES OF INSURANCE

1. One-Year Term Insurance and Ordinary Life Insurance. — The simplest form of life insurance is one-year term insurance under nhich the premium collected for one year is enough to pay the cost of insurance and expenses for that year. This type of insurance is sometimes called pure protection, indicating that there is no investment element. Since the cost of insurance increases with age, the premium for one-year term insurance increases every year. becoming prohibitive at the very advanced ages.

The disadvantages of increasing premiums were solved by the development of level premium life insurance. Perhaps the simplest and most familiar form is that known as ordinary life or straight life. This form provides a benefit of the face amount of the policy on the death of the insured and calls for a level premium at the beginning of every year during the lifetime of the insured.

The table below shows the premiums for one-year term insurance for $1,000 at quinquennial ages from 35 to 95 inclusive. The corresponding annual premium for ordinary life, issued at age 35, is $17.67. The premiums are based on the 1958 Commissioners Standard Ordinary table with $2\frac{1}{2}\%$ interest, and are net premiums (*i.e.,* no provision for expenses).

TABLE I.—Premiums for One-Year Term Insurance, Ages 35–95
(per $1,000)

Age	Premium	Age	Premium
35	$2.45	70	$48.58
40	3.44	75	71.58
45	5.22	80	107.30
50	8.12	85	157.21
55	12.68	90	222.58
60	19.84	95	342.67
65	30.98		

There are a number of types of life insurance in addition to one-year term and ordinary life. Some of the more common types are described below.

2. Limited Payment Life Insurance.—The benefit under limited payment life is the same as under ordinary life: namely, the payment of the face amount (or sum assured) on death. The difference is in the premium payment period. Under ordinary life, premiums are payable for life; under limited payment life, premiums cease at death or at the end of the premium paying period specified in the contract, whichever comes first. Under a 20-payment life policy, for example, no premiums are payable after 20 years in any event. After the 20th annual premium has been paid the policy is said to be paid up. The sum insured under the policy is payable at subsequent death.

3. Endowment Insurance.—Under this type of policy the benefit is the payment of the face amount on the death of the insured if he dies before the end of the term (specified in the contract), or the payment of the face amount as an endowment if the insured lives to the end of the term. A continuous premium endowment insurance policy calls for premiums payable during the entire term—or until prior death. A limited payment endowment insurance policy is similar to a limited payment life policy in that the premiums are limited to some period less than the term of the policy. Under a 20-payment, 30-year endowment insurance policy, for example, premiums are payable for 20 years—or until prior death—but the term of the policy is 30 years; thus the benefit is payment of the face amount on death, if death occurs within 30 years, or the payment of the face amount at the end of 30 years, if the insured is then living. Limited payment endowment insurance is not generally written in Great Britain.

4. Term Insurance.—The one-year term insurance contract described above is a special case of term insurance. Term insurance may be defined more generally as a promise to pay the face amount on death if death occurs during the specified number of years, called the term of the policy. Premiums for term insurance are almost always level and payable during the entire term.

5. Pure Endowment Insurance.—A pure endowment benefit is a promise to pay a certain sum if a specified person is alive at some specified future date. Issued as a separate contract in Great Britain, it is usual for the premium paid under a pure endowment to be returnable—sometimes with interest—at death during currency of the policy. This benefit is rarely granted by itself but is an important adjunct to surrender benefits, discussed in a later section. Mathematically, endowment insurance is a combination of pure endowment and term insurance. It is known in Great Britain as reduced premium optional assurance.

6. Modified Life Insurance.—Usually this refers to a policy for which the premium for the first few years is less than the ultimate premium but more than the term premium would be.

7. Income Endowment Insurance.—Under this type of policy the death benefit is the face amount, or the reserve if that is greater, if death occurs during the term of the policy. At the end of the term the insurance contract is in effect exchanged for an annuity contract. A common form of income endowment calls for annuity payments to begin at age 65, with monthly payments of 1% of the face amount of the insurance policy guaranteed for 10 years, subsequent payments being made only if the policyholder is alive at the time the payment is due. There is no generally accepted name for this type of insurance. Terms in common use, in addition to income endowment, include retirement endowment, retirement income, life income, insurance and income, income to insured. In Great Britain endowment insurance with guaranteed annuity option at maturity is written freely.

8. Family Income Insurance.—This benefit usually has a family income period of from 10 to 40 years, 20 years being very common. If death occurs during the period, a monthly income is paid from the date of death to the end of the period. At the end of the period the face amount of the policy is paid. The amount of the monthly income is commonly 1% of the face amount of the policy but may be some other percentage. The fact that the face amount is paid at the end of the period rather than at death results in some saving in interest to the insurance company, a saving that is used to reduce the premium from what it would be if the face amount were paid at death. A family income benefit is an example of reducing term insurance. In Great Britain a sustained demand for family income insurance led to the issuance of a variety of contracts written as installments of a capital sum, the income benefits being free of British income tax.

9. Double Indemnity Benefit and Disability Benefit.—Many life insurance policies provide supplementary benefits in the event of accidental death or disability. A common accidental death benefit, frequently called double indemnity, calls for a death benefit of twice the regular death benefit in the event that death occurs before age 60 and is due to an accident as defined in the policy. A common disability benefit provides that the company will waive payment of any premiums that come due while the insured is disabled within the meaning of the contract. Some contracts provide that the company will not only waive premiums during disability but will pay an income in addition.

There are a number of types of life insurance not described above; but most of them amount to combinations of the types described.

See also *History: U.S.: Credit Life Insurance and Family Insurance* below.

II. RESERVES

The company must set up a reserve in the early years of a policy in order to avoid a financial deficiency in the later years. From a comparison of one-year term premiums (see Table I above) with the premium for an ordinary life policy taken out at age 35, it can be seen that a person becoming insured at age 35 would pay less for his insurance on the one-year term plan than on the ordinary life plan until some age between 55 and 60, whereupon the one-year term premium would become more expensive than the ordinary life premium. Since the one-year term premium is the amount the insurance company needs to pay the death claims for the particular age group, the company is collecting more than enough to pay claims in the early years of a policy but less than enough to pay claims in the later years.

Actuaries customarily analyze reserves from two points of view: retrospective and prospective. From the retrospective point of view the reserve is the accumulated amount of that part of the premiums already collected that is not needed to pay the death claims already incurred. From the prospective point of view the reserve is the present value of future benefits less the present value of future premiums. Various actuarial techniques have been developed to calculate reserves. In most life insurance companies the policy reserves constitute by far the major portion of the company's liability. The subject of reserves is therefore extremely important.

There are essentially three systems in common use for valuing a company's reserve liability: (1) full net level; (2) modified net premium; and (3) gross premium. Under the full net level method (1), a net level premium for a policy is calculated on certain assumptions regarding interest and mortality and with no provision for expenses. The reserve for the policy at a given time is computed as the present value of future benefits less the present value of future net level premiums. Under the modified net premium method (2), a modified net premium is calculated in accordance with a formula. In the United States the formula is specified by state law. This modified premium is greater than the net level premium, so that reserves under this method are less than corresponding reserves under the full net level method. Under the gross premium method (3), the reserve is computed as the present value of future benefits and expenses less the present value of future gross premiums, the term "gross premium" meaning the premium actually collected.

In the United States state laws require that a company use either the full net level method or the modified net premium method in computing reserves for the annual statement. In Great Britain the gross premium method is in common use. Many U.S companies also use the gross premium method for internal purposes.

III. SURRENDER VALUES

Under most policies other than term insurance a company will, after a certain number of premiums have been paid, pay a sum of money on surrender of the policy, this sum being known as the cash value or surrender value.

In the U.S. and certain continental countries the laws require that the policy state the amount of the surrender value for various policy years or state the method of calculation or both. It is customary for a company to grant a loan on the security of the policy, the amount of the loan being limited by the surrender value and the interest charge. An alternative to surrender for cash is the election of paid-up insurance. There are two common paid-up insurance options, commonly called nonforfeiture options. Under the reduced paid-up option, the benefit is paid-up insurance on the same plan as the original policy but for a reduced amount. The reduced amount is such that the paid-up insurance and the surrender value are actuarial equivalents; *i.e.*, the present value of the reduced paid-up insurance is equal to the surrender value.

Under the extended term insurance option the benefit is term insurance for the amount of insurance in force at the time the policy was surrendered. The length of the term is such that the paid-up term insurance and the surrender value are actuarial equivalents. In the case of endowment insurance the term for the paid-up insurance will not extend beyond the original term of the policy. Thus if the surrender value is large enough, the extended term insurance consists of term insurance for the original amount plus a pure endowment for a reduced amount.

IV. PARTICIPATION IN PROFITS

A mutual company returns to the policyholders any profits not needed to strengthen reserves, contingency funds and surplus. A stock company's relation with its holders of participating policies is the same except that the shareholders may take a small part of the profits.

The method of distributing profits to the policyholders varies from country to country. In Great Britain some companies make annual distributions while others make distributions every three or five years; the distribution is called a bonus distribution and takes the form of an addition to the sum insured. Two common bonus plans are: (1) the simple bonus plan, which provides additions at a given rate for each £100 of original insurance; and (2) the compound bonus plan, which provides additions to the sum insured, calculated on original insurance and accrued bonuses.

In the United States and Canada annual distributions are the rule. The distribution to an individual policyholder is called the dividend. Policies provide that a dividend may be taken in various forms. called dividend options. The more common options available are: (1) cash; (2) reduction of the next premium; (3) leaving with the company to accumulate at interest; and (4) use for purchase of a paid-up addition to the policy, the paid-up addition being similar to the British bonus.

V. HISTORY

The beginnings of life insurance—that is to say, the payment of certain benefits on death, against certain periodical subscriptions—are to be found in the Roman collegia (artisans' associations). The guilds of medieval times would, in many cases, make provision for the decent burial of a member, but this was not life insurance in the full sense. Marine insurance is generally believed to have had an earlier origin than life insurance, and it is therefore natural that the first definite contracts of life insyrance should have been on the lives of mariners.

1. Great Britain and the Commonwealth.—The earliest life insurance transaction recorded to have been made in England was in 1583, when a number of merchants of the city of London subscribed to an insurance on the life of William Gybbons, described as a citizen and salter of London. This insurance was for a period of 12 months at a premium rate of £8 sterling per £100. During the folloning century insurance for temporary periods, such as might be required to protect the policyholder against the perils of travel and other risks arising during a limited period, was granted by individuals and certain civic guilds.

The history of life insurance companies in England commenced in 1706 when the Amicable Society for a Perpetual Insurance Office mas formed. The insurance method was rudimentary and provided merely for the dividing up of certain sums among the representatives of those members who died each year. After a separate existence of 160 years, during which time it adopted a graduated scale of premiums according to age, the Amicable in 1866 became merged with the Norwich Union Life Insurance society.

A number of minor companies became defunct during the period of speculative financial schemes which resulted in the crisis of 1720. popularly known as the South Sea Bubble (*q.v.*). Speculation was common throughout the century, and in order to counteract the improper use of life insurance the Life Assurance act, known as the Gambling act, was passed in 1774. This act, which still remained on the statute book in the second half of the 20th century, provided that no insurance should be effected unless the person in whose favour the policy was taken out had a pecuniary interest in the life to be insured.

The Equitable society, founded in 1762, was the first to issue whole life insurance. The premium rates varied with age and were originally based on a mortality table constructed from the registers of Breslau, Germany. for the years 1687–91. The rates were later based on a mortality table deduced from the London bills of mortality for 1728–37; and still later on the Northampton tables which nere prepared from a record of baptisms and deaths obtained from the registers of the town of Northampton during the years 1735–80. When experience showed that rates could be reduced, policyholders paying the original higher rate were granted an addition to the sum insured.

Many new concerns were floated during the closing years of the 18th century, while between 1800 and 1870 some 500 new offices were established. A number of these companies had little hope of long surviving and some were of definitely fraudulent intent. This activity in company promotion was followed by a period of amalgamation, also marked by many abuses. The financial difficulties of two companies, the Albert and the European, were a factor in hastening much needed legislation. The Life Assurance Companies act (1870) was designed to prevent effectually a repetition of such disasters. Under the provisions of this act companies transacting life assurance business were compelled to submit annual accounts in a prescribed form to the board of trade for subsequent publication, and no new office was allowed to issue life policies until it had deposited £20,000 with the court of chancery. This act governed the business in Great Britain until it was practically re-enacted in the Assurance Companies act (1909), which was amended in turn by the Assurance Companies act (1946), and by certain provisions of the Companies acts (1929 and 1948).

The Married Women's Property act (1882) and the Married Women's Policies of Assurance (Scotland) act (1880) conferred certain powers on married women, enabling policies to be effected on their own lives or on the lives of their husbands for their own separate use. Similarly, married men were enabled to effect policies on their own lives for the benefit of their wives or their children, or both, and such policies were protected against their creditors absolutely.

British income tax laws encouraged life insurance ownership by providing that a policyholder who pays premiums for insurance on his own life, or on that of his wife, is entitled to claim relief from taxation in respect of such premiums paid. The relief took the form of a deduction from the policyholder's assessable income before income tax liability is calculated. The deduction represented the premium or a percentage of it, subject to a maximum percentage of income and to a maximum percentage of the amount guaranteed by the policy to be paid at death. Premiums for deferred annuities were also allowed as a deduction, subject to certain limitations and restrictions concerning the premium amount and policy use.

Life insurance in Australia, New Zealand and South Africa developed in the main in accordance with the practice followed in the United Kingdom. British mortality experience is largely used in these countries. In Canada life insurance was modeled very largely on the U.S. system (see below). In all these countries the industry functions under varying degrees of legislative control, such legislation being in general more restrictive than British legislation, which is based on the principle of freedom combined with publicity. In India and Pakistan the general pattern of life insurance is British, but at a much earlier stage of development than in Australia, New Zealand, South Africa and Canada. Life insurance in India was nationalized at the beginning of 1956 and business transferred to the Life Insurance Corporation of India. In the same year British and French life insurance interests in Egypt were sequestrated.

See also FRIENDLY SOCIETIES.

2. Europe.—Life insurance on the continent developed later than in Great Britain. The first successful venture in France was made in 1819 when the Compagnie d'Assurances Générales sur la Vie was founded. In Germany branches of English offices were operating before the end of the 18th century but the first German company was not founded until 1828.

Detailed governmental control is the general rule in continental countries, the control extending in many countries to premium rates, reserve bases and investment policy. In France all insurance companies with premium incomes exceeding a prescribed amount are nationalized. British insurance companies operating in France, although otherwise free from nationalistic control, are obliged to reinsure a small proportion of all business written in that country with the French state reinsurance institute—La Caisse Centrale de Réassurance. British companies maintained an interest in France, Belgium and Spain in the second half of the 20th century, but had ceased to operate in Germany.

Although the years immediately after World War II witnessed a considerable growth in life insurance in continental countries. the expansion did little more than bring the average sum insured into line with the higher level of values. Continental practice included the issue of policies with the right to participate in profits.

(RT. E. L.)

3. United States.—Early History.—What little life insurance there was in the United States during the colonial and confederation periods was furnished by British companies. Though the Corporation for the Relief of Poor and Distressed Presbyterian Ministers (and their survivors) was chartered by Pennsylvania in 1759 and issued life insurance con'tracts in 1761, it was in part a charitable organization, and limited in its scope of activity. Not until more than a century later was it authorized to do a general life insurance business under the name of the Presbyterian Ministers' fund. A few life insurance policies also were written by fire and marine insurance companies prior to 1800.

Between 1800 and 1843 scientific life insurance in the United States got its start by way of the proprietary (stock) and trust companies. The first commercial company for life insurance exclusively was the Pennsylvania Company for Insurance on Lives and Granting Annuities, chartered in 1812; it was also the first to use U.S. mortality statistics. The Massachusetts Hospital Life Insurance company (1818) was from the beginning more concerned with its trust business than life insurance, but the New York Life Insurance and Trust company (1830) actively promoted the sale of life insurance by way of the agency system. The Girard Life Insurance, Annuity and Trust company (Pennsylvania, 1836), following the example of some of the British companies, provided for policyholders' participation in the income of the company. There were various other stock companies chartered prior to 1840.

Life insurance in the United States made its first important growth with the organization of the mutuals in the 1840s. The mutual principle made it possible for resourceful men to form companies and give protection to the policyholder without the necessity of raising a sizable sum of capital to invest in the business. Eight of the more important companies founded in this period are still in business. They are the New England Mutual Life Insurance company (chartered in 1835, began business in 1843) ; The Mutual Life Insurance Company of New York (1842 and 1843); the State Mutual Life Assurance Company of Worcester (1844 and 1845) ; the Nautilus Insurance company (1845), which in 1847 was renamed the New York Life Insurance company; The Mutual Benefit Life Insurance Company of New Jersey (1845); The Connecticut Mutual Life Insurance company (1846) ; the Penn Mutual Life Insurance company (1847) ; and-the Union Mutual Life Insurance company (1848 and 1849). About 40 other companies were organized by 1850, a number of which failed to survive. Companies pioneered in education of the public to the need for and advantages of life insurance and in promotion of volume sales through the agency system. From less than $5,000,000 of life insurance in force in 1840 the amount increased to $96,000,000 in 1850.

Several of the prominent companies which began writing life insurance in the 1850s were stock companies. Among them were the Aetna Life Insurance company, The Manhattan Life, the United States Life, the Charter Oak and the Knickerbocker. The Massachusetts Mutual Life Insurance company (1851), the Mutual Life Insurance Company of the State of Wisconsin (1857; in 1865 it became The Northwestern Mutual Life Insurance company) and The Equitable Life Assurance Society of the United States also began business. The last-named company, founded in 1859 by Henry Baldwin Hyde, a former cashier in the Mutual of New York, was originally a stock company but operated from the beginning as a mutual in regard to distribution of earnings.

Many of the early policies were for term insurance, but by 1860 approximately nine-tenths of the policies issued were level-premium life policies. Endowment insurance payable to the insured at a certain age—or to his beneficiaries—had its beginnings in the middle 1850s. By the late 1850s the application had become a part of the insurance contract and untrue statements made therein could render the contract void. The companies provided their own medical examiners to scrutinize the examinations made by local physicians. Extra premiums were required for hazardous occupations, residence in the less healthful portions of the country, military service or travel beyond the northern and eastern sections. Although most of the companies by 1860 paid some sort of surrender values after the fifth year if the policy was surrendered before it lapsed, there were no provisions in the contract regarding nonforfeiture. In 1860, however, New York Life marketed a policy which recognized nonforfeiture as a right. For calculation of premiums and policy reserves the companies used various British mortality tables and assumed 4% or 4.5% interest on the reserves. Investments were generally confined by law to United States and state and local bonds and to mortgages on improved real estate in the state where the company was chartered.

From the beginning insurance in the United States was under state supervision. Early laws sought to raise revenue and secure publicity by means of company reports, but systematic supervision by a commission or commissioner began in New Hampshire and Massachusetts in 1851–52. Elizur Wright, Massachusetts abolitionist turned mathematician, prepared lengthy tables by which the necessary reserves on policies might easily be calculated and the soundness of the company determined. As one of the insurance commissioners of his state he not only kept check on the companies but helped bring about the first step toward a nonforfeiture law (1861), by which four-fifths of the net value of the lapsing policy was to be used as a single premium for temporary insurance. A more complete nonforfeiture law was enacted in 1880. and most of the states soon followed suit. For this and other work in the field of life insurance Elizur Wright has sometimes been called the "father of American life insurance."

The Civil War stimulated the purchase of life insurance as it stimulated agriculture, industry and business. Approximately 24 nen companies were organized during the war years. One of these. projected in 1863 with the idea of insuring the lives, limbs and health of men in the military service. became in 1868 the Metropolitan Life Insurance company, eventually the largest life insurance company in the world. The Connecticut General Life Insurance company (186 j) pioneered in the writing of substandard risks — that is, the insurance of persons unable to pass the regular medical examinations — a practice later accepted by most companies. Life insurance in force more than trebled from 1861 to 1865.

Growth and Development, 1868–1905.—The years 1868 and 1869 nere important in life insurance history. First, Sheppard Homans. actuary of Mutual Life, compiled the first important mortality table based upon United States data. New York law established it as the standard for calculating reserves and this, the American Experience Table, came to be the most widely used by United States companies until it was superseded in the 1940s. Second. in 1869 the supreme court of the United States in *Paul* v. *Virginia* ruled that an insurance policy was not a transaction in commerce and hence not subject to federal regulation. Third. Henry B. Hyde and Equitable in 1868 introduced the famous tontine policies which helped popularize life insurance but brought on a long and lively controversy. Going back to Lorenzo Tonti for the basic idea, the tontine policy provided for payment of "dividends" or refunds at the end of a definite period such as 15 or 20 years. Those policyholders in each group who lived and maintained their policies collected not only their own accumulated "dividends" but the forfeited "dividends" and reserves of those who dropped out. Tontines of various types proved popular, and those companies nhich aggressively promoted them grew rapidly nhile those which opposed them on principle failed to keep pace or actually diminished in size. The war between the two schools of thought was long and bitter.

The period of the 1870s was a trying one. More than 200 new companies entered the field, but many were caught in the depression which began in 1873. One constructive step was the organization in 1871 of the National Convention of Insurance Comn~issioners(after 193 j the National Association of Insurance Commissioners), an organization which did much to bring order to the conflicting laws of the states Entry of the larger U.S. companies into foreign fields came in the 1870s, and before many years policies of these companies were being sold in practically every country.

The liberalization of the policy continued during the post-Civil War period. Travel and residence restrictions were gradually removed cash loan and surrender values were included in the ordinary life policy, and the contract was made incontestable after three years. Investments in bonds of states and their subdivisions, and of foreign countries in nhich the companies were licensed to do business, were made legal, as were the stocks and bonds of corporations and mortgages on real estate.

Life insurance first began to reach the manual labouring class with the advent of industrial insurance — small policies with neekly premiums collected by the agent—in 1875, when the Prudential Friendly society (after 1878 The Prudential Insurance Company of America) issued its first policy The Metropolitan, John Hancock Mutual, Guardian and other companies also began to sell industrial insurance, and by 1890 industrial insurance in force totalled more than $400,000,000.

Life insurance was also brought to the masses by the development of mutual assessment or co-operative societies and fraternal organizations nith life insurance features. The assessment concerns criticized the high cost of legal-reserve level-premium life insurance and maintained that it was just as safe, and much cheaper, to "keep your reserve in your pocket" and pay death benefits by assessing the remaining members as required. But these organizations inevitably ran into the laws of both arithmetic and human nature; members died more frequently with increasing age. and young members could not be recruited in sufficient numbers to carry the increasing and uncertain assessments. By the mid-1880s there were hundreds of assessment societies; all sooner or later ceased functioning.

As assessment societies waned. the fraternal organizations reached their peak. By the end of the century there were more than 300, with 4,000,000 members and $6,000,000,000 of life insurance. Although in the beginning many of the fraternal organizations differed but little in insurance practices from the assessment societies. eventually they either had to conform to actuarial standards or fall by the way. Some of them mere converted into legal-reserve companies.

The race for size on the part of the "big three" — Equitable, Mutual and New 1⁷0rk Life — reached its height toward the end of the century and in the early 1900s. New types of policies were introduced periodically, extravagant promises were sometimes made regarding "dividends," and, despite various agreements, the companies continued to attract each other's agents and policyholders. Rebating by agents on commissions was a not uncommon practice, the proportion of lapsed policies increased and expenses became high. Then the tremendous surpluses which resulted largely from various types of deferred dividend policies tempted some of the companies to engage in financial operations not properly the function of life insurance companies. These factors—combined with the general tenor of the times that produced the muckraking movement — led to the New York legislative investigation of 1905 by the Xrmstrong committee with Charles Evans Hughes as counsel. As a result, New Tork enacted laws which limited expenses and the amount of new insurance a company might sell annually; provided for annual distribution of dividends; and prohibited the companies from engaging in underwriting syndicates. Other states enacted similar laws.

20th Century — The temporary embarrassment of some of the larger companies in 1905 encouraged the organization of hundreds of new companies, largely in the south and west. In 1911 Equitable wrote the first group insurance policy — insurance without medical examinations on a group of employees, members of a labour union, etc.—and thus opened a new field for life insurance. Life insurance came through World War I and the influenza epidemic of 1918 in sound condition. By 1920 there was more than $40,000,000,000 of life insurance in force in the United States, and in 1930 there was more than $106,000,000,000.

The great depression of the early 1930s did not hit the life insurance companies severely until the banks mere closed in 1933 and moratoria were declared on mortgages, while at the same time death benefits and other claims were expected to be paid promptly. State insurance departments came to the aid of the companies by putting temporary restrictions upon policy loans and surrenders, except for emergencies The companies were further hit by the low interest rates maintained by the government, and the policyholders nere affected by the devaluation of the dollar and the inflation policies of the government Not until 1937 did life insurance in force again equal that of 1931.

In 1936 the National Association of Insurance Commissioners inaugurated a movement for a new mortality table. After several years' work the Commissioners Standard Ordinary (C.S.O.) Mortality Table and a Standard Industrial Mortality Table were completed in 1941. A committee headed by Alfred N. Guertin of the New Jersey insurance department prepared model bills on nonforfeiture benefits and reserve standards which were recommended by the N.A.I.C. in 1942 and generally adopted by all the states nithin the next five years

Meanwhile life insurance came through the investigation of the national economy by the temporary national economic committee of the U.S. senate in 1939–41 — as its chairman, Sen. Joseph C. O'Mahoney put it—"with flying colours." Though the movement for federal regulation desired by some seemed again to have been sidetracked. the whole question was reopened in 1944 by the decision of the supreme court of the United States in *U.S.* v. *South-Eastern Underwriters' Association, et al.,* which overruled the decision in Paul v. Virginia and held that insurance was commerce and hence, when it crossed state lines, subject to federal regulation. To obviate the possible resulting confusion, public law 15 of the 79th congress (the McCarran act) in March 1945 stated that "the continued regulation and taxation by the several states of the business of insurance is in the public interest" but provided that after Jan. 1, 1948, the federal antitrust laws and the like would be applicable to the business of insurance to the extent that such business was not regulated by state laws. Committees representing the National Association of Insurance Commissioners and all parts of the insurance business prepared model bills to meet the intent of the McCarran act, and they were adopted by most of the states by the second half of the zoth century. This legislation together with the standard nonforfeiture and valuation legislation being enacted at the same time gave insurance regulation laws a practical uniformity among the states.

In the second half of the zoth century, life insurance in force was more than four times that in 1940. (R. C. BY.)

Credit Life *Insurance.*—The rapid increase in credit life insurance in force after World War II was a significant development in the history of U.S. life insurance. Under credit life insurance the life of a borrower or installment purchaser is insured to cover payment of a loan balance in the event of death. A specific credit life policy was written for the first time in 1917 on an individual basis. Group credit life was first written in 1926. Credit life insurance in force rose steadily (except for declines in the early 1930s and again in the early 1940s), reaching a total of $1,200,000,000 by the end of 1947. In the second half of the zoth century it reached a total of $21,500,000,000 and was beginning to be considered a fourth major division of life insurance, the others being ordinary, group and industrial.

Family *Insurance.*—In the second half of the zoth century family insurance became an important factor in U.S. life insurance sales, accounting for about 20% of the total purchases of ordinary insurance. The essential idea of family insurance is that all members of a family are covered under one policy. Although the details of the policy vary among insurance companies, a typical policy pays $5,000 on the death of the husband, a lesser amount (depending on the difference in age of husband and wife) on the death of the wife before the husband's age 65 and $1,000 on the death of a child before age 21. The policy covers all children, including those unborn at the time the policy is issued, except that it is usual to restrict or deny the death benefit in the case of infant deaths The premium is, typically, the same regardless of the number of children.

Taxation.—Originally state taxes on life insurance were intended to meet the expenses of the state insurance departments but the taxes soon greatly exceeded the expenses and became sources of general revenue. In the second half of the 20th century every state imposed a premium tax, the average rate of tax among all the states being 1.82% for life insurance and 0.72% for annuities, the total annual premium tax collected by all the states from life companies being about $250,000,000.

Both the rate of tax and the formula for determining the amount subject to tax vary from state to state and are subject to change within a state. A typical premium tax law required a foreign (out-of-state) company to pay 2% of all life insurance premiums collected less dividends returned, with respect to policyholders who are residents of the state in question. The tax on domestic (in-the-state) companies is frequently less than the tax on foreign companies. Many states have a retaliatory law, which says in effect that a company domiciled in state A and doing business in state B must figure its state B tax on two bases and pay the greater: one basis is the tax specified in the statutes of state B; the other is the tax according to state A's formula for foreign companies.

Federal income taxation of life insurance companies is a complicated subject. Since life insurance company commitments run far into the future, the difficulty of accurately measuring taxable income for periods as short as a year is almost insurmountable. Hence federal income tax lams made special provision for liie insurance companies. The Revenue act in effect from 1913 to 1921 sought to tax life insurance companies in the same way as any other corporation, but with certain special adjustments necessitated by the peculiarities of the business. This method was replaced in 1921 by various formulas designed to use investment income as a base for determining a workable approximation of yearly taxable income.

In 1959 a new formula was adopted and made retroactive to results of 1958. Under this formula the tax depended on both investment income and change in surplus as well as some other factors. The formula was designed to produce a total revenue of $500,000,000 as compared with about $290,000,000 for 1957.

No generally acceptable method has yet been found. Many different positions have been taken on the subject. One position is that life insurance premiums are essentially savings and should not be taxed any more than other forms of savings. Another position, taken by persons who do not appreciate the significance of life insurance reserves, is that all investment income should be taxed at the regular corporation rate and that failure to do so constitutes an unfair tax advantage to the life insurance companies.

VI. LIFE INSURANCE FOR U.S. SERVICEMEN

1. War Risk Insurance.—The original World War I insurance was issued under the provisions of a 1917 amendment to the War Risk Insurance act of 1914. War risk insurance was issued for a maximum of $10,000 on the one-year renewable term plan with the option to convert to a permanent plan at the end of the war. The maximum amount in force during the war was about $40,000,000,000 and about $4,000,000,000 worth was converted to permanent insurance after the war.

2. U.S. Government Life Insurance (U.S.G.L.I.).—This life insurance consis'ts of two types: (1) conversions from war risk insurance; and (2) new insurance issued between World War I and World War II to active service personnel and to veterans of World War I. In the second half of the 20th century the amount of U.S.G.L.I. in force had dropped to the still very significant amount of about $1,500,000,000.

3. National Service Life Insurance (N.S.L.I.).—Under the provisions of the National Service Life Insurance act, which became law in Oct 1940, insurance was made available to all servicemen in World War II. Originally issued for a maximum of $10,000 on the five-year term plan, it was convertible to any one of three permanent plans at any time after one year from issue. After the war the term was increased to eight years without increase in premium. In 1948 the right was granted to renew for an additional five years at the premium for the attained age.

Dividends under N.S.L.I. were very generous for two major reasons: expenses were paid by the government and not charged to the insurance fund; and claims ruled as war-connected (88% of deaths during the war) were paid directly from the treasury department and not charged to the insurance fund.

Insurance in force under N.S.L.I. reached about $140,000,000,000 during World War II, an amount approximately equal to the total life insurance then in force in all the private companies combined. In the second half of the zoth century it had dropped to about $35,000,000,000.

In April 1951 congress passed the Servicemen's Indemnity and Insurance acts, which terminated all future sales of both U.S.G.L.I. and N.S.L I. and created a new system, retroactive to the beginning of the Korean war, of free indemnities for death during active service. The indemnity consisted of $10,000 less the amount of U.S.G.L.I. or N.S.L.I. in force.

VII. MORTALITY TABLES

The rate of mortality is the probability that a person will die within one year. The table below shows the rates of mortality at ages 20, 40, 60 and 80 according to seven of the historically more important mortality tables used for life insurance purposes.

The Northampton table, published by Richard Price in 1783, based as it was on a study of death and christening records in Northampton (no census of the population being available), was not really accurate. Mortality according to the Northampton table was excessively high, even for the 18th century.

TABLE 11.—*Rates of Mortality According to Seven Mortality Tables*

Table	*Age 20*	*Age 40*	*Age 60*	*Age 80*
Northampton	.0140*	.0209	.0402	.1343
Carlisle	.0071	.0130	.0335	.1217
Actuaries'	.0073	.0104	.0303	.1404
British Offices' O^M	.0040	.0092	.0289	.1384
American Experience	.0078	.0098	.0267	.1445
1941 C.S.O.	.0024	.0062	.0266	.1319
1958 C.S.O.	.0018	.0035	.0203	.1100

*One hundred and forty out of 10,000 persons age 20 will die within one year.

The Carlisle table, published by Joshua Milne in 1815, was based on two censuses and the death records for two parishes in Carlisle. The table has been very extensively used.

The Actuaries' table was based on a detailed study of mortality among policyholders of British companies. The table was published in 1843. It is sometimes called the Combined Experience table and also the Seventeen Offices' Experience.

The British Offices' Life tables (1893) were based on the experience of 60 British companies from 1863 to 1893. The study showed rates of mortality separately for different classes of policies and for both sexes. The best known and most important of these tables was the O^M table, based on the experience of male holders of whole life participating policies; it remained the standard table from 1903 until supplanted in 1935 by the A1924–29 tables, followed by the A1949–52 tables of mortality for lives insured and the A(55) tables in respect of life office annuitants.

The American Experience table was constructed about 1860 and first published under its present name in 1868. Sheppard Homans, the table's author, once stated publicly that the experience of Mutual Life of New York was the main basis for the table but that the table was not intended to be an accurate interpretation of that experience. Until 1948, most U.S. companies used the American Experience table for reserve and nonforfeiture calculations.

The 1941 C.S.O. table was based on American life insurance experience for the period 1930–40. The 1958 C.S.O. table was based on experience for the period 1950–54.

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See also various papers in Institute of Actuaries: *Journal;* Faculty of Actuaries, *Transactions* (published irregularly); Society of Actuaries, *Transactions.* Useful yearbooks include the *Insurance Blue Book and Guide* (London) and the *Life Insurance Fact Book* (New York).
(RT. E. L.)

LIFE SPAN, ANIMAL. Much of what is known about the length of life of animals derives from observations of domesticated species or animals in laboratories and zoos. One has only to consider how few animals reveal their age to realize the difficulties involved in answering the apparently simple question of how long they live in nature. In many fishes, a few kinds of clams and an occasional species of other groups. growth is seasonal, so that annual zones of growth, much like tree rings, are produced in some part of the organism. Among game species, methods of determining relative age by indicators such as the amount of tooth wear or changes in bone structure have yielded valuable information. Bird bands and other identifying marks also make age estimation possible. But one of the consequences of the fact that animals move is that virtually nothing is known about the life span of most species as they exist in nature. For a discussion of man's life span see LIFE SPAN, HUMAN.

It is therefore reasonable to expect some surprises, as more information accumulates. The extreme claims of longevity that are occasionally made for one species or another have consistently been proven empty when subjected to critical scrutiny. Although the maximum life span that has been observed for a particular species cannot be considered absolute, since at best a limited number of individuals has been studied, this datum probably provides a fair approximation of the greatest age attainable for this kind of animal under favourable conditions. Animals in captivity, which provide most of our records of extreme age, are exposed to far fewer hazards than those in the wild. In the following table of maximum life spans, particular species have been so selected as to encompass the known range of longevity of other members of the taxonomic group to which they belong.

Very few generalizations about maximum life span can be made. Many animals are capable of living several years or decades. Ages of more than 100 years are well established only among the turtles. There are indications that large animals can live longer than smaller ones, but many exceptions to such a rule exist. The box turtle and water turtle, for example, are similar in size—as are

TABLE.—*Maximum Life Span of Animals in Captivity**

Animal	Maximum Life Span in Years	Animal	Maximum Life Span in Years
Mammals:		Amphibians:	
Bat (*Eptesicus fuscus*)	2	European Black salamander (*Salamandra atra*)	3
Grizzly bear (*Ursus horribilis*)	31	Spotted salamander (*Ambystoma maculatum*)	25
Cat (*Felis catus*)	21	Frog (*Rana* species)	5–15
Chimpanzee (*Pan troglodytes*)	37	Fishes:	
Dog (*Canis familiaris*)	34	Eel (*Anguilla rostrata*)	6
Elephant. Indian (*Elephas maximus*)	57	Goldfish (*Carassius auratus*)	25
Goat (*Capra hircus*)	18	Sturgeon (*Acipenser transmontanus*)	50
Golden hamster (*Mesocricetus auratus*)	1.8	Insects:	
Horse (*Equus caballus*)	62	Ant (*Lasius* species)	15
Lion (*Panthera leo*)	29	Buprestid beetle (*Buprestis splendens*)	30
Mouse (*Mus musculus*)	3	Fruit fly (*Drosophila melanogaster*)	0.1
Ox (*Bos taurus*)	30	Spiders:	
Squirrel, gray (*Sciurus carolinensis*)	15	Bird spider (*Avicularis avicularis*)	15
Wild boar (*Sus scrofa*)	27	House spider (*Tegenaria civilis*)	0.01
Birds:		Crustacea:	
Blue jay (*Cyanocitta cristata*)	4	Crayfish (*Astacus fluviatilis*)	30
Canary (*Serinus canaria*)	24	Water flea (*Daphnia magna*)	0.2
Macaw (*Ara macao*)	64	Mollusks:	
Nightingale (*Luscinia luscinia*)	3.8	Clams, various species	1–10
Pigeon (*Columba livia domestica*)	35	Snails, various species	1–30
Titmouse (*Parus major*)	9	Annelid worms:	
Reptiles:		Earthworm (*Lumbricus terrestris*)	10
Alligator (*Alligator mississipiensis*)	56	Medicinal leech (*Hirudo medicinelis*)	27
Garter snake (*Thamnophis sirtalis*)	6	Rotifers:	
Box turtle (*Terrapene carolina*)	123	Various species	0.03–0.1
Giant tortoise (*Testudo elephantopus*)	177		
Water turtle (*Pseudemys scripta*)	7		

*Condensed and adapted from W. S. Spector (ed.), *Handbook of Biological Data* (1956).

the European and spotted salamander—yet their life spans differ markedly. There also are indications that extreme longevity is a characteristic of certain large taxonomic groups. *e.g.,* the reptiles; but every such group also includes some proportion of short-lived species.

Not only do different species differ in longevity, but wide variations commonly exist among individuals of the same species. Knowledge of maximum length of life is therefore not nearly so meaningful as is information about average longevity. Better yet is a set of data that describes the probability of death for individuals of any age in any environment. Before examining what is known about life span in this statistical sense, it is essential that one take a closer look at the meaning of life span itself.

The concept of life span implies that there is an entity; the individual, whose existence has a definite beginning and end. What constitutes the individual in most cases presents no problem: among organisms that reproduce sexually the individual is a certain amount of living substance capable of maintaining itself alive, and endowed with hereditary characteristics that are in some measure unique. In some organisms, however, extensive and apparently indefinite growth and reproduction may occur by division of a single parent organism. If these divisions are incomplete, a colony results. If the parts separate from each other, separate organisms, genetically identical but perhaps exposed to very different conditions of life. are formed. Among the one-celled Protozoa it may be impossible to distinguish between parent and daughter organisms. If we are to consider life span in such animals, the individual must be arbitrarily defined, for the organisms are continually dividing. In a strict sense, life span in these animals is not comparable to that of sexually produced forms.

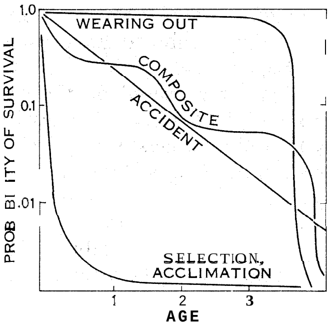
The end of the animal, or death, results when irreversible changes have occurred to such an extent that the individual no longer actively retains its organization. There is a brief period when it is impossible to say whether the organism is still alive. This time is so short relative to the total length of life that it creates no great problem in determining life span. Death, as defined: is an attribute of the individual as a whole. Although it is possible to maintain parts of higher organisms alive indefinitely, the majority of species of animals undergo processes of deterioration with time. (The nature of these aging phenomena is discussed in DEATH. BIOLOGICAL ASPECTS OF.) Some animals, however, are potentially immortal. Unless some accident puts an end to life, they are capable of surviving indefinitely. Without examining the various causes of death in detail, a distinction can be made between death as the result of internal changes, *i.e.,* aging, and death caused by some purely external factor. It is worth noting that the absence of aging processes is correlated with the absence of individuality. Many of those animals wherein the individual is hard to define do not age.

The beginning of the individual can be closely defined by the formation of the fertilized egg; or, in asexual species, by the time when physical separation of the new organism occurs. In practice, birth is commonly considered the beginning of the life span. However, the timing of birth is so different in various kinds of animals that it is only a poor criterion for this purpose. In many marine invertebrates the hatching larva consists of a relatively few cells, not nearly so far along toward adulthood as a newborn mammal. Likewise among the mammals there are large variations. A kangaroo at birth is little more than an inch long, scarcely comparable to a newborn deer. If life spans of different kinds of animals are to be compared, it is essential that these variations be eliminated.

Life span usually is measured by units of time. Although this may seem eminently logical. certain difficulties may arise there also. In cold-blooded animals in general the rate of metabolism that determines the various life processes varies with the temperatures to which they are exposed. If aging depends on the expenditure of a fixed amount of vital energy, an idea first proposed by Max Rubner in 1908, life span will vary tremendously depending on temperature or other external variables that influence life span. There is considerable evidence attesting to the partial cogency of this argument. Cold-blooded invertebrates do live longer at low than at high temperatures, so long as a certain range is not exceeded. Rats in the laboratory live longest on a somewhat restricted diet that does not permit maximum metabolic rate. Of perhaps even greater significance is the fact that many animals undergo dormant periods. Many mammals hibernate; a number of arthropods have life cycles that include periods of diapause during which development becomes arrested. Under both conditions the metabolic rate becomes very low. It is certainly questionable whether such periods should be included in computing the life span of a particular organism. Comparisons between species, some of which have such inactive periods while others do not, certainly are dangerous. It is possible that life span would be measured more adequately by total metabolism; however, data for this purpose are almost entirely lacking.

Length of life is controlled by a multitude of factors, which collectively, may be termed environment, operating on a genetic system that determines how the individual will respond. It is impossible to list all the environmental factors that may lead to death. For analytical purposes it is, however. useful to make certain formal separations. Every animal is exposed to: (1) a pattern of numerous events. each with a certain probability of killing the individual at any moment, and, in the aggregate. causing a total probability of death or survival; (2) climatic and other changes in the habitat modifying the frequency with which the various potentially lethal events occur; and (3) progressive systemic change, inasmuch as growth, reproduction, development and senescence are characteristics intrinsic in the organism and capable of modifying the effect that various environmental factors will exert.

Consider a group of similar animals of the same age. Although no two individuals can have precisely the same environment! let it be assumed that the environment of the group remains effectively constant. If these animals also undergo no progressive physiological changes, the factors causing death will produce a death rate that remains constant in time. Under these conditions, it will take the same amount of time for the population to become reduced to one-half its former number, no matter how many animals remain at the beginning of the period considered. The animals therefore survive according to the pattern of the accident curve of the figure. This is the sense in which many of the lower animals are immortal. Although they die, they do not age; how long they have already lived has no influence on their further life expectation. The situation is equivalent to that observed in the decay of a radioactive substance, wherein one can determine a half-life that indicates the rate of transformation of its atoms.



OF SURVIVORSHIP CURVES
(Numbers are in relative units)

Another group of animals may consist of individuals that differ markedly in their responses to the constant environment. They may be genetically different, or their previous development may have caused variations to arise. Those individuals that are most poorly suited to the new environment will die. leaving survivors that are better adapted. The same result can also be achieved in other ways. If the environment varies geographically, those individuals which happen to find areas in which existence can be maintained will survive, while the remainder will die. Or, as a result of their own properties, animals in a constant environment may acclimate in a variety of ways, thus adjusting to the existing conditions. The pattern of survival that results in each of these cases is one in which the death rate declines with time, as illustrated by the selection-acclimation curve.

In the absence of death from other causes. all members of a population may exist in their environment until senescence sets in. This causes a decline in the ability of individuals to survive. In a sense they can be considered to wear out as does a machine. Their survival is best described by the wearing-out curve. Individual differences among members of the population determine the degree of curvature of the survival line. The more the population varies; the less abrupt is the transition from total survival to total death.

Under the actual conditions of existence of animals the three types of survivorship outlined above all enter as components of the realized survival pattern. Thus in animals which are carefully maintained in the laboratory, survival is approximately that depicted in the wearing-out curve. Environmental accidents can be kept to a minimum under these conditions, and during the major part of the life span survival is almost complete. In all known cases, however, the early stages of the life span are characterized by a noticeable contribution of the selection-acclimation curve. This must be interpreted as a result of developmental changes that accompany the early life of the individuals, and of selective processes that operate on those organisms whose genetic constitutions are ill fitted for that environment.

In some of the larger mammals in nature, the existing evidence points to a similar survival pattern. However, in a variety of other animals, including fishes and invertebrates, mortality of the young stages is so high that the selection-acclimation curve predominates. One estimate places the mortality of the Atlantic mackerel during its first 90 days of life as high as 99.9996%. Since some mackerel do live for several years, a mortality rate that decreases with age is indicated. Similar considerations probably apply to all those animals that have larval stages which serve as dispersal mechanisms.

When the postjuvenile portion of the life span is considered by itself, a number of animals for which such information has been gathered — including primarily fishes and birds — have survivorship curves that are dominated by the accident pattern. In these species in nature, death from old age apparently is rare. Their chance of surviving to an advanced age is so small that it may be statistically negligible. In modern times human predation is a large factor in the mortality of these species in many cases. Since deaths from fishing and hunting are largely independent of age. once an animal has reached a certain minimum size, such a factor only makes the survival curve steeper, but does not change its shape. One consequence of such increased mortality is that fewer old and large individuals are noticed in a population.

More complex survival patterns, such as the hypothetical one illustrated by the composite curve. undoubtedly exist. They should be looked for in those species in which extensive reorganization of the animal is part of the normal life cycle. In effect these animals change their environment radically, in some cases several times during a lifetime. The frog offers a familiar example. During its period of early development and until shortly after hatching, the animal is subject to major internal and some external change. As a tadpole it is adjusted to an aquatic, herbivorous life. The metamorphosis to the terrestrial, carnivorous adult form is accompanied by varied physiological stresses that must be expected to produce a temporary increase in mortality rate. In some insects the eggs, larvae, pupae and adults are exposed to and respond to quite different environments. In these species a survivorship pattern even more complex than that described by the composite curve may exist.

The same species will exhibit changed survival in different environments. In captivity an animal population may approach the wearing-out curve; in its natural habitat survivorship may vary with age in a quite different way. Although one can assign a maximum potential life span to an individual—while realizing that this maximum may not be attained—it is impossible to specify the shape of the survivorship curve unless the environment is also specified. This is but another way of saying that life span is the joint property of the animal and the environment in which it lives.

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LIFE SPAN, HUMAN. The human life span may be defined as the interval from conception to the age beyond which a person could not live even under the most favourable conditions. It may conveniently be designated by its maximum limit; as, for example, a life span of 100 years.

The life span frequently is erroneously thought to be synonymous with: (1) the average length of life; and (2) the expectation of life. The average length of life is the number of years lived by a group of persons, divided by the number of persons in the group. It may refer to the average length of life of the members of a group or cohort of persons (*e.g.,* presidents of the United States elected prior to 1900, or veterans of World War I), who are traced until the last member has died and whose deaths usually occur during a period of several years; it also may refer to the average age at death of persons who die during the same period of time (*e.g.,* the average age at death of persons dying in England and Wales during a calendar year).

The expectation of life is a hypothetical number computed from a mortality table. It represents the average number of years that a group of persons. all born at the same time, would be expected to live if they were subject to a fixed set of age-specific death rates from birth until the last person of the group had died. It may be computed for persons of any specified age, but the expectation of life at birth is the number most often cited (see LIFE EXPECTANCY).

The average length of life, average age at death and expectation of life are group characteristics. Except in very rare instances some members of the group will live longer than the average, some will live less than the average and none may have a duration of life equal to the average. In contrast, the span of life is the maximum age beyond which an *individual* cannot live, given even the most favourable conditions.

In this sense, the span of life is a theoretical number whose exact value cannot be determined from existing knowledge. Presumably there is a maximum life span for the human race, but until there is discovered some property of protoplasm that definitely limits the possible duration of human life, the exact duration of man's span of life will remain unknown.

At first thought. this statement seems irrational. Surely no human being can live 1,000 years. Even though all may agree that the likelihood of an individual living 1,000 years is infinitesimal, there is no scientific proof that this statement is, or is not, true. The indeterminacy of the maximum limit of human life may be made more comprehensible if one chooses a number that may appear to many as a more reasonable limit.

Since there is no verified instance of a person having lived 150 years, this number may, for purposes of illustration, be arbitrarily accepted as the maximum limit of the span of human life. But if the possibility is admitted that an individual may live exactly 150 years, there is no valid reason for rejecting the possibility that some other individual may live 150 years and one minute. And if 150 years and one minute is accepted why not 150 years and two minutes. and so on? Thus, based on existing knowledge, a precise figure for the span of human life cannot be given.

The span of life, as defined here, is a biological trait and as such is genetically determined. Its observed expression, a person's length of life or age at death, reflects the lethal effect of environmental factors that continually act upon each individual from conception until death. Although evidence supports the belief that the span of life is genetically determined, the nature of the genetic mechanism is unknown.

Much of the information concerning the inheritance of longevity has come from the study of genealogical records. Among the more important studies are those by M. Beeton and Karl Pearson, B. Stoessiger and S. J. Holmes, based on the genealogical records of nobility and landed gentry; Alexander Graham Bell's analysis of the Hyde family; E. B. Wilson and Carl Doering's study of the Peirce genealogy; and I-Chin Yuan's investigation of the records of a Chinese family for the period 1365 to 1914.

The early genealogical studies were criticized on the grounds that the downward trend in the death rate (attributable generally to scientific advancements) introduced a spurious positive correlation in statistics derived from records extending over long periods of time. It was argued that in some instances records were included of persons who, at the time of the study, had not had the opportunity of living out their possible life span. Yuan, however. excluded all persons born after 1819. His findings supported those of previous investigators in showing that the expectation of life of sons of long-lived (longevous) parents, *i* e., those living to age 70 years or older. was greater than that of sons of shorter-lived parents, *i.e.,* those having attained less than age 50 at the time of death.

Raymond Pearl attempted to avoid the defects of genealogical studies by collecting records of the family histories of 365 nonagenarians and of a comparison group of 143 individuals of varying ages, selected because all of their six immediate ancestors were dead.

Pearl introduced the concept of "total immediate ancestral longevity," or TIAL—the sum of the ages at death of the two parents and the four grandparents of a given person—as a measure of longevity. This number is unlikely to be greater than 600 or less than 90. The average TIAL of the nonagenarians and centenarians definitely exceeded that of the comparison group. This held true not only for the six immediate ancestors as a group, but also for each category—father, mother, paternal and maternal grandparents.

Pearl also computed the expectation of life for sons of fathers classified into three groups by age at death: (1) under age 50; (2) ages 50–79; and (3) age 80 or over. At birth the expectation of life for the three groups of sons was 47.0, 50.5 and 57.2 years, respectively. The same relative ranking continued through the lifetime of the sons, their expectation of life at age 40 being 27.3, 28.9 and 32.0 years, respectively.

Taken at their face value, these data show clearly that longevous persons had parents and grandparents who lived longer than the parents and grandparents of shorter-lived persons. But Pearl's study, like those of earlier investigators, is open to criticism. The comparison group consisted of persons not selected because of longevity, all of whose six immediate ancestors were dead, and who themselves had died at various ages. The failure to impose a lower limit for the age of members of the comparison group greatly increased the likelihood that the average TIAL for this group would be less than that for the longevous group. If all of the parents and grandparents of a person aged 20 are dead, some of them must have died at a relatively young age. Since four persons in the comparison group were less than 20 years of age, the results of Pearl's study must have been influenced by the method of selecting that group.

Pearl recognized this bias and attempted to correct for it. He concluded that it could not account for all of the difference in the length of life of the ancestors of the longevous and comparison groups, and that the data taken as a whole supported the belief that heredity is an important determinant of the longevity of individual human beings.

Since longevity is so important in life insurance underwriting, several studies have been made of the relationship between heredity and the life span by an analysis of life insurance records. The data from these records have a number of defects that limit their usefulness for this purpose. Persons considered to be poor risks because of ill health or a family history of disease usually are excluded. The studies were based upon the age of the parents as shown in the application for insurance. But in many cases one or both parents of the policyholder are alive at the time the application is prepared, so that their age at death is unknown

These defects limit the value of life insurance records for the investigation of the relationship between the length of life of parents and their children. Analyses of life insurance data shoved that policyholders, both of whose parents were living nhen the policy was written, live longer than those whose parents were dead when the policy was written. These results are in conformity with those obtained from genealogical records and family histories.

Each of the various types of studies of the inheritance of longevity—genealogical records, life insurance records and family histories of the general population—has limitations that restrict the generality of the findings. Nevertheless the principal studies indicate that the children of longevous parents are more likely to be longevous than are the children of short-lived parents. Conversely the immediate ancestors—parents and grandparents—of longevous persons on the average are older at death than are the immediate ancestors of persons who die at a relatively young age. These studies support the conclusion, mentioned earlier, that longevity is determined in part by heredity.

It should be observed that this conclusion relates to the inheritance of longevity—the observed expression of the span of life—and not to the span of life itself. The actual length of life is shorter than the possible life span, since the former reflects the effect of unfavourable or morbid environmental factors. It is not practicable to observe directly the effect of heredity upon the human life span, but existing knowledge supports the belief that heredity is the most important determinant of the length of the span of life.

In the absence of any biological data from which the maximum limit of the span of life can be determined precisely. an estimate of this limit must be obtained from observation of the actual length of life of persons who already have died. But such observations cannot establish a fixed limit for the span of life.

The estimation of the length of the span of life from observed data is a form of sampling from a large but incomplete population. The tabulation of the ages at death of a large number of persons from a large general population, such as the population of the United States, will give an asymmetrical frequency distribution with tno modes, or peaks of highest frequency: the first at age zero last birthday. and the second between ages 75 and 80 years. The frequency distribution is bounded by age zero at the lower limit but there is no boundary at the upper limit.

The number of deaths of persons whose length of life is near the upper limit of this frequency distribution (*e.g.*, 100 years or more) varies from year to year. The age of the oldest person dying also varies from year to year

The number of deaths of centenarians depends in part upon the number of deaths counted. For example. during the 16-year period 1930–1945. 1.611 deaths of centenarians were registered in England and Wales. This is slightly smaller than the number (1.631) registered in the United States in one year (1956). In neither country were the ages at death verified. so that the true numbers of centenarians almost certainly were less than those given in the official vital statistics.

Only a very small proportion of the deaths that have occurred throughout the history of the human race have been registered. The potential number of future deaths greatly exceeds the number that already has occurred

Statistical theory supports the expectation that as the total number of deaths continues to increase the death will be recorded of a person nhose length of life will be longer than that of any person previously known.

Observation of the length of life of persons who had died can show that it is possible for a human being to live to the oldest age recorded as of any specified date, and can provide an estimate of the relative frequency or probability of that event. Such observations, however. do not provide a logical basis for fixing any age as the maximum possible limit of the life span.

The continuation of the world-wide decline in the death rate will naturally result in an increase in the number of persons who live until age 100 years or more. Only 7 of every 100 white female babies nho are subject throughout their lifetime to the death rates in the United States registration area during 1900–02 would be expected to attain age 85. On the other hand, more than three times as many, or 24 out of every 100. white female babies subject throughout their lifetime to the death rates recorded in the United States during 1956 would be expected to celebrate their 85th birthdays. In other words, 417,000 of the 1,738,000 nhite female babies born in the United States during 1956 could expect to live at least 85 years even if there should be no further decrease in the death rate. About 6.000 of these should live a century or more.

Comparable mortality rates exist in all of North America. Australia, New Zealand, central and northwest Europe, and soon may be found also in all of Europe. Since the number of persons who may live to an advanced age, such as 110 or 115 years, is directly related to the number of persons nho live to age 100, an increase in the latter number will increase the probability that the death of an individual attaining some greater age (*e.g.,* 11j years) will be recorded at some future date

Many instances have been recorded of persons alleged to have died at an age considerably greater than 100 years Statements concerning the age at death of Biblical characters such as Methuselah can be dismissed, since scientific verification is impossible. Three of the most frequently cited cases of more recent times are: Thomas Parr, who died in Nov. 1635 at the alleged age of 152 years, Henry Jenkins. who died in Dec. 1670 at the alleged age of 169 years; and Catherine, countess of Desmond. who died in 1604 at the alleged age of 140 years. William Harvey, the famous English physician, performed an autopsy on Thomas Parr and the account of the autopsy was cited for many years as evidence that Harvey—in his paper—had confirmed Parr's age. Quite apart from the fact that it is impossible to determine accurately the age of a person by an autopsy. Harvey made no attempt to verify Parr's age but merely referred to the current estimates. Subsequent investigations have revealed that no proof exists of the age at death of any of these three individuals and that their reported ages were based solely upon hearsay

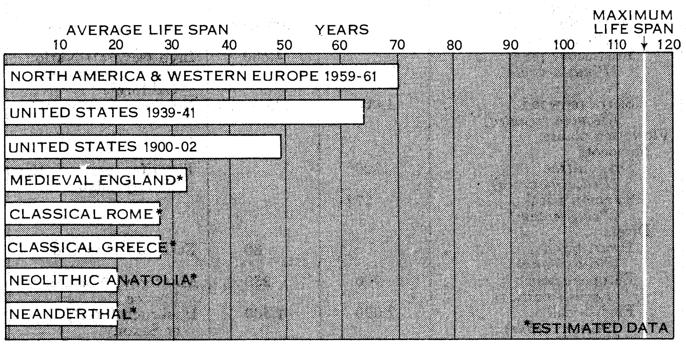
An example with more definite documentation is that of Christian Jacobsen Drakenberg. stated to have been born on Nov. 18, 1626. and to have died on Oct. 9 1772, aged 145 years and 32j days An extensive biographical sketch appears in the *Dansk Biografisk Leksikon,* and the authenticity of his age has been attested to by many persons including tno celebrated Scandinavian actuaries and statisticians, Harald L. W. Westergaard and J. F. Steffensen. However, later investigations cast doubt upon the authenticity of the persons stated to have certified to Drakenberg's date of birth. Furthermore it is difficult to accept the statements concerning Drakenberg's age at death, since this age is more than 30 years greater than the next oldest verified age at death—a difference that in itself casts doubt on its authenticity.

In 1939 W. G Bowerman stated that the oldest known age attained by an insured life or an annuitant in Great Britain or America was 107 years. Bowerman cited eight individuals for whom. in his opinion, records substantiated the fact that each had lived more than 108 years. Seven of these were females. Six of the eight were more than 110 years old at death. The oldest was Pierre Joubert. who was born July 15, 1701, and died Nov. 16. 1814. aged 113 years and 124 days. This is the oldest age at death that has been generally accepted as authentic. It is possible that Drakenberg may have lived longer than this, but his exact age at death has not been reliably determined.

It may be concluded that the span of human life is at least 114 years, but that this is not the maximum upper limit This does not mean that the span of life of each individual now living or to be born in the future is at least 114 years. The span of life, since it is determined by heredity, varies from one individual to another as do other genetically determined traits.

A significant proportion of human embryos and fetuses die before birth (*see* ABORTION). Other infants at birth have defects that limit their span of life to a few years Some malformations, *e.g.*, certain cardiovascular defects. are developmental rather than genetic in the strict sense of the word and can be corrected so that the length of life of such persons is extended (*see* FETAL DISORDERS; MONSTER).

In the past the length of life of most individuals has been con-



H. F. DORN, AFTER EDWARD S. DEEVEY. JR. IN "SCIENTIFIC AMERICAN"

AVERAGE AND MAXIMUM LIFE SPAN OF MAN

siderably shorter than their possible span of life because of unhealthful environmental factors. As these factors are increasingly brought under control or eliminated the actual length of life will approach more closely the span of life.

At the end of the 18th century the expectation of life at birth in North America and northwestern Europe aas about 35 or 40 years. By 1960 it had just exceeded 70 years. At some future date the death of a person at an authenticated age of more than 114 years can be expected.

There is no evidence that the span of human life has increased since the beginning of recorded history. Neither is there any evidence that the death rate of centenarians has decreased. The remarkable increase in the average length of life during the past 2.000 years—from 20–25 years to 70 years under favourable conditions—has increased the likelihood that a person may live to the maximum limit of his span of life. The expected increase in the number of centenarians results from a decrease in the death rate at ages under 100 years and not from any demonstrable increase in the maximum length of the span of life.

See also DEATH, BIOLOGICAL ASPECTS OF; DEATH RATE; LIFE SPAN, ANIMAL.

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LIFE SPAN, PLANT. Plants grow old as surely as do animals; however, a generally accepted definition of age in plants has not yet been realized. If the age of an individual plant is that time interval between the reproductive process which gave rise to the individual and the death of the individual, the age attained may be given readily for some kinds of plants but not for others.

Problem of Defining Age in Plants.—An English oak that has 1,000 annual rings in the trunk is 1,000 years old. But how old is an Indian lotus plant that germinated from a seed which, containing the embryo lotus plant, had been lying in peat deposits for 1,000 years?

How old is a cultivated banana plant? Cultivated bananas produce seeds incapable of germination. Propagation of bananas is carried out by separating offshoots from a mature plant. The offshoot matures and in turn produces new offshoots. This process of growth and development has been continuing for thousands of years uninterrupted by sexual reproduction.

The mushroom caps that appear in some fairy rings persist for only a few days, but the network of fungus filaments in the soil (the mycelia) may be as old as 400 years. Because of important differences in structure, the life span of higher plants cannot be compared with that of higher animals. Normally, embryonic cells (that is, cells capable of changing in form or becoming specialized) cease to exist very early in the life of an animal. In plants, however, embryonic tissue—the plant meristems—may contribute to growth and tissue formation for a much longer time in some cases throughout the life of the plant. Thus the oldest known trees, bristlecone pines of California, have one meristem (the cambium) that has been adding cells to the diameter of these trees for about 4,600 years, and another meristem (the apical) that has been adding cells to the length of the tree for the same period. These meristematic tissues are as old as the plant; they are derived from the pine embryo that existed in a seed 4.600 years ago. The wood, bark, leaves and cones, however, live for only a few years. The wood of the trunk and roots, although dead, remains part of the tree indefinitely, but the bark, leaves and cones are continually dying and sloughing off.

Life Span in Some Major Plant Groups.—Because reproductive processes and vegetative structures vary greatly among the major plant groups, the life span of each must be considered separately.

Blue-Green Algae.—Among living things, blue-green algae have one of the longest fossil records. Sexual reproduction in this group is not known; multiplication is only by cell division and fragmentation of the algal filaments. Since there is no fusion of sex cells, each new individual is a continuation of an already existing one. For this reason some botanists have said that blue-green algae have indefinitely long life spans.

Diatoms.—Each diatom consists of a cell that secretes two half shells. One of the half shells fits into the other to make a miniature pill box that encloses the cell substance. When cell division takes place, one of the new cells receives the larger shell, the other the smaller. Each new cell then secretes a smaller half shell to fit into the existing half shell. The smaller shells may expand in some species, but for others, each division results in one offspring being smaller than the parent. The trend toward reduction in size ends with sexual reproduction or a discarding of the old shells with increase in size of the cell. In either case there is a clear ending to the old generation of cells and a beginning of a new generation. Reduction in size can continue past the point of reversal by sexual reproduction or discard of shells. In this event the cell that has reached minimum size dies. For many species of diatoms, then, there is a fairly definite life span, which depends upon the number of cell divisions that have taken place.

Bacteria.—For these forms, as for many other one-celled organisms, there is a problem as to what, in the absence of injury, constitutes death. Some students of microorganisms regard the appearance of a lifeless residue as a mark of death. When a bacterial cell is subjected to certain unfavourable conditions, it dies, and the entire cell comprises a lifeless residue. Sometimes a portion of the cell becomes a spore, a resistant structure that may be capable of resuming growth after many years of inactivity. The longevity of an individual cell, however, is figured from the time of the appearance of the cell by division until the cell itself divides. This interval is sometimes as brief as 20 minutes.

Brown Algae.—One of the giant seaweeds (*Macrocystis*) of the Pacific coastal zones may attain a length of 200 ft. Estimates of the time required to reach this length range from 100 to 800 years.

Mosses.—Only a few mosses possess structures that enable an estimate of their age to be made. The haircap moss (*Polytrichum*) grows through its own stem tip each year leaving a ring of scales which marks the annual growth. Three to five years' growth in this moss is common, but life spans of ten years have been recorded. The lower portions of such a moss are dead. though intact. Peat moss (Sphagnum) forms extensive growths that fill acid bogs with a peaty turf consisting of the dead lower portions of mosses whose living tops continue growing. Mosses that become encrusted with lime (calcium carbonate) and form "tufa" beds several metres thick also have living tips and dead lower portions. On the basis of their observed annual growth some tufa mosses are estimated to have been growing for as long as 2,800 years.

Ferns.—No reliable method for determining the age of ferns exists. On the basis of size attained and growth rate, however, some tree ferns are thought to be several decades old.

Club Mosses.—Some club mosses have a "storied" growth pattern similar to that of the haircap moss. Under favourable conditions some specimens live five to seven years.

Higher Plants.—The woody seed plants, such as conifers and broadleaf trees, are the most amenable to determination of age. In temperate regions. where each year's growth is brought to an end by cold or dryness, every growth period is limited by an annual ring—a new layer of wood added to the diameter of the tree. These rings may be counted on the cut ends of a tree which has been felled, or a special instrument, an increment borer, can be used to obtain a cylinder of wood for the purpose of counting and studying growth rings. In the far north growth rings are so close together that they are difficult to count. In the moist tropics growth is continuous so that no rings are formed.

Often the age of a tree is estimated on the basis of its diameter, especially when the average annual increase in diameter is known. The source of greatest error in this method is the not infrequent fusing of the trunks of more than one tree. Thus the famous Montezuma cypress of Santa María del Tule, a little Mexican village near Oaxaca, is 31 metres in circumference, measured 1¼ metres above the ground. This tree, described by Cortés, was earlier estimated on the basis of its great thickness to be 6.000 years old; later studies, however, proved it to be actually three trees grown together. Estimates for the age of English yews have been as high as 3.000 years; these figures also have been found to be based upon the fusion of close-growing trunks, none of which is more than 250 years old.

Seed Plants Classified According to **Life** Span.—Annuals.—Plants, usually herbaceous, that live for only one growing season and produce flowers and seeds in that time are called annuals. They may be represented by such plants as corn and marigolds, which spend a period of a few weeks to a few months rapidly accumulating food materials. As a result of hormonal changes—brought about in many plants by changes in evironmental factors such as day length and temperature—vegetative (leaf-producing) meristems change abruptly to flower-producing meristems. The formation of flowers, fruits and seeds rapidly uses up food reserves and the vegetative portion of the plant usually dies. Although the exhaustion of food reserves often accompanies death of the plant, it is not necessarily the cause of death.

Biennials.—These plants, too, are usually herbaceous. They live for two growing seasons. During the first season, food is accumulated, usually in a thickened root (beets, carrots); flo ering occurs in the second season. As it does in annuals, flowering exhausts the food reserves, and the plants die after their seeds mature.

Perennials.—These plants have a life span of several to many years. Some are herbaceous (iris, delphinium), others are shrubs or trees. The perennials differ from the above-mentioned groups in that the storage structures are permanent, or are renewed each year. Perennials require from one to many years growth before flowering. This preflowering (juvenile) period is usually shorter in trees and shrubs with shorter life spans than in those with longer life spans. The long-lived beech tree (*Fagus sylvatica*), for example, passes 30–40 years in the juvenile stage, during which time there is rapid growth but no flowering.

Some important crop plants—cotton, for example—are perennials in their native tropical regions, but are capable of blooming and producing seeds or other useful parts in their first year. Such plants are often grown as annuals in the temperate zones.

Changes Accompanying Aging.—For all plants, the transition from vegetative growth to flowering (adult) is sharp, but conditions within the plant move gradually toward the flowering state. In English ivy, mulberry, acacia and eucalyptus, leaf shape changes. Characteristics of juvenile and adult stages have also been distinguished for apples, apricots, pecans, beech, oaks, rubber (Hevea) and citrus. Juvenile oaks retain their leaves longer in the winter than do adult oaks; young citrus are thorny, whereas

Maximum Ages for Some **Seed** *Plants*

Plant	Maximum age in years		Locale of verified specimen
	Estimated	Verified	
Conifers			
Common juniper (*Juniperus communis*)	2,000	544	Kola peninsula, north-eastern Russia
Norway spruce (*Picea abies*)	1,200	350–400	Eichstatt, Bavaria
European larch (*Larix* decidua)	700	417	Riffel alp, Switz.
Scotch pine (*Pinus sylvestris*)		584	
Swiss stone pine (*Pinus cembra*)	1,200	750	Riffel alp, Switz.
White pine (*Pinus strobus*)		400–450	
Bristlecone pine (*Pinus aristata*)		4,600	Inyo (several) National forest, east central California
Sierra redwood (Sequoia *gigantea*)	4,000	2,200–2,300	Northern California
Flowering plants			
Monocots			
Dragon tree (*Dracaena draco*)	200*		Tenerife, one of the Canary Islands
Solomon's-seal (*Polygonatum*)	17†		
Dicots			
Dwarf birch (Betula *nana*)		80	Eastern Greenland
European beech (*Fagus sylvatica*)	900	250	Montigny, Normandy, France
English oak (*Quercus robur*)	2,000	1,500	Hasbruch forest, Lower Saxony
Bo tree (Ficus *religiosa*)	2,000–3,000‡		Buddh Gaya, India; Anuradhapura, Ceylon
Linden (*Tilia*)		815	Lithuania
English ivy (*Hedera* helix)	440		Ginac, near Montpellier, Prance

*Exaggerated estimates for this historic specimen reach 6,000 years. †Scars on rootstock counted. ‡According to Buddhist and Roman history.

adult citrus are thornless or nearly so. It is often possible to observe juvenile and adult areas on a single plant. Thus in some specimens of beech and oak, during the early winter, leaves may be seen on the inner branches. which still exhibit their juvenile characteristics, while the outer branches, which are adult, are barren.

English ivy gro s from seed as a creeping, nonflowering vine with five-lobed leaves and aerial roots; after about ten years. erect flowering branches with oval leaves and no aerial roots are formed. Heavy pruning or treatment with the growth substance gibberellic acid may cause the adult form to revert and produce juvenile shoots. In many woody plants cuttings from juvenile portions form roots more readily than cuttings from adult portions.

Seeds.—Although there is great variety in the longevity of seeds, the dormant embryo plant contained within the seed will lose its viability (ability to grow) if germination fails to occur within a certain time. The frequent reports of the sprouting of wheat taken from Egyptian tombs are unfounded. but some seeds do retain their viability for a long time. Indian lotus seeds (actually fruits) have the longest known retention of viability (see above).

On the other hand, seeds of some willows lose their ability to germinate within a week after they have matured.

The loss of viability of seeds in storage, although hastened or retarded by environmental factors, is the result of changes that take place within the seed itself. The changes that have been investigated are: exhaustion of food supply; gradual denaturing or loss of vital structure by protoplasmic proteins; breakdown of enzymes; accumulation of toxic materials resulting from the metabolism of the seed. Some self-produced toxic materials may cause mutations that hamper the ability of the seed to germinate. Since seeds of different species vary greatly in structure, physiology and life history (conditions under which they normally reside between maturation and germination), no single set of age factors can apply to all seeds. (See also SEED TESTING.)

Aging of Tissues and Cells.—Tissues of higher plants are layed down in meristems, areas of continuous cell division, in the stem root tips and elsewhere. All the specialized cells of leaves, fruits and other plant parts eventually undergo senescence and die. During senescence the ability of cell membranes to retain or allow passage of certain substances changes, exudation of cell materials occurs, the cementing materials between cells break down chemically. air spaces become liquid logged and cell proteins become denatured.

The meristems themselves usually remain unchanged in appearance. Only when a shoot tip meristem becomes a flower does an apparent change take place. Functional changes, however, are thought by many botanists to occur with age. The functional change may be in the meristem cells themselves, which utilize salts, carbohydrates, nitrogenous materials and hormones in one way during juvenile stages and in another way during adult stages; or the meristem may remain physiologically the same but the materials coming to it from the rest of the plant may change with age of the plant. Whichever of these suggestions is correct, the meristems of the oldest bristlecone pines are remarkably long-lived tissues that have been alive for 4,600 years. *See* also PLANTS AND PLANT SCIENCE.

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LIFE TABLES. This name is applied to tables showing the number of survivors to each successive age out of a stated number (usually 100,000) of live, human births, on the basis of a given set of death rates for the various ages.

The earliest life tables. such as the table of expectation of life given about the third century A.D. by Ulpian and the table of survivors based on death records in London published by John Graunt in 1662, were based either on conjecture or on death records alone. As reliable death rates at the various ages cannot be obtained in this manner, these primitive tables must be regarded, at best. as rough approximations. The first approximately accurate life table was published in 1693 by Edmund Halley, and was based on the records of baptisms and deaths in the city of Breslau. Ger. The earliest table to be constructed on correct scientific principles. using both death records and population data classified by age, was the Carlisle table (1815) by Joshua Milne.

The compulsory registration of births, deaths and marriages in England and Wales began in 1837, and the resulting statistics, taken in conjunction with successive decennial censuses, led to the publication of the valuable series of English life tables, the first of which was prepared by William Farr and published in 1843.

The earliest U.S. mortality table, published in 1793 by Edward Wigglesworth of Harvard and based entirely on death records of a number of Massachusetts and New Hampshire towns, was constructed by faulty methods and seriously understated the average length of life. The first general population life tables for the U.S. founded on adequate statistics were prepared by James W. Glover and published by the bureau of the census in 1916. They covered only ten states and the District of Columbia. The first official life tables for the entire U.S. were those issued in connection with the 1930 census.

See DEATH RATE; LIFE EXPECTANCY; see also LIFE SPAN, HUMAN.

LIFT, see ELEVATOR.

LIGAMENT, anything which binds or connects two or more parts; in anatomy a piece of tissue connecting different parts of an organism. It consists of a cord. band or sheet of connective tissue between two or more structures which it helps to support and strengthen. These structures may be bones, cartilages, other fasciae, muscles and viscera such as the uterus, liver and others. *See* CONNECTIVE AND SUPPORTING TISSUES; JOISTS AND LIGAMENTS. (F. L. A.)

LIGGETT, HUNTER (1857–1935), U.S. soldier, was born at Reading. Pa., on March 21, 1857. He graduated from the U.S. Military academy. West Point. N.Y., in 1879, and saw service in the west against the Indians. In the Spanish--American war in 1898 he served on the staff of the adjutant general, and later was in the Philippines where, as major of volunteers he served for three years. In 1902 he was appointed a major in the regular army and spent several years with the department of the lakes and at Fort Leavenworth. In 1909 he attended the War college, and on being graduated in 1910 was appointed a director there, and in 1913 president, becoming brigadier general in the same year. From 1915 to 1917 he was again in the Philippines, being for one year commander of the department.

In 1917 Liggett was made major general and commander of the western department, but in September went to France as commander of the 41st division of the American expeditionary force. He was at the second battle of the Marne, at St. Mihiel and in the Argonne, commanding the 1st army corps and later the 1st army, and commanded the 3rd army of occupation on the Rhine. In 1919 he was commander of the western division, and in 1920 commander of the 9th corps area, retiring on March 21, 1921, with the rank of major general.

LIGHT, subjectively, the sense impression formed in the eye. (See VISION.) The present article deals with it purely objectively and is concerned with the more fundamental characteristics of light and optical instruments.

For the more practical applications which are not here discussed in detail *see* INTERFEROMETER; MICROSCOPE; OPTICS; PHOTOMETRY; TELESCOPE.

The subject is conveniently still further subdivided as to whether we are more interested in how the light originates or how it behaves after it has been emitted. The present article is chiefly concerned with the behaviour of light after it has been emitted, a branch of the subject often called physical optics, dealing almost entirely with the wave theory of light.

Following are the main sections and divisions of the article:

I. Introduction
- A. Light Waves and Photons
- B. Types of Radiation
- C. The Appearance of Ordinary Things

II. History
- A. The Age of Newton and Huygens
- B. The Age of Fresnel
- C. The Dynamical Theories of the 19th Century
- D. The Experimental Discoveries of the 19th Century
- E. Developments in the Early 20th Century

III. Waves and Interference
- A. General Characteristics of Waves
- B. The Velocity of a Group of Waves
- C. The Pressure of Light
- D. The Doppler Effect
- E. The Colours of Thin Plates

IV. Diffraction
- A. Fresnel's Construction
- B. The Formation of Shadows
- C. The Fraunhoier Diffraction Phenomena
- D. The Nature of White Light
- E. Resolving Power

V. Polarization and Electromagnetic Theory
- A. Types of Polarized Light
- B. Methods of Producing Polarization
- C. The Analysis of Polarized Light
- D. The Electromagnetic Equations

VI. Refraction and Double Refraction
- A. The Electromagnetic Equations for Refracting Media
- B. Refraction in Transparent Media
- C. Refraction in Absorbing Media

I. INTRODUCTION

It might perhaps be expected that we should begin by saying what light "really" is and should then develop its characters from such a starting point; but this procedure is not possible, since light is essentially more primitive than any of the things in terms of nhich we might try to explain it. The nature of light is describable only by enumerating its properties and founding them on the simplest possible principles. As these principles transcend our ordinary experience they must be cast in a purely logical—that is to say mathematical—form. But that is never enough. for, though logic tells us what deductions must be right, it does not tell us nhat will be interesting, and so gives no guidance as to the direction the theory will take. In choosing this direction much help is derived from analogies and models. which are often loose and incomplete but without nhich no proper understanding of the subject can be acquired. We shall therefore describe, largely by means of analogies, the behaviour of light, and this is the "real" nature of light.

A. Light Waves and Photons.— In our review of the history of the theory of light, we shall see that two very different models have vied with each other from the outset. On the one hand light mas pictured as a wave motion of some sort. and on the other as a flight of fast-moving particles. During the 19th century the former model gained almost universal acceptance, thnnks to a remarkable series of developments on both the experimental and theoretical sides. These culminated in J. Clerk Maxwell's celebrated demonstration of the electromagnetic character of light waves. At the opening of the 20th century. however. a number of new properties were discovered which apparently can be explained only by a corpuscular theory. The nature of these corpuscles. now called photons, is considerably more subtle than was imagined in the early days, but it is found that they possess energy and momentum localized in discrete packets. so that in this respect at least they resemble ordinary material particles. The existence of these two diametrically opposed models of light, each very successful in dealing with the phenomena in its own domain, presented a formidable dilemma to physics. It has led to the realization of the inadequacy of any models of the fundamental entities such as light and the elementary particles of matter. The interpretation of this dual character of light, and also of matter. which possesses wave properties as well, has been an important achievement of quantum mechanics. (See QUANTUM MECHANICS.)

In those phenomena requiring the concept of photons, the property most readily measured is the energy of the photons. The different colours of light represent photons of different energy, those of blue light having nearly twice the energy of the red. The connecting link between the corpuscular and wave models lies in the fundamental postulate of quantum theory that the energy of the photons is directly proportional to the frequency of the light waves. The latter quantity fixes the wave length, or the distance between successive crests, so that on the wave picture the various pure colours correspond to various wave lengths. Several of the wave phenomena of light can he used to measure the wave length, in some cases with a remarkable accuracy, which can exceed 1 part in 1,000,000. This is in spite of the fact that the wave length itself is very minute, amounting to only one fifteen-thousandth of a centimetre for red light. When light is dispersed into a spectrum, as by a prism, the range of colours between red and violet represents wave lengths covering somewhat less than one octave. It is therefore not surprising to find that there are invisible radiations possessing both longer and shorter wave lengths than those capable of affecting the eye.

B. Types of Radiation.— Light would be taken strictly speaking to mean only that which is seen, but it is customary to include in the term the various types of invisible radiation, because, though they cannot be seen, in all other respects their behaviour is similar. These are the ultra-violet and infra-red radiations, which lie just beyond the limits of the visible spectrum, and, more remotely, on the side of the ultra-violet. the X-rays or roentgen rays and the y-rays (see RADIOACTIVITY, NATURAL); while on the side of the infra-red we have the electromagnetic vibrations used in radio. All these radiations have an important property in common, an equal speed of propagation. The most accurate measures of the velocity of light (see VELOCITY OF LIGHT) assign the value $(2\ 997930 \pm 0\ 000003) \times 10^{10}$ cm. per second. The distinction between the various types of radiation is merely one of convenience and is based upon the different methods used for production and detection. They all represent a single phenomenon, and the differences lie only in the matter of wave length. or energy of the photons. Rough values of these quantities are given in the table.

It is not convenient to use the same units of wave length throughout such an enormous range. It is customary to measure radio waves in metres. The infra-red rays are measured in units called microns or μ, the thousandth of a millimetre, but for light the unit universally used is the Ångström unit (Å), which is 10^{-8} cm. This unit is also most frequently used for X-rays, though in precision work X-units of 10^{-11} cm. have been introduced. Much of nhat we shall say here applies to the whole range. but it is not unnatural that there should be differences, and when these occur we shall restrict ourselves to the case of light, visible, ultra-violet and infra-red.

	Wave length	Photon energy
Electric waves		
Radio broadcasting	1×10^{4} cm.	2×10^{-17} erg
: waves.		
Shortest electric waves	2×10^{-2}	1×10^{-14}
Infra-red rays		
Longest heat waves	3×10^{-2}	7×10^{-15}
Longest "rest-rays"	1.5×10^{-2}	1.3×10^{-14}
Average "rest-rays"	5×10^{-3}	4×10^{-14}
Infra-red down to	7×10^{-5}	3×10^{-12}
Visible light		
Limit of red	7.2×10^{-5}	2.8×10^{-12}
Yellow	5.8×10^{-5}	3.4×10^{-12}
Green	5.0×10^{-5}	4.0×10^{-12}
Blue	4.5×10^{-5}	4.4×10^{-12}
Limit of violet	4.0×10^{-5}	5.0×10^{-12}
Ultra-violet rays		
Limit of transparency of glass	3.5×10^{-5}	5.7×10^{-12}
Limit of transparency of quartz	1.8×10^{-5}	1.1×10^{-11}
Lyman rrgion	1×10^{-5}	2×10^{-11}
"Hot spark" region	1×10^{-6}	2×10^{-10}
X-rays		
Longest X-rays	1×10^{-7}	2×10^{-9}
Average X-rays	1×10^{-8}	2×10^{-8}
Shortest X-rays	1×10^{-9}	2×10^{-7}
y-rays	2×10^{-10}	1×10^{-6}

C. The Appearance of Ordinary Things.— In many branches of science, though we start with familiar and crude observations, we very soon find it necessary to discuss much more recondite questions, and this leads to an elaboration of the theory until the most important things in it are quite different from what is familiar to us. This situation is very emphatically true of light. For example, the most familiar thing about light is that it goes in straight lines, and hardly any of our ordinary experiences disagree with this fact. But by more refined experiments it is easy to exhibit that light is sometimes bent (diffracted), and such cases prove more important to the theory than the commonplace observations. Almost the only example of these phenomena, diffraction and interference, which is a matter of common experience is the iridescent colours that appear on soap bubbles and on the surface of greasy water.

So it comes about that the theory of light is not much concerned with the appearance of ordinary things, and. as we shall later have very little to say about them. we may consider them briefly here. In things we see, we may distinguish between the luminous and the nonluminous—in daylight between the sun and everything else. The nonluminous objects are visible only by light reflected from some luminous source. the sun or a lamp, and their different appearances are attributable solely to the different mays in which they reflect light. Thus a black object is one which does not reflect at all. A coloured object is one which reflects some colours but not others. This is easily proved by illuminating a piece of red paper by light passed through a green glass, when it will appear black because there was no red light for it to reflect. White being a mixture of all the colours. a white object is one which reflects all colours about equally. and so it looks coloured if lighted by a coloured light. When two pigments are mixed together the resulting colour will be that which they are *both* capable of reflecting, and may be quite different from the colour seen when the light of two coloured lamps is projected together onto a white screen; for exainple if the light from red and green lamps is compounded in this way the result is a brilliant yellow\,but red and green paints when mixed give a dark muddy colour because there is little light which they can both reflect (see COLOUR).

Many substances are really nearly transparent, but appear opaque because they are not homogeneous, so that the entering light is reflected and refracted many times until it is completely scattered. The most obvious example of this is ground glass, but the same is largely true of paper and white wood. An easy test of whether a substance is opaque in this way or by an inherent opacity to light is to see whether it is of the same colour for reflected and transmitted light. A sheet of red paper looks red whether we look at it or through it at a light, because in both cases what we see is light which has got tangled in the fibres and at each reflection has lost a little of the green and blue light by absorption, so that only the red emerges on both sides. On the other hand. if a substance is truly opaque the'colours on the two sides will be quite different. For example the yellow colour of gold is a result of the fact that it reflects the yellow light more effectively than other colours, and. by a paradox which we shall explain later, this means that it absorbs the yellow more strongly. If then we take a very thin sheet of gold, the yellow light will not penetrate it so easily and the transmitted light will be bluish green.

II. HISTORY

The ancients were acquainted with mirrors and with the burning glass, hut their theories of optics were rather of the metaphysical character so much more congenial than experiment to the Greek temperament. The Pythagoreans believed in an emission theory, supposing that the seen object emitted particles which bombarded the eye, but the Platonists complicated the matter by supposing that vision was produced by a triple interaction between rays emitted by the sun, the object viewed and the eye itself. Among these speculations we can distinguish the discovery of only one real scientific law, cnunciated by Hero of Alexandria, who saw that the equality of the angles of incidence and reflection at a mirror could be expressed by saying that the ray took the shortest possible course between object and eye. This law is the first statement of the general "principle of least action," a principle which now dominates not only geometrical optics but also dynamics.

We may omit the other speculations of the Greeks, Romans and Arabs and come to the Revival of Learning. The earliest developments were practical, such as the invention of spectacles and later of the telescope, with which we shall not be concerned here. The first great theoretical discovery was the law of refraction discovered by Willebrord Snell in 1621 but not published until after his death by René Descartes. This law asserts that when a ray of light passes from one medium to another, the plane of the two rays contains the normal to the surface, and the sines of the angles of incidence and refraction are in a constant ratio, the refractive index. Descartes was led by a metaphysical argument to maintain that light was some sort of pressure in a medium (in a very indefinite way something like the present wave theory) and thought that the velocity of light must be greater in a denser medium. This view was combated by Pierre de Fermat, also on metaphysical grounds, and modern theory supports Fermat though not his reasoning. It seems to be the rule rather than the exception that correct results are first obtained from quite incorrect arguments. Fermat asserted that nature performs its operations always by the most direct path, and that therefore a ray of light between two places must take the shortest possible time. Now it is easy to show that there are many examples, both for reflection and refraction, in which the time of transit is not a minimum. but a maximum: The generalization of Fermat's "principle of least time" subsequently made by Sir William Hamilton rnerely states that the actual path shall be stationary with respect to other closely adjacent paths. Snell's law then implies that the velocity of light in the medium is inversely proportional to its refractive index, in agreement with Fermat's conclusion.

A. The Age of Newton and **Huygens.**—The first great era in the theory of light is the second half of the 17th century. Francesco Grimaldi discovered (and named) the phenomenon of diffraction, that light going through a fine slit cannot be prevented from spreading on the farther side, and that no matter how small the source of light, the edge of a shadow cannot be perfectly sharp. Robert Hooke independently discovered the same thing and offered a theory approaching closely to the wave theory in that he had the idea of wave fronts and of light's being some sort of oscillation; but it was more than a century before it was seen that the strongest possible argument for this theory lay in the discovery of diffraction. During the same era Olaf Roemer measured the .velocity of light for the first time, by a comparison of the calculated and observed times of the eclipses of Jupiter's satellites.

Of all the founders of the theory of light, undoubtedly the greatest were Sir Isaac Newton and Christiaan Huygens (*qq.v.*). Newton discovered the theory of the spectrum. By passing a fine beam of sunlight through a glass prism he resolved it into its component colours: red. orange. yellow, green, blue, indigo and violet. It had already been known that white light was resolved into colours on passing through glass or water (for example the rainbow had been explainedj. but it was supposed that the glass had produced a definite alteration in the light. Newton showed that, if the light passed through a second prism reversed. the coloured lights would recombine into white, but that if a single colour were selected from the spectrum, no subsequent treatment could change it in any way. He was thus led to the correct explanation of white light as a compound of all the colours, but the further details of this question would lead us into physiological optics (see VISION OR SIGHT).

Newton also investigated the colours of thin plates such*as soap bubbles. He placed a slightly convex lens on a flat piece of glass and observed the reflected light. At the centre the surfaces are in contact and nothing is reflected, but round this point, where they are very close, though not in contact, there appears a succession of brilliantly coloured rings, the succession of colours being black, faint blue, strong white, orange, red, dark purple, violet. blue, faint green, vivid yellow, etc. The rings become narrower and fainter as we go outward and soon become invisible. These are not the colours of the spectrum, and their origin is better appreciated by considering the case where the illumination is by monochromatic instead of white light. There is then a dark centre surrounded by a large number of rings of the colour used. The sizes of the rings depend on the colour of the light; they are closer together for blue than for red. If then we illuminate simultaneously with red and blue light there will be places where the rings fall together, so that we get alternately purple and dark rings, and other places where they fall apart and we get alternate rings of red and blue. Where the two ring systems coincide they look sharp; otherwise they are blurred. The rings in white light can be explained in the same way as resulting from a superposition of all the colours, and at no great distance from the centre so many of the coloured rings overlap that they become completely blurred.

Newton was very cautious in making theories, and he did not really succeed in explaining his rings, but he attributed them to certain "fits" of reflection and transmission which later were seen to be very like the "phases" of the wave theory. As to the general theory of light he was also very noncommittal, but he criticized the wave theory as being unable to explain rectilinear propagation, and his followers, interpreting his views in a much narrower way than he intended, adopted a complete corpuscular theory of light which held the field for more than a century. This theory supposed that light consists of minute particles, or corpuscles, shot out from the luminous body, and attempted to explain all the phenomena by suitably modifying the properties of these corpuscles. The theory implies that the velocity of light must be proportional to the refractive index, not inversely proportional as in Fermat's principle and the wave theory, and this distinction later provided a critical test which condemned it.

Huygens is the real founder of the wave theory of light. He based his belief in it primarily on the fact that, if a beam of light were like a flight of arrows, then when two beams cross there should be collisions between the arrows. He succeeded in explaining reflection and refraction, and we may consider his construction, as it lies at the foundation of modern methods. The general idea is that light is a disturbance in a medium, but it need not be specified what is the character of the disturbance; for purposes of rough visualization we may think of the medium as a jelly which is distorted so that its particles move out of their usual places. Any disturbance then acts as a centre causing the propagation of a wave of disturbance to go out at a constant speed, so that at any subsequent time the effects of the initial disturbance will be found on a sphere surrounding it. When the initial disturbance is not confined to a single point, each point of it is to be regarded as a source, and the subsequent disturbance is the geometrical envelope of the spheres surrounding all these sources. Refraction is explained by supposing that the velocity of light is different in different media. Consider light obliquely incident on a flat surface, say of water (*see* fig. 1). The velocity of propagation outside is c, the velocity of light; in the water it is v, a slower velocity. The advancing disturbance is at one moment spread as a pulse over the surface AB. Each point of AB gives out a spherical pulse, and, to reconstruct the wave later, we draw spheres of equal radii round all the points of AB. Obviously one such set of spheres will give the line CD as its envelope, and this shows that the light goes in the direction AC outside the water. But if we repeat the construction starting at CD we have to allow for the fact that the velocity is less in water than in free space. Thus, corresponding to the sphere of radius DF about D, we draw round C a sphere of radius $CE=(v/c)DF$, and it is evident that EF will be bent round more nearly parallel to the face than was CD. After this both spheres are in the water and the propagation goes straight again on to GH. This construction immediately gives Snell's law of refraction, for $\sin ACM/\sin GCN=DF/CE=c/v$, and the refractive index is simply the ratio of velocities. The construction fails in the case of very oblique incidence if v is greater than c, for then the circle round C may have a radius actually greater than CF itself. Refraction is then impossible, and all the light is reflected. This is the phenomenon of total internal reflection which we shall discuss later. A simpler construction than that we have given applies for reflection, and the same principle also explains diffraction, but Huygens did not find this out.

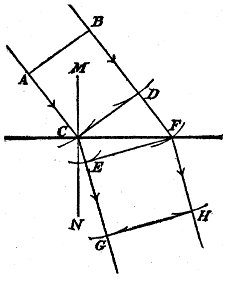


FIG. 1.—HUYGENS' CONSTRUCTION FOR REFRACTION

Huygens' other great investigation is connected with double refraction. Certain crystals of calcium carbonate, from Iceland, called calcite or Iceland spar, have the extraordinary property that objects viewed through them appear double. To reduce the matter to simpler terms it can be expressed thus: a crystal of calcite resembles a cube that has been compressed along one of its diagonals. Suppose that a narrow beam of light is incident on one face perpendicularly. If the crystal were glass the beam would emerge from the opposite face in the same line. Actually two beams emerge, one in the same way as for glass, but the other in a new line though in a direction parallel to the first (*see* fig. 2). These two beams are called the ordinary and extraordinary rays. Huygens successfully applied his wave construction to explain them by supposing that two surfaces must be constructed round each point, one a sphere which would give the ordinary ray, but the other a spheroid with its axis of revolution determined by the crystal axis (that is, by the shortened diagonal of the cube) which would give the extraordinary ray. This is illustrated in fig. 3. Round the points C and D we draw not only a sphere but also a spheroid, which is such that the two surfaces touch at the points that lie in the direction of the crystal axis (the point K in fig. 3). The envelope of the spheres is the plane EF, the direction of motion of which shows the path of the ordinary ray, while the plane GH is the envelope of the spheroids and its motion shows the path of the extraordinary ray. Observe that the latter ray is not perpendicular to the wave front. The ray must here be conceived as the direction in which the energy flows.

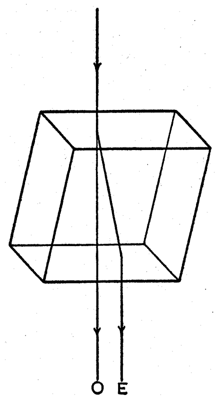


FIG. 2.—DOUBLE REFRACTION, SHOWING TWO RAYS EMERGING WHEN A SINGLE LIGHT RAY STRIKES A CALCITE CRYSTAL PERPENDICULARLY

Huygens also discovered, though he did not explain, the phenomenon of polarization. If we rotate our crystal about an axis in the direction of the beam and observe the projections of the two rays on a screen, the ordinary ray will stay fixed, and the extraordinary, which will be equally bright, will rotate round it. But now suppose that we isolate the ordinary ray and pass it in the same way through a second crystal. In general it will give rise to two rays, ordinary and extraordinary, but this time they will usually be of unequal brightness. If the two crystal axes are parallel, the extraordinary ray will be absent altogether, but as the second crystal is turned it will gradually grow in brightness at the expense of the ordinary, until, when the crystal has turned through a right angle, the ordinary ray will be entirely extinguished. Rotation through a further right angle will restore the ordinary ray and destroy the extraordinary. A similar rule applies for the extraordinary ray from the first crystal; it usually gives both types, but only an extraordinary ray when the crystals have their axes parallel. Newton recognized the essential features of the matter in saying that a ray of light may have *sides;* in fact that this light differs from ordinary light as a thin lath differs from a round stick. This characteristic we now describe by the word polarization. The idea of transverse vibrations had not yet been formulated, so that no further advance could be made at this stage.

We may here remark that the Huygens wave construction explains what some may regard as a philosophic difficulty in Fermat's principle. According to this principle the rays of light between two points A and G (fig. 1) adopt that path which takes the shortest time; and though the only way we have ordinarily of determining a minimum is to try a number of paths and see which is quickest, yet the ray appears to adopt the right course without any alternative trials. The wave construction explains why it does so, for it shows that the wave is, so to speak, all the time trying alternative routes, and is adopting the shortest because the waves in other paths cancel out.

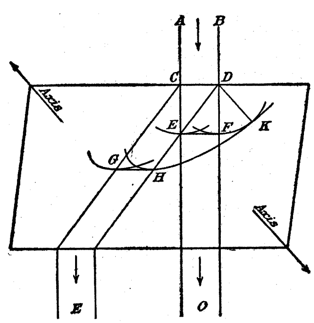


FIG. 3.—HUYGENS' CONSTRUCTION FOR DOUBLE REFRACTION

Each point of C and D sends out a sphere and spheroid wave. The spheres give the ordinary ray through EF; the spheroids the extraordinary ray through GH

In spite of these great advances, the state of knowledge at the end of the 17th century was really insufficient to give a decision between the two theories, and moreover there was hardly the beginning of a mathematical wave theory as yet, so it is perhaps not surprising that the corpuscular theory of light gained the upper hand. The 18th century was singularly barren in optics, and the only first-class discovery appeared strongly to support this theory. This was the discovery of stellar aberration, by James Bradley (see ABERRATION OF LIGHT), which for corpuscles is immediately explained by the idea of relative motion; with waves, though a crude explanation is not hard, the final solution was only obtained in the 20th century with the advent of relativity.

B. The Age of **Fresnel.**—The second great period of discovery coincided with the beginning of the 19th century, and the first successes fell to Thomas Young. He adopted the wave principle of Huygens, but extended its application. Thus Huygens had only considered waves of the form that we should now call pulses, but Young made use of continuous periodic waves, and so was enabled to explain Newton's rings in a manner we shall discuss later. He clearly stated the general principle of superposition, that "when two undulations from different origins coincide, either perfectly or very nearly in direction, their joint effect is a combination of the motions belonging to each." This principle is quite general, but Young perceived that interesting results would follow only when the two sources are coherent, that is to say, when two beams from the same source are brought to superposition, for only so could the irregularities in the process of emission be the same for both. He therefore set up what has proved to be one of the classical experiments of optical theory.

Two holes are made close together in a screen, and light from a distant point passes through them and illuminates another screen. If the holes are large there will be merely two patches of light on the screen, but when the holes are made smaller diffraction occurs, so that the rays of light spread and the patches are larger instead of smaller as might be expected at first sight. When the holes are very small the patches will overlap and it is then observed that they are crossed by a number of fine bands. To understand this, let us suppose the light to be monochromatic (of a single wave length) so that the vibrations of the light wave are in the form of a travelling sine curve. The source of light is equidistant from the two holes A and B (fig. 4), so that at those points the waves are in the same phase (shown diagrammatically in the figure). On passing through the small hole, each beam emerges as a spherical wave. At the central point O of the screen the distances to A and B are equal so that the phases agree at every moment; the effects from the two holes will reinforce one another and O will be illuminated. Consider however a point P which is $\frac{1}{2}$ wave length nearer to A than to B. Here the waves from A and B are at all times in opposite phases (in the diagram when one wave is at the top the other is at the bottom, etc.) and so cancel, with darkness as the result. At the point Q, which is a whole wave length nearer to A than to B, the waves will reinforce each other again, because one wave is exactly a wave length behind the other, and there will be light. Proceeding in this way the whole field is seen to be covered by alternate bright and dark bands. In the case of white light there will be a few coloured bands in the middle and the rest will look white; the colours can be worked out in just the same way as with Newton's rings. Young's interference pattern is by no means easy to observe, as it requires very careful adjustments because of the exceedingly short wave length of visible light. To give an idea of its magnitude, if the holes are 1 mm. apart and the screen is at a distance of 1 m., then for red light the bright bands are a distance 0.6 mm. apart.

The investigation of polarization (see *V.* Polarization *and* Electromagnet-*Theory,* below) at this epoch received a great impetus by the discovery of Étienne Malus that, when sunlight is reflected from glass, the reflected ray may be polarized. Sir David Brewster studied the matter and found the rule that the reflected light was completely polarized when the reflected and refracted rays were perpendicular to one another. In the course of this work he discovered experimentally the formulas for the intensity of the two polarized components of light reflected from a transparent substance. If i is the angle of incidence and r that of refraction, the fraction reflected is $\sin^2(i-r)/\sin^2(i+r)$ or $\tan^2(i-r)/\tan^2(i+r)$, according to the direction of polarization. These expressions are usually called Fresnel's sine and tangent formulas, and have played

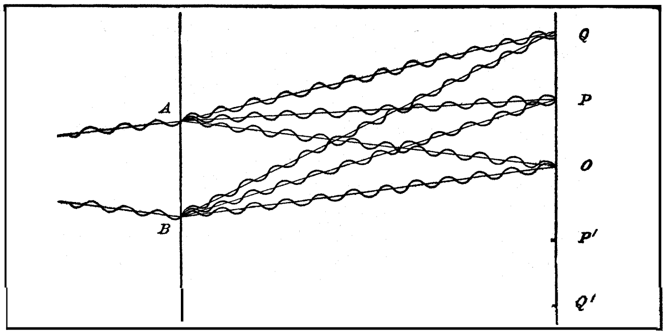


FIG 4 — YOUNG'S INTERFERENCE EXPERIMENT

Monochromatic light falls on the two holes A, B. Point O is equidistant from them, so that the waves reinforce each other. P is ½ wave length nearer to A than to B, so that the waves cancel out, while Q is a whole wave length nearer, and they reinforce again. Bright bands will appear at O and Q,Q′, and darkness at P,P′

a part in the history of optics. In the special case where $i+r=90^\circ$ the tangent expression vanishes and. as the other does not, the reflected light is completely polarized. Brewster also made the important discovery that some crystals exhibit double refraction of a different type from that of calcite investigated by Huygens. In these crystals there are two directions instead of only one for which the light does not become polarized. That is, instead of the single axis shown in fig. 3. such crystals have two, and are called biaxial. We may also here mention the discovery by Dominique F. J. Arago of gyration (formerly called "optical activity"). When a beam of polarized light is sent through a quartz crystal along the axis, or through a sugar solution, it is observed that, on emergence of the beam, the plane of polarization has rotated by an amount proportional to the length of the path it has traversed. We shall discuss all these matters in detail later.

The greatest investigator of this period was Augustin Fresnel, and in his hands optical theory attained the outline nhich it has kept ever since. As we shall have to deal aith his work in detail, we shall here only mention his discoveries without explaining them. First he adapted Huygens' construction to explain diffraction. and thereby established the superiority of the wave theory over the corpuscular. In the course of this work he demonstrated the remarkable fact that there is a bright spot exactly in the centre of the shadow of a circular screen. Like Young he also made various experiments to exhibit the interference of two beams of light. He then turned his attention to the optical effects of moving bodies (including the motion of the earth) and correctly formulated all the principles; this important work had a great influence in connection with relativity theory, but is outside our scope here. Next he made the discovery (with Xrago) that, when two beams of light are differently polarized, even if they arise from the same source, it is impossible to make them interfere. At this period the vibrations of light were thought to resemble those of sound, so that there seemed to be no room for polarization in the theory, but Young hit on the solution that the vibrations were transverse, so that a wave of light may have sides, as Newton had said. Fresnel next turned his attention to double refraction and completely solved the whole problem, uniting into a single system both Huygens' uniaxial and Brewster's biaxial types. Finally he deduced theoretically the laws of refraction and reflection and obtained the sine and tangent formulas to which we have referred. Fresnel's whole work was devoted to establishing rigorous principles for light, and the enormous progress he made is the more remarkable when we remember that the mathematical theory of naves was only in its infancy, and that there hardly existed at all any dynamical theory of continuous media.

C. The Dynamical Theories of the 19th **Century.**—With the discoveries of Fresnel, the more geometrical part of the wave theory of light nas practically complete; but it was still necessary to build a proper dynamical formulation, and this was the chief preoccupation of theorists during most of the 19th century. It was felt necessary to make a model of some sort of matter which should behave like the optical medium. The most obvious model suggested was that of an elastic solid, and, with the help of this, Augustin Cauchy, Franz Neumann and others had considerable success in explaining the phenomena for a single medium, but the theories got into difficulty when it came to the passage of light from one medium to another. Only by highly artificial hypotheses was it possible to obtain the sine and tangent formulas.

The work of George Green on the propagation of waves in elastic solids is the real beginning of the modern mathematical theory of waves. A piece of solid matter can be strained (altered in form or position) in three ways. It may be compressed without other change of form, or it may be sheared so that a square becomes a rhombus, or, without changing its shape, it may be rotated in position. The third type of strain can take place without the necessity of forces, but the first two require the action of forces in order that they may occur. The solid will possess two elastic constants corresponding to these forces (we are thinking of an isotropic body, not a crystal which may possess 21), and can propagate two types of wave, a longitudinal corresponding to compression, and a transverse corresponding to shear. Green showed that when a transverse elastic wave passes from one medium to another it necessarily gives rise to a longitudinal wave, and for this there is no room in the theory of light. Though his result was thus mainly negative, Green's calculus firmly established what conditions a valid theory must satisfy. Under the inspiration of Green's methods, Sir George Stokes gave a rigorous solution of the problem of diffraction in place of Fresnel's approximate geometrical method.

A valid formulation for the dynamic theory of light was first made by James MacCullagh, who assumed that the ether was a new kind of material which opposed no resistance to compression or shear, but which resisted rotation. Such a material satisfies all the necessary conditions, but it suffers from the objection that there is no known kind of matter which has the property, and for this reason it was regarded with great suspicion and its importance was not appreciated till long afterward. During the middle of the 19th century there were many attempts, especially by Lord Kelvin (then W. Thomson), to invent a substance which should satisfy all the necessary conditions, but they were mostly very artificial. The modern theory was finally formulated about 1860 by James Clerk Maxwell, who showed that electric oscillations must involve emitted waves which would have the same transverse character and would travel with the same velocity as light. He therefore identified light with electric waves, and gave the complete system of equations (then seen to be identical with MacCullagh's) which determine the behaviour of light. This theory has firmly held the field ever since, and Maxwell's name ranks as high as any among the contributors to optical theory. The completeness of his theory, and perhaps the familiarity that grows with the lapse of time, has overcome the objection that no known matter conforms to the same rules of vibration as the ether.

D. The Experimental Discoveries of the 19th Century.— During the period of these great theoretical investigations the experimental side had of course not been neglected, and many important discoveries had been made and instruments invented. Joseph von Fraunhofer studied diffraction in a rather different way from Fresnel, and constructed gratings by winding wire between two fine screws and by ruling lines with a diamond on glass. With these he analyzed the solar spectrum, and his work is thus the origin, both in subject matter and in method, of the modern science of spectroscopy. The invention of Nicol's prism (usually called the nicol and described below in connection with fig. 14) made it easy to produce polarized light, and this was for a long time the standard instrument in the study of polarization. Stokes began the study of ultra-violet light, rendering its effect visible by means of the property of fluorescence (see LUMINESCENCE); it is now more usually investigated by photography. Michael Faraday discovered the theoretically very important phenomenon of magnetic gyration—that. when a transparent substance is in a strong magnetic field, a beam of polarized light passing through it along the direction of the field has its direction of polarization rotated. This was the earliest connection discovered between light and electricity. Armand Fizeau and Jean Foucault developed methods of measuring the velocity of light accurately, and among other things showed that light really does go more slowly in water than in air, as is demanded by the wave theory.

We must also mention the slow development of the theory of dispersion; *i.e.*, the dependence of the refractive index on the wave length. Fresnel and Cauchy had propounded a theory which attributed it to the coarse-grainedness of the refracting medium, from which it followed that the refractive index could be expanded in powers of the inverse square of the wave length. This is often possible, but its inadequacy was seen when F. P. Leroux discovered the phenomenon of "anomalous dispersion" (which is not really at all anomalous), that substances exist which refract the red more than the blue. A hint of the modern theory was given by Maxwell, but its real development is attributable to W. Sellmeier, who showed that dispersion was an example of the general phenomenon of resonance. At the end of the 19th century Hendrik Lorentz revised the whole of Maxwell's theory, introducing the idea of electrons, and in the course of his work improved Sellmeier's dispersion formula.

During the closing decades of the 19th century an aspect of the wave theory which has had results of the most far-reaching importance was much studied experimentally. Fresnel had successfully treated the optical theory of moving media up to a point, but many difficulties remained with regard to the movement of the earth as a whole. Stellar aberration suggested a fixed ether through which the earth moved, but then it seemed possible that for terrestrial experiments this motion ought to be detectable. Because of the great velocity of light, none of these experiments was easy, but all gave negative results; particular mention may be made of the experiment of Albert Michelson and Edward Morley, which was of such accuracy that, though it depended on the square of the ratio of the earth's velocity in its path about the sun to that of light, it definitely established the negative. The mathematical theory was developed by Sir Joseph Larmor and Lorentz to deal with this matter, and a very profound interpretation, given to it by Lorentz, led to the promulgation of the theory of relativity by Albert Einstein ***(see*** RELATIVITY).

E. Developments in the Early 20th Century.—As the 20th century opened, it seemed that optical theory had attained a completeness and perfection which hardly left room for further development. But this complacent view was destined to receive a series of rude shocks as a number of new phenomena concerned with the interaction of light and matter were discovered. As was mentioned in the introduction, these apparently could not be reconciled with the theory of electromagnetic waves, but required a return to the corpuscular theory in a modified form. Yet the classical wave picture was so thoroughly successful in dealing with the majority of optical effects that there could be no question of its being supplanted by one so radically different. The way in which these two views of the nature of light have been reconciled will be indicated at the close of the present article, and a more complete discussion will be found under QUANTUM MECHANICS (*q.v.*).

The experimental discoveries that led to the introduction of photons or light quanta are relatively few, although as a result of the mathematical formulation of the quantum theory in 1926 it became clear that they are essential in explaining all phenomena that involve the emission of light, as well as its transmission through and absorption by matter. Foremost among the early discoveries, and the one which showed most clearly the inadequacy of the electromagnetic theory, was the photoelectric effect (see PHOTOELECTRICITY). The work of Philipp Lenard in 1899 had shown that the electrons which are ejected from a polished metal plate when light falls upon it have velocities that are uninfluenced by the intensity of the light. Greater intensity merely increases the number of electrons. Altering the wave length of the light does affect the velocity, and in such a way that the energy of the electrons is inversely proportional to the wave length when the latter is sufficiently short. These facts led

Einstein in 1905 to propose that in its interaction with electrons the light is concentrated in the form of small corpuscles (photons) of energy proportional to the frequency of the light. The entire energy of one photon is absorbed by the electron, and the photon is annihilated Less direct evidence for the absorption and emission of radiation in discrete amounts had already been found by Max Planck (1900) in attempting to explain the distribution of energy in the various wave lengths emitted by hot bodies. The constant of proportionality between frequency and energy found by Planck was exactly the one needed to give the proper energies in the photoelectric effect. Its numerical value is now taken to be $h=(6.6252\pm0.0002)\times10^{-27}$ erg$\times$sec. The energy E of a photon in light of frequency ν is then given by $E=h\nu$.

Other corpuscular effects appeared in rapid succession. The explanation of the spectrum of hydrogen by Niels Bohr in 1913 required an assumption that the frequency is to be determined by equating the change in energy of the atom to $h\nu$. *(See* SPECTROSCOPY.) In X-rays the existence of a sharp upper limit to the frequency of the continuous radiation showed that the energy of the electrons striking the target, if completely converted into radiation, could only yield a certain maximum ν determined by $E=h\nu$. Again, the lowering of the frequency of X-rays when they are scattered by matter mas interpreted by A H. Compton as caused by the loss of energy when a photon rebounds from a collision with an electron. The fact that photons possess momentum was strikingly displayed in this experiment. *(See* COMPTON EFFECT.) These investigations were the first to give rise to the concept of photons, and they have been followed by many others that are readily interpreted by considering the interaction of photons with particles of matter but that are inexplicable on a wave theory.

It is important to notice the characteristic realms of optical phenomena in which the tno models of light, nave and photon, find their applicability. Certain readily observed properties, such as rectilinear propagation, reflection and refraction, fit well with either picture. Interference and diffraction, however. which are cases of the interaction of light with light, are explainable only by waves. The wave theory is also capable of dealing with the transmission of light through matter, provided that the light is of not too high a frequency nor too close to characteristic absorption frequencies of the material. Thus the electromagnetic theory gives a good account of dispersion, polarization and double refraction, as we shall see in the following sections. The corpuscular properties of light come into special prominence when we have to do with the interaction with matter of light of high frequency, which means photons of high energy. As the wave length becomes shorter in proceeding through the electromagnetic spectrum. the wave properties steadily give place to corpuscular properties. At the short wave length end. with X-rays andy-rays. it is even very difficult to detect the wave properties, although the interference of X-rays has been beautifully demonstrated. Radio naves. at the other extreme, can be treated purely as electromagnetic vibrations, and their corpuscular properties are of no importance.

Light occupies an intermediate position on the wave length scale. and correspondingly we find that it displays nave properties under certain conditions, corpuscular properties under others. The fact that the latter remained undiscovered until comparatively recently is an indication that in its commonest aspects light is most suitably represented as a wave motion. This is the justification for presenting the subject, as is done here. exclusively from the point of view of wave theory. It is true that very weighty matters, such as the processes of emission and absorption, cannot be included in such a discussion but are more appropriately treated under SPECTROSCOPY and QUANTUM MECHANICS.

III. WAVES AND INTERFERENCE

The most familiar form of waves is of course the surface waves of water. but the term is extended to cover any vibratory effect propagated through a medium. For example, if we take a long stretched string and strike it near one end, a small hump will form and will travel without change of shape down the string. Though the portion of the string humped is changing all the time, the geometrical form is unchanging. and so we can endow this form with individuality and say that the wave goes at a certain speed. If x denotes the distance of any point on the string from the point of reference, or the origin, and ϕ the displacement of the string at that point, the motion is described by the differential equation

$$\frac{\partial^2\phi}{\partial x^2}=\frac{1}{c^2}\frac{\partial^2\phi}{\partial t^2},$$

the solution of which is $\phi = f\,(x- ct)$. This expresses the fact that. whatever the initial form, the form at time t is the same with the origin shifted a distance ct.

A. General Characteristics of Waves.—The vibration of a string is especially simple because the wave undergoes no change of form, but in most cases, such as water waves, that is not so; for as the wave travels it alters shape, and so it is no longer possible to speak of a definite velocity. It is therefore necessary to analyze the waves into definite types which can be studied separately, and the type which is incomparably the most useful is the sine curve. That such an analysis is useful is a consequence of the principle of superposition enunciated by Young; mathematically this principle follows from the fact that the differential equations of wave motion are linear. so that if we have two solutions of a wave problem we can derive a third by taking their sum. Thus any problem can be solved by expressing the initial state as a sum, or more usually an integral. of sine curves of various wave lengths, then solving the motion for each of these separately and finally recombining them. This is the only method available for water waves; and though plane waves of light are propagated in free space without change of form, any obstacle or refractive medium destroys this simplicity and makes analysis necessary.

In discussing the general characteristics of waves we may conveniently think of a stretched string. but when the appropriate name is given to the dependent variable ϕ everything we shall say applies equally well to water waves. sound or light. Thus, ϕ in the string means the displacement of the string sideways, in water waves the elevation of the surface above its average height, and for sound it might mean the variable part of the air pressure; for light we shall later specialize it rather more and identify it with the electric force. In all these cases the typical solution is

$$\phi=A\cos\left[2\pi\,(\nu t-x/\lambda)-\epsilon\right].$$

First considering the motion of a particle of the string, we keep x constant and see how ϕ depends on t. It is a pure harmonic vibration of amplitude A and frequency ν, frequency meaning the total number of vibrations performed in a second. The expression $2\pi(\nu t-x/\lambda)-\epsilon$, regarded as an angle, is the phase at the time t at the distance x from the origin. It can be interpreted very simply by the consideration that, nhen a point describes a circle at uniform speed, its projection on a diameter describes a harmonic motion: then the angle betneen this diameter and the radius through the point is the phase angle. The term phase. though quite precise, is often used in a looser sense, because its absolute value does not matter. whereas differences in phase are of the very greatest importance in deciding the character of a wave. We next examine the shape of the string at any instant of time and see that it is a sine curve of wave length λ. The amplitude, frequency, wave length and phase are the four quantities characteristic of any wave.

The wave is progressive because of the phase relations between the various points of the string. If at any instant we compare the phases at x and $x+a$, we see that the latter is an angle $2\pi a/\lambda$ behind, and that at a time $a/\lambda\nu$ later it will have arrived at the phase which was at x initially. We therefore take $\lambda\nu=V$ as the wave velocity or phase velocity; it is the rate at which the crests move. Though phase velocity plays a most important part in wave theory, it is misleading to think, of it as a real velocity. For example, it is a general principle that no effect of any kind can be propagated with a speed greater than c, the velocity of light in *vacuo,* but it is always possible to find certain frequencies for which the phase velocity of light is considerably higher. When we say that no effect can travel faster than c, we are thinking of the rate at which waves advance into a region previously undisturbed, but phase velocity has a meaning only in connection with a sine curve. and a sine curve extends indefinitely in both directions, so that there is no undisturbed region to which the principle can apply.

In the case of water waves, and perhaps of electric waves of very long period, we can observe the crests and so can see directly the wave velocity and measure the amplitude, but in general it is impossible to do this. Usually we observe only some dynamical effect. such as that which occurs when the rays of light impinge on the retina of the eye. The exact form of this effect is special to each type of wave, but it is a general principle that the effect depends on the energy of the waves, and this is proportional to the average value of the square of the amplitude of the wave variable ϕ. This quantity is the intensity; it is often quite unnecessary to know the factor of proportionality associated with it. It is important to observe that the amplitude can be deduced from the intensity but that nothing can be said about the phase; this is a consequence of the dynamical fact that only by altering the phase can the wave medium do work on the observing instrument, so that only by spoiling the phase can we observe the wave.

The case of waves in three dimensions is of course more complicated than that in one. In thinking about them the most important idea is that of the wave front, which is any continuous surface over which the phases are all the same. For mathematical treatment such waves are sometimes resolved into sets of plane waves going in all directions, but it is more often convenient to make use of spherical waves. It can be shown that. if a three-dimensional medium propagates plane waves according to the rule

$$\phi = A\cos[2\pi(\nu t - x/\lambda) - \epsilon],$$

then it can propagate a spherical wave of the form

$$\phi = (A/r)\cos[2\pi(\nu t - r/\lambda) - \epsilon],$$

where r is the distance from the origin. The wave fronts are spheres round the origin as centre, and the wave represents an emission from a point source at the origin. The amplitude decreases as the wave spreads out. and is always proportional to the inverse distance. The intensity is therefore proportional to the inverse square of the distance, and this is the fundamental law of photometry (see PHOTOMETRY). This type of wave suffices for the discussion of a great many phenomena in optics, but it may be mentioned that it will require some unessential modifications when we come to discuss polarization and electromagnetic waves.

B. The Velocity of a Group of Waves.—Much of optical theory can be developed by the consideration of pure monochromatic waves, and indeed it may be said that experimental methods have tended to move in directions for which these suffice. The monochromatic wave, however, gives a very incomplete account of events, because it ranges over an infinite extent of time and space, whereas we usually uant to know about events in some limited region. We saw, for instance, in Huygens' construction for double refraction, that the extraordinary wave has its front parallel to the ordinary, but yet that the rays go in a different direction. Even in the simpler case of plane waves of unlimited breadth there is a similar complication when the wave velocity depends on the wave length. as is the case in refracting media. Let us take a group of approximately monochromatic waves of limited length, and find the group velocity with which it travels as a whole. To construct such a group me take a sine curve multiplied by a factor such that the waves are not of uniform height, but fall away gradually to zero on both sides of the centre. The solution then shows that, though the crests travel forward uith the wave velocity appropriate to the wave length. yet they alter in height as they go, so that after a time the crest which was highest at first will have become quite inconspicuous, while another wave originally quite small will have grown up and taken its place as highest crest. Thus the group as a whole moves with a velocity different from that of its component waves. The group velocity U is derived from the wave velocity V by the formula $d(kV)/dk$, where k is the reciprocal of the wave length. The phenomenon of group velocity is easily observed from the deck of a ship, for after a very short time a large wave under observation becomes quite small while another behind it has gronn at its expense. For water the wave velocity is proportional to the square root of the wave length, and our formula then shows that the group velocity is half the wave velocity. For other types of waves it may be greater than the ware velocity. and there is nothing to prevent its even being in the opposite direction, though no case of this is known. Only in the case where the wave velocity is independent of the wave length is it equal to the group velocity; in this case any wave can be propagated without change of form.

The most important application of the idea of group velocity to optics arises in the measurement of the velocity of light. Every type of measure depends in some way on interrupting the light and thus gives the group velocity. In free space the wave velocity of light does not depend on the wave length and so is the same as the group velocity, but this is not so in other cases. The superiority of the wave theory of light over the corpuscular theory was held proved when Foucault showed directly that light goes more slowly through water than air; but he did not in fact prove it, for the refractive index depends on wave velocity, and his work dealt uith group velocity. However, since either can be deduced from the other, it is easy to verify the correctness of his result indirectly. In much of optics these considerations do not arise. and so they are frequently forgotten. Nevertheless they are indispensable for a full understanding of waves, and many difficulties have been caused in the past through neglecting them.

C. The Pressure of Light.— In the course of his theoretical investigations Maxwell discovered the pressure of light. He derived this effect from the electromagnetic theory, but as a matter of fact it can be shown to follow from any wave theory, and was foreseen in the 18th century by Leonhard Euler. If plane waves fall perpendicularly on a surface it may be shown that they exert a pressure on it of a magnitude equal to the density of energy in the naves. This result is exceedingly difficult to observe, as the pressure is very small in practical cases. The first attempt led to the invention of the radiometer by Sir William Crookes. In this instrument freely moving vanes are coated with black on one side and are polished on the other. The side which is black absorbs the radiation while the reflecting side sends it back; so there is more energy in the space in front of the reflecting side and therefore a greater pressure. When the radiometer is illuminated it does go round, but the wrong way! This is the result of a rather complicated effect depending on the heating of the residual gas in the vessel, and in order to observe the pressure of radiation much more delicate means are required. It was eventually measured by P. N. Lebedev by so improving the radiometer that the effect of the gas was eliminated. There are also indirect methods by which the pressure of light can be verified. chief among which is the thermodynamic law for the emission of radiation (see *HEAT*). Light pressure plays scarcely any part in our common experience, but it grows to enormous values in the hot interiors of stars and plays a dominating part in controlling their state.

D. The Doppler Effect.—When monochromatic light passes through any fixed optical system there is one property that is always conserved. the frequency of the vibrations; but this frequency can be changed if the light is reflected by a moving mirror, or if there is a difference in the motions of source and observer. This change of frequency is called the Doppler effect (*q.v.*), after its discoverer, and is easily explained by the wave theory. Consider a fixed source emitting light of frequency ν, and sending it to an observer who is receding at velocity v. Because of his motion the successive crests of the light waves will reach him at longer intervals than if he were at rest, and a simple calculation shows that he will receive them with a frequency $\nu(1-v/c)$; the light will appear to him slightly redder than it really is. If he is approaching, it will appear bluer, and if his motion is oblique to the direction of the source, the change of frequency will depend on the component of his velocity in the line of sight. In the case where light is reflected from a receding mirror it has to traverse the increasing distance twice over. and so the effect is doubled, and the frequency of the reflected light is $\nu(1-2v/c)$. It should be said that these values are not quite precise when v is large. The Doppler effect plays a very important practical part in astronomy. for by its means it is possible to discover the velocity of stars in the line of sight. and thus for example to calculate the motion of the components of a double star which are so close together that they cannot be seen separately. The "red shift" of the lines in the spectra of distant spiral nebulae is usually interpreted as a Doppler effect resulting from the expansion of the universe. If this is correct, it would indicate that the most distant nebulae we can now observe are receding from us at a speed of some 6,200 mi. per second. The Doppler effect has been vital in the theoretical investigation of the distribution of energy in the spectrum. A further consequence arises in practical spectroscopy. In a hot gas some of the atoms will be approaching the spectroscope and so will give light bluer than the average, while others will give a redder light in consequence of their recession. and thus the light will never be purely monochromatic. In some experiments it is necessary to minimize this effect by cooling the gas with liquid air.

E. The Colours of Thin Plates.—When white light is reflected from a film of a transparent material, interference occurs between the light reflected from the top and bottom surfaces. This gives rise to colours. as in Newton's rings, which have an explanation similar to the coloured bands obtained in Young's experiment. In the present case, however. waves from a large number of coherent sources: instead of from only two, are superimposed, as a result of the multiple reflections within the film.

We have already described Huygens' construction for reflection and refraction. When a beam of light falls on a surface, part is directly reflected and part is refracted. Consider now a thin plate, say a soap film. under the action of an incident beam of monochromatic light (fig. 5). The beam refracted at the first surface comes to the second, and a portion emerges, while the rest is reflected back. This second part comes back to the first face, and part of it emerges while part is again reflected. Thus, if we want to know the total amount reflected! we have to consider the compounded effects of all the waves arising from direct reflection and any number of internal reflections. Now, in order to explain the process, fig. j has been drawn as though the rays *AP*, *CQ*, ER . . . were a considerable distance apart. In reality, they are extremely close together, for the film is supposed to be thin, and many of them will be brought together by the lens of the eye of the observer. Evidently this is a case like Young's experiment in which we have to consider the phases of the various waves. If these phases agree we shall have a brilliant reflection; otherwise it will be feeble. We shall see that the phases agree for only one colour at a time. and so the film looks coloured though it is illuminated by white light. In order to see the detail of this we must examine the process of refraction somewhat more closely.

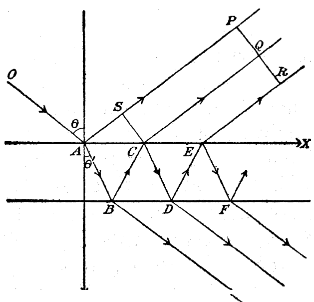


FIG. 5.—COLOURS OF THIN PLATES

The total amount of light reflected will depend on the phase differences of AP, CQ, ER, and these will vary with the colour and inclination of the light

We first consider a single interface illuminated obliquely by a plane wave of light K (see fig. 6). This will be broken into a reflected wave L and a refracted wave *M*. The strengths of these can be calculated exactly in the detailed theory (they are given by Fresnel's sine and tangent formulas), but we do not require their values here. Let us say that. if K has unit amplitude, then L has amplitude *r* and *M* has amplitude *t*. We shall assume (from the more detailed theory) that there is no change of phase at the interface. We also must consider the effect of a beam coming to the surface from the other side. Let us suppose that the reversed wave *M* would give a transmitted wave along K of amplitude t' and a reflected wave along *N* of amplitude r'. Son. there is an important and very general mechanical principle, that. if all the parts of a system are simultaneously reversed in their motions, the system will retrace its course to the point from which it started. Thus, if we fake a wave *r* along L reversed and simultaneously *t* along *M* reversed, they will give rise to unit amplitude along K reversed and no wave along *N*. The wave r from L gives r^2 along K and rt along *N*, while *t* from *M* gives tt' along K and tr' along *N*. We thus have the two equations $r^2+tt'=1$, $rt+tr'=0$. The last implies that r' must be equal to *r*, but that there is a change of phase of 180° at the interface upon reflection from below; me can allow for it completely by simply writing $-r$ for r'.

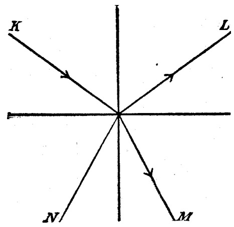


FIG. 6.—REFLECTION AND REFRACTION AT AN INTERFACE

We now return to the film of fig. j. The reflected ray A P has amplitude *r*, the ray AB has *t*. Of this a fraction r' is reflected at *B*, so that tr' arrives at C and CQ has amplitude $tr't'$, while CD has tr'^2. Similarly *ER* will have tr'^3t' and so on. On the other side the waves emerging at *B*, D, F will have amplitudes tt', tr'^2t', tr'^4t', etc. We must now compare the various phases of the paths OAP, *OABCQ*, etc. Let us suppose that θ is the angle of incidence and 0' that of refraction. and that n is the refractive index. If me allow for the difference of the wave velocity in the film, the phase difference for a singular pair of internal reflections will be $\frac{2\pi}{\lambda}(n.ABC-AS)$, where *S* is the foot of the perpendicular from C on *AP*. This is equal to $2\cdot\frac{2\pi}{X}bn\cos\theta'$, if *b* is the thickness of the film; we shall denote it by 26. Thus if the phase at P is ϵ, that at *Q* is ϵ − 28, and therefore that at R is $\epsilon - 4\delta$ and so on. The whole reflected wave thus has amplitude

$$r\cos\epsilon+tt'r'\cos(\epsilon-2\delta)+tt'r'^3\cos(\epsilon-4\delta)+\cdots.$$

This series is now summed and reduces, with the help of the relations between *r*, **/**, etc., to

$$\frac{2r\sin\delta}{1-2r^2\cos 2\delta+r^4}[-\sin(\epsilon-\delta)+r^2\sin(\epsilon+\delta)];$$

and the resulting intensity follows by squaring and averaging over all values of ϵ. The fraction of the incident wave reflected is

$$4r^2\sin^2\delta/[(1-r^2)^2+4r^2\sin^2\delta].$$

It can be shown similarly that the fraction transmitted is

$$(1-r^2)^2/[(1-r^2)^2+4r^2\sin^2\delta].$$

For a soap film the coefficient *r* is not very large. The chief effect is when sin8 vanishes—that is. when $bn\cos\theta'$ is any multiple of half a wave length—for at such an angle of incidence there will be no reflection at all. Hence, nhen a film is lighted by white light, some of the colours will be absent from the reflection and just these will be present in excess in the transmission. Therefore the light reflected by and transmitted through the film will show the complementary colours. The case of Newton's rings is very similar to the above. The film is of air betneen the two glass surfaces. and the distance betaeen these surfaces increases outward from the point where the glasses touch, so that b passes progressively through values where there is no reflection for each colour in turn.

These interference effects have been put to very important practical use in the various types of interferometer. The Fabry and Perot interferometer uses multiple reflections between two lightly silvered glass plates set accurately parallel. Because of the considerably larger reflection co-efficient *r* the transmitted interference rings are quite narrow. The thickness b of the air plate is one to five centimetres, with the result that a telescope must be used in this case to observe the complete ring system In the Lummer-Gehrcke plate the internal reflections occur at an angle close to the critical angle for total reflection, thus affording a large *r* without the necessity of silvering. These instruments are the most powerful tools for the study of spectra, although the modern diffraction grating is a close competitor (see SPECTROSCOPY). In the Michelson interferometer two beams which have traversed widely different paths are brought together by two mirrors to produce interference. The effects are in many ways similar to those that would be obtained with a film or plate of air the thickness of which is determined by the distance between one of the mirrors and the virtual image of the other. (See INTERFEROMETER.)

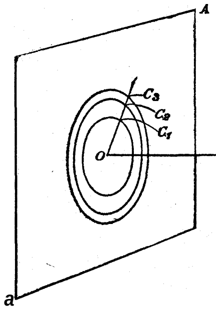


FIG. 7.—FRESNEL'S ZONES
A wave is advancing from plane AB to P. The circle round O is the first zone; the rings outside, the succeeding ones. Zones give nearly the same effect at P, but with alternating signs

The interferometer can be used to measure how nearly any spectral line is truly monochromatic. If the wave emitted by an atom were literally a sine curve, this would imply that, like that curve, it is infinitely long (so the mere fact of switching the light on and off assures that it is not one), but in fact the trains waves given out by the atoms have a limited length and this can be measured by finding how large a difference of path the interfering beams may have before the rings disappear entirely. In practice, this maximum path difference is about 70 cm., implying that after an atom has executed roughly 1,000,000 vibrations it changes phase arbitrarily before emitting again.

IV. DIFFRACTION

There is no essential difference between the phenomena of diffraction and interference, but only a difference in emphasis. Thus the term diffraction is used for phenomena connected with the spreading of waves on passing through a slit, shadow formation, etc., and these are explained as the joint effect of the interference of all the secondary waves emanating from the exposed part of the wave front. The term interference, however, is usually applied to simpler cases, such as Young's experiment, where waves from a finite number of separate but coherent sources are superimposed. When we described Young's experiment, we regarded the two holes in the screen as themselves secondary sources of light emitting spherical waves. A similar construction was applied in Huygens' description of refraction, and may also be used in free space. We shall do this as a preliminary to describing the formation of shadows.

A. **Fresnel's Construction.**—In fig. 7 we have a plane wave with front at AB progressing toward P. We know of course that at P it will in fact be a plane wave too, with phase $\frac{2\pi}{\lambda}\cdot$ OP behind that at O, but we are now supposing that we can take each point in the plane AB as the source of secondary waves, and that the wave at P is due to the superposition of all these waves. In the plane AB describes circles round O of radii OC_1, OC_2 . . . etc., such that

$$PC_1-PO=\tfrac{1}{2}\lambda,\ PC_2-PO=\lambda,\ PC_3-PO=\tfrac{3}{2}\lambda,\ \text{etc.}$$

The central circle and the ring spaces round it are called Fresnel zones and are all of nearly the same area. Each point is supposed to emit light, and this light will arrive at P with a phase depending on the distance to P. The phases of the waves arriving at P from a single Fresnel zone are all the same within half a vibration. If we take the moment when the phase arriving from O is just 90°, then all the phases from points in the central zone will lie between 90° and $-$90°, and they will all make a positive contribution. Those from the second zone will all make a negative contribution, from the third positive and so on., We may represent the total effect as due to the sum of the effects of all the zones and write it as

$$m_1-m_2+m_3-m_4+\ .\ .\ .\ .$$

Each of these quantities is nearly the same because of the nearly equal areas of the zones, but they slowly diminish because of the increasing obliquity, as we shall see. To allow for this decrease we sum the zones in the form

$$\tfrac{1}{2}m_1+(\tfrac{1}{2}m_1-m_2+\tfrac{1}{2}m_3)+(\tfrac{1}{2}m_3-m_4+\tfrac{1}{2}m_5)+\ .\ .\ .\ ,$$

and then, the decrease in the m's being assumed to take place at a constant rate, all the bracketed terms cancel, and the effect at P is equal to half that of the first zone. This argument is of course not a proof, but the full proof requires deeper mathematics than can be given here; for the same reason we shall not check what value must be assigned to the emission of a small area in order to give the amplitude of the reconstructed wave.

In spite of its incompleteness our argument brings out two very important facts. First, as each point of AB has been supposed to give out a complete spherical wave, we should expect the absurd result that there would be emission in the backward direction toward the image point of P in the plane AB. The full solution shows that the amplitude of the secondary wave emitted at angle θ to the primary wave front involves an "obliquity" factor $1+\cos\theta$, and this vanishes in the backward direction. Second, we should expect the phase of the wave at P to correspond to the average of all the phases in the first Fresnel zone, whereas we know that in fact it corresponds to that of the point O. To put this right (and the full theory of course proves it) we make the rule that the secondary waves are to have their phases advanced 90°, or a quarter wave length, in front of the primary wave causing them. These rules may be regarded merely as artifices to avoid a deeper inquiry, but they have important consequences; for, when we have a thin sheet of matter in the plane AB, its particles will scatter the incident light in much the same way as we have been considering, but in this case neither of the two effects will come in. There will be light scattered backward, which constitutes the reflected wave; and the light scattered forward will be a quarter wave length behind the primary wave, and this is the most primitive description of refraction.

The construction of the Fresnel zones explains the bright spot in the centre of the shadow of a circular disk. For, if the screen cuts out the first n zones, the wave at P will now be $m_{n+1}-m_{n+2}+\ .\ .\ .$, and the sum will be $\tfrac{1}{2}m_{n+1}$. In order to exhibit this effect the circle has to be cut with great accuracy, for if half of it is as little as a single zone wrong the amplitude at P will vanish. The same idea has been carried further in the construction of zone plates. If we make a screen which cuts out every alternative zone, we shall get an effect proportional to $m_1+m_3+m_5+\ .\ .\ .$, which will be enormously greater than the effect without screen. Zone plates have been made by drawing them in black on paper and then photographing down to a small scale. A brilliant spot will then be found at a point on the axis. The zone plate illustrates wave principles admirably, but has not found any practical application.

B. The Formation of Shadows.—We may apply the same wave construction to explain the formation of shadows. In fig. 8, AC is a screen with straight edge at C, and we consider the light falling on different points of the screen MN. The wave front is supposed parallel to ACB, and the screen blocks out the part AC, so that we have to consider only the secondary waves emitted by the part CB. First take P, the geometrical edge of the shadow. If we draw the Fresnel zones for this point, they will consist of a semicircle, with C as centre, and half-rings surrounding it. Each will therefore give half the effect of the whole zone, and the resulting amplitude at P will be just half as great as if P were fully illuminated. The corresponding intensity is thus one quarter as great. For a point Q we make the Fresnel construction starting at D; as Q moves away from P the sizes of the exposed parts of the zones diminish steadily, and we therefore conclude that the intensity falls steadily from $\tfrac{1}{4}$ to zero. For a point R outside the shadow we make the construction in the way we did before for free space. There will then be a circle surrounded by rings, but the line through C cuts across them in such a way that some are incomplete. Suppose that R is just so far from P that the central circle is complete but is touched by the line C. Then the central

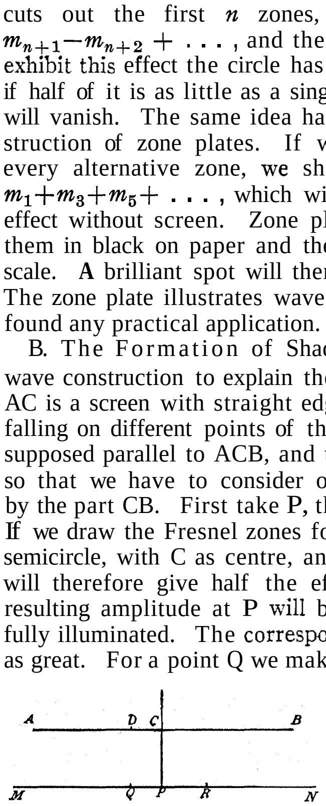
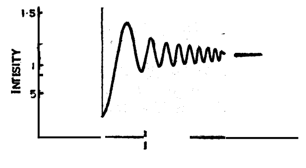


FIG. 8.—THE FORMATION OF SHADOWS
AC cuts off the light from part of the screen MN; P is the geometrical edge of the shadow, and the actual illumination in its neighbourhood is shown in fig. 9

zone gives its full contribution, but the second gives less than its full contribution, as do all the later ones. Consequently there is less to subtract than usual from the central zone, and the light at R will be actually brighter than if there were no screen. Similarly if the circle and the first ring are complete, but the second ring is cut by the line C, the second ring will give a diminished positive contribution and the light will be fainter again. Thus outside the shadow there are a series of alternating maxima and minima of intensity gradually fading into uniform illumination at a distance from the shadow. These light and dark bands are known as diffraction fringes.

The scale of the phenomenon depends on both the wave length of the light X and the distance CP. The intensity at a point R will depend on the numerical value of $PR/\sqrt{\lambda \cdot CP}$. For example if CP is 1 m. and $\lambda = 5 \times 10^{-5}$ cm. for yellow light, the first maximum and first minimum will occur at distances 0.061 cm. and 0.094 cm. outside the geometrical edge, and will have 1.37 and 0.78 of the intensity of the incident wave. Fig. 9 shows how the intensity changes near the edge of the shadow. When the incident light is white the corresponding effect can be calculated by the superposition of all the colours; at the point of geometrical shadow the light will again be white and of quarter intensity, and outside this there will first be a blue fringe. A similar process can be applied to work out the illumination due to a slit. If the slit is many wave lengths wide it can be regarded merely as two straight edges, while if it is only a small fraction of a wave length there will be no shadow at all, but a uniform illumination. For intermediate cases there mill be a rather complicated succession of fringes depending on the ratios of the three quantities, wave length, breadth of slit and distance of screen. In any given case the results are easily calculable.



FROM SCHUSTER AND NICHOLSON, "THEORY OF OPTICS" (EDWARD ARNOLD & CO.)
FIG. 9.— THE EDGE OF A SHADOW
Showing how illuminative intensity rises from zero inside to unity outside

C. The Fraunhofer Diffraction Phenomena.— There is another way, attributable to Joseph von Fraunhofer, in which diffraction may be studied; this is in fact more important than Fresnel's in the theory of optical instruments. In this method parallel light again falls on a slit or hole, but, instead of observing the illumination on a screen? the light is now observed in a telescope focused for infinity. The essential purpose of a telescope is that it brings all the rays going in a given direction into focus at a point; at this point a photographic plate may be placed, or alternatively the real image may be viewed with the help of a magnifying lens. If the slit is narrow enough, or the hole sufficiently small, the naked eye may replace the telescope. Then the slit or other aperture must be placed immediately before the eye, the latter being focused on a small source some distance away. For observing diffraction by a slit, a single-filament lamp makes a good source. To deduce what will be seen under these conditions. we must find the intensities of the waves passing through a slit in various directions.

In fig. 10, AB is a slit, and we require to know what intensity goes at angle θ into the direction AM. We break up the wave at the slit into secondary waves. That arising at P has to go a distance $PR = AP\sin\theta$ farther than that from A. If the phase of the wave from A is ϵ, that from P is $\epsilon - \frac{2\pi}{\lambda} s \sin\theta$, where $s = AP$.

For a slit of breadth l the whole effect will be

$$\int_0^l \cos\left[\epsilon - \frac{2\pi}{\lambda} s \sin\theta\right] ds.$$

If this is integrated and then squared and averaged, we find the intensity proportional to

$$\left[\sin\left(\frac{\pi}{\lambda} l \sin\theta\right) \Big/ \left(\frac{\pi}{\lambda} l \sin\theta\right)\right]^2.$$

The form of the curve $y = \sin^2 x/x^2$ is shown in fig. 11, so that to find how the observed intensity depends on the angle 6 we require only to equate x with $\pi l \sin 6/\lambda$. Then if f is the focal length, the image corresponding to 6 will be formed at a distance approximately $f\sin\theta$ from the axis of the telescope. From the curve we see there is a very strong maximum at $\theta = 0$, and that no light goes in the directions given by $\sin\theta = n\lambda/l$; that is, when BS, in fig. 10, is any multiple of the wave length. About halfway between these directions of no light there are secondary maxima. which are much weaker than the central one; even the first is less than one-twentieth of it. When the slit is broad the whole figure will be crowded close together. We must also consider narrow slits; *e.g.*, if the slit is exactly one wave length broad the first zero will be at 90°; in any case nothing beyond that angle could be observed. If it is two wave lengths broad, the first zero will fall at an angle of 30° and there will be a secondary feeble maximum at an angle of about 50°.

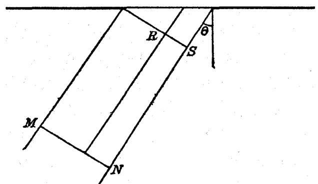
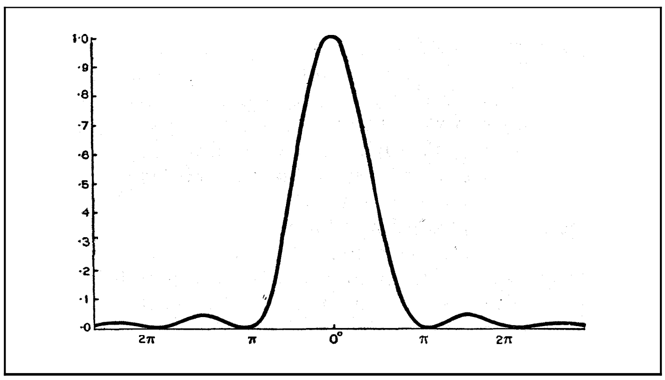


FIG. 10.—DIFFRACTION BY A SLIT

A similar construction can be applied for a hole as well as for a slit. For a small rectangular hole the diffraction pattern is broad in the direction in which the hole is narrow, and vice versa. In the case of a circular hole the pattern consists of a bright central circle surrounded by fainter rings. If the hole has radius R and the telescope focal length f, the bright centre is surrounded by the first dark ring of radius $0.61 \times f\lambda/R$, and five-sixths of the total light falls inside it. The first bright ring has radius $0.82 \times f\lambda/R$, and at its brightest point the intensity is only about one-sixtieth of that at the centre of the central spot. The diffraction pattern of a circular hole is of great importance in connection with the theory of telescopes.

The theory of Fraunhofer diffraction is fundamental to understanding the action of the diffraction grating. In fact, it was through his investigations of this instrument that Fraunhofer's name became associated with these phenomena. The grating is essentially a large number of narrow slits parallel to one another and spaced at equal distances a. The theory of its action is discussed under SPECTROSCOPY, where it is shown that the diffraction pattern consists of a number of very sharp and intense maxima at angles θ such that sin $6 = 0, \pm \lambda/a, \pm 2\lambda/a, \ldots$, called the central image, first order. second order, ... The positions of these depend on the wave length λ, and therefore when the light striking the grating contains various wave lengths they are dispersed into several spectra. one for each order. Two wave lengths very close together may be separated because of the sharpness of the maxima. whose width equals that of the diffraction maximum formed by a single slit of width equal to the total width of the grating. For this reason gratings have largely replaced prisms for the study of complicated spectra.



FROM SCHUSTER AND NICHOLSON, "THEORY OF OPTICS" (EDWARD ARNOLD & CO.)
FIG. 11.— CHART SHOWING FRAUNHOFER DIFFRACTION BY A SLIT
The curve $y = \sin^2 x/x^2$. The y ordinate measures the intensity of light at angle $where sin θ is proportional to x

D. **The** Nature of White **Light.— It** has been customary since the time of Newton to say that white light is compounded out of all the colours, hut the diffraction grating suggests quite another point of view. Let us imagine that the incident light is a plane wave consisting of a single thin pulse. Each slit of the grating diffracts this pulse into all directions, and, if we observe from a given direction. we shall receive in turn the pulses which have come through each slit. They will be evenly spaced and farther apart, the broader the angle from which we observe. At each position θ there will be something very like a monochromatic wave; more precisely it is a periodic wave composed of wave lengths $a\sin\,\theta$ and all its submultiples; *i.e.*, out of the superposition of light of the first, second and higher orders appropriate to the angle θ. Regarding the matter in this way, we have a perfect right to say that the coloured light has been created by the spectroscope. This is a point of view well worth keeping in mind, for in many branches of physics we determine some property by an experiment and then attribute it to the system, overlooking the fact that it may be the experiment itself that has evoked the property. In the present case the two points of view are reconciled by the fact that the pulse can be analyzed mathematically into an integral composed of lights of all wave lengths, and in this sense it is correct to say that white light contains all the colours, even though it is unnatural to attribute any periodic quality to a single pulse.

It may appear that the argument is special to the case of resolution by a grating, and that the spectrum of white light formed by a prism proves that the colours were there originally. Closer examination shows this to be wrong, though the argument is not so simple; by considering the property of group velocity it can be shown that the prism will convert a single pulse into successions of pulses differently spaced for the different directions, but it would take too long to develop the idea further here. The outcome of the argument is that the analysis of light into wave lengths is chiefly a matter of convenience. largely mathematical convenience; but this is enhanced by the fact that gases usually emit spectra consisting of very nearly pure monochromatic lines, so that it turns out to be also a practically important analysis.

E. **Resolving** Power. — It is of great importance when working with any optical instrument to know its resolving power. Thus the resolving power of a telescope tells us what distance there must be between two stars in order that we may be sure that they are two and not one. For a microscope it determines the fineness of recognizable detail in the object. and for a spectroscope the smallest difference in wave length. Resolving power must be distinguished from magnification, for. as we shall see. it is possible to magnify the images indefinitely, but the only effect is to make a small indistinct image into a large indistinct image. It is as though the image were painted on a sheet of rubber; stretching the sheet reveals no more detail. Diffraction theory determines the resolving power of all instruments, and we shall illustrate this by first considering the resolving power of telescopes.

The principle of the lens is usually discussed by geometrical methods (see OPTICS), but it is quite simple to work it out with the wave theory. In fig. 12 plane waves fall perpendicularly on the lens in the beam, PA,QC. The central ray through BE is retarded in the glass, but not so the extreme rays at A and C. The focus F is the point where all the secondary waves from AEC are in phase; the retardation of the central ray is balanced by the longer path of the extreme ones. The waves at AB are in phase, and the phase changes from there to F are given respectively by AF and $n{\cdot}BE+EF$, where n is the refractive index of the lens. Let BE be d, AB be r and EF be f, supposed much larger, then we have

$$d(n-1)+f=\sqrt{(f^2+r^2)},$$

whence, approximately, $f=\dfrac{r^2}{2d}\,\dfrac{1}{n-1}$, which determines the focal length of a plano-convex lens in terms of its curvature. If another set of waves at a small angle θ falls on the lens. their focus F can be found by the consideration that the waves from A and C must be in phase, while F is near F in a plane at right angles to the axis of the lens. We thus find that $FF'=f\sin\theta$, a familiar result in geometrical optics.

Supposing that the two waves are from stars, we inquire under what conditions they will be resolved. The image of the first star at F is of course not a point because of diffraction We can roughly estimate its size by the consideration that there will be points near F for which the waves from A and C and from other portions of the lens. though not perfectly in phase, are so little out of phase that there will be still a marked intensity. This is a question of the diffraction image of a circular hole and the radius of the central spot is o 61$f\lambda/r$. If the centre of the image of the second star is much closer than this, me shall have only one bright spot and shall not distinguish that there were two stars. Thus the angular distance that can be resolved is 0.61λ'r. For visible light and with the radius of the telescope in millimetres this gives for the angle in minutes of arc

$$\left(\frac{1.17}{r}\right)'.$$

The important thing to notice is that the resolving power in no way depends on the magnification but only on the diameter of the object glass. If the telescope has a short focal length the magnification will be small; but as long as the diameter is large the resolution will be good. and the small magnification can be overcome by the use of a stronger eyepiece. This result requires one qualification, for we have assumed that the whole object glass is operative in bringing rays to the eye. When the magnification is not very great it may happen that the pupil of the eye is the effective limitation and not the object glass, and in such cases the resolving poner will depend on the diameter of that part of the object glass from nhich light enters the pupil.

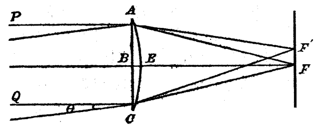


FIG. 12.—THE RESOLUTION BY A LENS
The Dower of resolvinq the imaqes F and F' depends on the size of the lens AC and not on the focal length EF

The tendency to make larger and larger telescopes is to be attributed partly to the fact that they collect more light. but much more to the increased resolving poner. An extreme example is given by the measurement of the diameters of stars. Stars are all so distant that no existing telescope could hope to resolve the separate parts of their surfaces. and the disk seen is never perceptibly larger than that which would be produced by a geometrical point. But if we could have a teleicope 50 ft. in diameter, the resolving poner should be sufficient to show the disk of a large star in the same way that an ordinary telescope does for a planet. It is not of course practicable to make such a telescope, but it is also not necessary; all that is required is two little pieces of such a telescope at the points A and C in fig. 12. In principle this is the way in which it has been found possible to measure the diameters of Betelgeuse and a few other stars.

The eye is an instrument similar to the telescope. Taking the diameter of the pupil as 2 mm., the same calculation shows that its resolving power should be 0.42$'$. The actual limit. about 1', is not very different and is no doubt affected by the structure of the retina. A similar limit would apply for any eye constructed on the same principle as man's; but insects' eyes are compound, being composed of a very large number of very small independent facets. There can be no phase relations between the separate facets, so that the resolving power can depend only on the size of each separately. It thus seems improbable that an insect can discriminate visually between objects less than some degrees apart.

The resolving power of the microscope presents a different problem from that of the telescope. because in the microscope we observe nonluminous objects illuminated usually by paralle! or not very convergent light. The discussion of the theory will be found under MICROSCOPE, and we here give only the result. If the lens can receive light from the object over a range of 180° (and for a good microscope it very nearly does). then some rough impression of form can be detected for an object of the size of half a wave length. By immersing the object in a refractive medium the wave length is shortened and the resolution improved, and it may be further improved by the use of ultra-violet light.

In the case of spectroscopes there are two other factors besides diffraction that must be taken into account. First, we remember that the width of each line is affected by the width of the spectroscope slit, but this limitation may be obviated by so narrowing the slit that it contributes a negligible amount to the width of the diffraction pattern. The second factor is the dispersion. which determines how far apart the centres of tno lines of different wave length will lie. Obviously if the lines have a given breadth, determined by diffraction of a beam of width corresponding to that emerging from the prism or grating. the resolving power will increase in direct proportion to the dispersion. For interferometers, the resolving power is not limited by diffraction, so that very high resolution can be reached with small apparatus. *(See* SPECTROSCOPY.)

V. POLARIZATION AND ELECTROMAGNETIC THEORY

In our review of the history of optics we described some of the earlier work on polarization, and we must now make its character clearer. The phenomena of interference and diffraction were all explained by regarding the light as a wave, leaving it entirely open what it is that vibrates and how it does it. In fact all that we have so far said would, with suitable changes of scale, be just as true for sound as for light. But when we come to the phenomena of double refraction, this is not so; they are explicable only if the vibrations are transverse. Though we saw that, in spite of many attempts, no material model could be found which would carry waves in the way that ether does light, still it is quite possible to visualize polarization. 4 string stretched horizontally may vibrate in a vertical or horizontal plane or simultaneously in both; at any instant a point of the string is displaced from its position of rest in a direction perpendicular to the line of the string, and this position can be indicated by drawing a line in the direction and of the length of the displacement. When a light wave is travelling through space, we can also represent it at any point and time by drawing a line in a definite direction and of a definite length. It should be explained that, unlike the case of the string, here the length is only diagrammatic and can be represented on any scale, as long as we are consistent and adopt the same scale for other points. This line is called the light vector, and the wave is said to be transverse, because the light vector is always found to be at right angles to the direction of the wave; that is to say, it lies somewhere in the plane of the wave front. The reason for this will appear when we come to the electromagnetic theory; we shall first describe the main properties of polarization without justifying them.

A. Types of Polarized Light.—Suppose that we have a wave of plane monochromatic light advancing perpendicular to the paper. At any point in the paper we draw the light vector, and it will go through a series of changes, returning to its original value in the period of the waves. We can represent any motion by giving the x, y co-ordinates of the end of the light vector, and for monochromatic light these must be sine or cosine functions of the time. If ν is the frequency we therefore take

$$X=A\cos(2\pi\nu t-\alpha),\ Y=B\cos(2\pi\nu t-\beta)$$

as the general description of the light. We first consider a few special cases. If $B=0$ we have a vibration in which the vector always lies in the direction of x and ranges between the values $\pm A$. This we call plane polarized in the direction x. Similarly if A = o we have light plane polarized in the direction y. If we have $\alpha=\beta$, we see that at any time $Y/X=B/A$, so that again we have plane polarized light, in direction arc tan (B/A) and with amplitude $\sqrt{(A^2+B^2)}$. Next consider the case $B=A$, $\beta=a+\frac{\pi}{2}$. Then $X^2+Y^2=A^2$, so that the vector describes a circle; this is therefore called circularly polarized light. In the general case we can find the locus of the light vector by eliminating t and get

$$\frac{X^2}{A^2}+\frac{Y^2}{B^2}-2\frac{XY}{AB}\cos(\alpha-\beta)=\sin^2(\alpha-\beta).$$

This is an ellipse of which the axes are determined as to position and magnitude by A, B and $\alpha-\beta$. The most general type of light is therefore called elliptically polarized, and we recognize our previous types as degenerate ellipses.

We next consider the propagation of such waves; that is to say, the phase relations of the light vectors for different positions of the wave front. Our wave is now written as

$$X=A\cos[2\pi\nu(t-z/c)-\alpha],\ Y=B\cos[2\pi\nu(t-z/c)-\beta],$$

and the character of the polarization is the same for all values of z, as it will depend on A, B and

$$(2\pi\nu z/c+\alpha)-(2\pi\nu z/c+\beta)=\alpha-\beta.$$

Next we take t as fixed and consider the way the light vector is drranged for various values of z. We may liken it to the stretched string. If $B=0$ it will be in the shape of a sine curve in the plane of xz with wave length c/ν, and similarly whenever $\alpha=\beta$, though for a different plane. If /?=a+$\frac{\pi}{}$ and $B=A$, the locus is a screw, or helix, of radius A and pitch equal to the wave length c/ν. If the axes are right-handed, so that a man standing with his head toward y and looking forward along z has x on his left, the light is by convention called left circularly polarized. even though the screw is a right-handed one. This convention refers to the sense of rotation of the vector at a given point in space as seen by an observer looking against the oncoming light. Here it is a counterclockwise or "left-handed" rotation. If instead $\beta=\alpha-\pi/2$, the rotation is clockwise and the light is said to be right circularly polarized. The distinction between right and left circularly polarized light is physically very important, as it plays a leading part in the phenomenon of gyration. In the case of elliptically polarized light, the locus of light vectors may be described as a flattened screw, which may again be either right- or left-handed. Fig. 13 shows the forms of vibration for various $a-/?$, the polarization in the first and last pairs of diagrams being left-handed. This suffices to describe the form of the waves. and it remains only to define the intensity. At any point this is given as the average value of the square of the light vector; in the cases we have considered it is the average value of X^2+Y^2. When the waves are travelling in an arbitrary direction instead of along z, we may have three components of the light vector, and in such cases $X^2+Y^2+Z^2$ is to be averaged over the time.

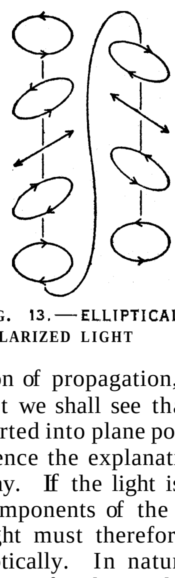


FIG. 13.—ELLIPTICALLY POLARIZED LIGHT

We must also consider the nature of ordinary unpolarized light. This has no "sides" and is symmetrical about the direction of propagation, and in this it is like circularly polarized light; but we shall see that circularly polarized light can easily be converted into plane polarized, whereas for ordinary light this is not so. Hence the explanation of its symmetry must be found in another way. If the light is rigorously monochromatic, the phases of the components of the light vector are maintained forever, and such light must therefore be polarized, either plane, circularly or elliptically. In nature, however, no light is rigorously monochromatic, for the Michelson interferometer fails to show interference for path differences of more than about 1,000,000 wave lengths, and this enables us to explain unpolarized light as being polarized light of which the direction of polarization is changed frequently. We suppose each atom to emit a polarized monochromatic wave which lasts for a time corresponding to 1,000,000 nave lengths, and then changes and emits one of a different polarization. The length of time of each separate type is so short that we cannot distinguish them but merely get an average of all the different types. and this average will be symmetrical about the direction of propagation.

The most general kind of light consists of a mixture of unpolarized light with light that is polarized, either plane, elliptically or circularly. A theorem due to Sir George Stokes states that any beam of light whatever may be exactly described by giving four numbers called Stokes's parameters. These are

$$I=[X^2+Y^2]_{\mathrm{Av.}} \qquad U=[2XY\ \cos(\alpha-\beta)]_{\mathrm{Av.}}$$
$$Q=[X^2-Y^2]_{\mathrm{Av.}} \qquad V=[2XY\ \sin(\alpha-\beta)]_{\mathrm{Av.}}$$

where the brackets indicate time averages. Evidently I measures the intensity of the beam, while Q, U and V specify its state of polarization. For unpolarized light the latter quantities fluctuate rapidly and average to zero. For any completely polarized beam, however: they have constant values. Then $I^2=Q^3+U^2+V^2$, and the intensity need not be known independently of the other parameters. Plane polarized light vibrating along x has $I=Q=X^2$ and $U=V=0$, circularly polarized light $I=V=2X^2$, $Q=U=0$, etc. The Stokes parameters are additive; that is, if two noncoherent light beams are superimposed, each parameter is the sum of the corresponding ones for the separate beams. Thus it is found that the general type of partially polarized light may be resolved into two parts, one of which represents a polarized beam of intensity $Q^2+U^2+V^2$, the other an admixture of unpolarized light given by the difference $I-(Q^2+U^2+V^2)$. We shall see later what types of experiments must be performed in order to determine the Stokes parameters for a light beam.

In describing plane polarized light we have said that it is polarized in the direction x when the light vector vibrates along x. Unhappily there is some confusion in the terminology used. When polarization was first discovered the convention was adopted that the light of the ordinary ray in double refraction is polarized in the plane through the axis of the crystal and the direction of propagation. It later appeared that the light vector must be perpendicular to this plane, so that the old convention would have described the light as polarized in the plane of yz, which we shall call polarized in the direction x. For most optical effects the behaviour is determined by the direction of the vector and not by the direction of propagation of the wave, so that it is practically inconvenient to mention two directions when one would do. The modern tendency. which we shall adopt! is to describe plane polarized light by the direction of the light vector; thus, in double refraction we shall say that the ordinary ray is polarized at right angles to the crystal axis. To avoid confusion with the older terminology, it seems desirable to avoid any reference to a plane of polarization, which we shall do by referring to the direction of polarization.

B. Methods of Producing Polarization. — The polarization of light is by no means uncommon. Its existence in the light transmitted by certain crystals has been mentioned here because this case was important historically, but double refraction is not the only way in which polarization may be produced, and we shall discuss other occurrences in detail later. Chief among them is reflection at a transparent surface set at a suitable angle. At other angles there is an incomplete polarization, which is sometimes very troublesome in experiments; for as light passes through any system of lenses or mirrors! it is almost impossible to prevent its becoming polarized, and this may easily obscure the study of its original polarization. We may also mention the polarization of scattered light, exemplified in the light of the sky. Again, in diffraction of light by a slit, the two components behave rather differently, and so the light is slightly polarized; the theory we have given is sufficiently correct for small angles, and we shall not consider the modification that is required for more exact results. Perhaps the most interesting occurrence of all is in the Zeeman effect (*q.v.*). Here the spectral lines of an atom become displaced and split when the atom is in a strong magnetic field, and the split components are polarized in certain definite ways, from which much information can be obtained about the mechanics of the atom.

There are two standard instruments for converting ordinary unpolarized light into plane polarized light: the nicol and the sheet polarizer. The former was devised in 1828 by William Nicol. and uses the principle of double refraction. One of the two polarized beams is removed by total reflection (see fig. 14). For over a century the nicol and its modifications were used almost exclusively in optical instruments involving the production or detection of polarized light. Beginning in 1932, however. a technique was developed by Edwin Land for producing thin sheets of a material which polarizes by virtue of a property called dichroism. As we shall see in discussing dichroic crystals. such materials exhibit a different degree of absorption for vibrations in two mutually perpendicular directions. Hence under suitable conditions one of these may be almost entirely eliminated from the transmitted light. Improvements in these dichroic sheet polarizers have permitted their use instead of nicols in many applications.

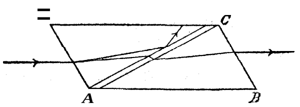


FIG. 14.—THE NICOL PRISM

In the construction of a nicol, a rhomb of calcite which is about three times as long as it is broad is sawed across the line AC (see fig. 14), and, after the cut has been polished, the two faces are cemented together with Canada balsam. The two ends AD and BC are also cut to a slightly different angle (68" instead of 72°). A wave, entering parallel to the axis of the prism, is doubly refracted so that the two waves go in somewhat different directions. the ordinary wave being most bent. Canada balsam has a refractive index intermediate between those of the ordinary and extraordinary waves, and as the ordinary wave meets the balsam layer very obliquely it becomes totally reflected and falls on the side DC, which is blackened so as to absorb it. Nearly all of the extraordinary wave passes through, so that the emergent light is plane polarized. A nicol will polarize light only over a certain range of angles of incidence. The limits are set by the condition that on one side both rays are reflected at AC-and lost. and on the other that a certain part of the unwanted ordinary ray is transmitted; under favourable conditions the range of angles may be 30°. The slight adjustment of the slopes of the end faces mentioned above is for the purpose of making this range extend equally on both sides. A typical experiment with polarized light involves the use of two nicols. The simplest example is the direct use of two "crossed" nicols. The first produces polarized light by eliminating one component; the second is placed with its axis in the same line as the first but is twisted round through 90°, so that the wave which was the extraordinary wave in the first nicol is now the ordinary one and so is not transmitted. This device has been used for secret signalling. The signaller rotates his nicol through 90°, and though to the naked eye his lamp appears to burn steadily, if it is viewed through a fixed nicol it will go out.

The main limitation of the nicol is its restricted size. It is difficult to find calcite crystals sufficiently large and clear to polarize a beam much more than an inch wide. Sheet polarizers are made the areas of which are measured in square feet, a development which opened up new technical uses for polarized light. To mention one, the glare of the headlights of approaching automobiles may be eliminated by covering both the lights and the windshields with such sheets, their axes of transmission both being tilted at 45° clockwise from the vertical. Then the driver may see the light from his own headlights, but that from oncoming vehicles will have its direction of polarization crossed with the axis of transmission of his windshield and will be seen only faintly. Dichroic polarizers consisting of single crystals of the mineral tourmaline had long been used instead of nicols in certain applications. Using the same principle in a different way, sheet polarizers were first made of a suspension of submicroscopic crystals in a cellulosic matrix, the axes of all the needlelike crystals being aligned parallel to one another. These were crystals of herapathite, which is much more strongly dichroic than tourmaline. Later it was found that a better polarizer can be made by stretching a sheet of polyvinyl alcohol and then treating it with iodine. Another polarizer, which has nearly as good polarizing properties and is more stable to heat and radiation, is produced by merely dehydrating a stretched sheet of polyvinylene. One drawback of sheet polarizers is the limited region of the spectrum over which the polarization is reasonably complete. The polyvinyl alcohol type covers the entire range of visible colours very well, so that when a bright light is viewed through two sheets in the crossed position only a feeble blue colour is seen. In other types, the polarization may extend over only a certain part of the visible spectrum; this may actually be put to advantage in certain applications, as for example in the projection of stereoscopic pictures.

C. The Analysis of Polarized Light. — Polarization is chiefly, though by no means exclusively, studied by using the property of double refraction in crystals. We discuss this below, but it will here suffice to say that when a wave goes through a crystal its light vector is resolved in two directions, mutually perpendicular and perpendicular to the direction of propagation, and the components in these directions have different wave velocities. Suppose that we have a plate with parallel faces perpendicular to z and that the wave is going through it along z, while the two special directions are x and y. In such a plate the light vector will be given by

$$X=A\cos[2\pi\nu(t-z/a)-\alpha],\ Y=B\cos[2\pi\nu(t-z/b)-\beta],$$

where a and b are the wave velocities for vibration in the directions x and y. If the incident light is plane polarized along x or y the wave mill go through unchanged, but if it is polarized, say at angle γ on entering the plate at $z=0$, we shall have $\alpha = \beta$ and A= Ccosy, $B=C\sin\gamma$. If the plate is of thickness l the light will emerge from the farther side as

$$X=C\cos\gamma\cos[2\pi\nu(t-l/a)-\alpha],\ Y=C\sin\gamma\cos[2\pi\nu(t-l/b)-\alpha],$$

and so X and Y are no longer in the same phase, and the light is now elliptically polarized. Fig. 13 shows diagrammatically how this transformation comes about. If we had started with elliptically polarized light, the emergent light would in general be elliptically polarized, but in a new direction. In special cases it might become plane polarized, and this illustrates the principle of an important instrument used in the study of polarized light, the quarter-wave plate. A quarter-wave plate is made by taking l so that $2\pi\nu l/a-2\pi\nu l/b=90°$. If the incident light is elliptically polarized, with the axes of the ellipse along x and y, we may write it as

$$X=A\cos(2\pi\nu t-\text{a}),\ Y=B\sin(2\pi\nu t-\alpha).$$

After passing through the quarter-wave plate the emergent light will be

$$X=A\cos(2\pi\nu t-\alpha'),\ Y=B\cos(2\pi\nu t-\alpha'),$$

and it is now plane polarized. As a case of special importance, if the incident light is circularly polarized, the emergent will be plane polarized at 45° to the x direction. and its right- or left-handedness will be indicated according to whether the direction is between x and $+y$ or x and $-y$. Quarter-wave plates are usually made of mica. which is easily cleft into thin sheets. These sheets exhibit a rather weak double refraction, so that a quarter-wave plate is not inconveniently thin. As mica is rather soft, it is often mounted between two sheets of glass, and scratches on these indicate the direction of the crystal axis.

When we want to determine the state of polarization of any given light beam, we must first find whether it is completely polarized or whether it contains some unpolarized light. In the former event the vibration is in general elliptical, and this may be made into plane polarized light by a quarter-wave plate set at the proper angle. It can then be extinguished by a nicol. When this condition is found, the crystal axis of the quarter-wave plate coincides with the major or minor axis of the ellipse. Tao data are thus obtained: the orientation of the plate, which tells the position of the axes of the ellipse, and the angle which it makes with the nicol, the tangent of nhich gives the ratio of these axes. These data suffice to determine two of the four Stokes parameters, the other two representing the total intensity of the light and the admixture of unpolarized light. If some of the latter is present, it will be impossible to extinguish the light by any orientations of the quarter-wave plate and nicol. One setting of the former may be found, however, which gives the largest variation of intensity as the nicol is rotated. The ratio of the maximum and minimum intensities will then give a measure of the degree of polarization of the original beam.

The quarter-wave plate is most useful for analyzing elliptically polarized light when we already know the position of the axes of the ellipse, as is the case in some important experiments; in other cases the making of two adjustments simultaneously is troublesome. The alternative instrument is called the compensator. In this the analysis is in two fixed perpendicular directions, instead of along the axes of the ellipse, and we measure the relative lengths of the components of the light vector in those two directions and their phase difference. The essential part of the compensator consists of two thin wedges of quartz, a crystal with rather weak properties of double refraction. One wedge is cut so that the crystal axis lies in a line parallel to the edge, and the other so that it is at right angles to it and parallel to the face (see fig. 15, where the lines and dots indicate the directions of the axes). Incident light will be broken into two components in the first wedge, of which one will have a higher phase velocity; but on entering the second this will change about, so that, if the thicknesses are exactly equal as at the centre A, there will be no resultant changes of phase. Thus, incident plane polarized light will emerge as plane polarized at A. At any other point B this will not be so, because the light will have gone farther through one crystal than through the other. If elliptically polarized light is incident, there will be places where the transmitted light is plane polarized, and so, if we use an analyzing nicol set at the proper angle, we may observe the field crossed bv dark bands. If one wedge is screwed over the other by means of the micrometer screw M, the bands will shift because of the changing differences in the thickness of the wedges. The reading consists in seeing how far the screw must be turned to bring one of the bands to the centre. This measures the phase difference in the components of the light vector along and across the wedge, while the ratio of their amplitudes is given by the setting of the nicol.

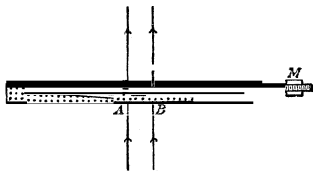


FIG. 15.—THE COMPENSATOR
The dots and lines indicate the crystal axes of the two quartz wedges, and M is the micrometer screw

D. The Electromagnetic Equations. — It was Maxwell who made the great discovery that the equations governing the behaviour of electric waves are equally applicable to light, and this provides a strict formulation for the whole theory, including of course polarization. For the derivation of the theory of electric waves see the article ELECTRICITY; we shall here take it as given and show how it applies for light.

Consider first the case of free space. At every point there may be an electric force $\mathbf{E}$ and a magnetic force $\mathbf{H}$. Each has both direction and magnitude and they can be most conveniently described by the components E_x, E_y, E_z and H_x, H_y, H_z along the directions x, y, z. The vector notation is well adapted to expressing their relations. In this notation

$$\frac{\partial E_x}{\partial x}+\frac{\partial E_y}{\partial y}+\frac{\partial E_z}{\partial z}$$

is written div $\mathbf{E}$ and called the divergence, while the three quantities

$$\frac{\partial E_z}{\partial y}-\frac{\partial E_y}{\partial z},\ \frac{\partial E_x}{\partial z}-\frac{\partial E_z}{\partial x},\ \frac{\partial E_y}{\partial x}-\frac{\partial E_x}{\partial y}$$

are the components of curl $\mathbf{E}$. A vector equation involving curl is thus three equations, when written in terms of the components.

The equations are

$$\frac{1}{c}\frac{\partial \mathbf{E}}{\partial t}=\text{curl }\mathbf{H},\quad \text{div }\mathbf{E}=0;$$

$$-\frac{1}{c}\frac{\partial \mathbf{H}}{\partial t}=\text{curl }\mathbf{E},\quad \text{div }\mathbf{H}=0.$$

In these equations c is originally a rather abstruse quantity, the ratio of a charge measured in electrostatic units to the same charge measured in electromagnetic units. It is a velocity. and one of the strongest evidences for the electromagnetic theory of light is that, when purely electric methods are used to determine the ratio, it is found to be the same as the velocity of light. We shall give a few examples of solutions, but before doing so must complete the theory by giving the rule for intensity. In our previous account of intensity we left a factor of proportionality undetermined, and this was right because we had then no other physical phenomenon to link with light, so that there was no way of fixing the absolute values. Now, however, we have a much more precise formulation, because we can imagine that we might measure (very ideally of course) the electric force in the light by means of an electrometer, and we can therefore make our definition absolute. Electrical theory assigns a value to the flux of energy (*i.e.*, to the rate at which energy is carried across unit area in unit time), and this is a suitable measure for intensity. It is called the "Poynting vector," after its discoverer, and is $\frac{c}{4\pi}[\mathbf{E}, \mathbf{H}]$ where $[\mathbf{E}, \mathbf{H}]$ is a vector product with component $E_y H_z - E_z H_y$ along x, etc.

We now consider some solutions of the electromagnetic equations. One such solution may be verified to be

$$E_x = A\cos\frac{2\pi}{\lambda}(ct-z),\ E_y=0,\ E_z=0;$$

$$H_x=0,\ H_y=A\cos\frac{2\pi}{\lambda}(ct-z),\ H_z=0.$$

We see in the first place that we have a wave travelling along z with velocity c, and purely electrical experiments have shown c to be equal to the velocity of light. Second, we see that it is a transverse wave, but it is ambiguous whether the electric or magnetic force is the light vector. A similar solution is

$$E_x=0,\ E_y=B\cos\frac{2\pi}{\lambda}(ct-z),\ E_z=0;$$

$$H_x=-B\cos\frac{2\pi}{\lambda}(ct-z),\ H_y=0,\ H_z=0;$$

and this evidently represents the other polarized component. A third solution can be formed by superposing these two, or by superposing them with a phase difference between E_x and E_y. The intensity in such a case would be $\frac{c}{8\pi}(A^2+B^2)$.

We must now consider whether the electric or magnetic force is the light vector. Since both always occur in the wave, a theory could be constructed in which either was so taken. and it is a matter of convenience which we choose. A number of phenomena show that the electric force is the more important, primarily because matter is constructed out of electrons and not out of magnetic particles. We may give as one example the case of standing waves. When a plane wave of monochromatic light falls perpendicularly on a mirror and is reflected straight back, the incident and reflected waves interfere with one another and produce a system of stationary oscillations. These may be described by

$$E_x = A\cos\frac{2\pi}{\lambda}(ct-z) - A\cos\frac{2\pi}{\lambda}(ct+z)$$

$$= 2A\sin\frac{2\pi}{\lambda}ct.\sin\frac{2\pi z}{\lambda};$$

$$H_y = A\cos\frac{2\pi}{\lambda}(ct-z) + A\cos\frac{2\pi}{\lambda}(ct+z)$$

$$= 2A\cos\frac{2\pi}{\lambda}ct\cdot\cos\frac{2\pi z}{\lambda}.$$

We see that at points where z is any multiple of half a wave length E_x vanishes all the time, whereas H_y vanishes all the time at points where z is an odd multiple of quarter of a wave length. Suppose that our mirror is coated with a nearly transparent photographic film, of some depth, which is afterward developed and examined in section. Then we shall find places where it is fogged by the action of the light vector, and others where it is unaffected, and the positions of these tell us that it is the electric force that is effective and not the magnetic. From this and similar cases we conclude that it is best to take the electric force as the light vector.

VI. REFRACTION AND DOUBLE REFRACTION

We have already made much use of the idea that the optical effect of a transparent medium can be represented by a refractive index. This is not of course an explanation of refraction; for that we shall have to consider atomic processes, but without doing this we can discuss many of its features. and can describe the experiments which have been used in its investigation. We shall be content for the most part with the description of results; to work them out in detail would involve rather elaborate mathematics.

A. The Electromagnetic Equations for Refracting Media.—The natural starting point for the discussion is the extension of the electromagnetic theory to cover electrical waves propagated through matter. When a static electric force acts on matter it may produce two effects: If the matter is a conductor, a current will flow according to Ohm's law; this is expressed by defining a current density $\mathbf{j}$ (a vector with components j_x, j_y, j_z) which is given by $\mathbf{j} = \sigma\mathbf{E}$, where σ is the specific conductivity of the medium. If the matter is an insulator, the electric force displaces the electricity in the atoms in a way that may be compared to the compression of a spring, and a new quantity has to be introduced to express this, which is called the dielectric displacement. In isotropic media, such as water or glass, the dielectric displacement bears a constant ratio to the electric force. We write $\mathbf{D} = \epsilon\mathbf{E}$, and call ϵ the dielectric constant. General electromagnetic theory then shows that the equations for free space must be altered so as to accommodate either or both of these properties of matter. We now write

$$\frac{1}{c}\frac{\partial \mathbf{D}}{\partial t} + \frac{4\pi}{c}\mathbf{j} = \text{curl } \mathbf{H},\quad \text{div } \mathbf{D} = 0.$$

Matter also has magnetic properties, and this suggests that the other equations should be changed as well. It is found however to be unnecessary, for the alternations of force in light are so rapid that the magnetic properties have no time to take effect. So we adhere to the equations

$$-\frac{1}{c}\frac{\partial \mathbf{H}}{\partial t} = \text{curl } \mathbf{E},\quad \text{div } \mathbf{H} = 0.$$

These equations together determine the behaviour of light in most types of matter, but we must remember that we always have to make observations outside, and therefore require to know how the light will pass from one medium to another. Electric theory again provides the answer; when light goes through a boundary between two media, at every point of the surface and at every instant of time, the tangential components of electric and magnetic force just on one side of the boundary must each be equal to the tangential components of the corresponding forces just on the other side. (See ELECTRICITY.)

B. Refraction in Transparent Media.—In a nonconducting isotropic medium, the equations assume the form

$$\frac{\epsilon}{c}\frac{\partial \mathbf{E}}{\partial t} = \text{curl } \mathbf{H},\quad -\frac{1}{c}\frac{\partial \mathbf{H}}{\partial t} = \text{curl } \mathbf{E}.$$

It is easy to verify that these are satisfied by

$$E_x = A\cos\frac{2\pi}{\lambda}\left(\frac{c}{\sqrt{\epsilon}}t - z\right),\quad E_y=0,\quad E_z=0;$$

$$H_x=0,\quad H_y = A\sqrt{\epsilon}\cos\frac{2\pi}{\lambda}\left(\frac{c}{\sqrt{\epsilon}}t - z\right),\quad H_z=0.$$

The electric force is transverse to the waves and the wave velocity is $c/\sqrt{\epsilon}$, so that the medium has refractive index $\sqrt{\epsilon}$. An apparent difficulty at once arises, for our result seems to imply that the refractive index should not depend on the colour of the light. This will be explained when we come to the atomic theory, where it will appear that the dielectric constant depends on the frequency of the inducing electric force.

We next consider the passage of light from one medium to another. Suppose that they have refractive indexes n and n', and first suppose n to be the lesser; in the case of free space it will be unity. To find the formulas for refraction and reflection we take a given incident wave and assume that there are reflected and refracted waves but without making any assumptions about their wave lengths or directions. The boundary conditions then require that the sum of the tangential components of incident and reflected forces at the boundary in the first medium are everywhere and at every time equal to the corresponding forces in the refracted wave on the other side of the boundary. These conditions lead in the first place to the law that the frequencies of all three waves must be equal, so that the wave length of the refracted wave is $\lambda n/n'$, and then to the law that the angle of reflection is equal to the angle of incidence θ, while the angle of refraction θ' is given by $n\sin\theta = n'\sin\theta'$. These rules can be deduced merely from the fact that there are boundary conditions and would be the same whatever the form of those conditions. Next, with the special conditions of the electrical theory, we can find the amplitudes of the reflected and refracted waves. Taking the component in which the electric force is polarized perpendicular to the plane of incidence, me find as amplitude of the reflected wave $\sin(\theta-\theta')/\sin(\theta+\theta')$, while the component polarized in the plane of incidence gives $\tan(\theta-\theta')/\tan(\theta+\theta')$. These are Fresnel's sine and tangent formulas; their squares give the intensities of reflection. The intensities of the refracted wave may also be given, but are not so important.

We may now consider how the reflection varies with the angle of incidence. Take the sine formula first. For perpendicular incidence the formula becomes indeterminate, but may be shown to equal $(n'-n)/(n'+n)$. For water the refractive index is about $1\frac{1}{3}$, and so, when light falls perpendicularly on water, the amplitude of the reflected wave is one-seventh of that of the incident, and therefore the intensity is only about 2%. With increasing angle of incidence, the reflection increases somewhat (for incidence on water at 45° it becomes about 5%), and, as the incidence approaches grazing, it increases rapidly up to unity, which means perfect reflection. The phase of the reflected light is always opposite to that of the incident. The tangent formula behaves quite differently. For perpendicular incidence it has the same value, but it starts diminishing, and finally vanishes at the polarizing angle, when $\tan\theta = n'/n$, at which angle the reflected and refracted waves are perpendicular to one another. For water this angle of incidence is about 54°. After this it increases again and reaches unity at grazing incidence. The phase is the same as that of the incident light up to the polarizing angle, and from there onward differs from it by 180°.

These phenomena have been much studied experimentally. The behaviour of a transparent medium depends only on its refractive index, which is most accurately determined by the refractometer (essentially, a prism of the substance), so that experiments on reflection do not provide new information, but serve as a very valuable check on the theory. Suppose. for example, that we illuminate a glass surface obliquely with light polarized in some direction neither in nor perpendicular to the plane of incidence. To find the reflection this light must be resolved into two components, one of which obeys the sine and the other the tangent formula. They will be unequally reflected, but in neither case is the phase changed at the reflection (or only through 180°, which does not matter); and so the reflected light will again be plane polarized, but in a new direction. If the light is incident at the polarizing angle, the reflected light will contain only the component polarized in the direction at right angles to the plane of incidence. If ordinary light is incident the same is true, and this process is often used for obtaining polarized light. The most refined experiments have revealed the fact that the polarization is never perfect, but the unwanted component can usually be attributed to the presence of grease on the surface. If elaborate precautions are taken to remove this grease the effect becomes very small, but it never quite vanishes. This is probably to be attributed to the fact that the surface atoms are necessarily in a different state from those inside, so that it is not possible for a medium to remain truly homogeneous up to the boundary.

We have described what happens when the incident light is in the medium of lower refractive index. In the contrary case the intensity of reflection follows similar rules for the two components, but with one very important difference. In this case the angle of refraction is larger than the angle of incidence, and the reflection becomes complete for both polarized components when the refracted ray is at 90°, at which point the inclination of the incident ray is given by $\sin\theta = n'/n$. For greater angles of incidence the phenomenon of total internal reflection supervenes, and this we must now consider.

When $\sin\theta > n'/n$ there is no angle θ' for which the equation $n\sin\theta = n'\sin\theta'$ can be satisfied, and so there can be no progressive wave in the second medium. The appropriate solution involves instead a real exponential factor. If the boundary is the plane $z=0$, and if the incident wave is at angle θ, its phase will be given by $\cos\frac{2\pi}{\lambda}\left(\frac{ct}{n} - x\sin\theta - z\cos\theta\right)$, and the appropriate solution in the second medium is $e^{-(2\pi/\lambda)z\sqrt{(\sin^2\theta - n'^2/n^2)}}\cos\frac{2\pi}{\lambda}\left(\frac{c}{n}t - x\sin\theta - \epsilon\right)$,

which evidently fits the boundary condition and may be verified to satisfy the wave equations. The real exponential implies that the disturbance drops to a very small fraction of its original intensity in a single wave length. When the amplitudes are worked out, the reflected wave is found to have amplitude equal to the incident, but with a changed phase, and the change is unequal for the two polarizations. Thus, if incident plane polarized light is totally reflected, the emergent light is polarized elliptically. Working on this principle, Fresnel devised an instrument known as the Fresnel rhomb, which turns plane into circularly polarized light.

For water and air the angle of total reflection is about 49°. Thus, when the surface of a glass of water is viewed obliquely from below, it looks like mercury. Total reflection has a curious effect on the field of view of a fish, for however close it is to the surface, everything outside the water must be crowded into a cone of angle 49°, the edge of which will represent the horizon; while, because of the total reflection, the fish will be able to see the bottom, except for parts nearly underneath, quite as well reflected in the surface as directly. Total internal reflection is much used in optical instruments, as it provides more perfect reflection than any metallic coating. In many types of binocular the rays are internally reflected no fewer than four times between the two lenses of each telescope (see BINOCULAR INSTRUMENT).

C. Refraction in Absorbing Media.—To discuss the passage of light through metals, we take both a dielectric constant and a conduction current and, by Ohm's law, the latter will be proportional to the electric force. The first electromagnetic equation is now

$$\frac{\epsilon}{c}\frac{\partial \mathbf{E}}{\partial t} + \frac{4\pi\sigma}{c}\mathbf{E} = \mathrm{curl}\ \mathrm{H},$$

while the remainder are unchanged. The presence of the conduction term has an effect something like what we found in total internal reflection, for it compels us to introduce a real exponential. For a wave of frequency ν going along z a solution can be found in which

$$E_x = e^{-2\pi\nu\kappa z/c}\cos 2\pi\nu(t - nz/c),$$

provided that n and κ satisfy the equations

$$n^2 - \kappa^2 = \epsilon,\ n\kappa = \sigma/\nu;$$

n is the refractive index, and κ is called the absorption coefficient. Considered at a given instant of time, the wave is a damped sine curve of wave length $c/n\nu$ and the amplitude decreases to a fraction $e^{-\kappa/n}$ of itself for each successive crest. For actual metals κ/n is quite large, so that the light can penetrate only a very short distance. The value of n could be determined experimentally from the deflection of light by a prism, if one could be made so thin as to transmit light, and κ could be determined by finding how much the light is attenuated in passing through a plate; but in view of the extreme opacity of metals such methods are very troublesome, and it is more convenient to deduce n and κ from experiments on reflection.

The principle of reflection is just the same as for transparent media, but the details are very different because of the real exponential in the internal wave. There is a change of phase in the reflected wave, and it is different for the two polarizations.

Consequently. if plane polarized light is reflected, it becomes elliptic, and the study of this ellipticity is the most powerful method of evaluating n and κ. In the case of perpendicular incidence it can be shown that the intensity reflected is $(n^2+\kappa^2+1-2n)/(n^2+\kappa^2+1+2n)$. For all metals κ is considerably larger than n, and so the reflection is not far from complete. We also see how it comes about that strong absorption, or large κ, means strong reflection. The refractive indexes of metals vary over a much nider range than those of transparent substances. Thus, while the latter range roughly speaking between 1 and 2.4, silver has refractive index 0.18. associated with absorption coefficient 3.67. More remarkable still is sodium, which, if it can be used untarnished. is an even better reflector than silver. For the yellow light characteristic of sodium we have $n=0.005$ and $\kappa=2.61$. and 99.7% of the light is reflected at perpendicular incidence. In so far as wave velocity has a meaning in such a substance, the mave velocity is 200 times the velocity of light.

Other substances besides metals are opaque, quite apart from the opacity due to the repeated scattering of light. Indeed ordinary transparent substances are always opaque for light of some part of the spectrum, and for such light they behave much like metals. In particular, light which is strongly absorbed will be strongly reflected. H. Rubens took advantage of this fact in his study of "rest-rays," which consist of light in the extreme infra-red. For example. rock salt absorbs light of wave lengths around 50 μ, and so reflects it strongly, although the crystal is transparent to other wave lengths. If then the light from a lamp emitting all wave lengths is reflected to and fro several times by rock salt mirrors, the other wave lengths will be eliminated and the reflected light will be nearly pure. After the last reflection its wave length is determined by means of a grating. Unlike the case of metals, here the process of absorption has been fairly completely explained with important consequences for the theory of the solid state.

D. **Double Refraction.**—In crystals the atoms are packed together in a regular manner. and this packing implies that they will fall into rows in certain directions. Consequently the physical characters of the crystal will differ for different directions, and it is said to be anisotropic. The geometrical theory of crystallography only permits of certain definite types of packing, and these are classified according to the types of symmetry they possess. For purposes of electricity and optics we need to know the way in which the anisotropy will affect the relation between electric force and dielectric displacement. It can be shown that in general the displacement need not be in the same direction as the force? but that there must always be three mutually perpendicular directions in the crystal for which they are in the same direction. We take these directions for our axes, and have

$$D_x=\epsilon_1E_x,\quad D_y=\epsilon_2E_y,\quad D_z=\epsilon_3E_z.$$

But the crystal symmetry may make a further restriction. Thus in the regular system of crystals, the three mutually perpendicular axes are equivalent to one another. so that all physical properties in these three directions must be the same, and therefore ϵ_1, ϵ_2, ϵ_3 must be equal. For electrical and optical purposes therefore, though not for others, the regular system is isotropic. In the hexagonal, tetragonal and trigonal systems there is an axis of six-. four- or threefold symmetry. and, if this is taken as the z axis it follows that $\epsilon_1=\epsilon_2$, though they need not equal ϵ_3. Calcite and quartz both belong to this type. In all other crystal clashes all three ϵ's may be different. We thus have three types of crystal, the regular, the uniaxial and the biaxial. The regular behaves for light as though it nere isotropic, and we shall deal with the uniaxial as a special case of the biaxial (*see* CRYSTALLOGRAPHY).

For a transparent crystal the electromagnetic equations assume the form

$$\frac{1}{c}\frac{\partial\mathbf{D}}{\partial t}=\text{curl }\mathbf{H},\quad \text{div }\mathbf{D}=0;$$

$$-\frac{1}{c}\frac{\partial\mathbf{H}}{\partial t}=\text{curl }\mathbf{E},\quad \text{div }\mathbf{H}=0;$$

together with $D_x=\epsilon_1E_x$, $D_y=\epsilon_2E_y$, $D_z=\epsilon_3E_z$.

The whole question can be discussed with either E, H or D as the primitive quantity, and of course exactly the same results would emerge. but it is most convenient to take D. This is the light vector used by Fresnel in his original theory, before it was given an electrical meaning. The process of solution consists first in eliminating E and H in terms of D, and then fitting a plane wave of arbitrary direction so as to satisfy the equations for D. If l,m,n are the direction cosines of the wave front and L,M,N those of the light vector, and if the wave velocity is V, the wave will be of the form

$$D_x=LS,\ D_y=MS,\ D_z=NS,$$

where
$$S=A\cos\frac{2\pi}{\lambda}\,(Vt-lx-my-nz).$$

In giving the results of the substitution we shall write α^2. β^2, γ^2 for c^2/ϵ_1, c^2/ϵ_2, c^2/ϵ_3. Then it is found that the wave velocity V must satisfy the equation

$$\frac{l^2}{V^2-\alpha^2}+\frac{m^2}{V^2-\beta^2}+\frac{n^2}{V^2-\gamma^2}=0.$$

This is a quadratic equation in V^2, and we conclude that for a given direction of the mave front there are two wave velocities. Associated with each of these values there are definite values of L,M,N, and these determine the polarizations of the two waves. They are at right angles to one another and to the direction of the wave. A simple example is given by a wave going along the direction of z, where the two velocities are α and β and the directions of polarization x and y. Another example is given by a uniaxial crystal where $\alpha=\beta$. The wave velocities are then given by

$$V=\alpha \text{ and } V^2=\alpha^2n^2+\gamma^2(l^2+m^2).$$

Thus one wave has velocity independent of the direction; this is the ordinary mave, and its light vector lies in the plane perpendicular to the axis. The other, the extraordinary wave, is polarized in a direction contained by the axis and the wave direction. and its velocity depends on the wave direction and ranges between γ and α. The values of the wave velocities for different directions can be best appreciated by constructing the normal velocity surface. This is a two-sheeted surface constructed by laying off in every direction from an origin two radii proportional to the two wave velocities, which are the phase velocities of plane waves perpendicular, or normal to the plane. Its general form can be seen from fig. 16. which shows a perspective drawing of a portion of it; the complete surface is obtained by reflection in the principal planes.

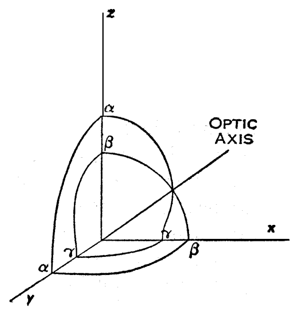


FIG. 16.—PART OF THE NORMAL VELOCITY SURFACE OF A BIAXIAL CRYSTAL

The figure is drawn on the assumption that $\alpha>\beta>\gamma$, and it will be seen that the two sheets meet in four conical points one in each quadrant of the plane of xz; that is, in the plane perpendicular to the intermediate axis. Waves going in the directions of these conical points will have the same velocity whatever their polarization. and so ior these directions light will not be polarized. These are the two optic axes which give rise to the name biaxial. Uniaxial crystals may be regarded as a degenerate case in which the two optic axes have approached one another; the normal velocity surface becomes a sphere and an oval surface, which touch along the direction of the axis. The normal velocity surface does not show how the waves corresponding to the two sheets are polarized. and for this Fresnel gave a very convenient construction. An ellipsoidal surface is obtained by laying off a radius in each direction l, m, n according to the rule

$$r^2=\alpha^2l^2+\beta^2m^2+\gamma^2n^2.$$

When this surface is cut by a plane parallel to the wave front, the longest and shortest radii of the section give the two values of the wave velocity, and their directions give the polarizations. The two circular sections of the ellipsoid are perpendicular to the optic axes.

The phenomena we have so far described suffice to explain many of the features of crystal optics; in particular they are all that is required to understand the action of quarter-wave plates, nicols and other polarizing instruments, but they do not explain the fundamental fact that things seen through a crystal look double. To understand this we have to consider rays, not plane waves of indefinite breadth. In making Huygens' construction it mould be wrong to draw the normal velocity surface round each point and base the construction of fig. 3 on this, for the normal velocity surface is only a diagram describing how plane waves can go, and does not represent the front of a wave emitted from a point. To find the form of this wave front, we imagine that at every point of the normal velocity surface a plane is drawn perpendicular to the radius vector. All these planes will envelop a surface of two sheets, and this we call the ray velocity surface. Like the normal velocity surface, it consists of two sheets and has four conical points lying in the same plane, but now at different angles; these are called the ray axes. Its shape is simpler. however. since the cross sections are ellipses and circles rather than the ovals of fig. 16. Huygens' construction is done with the ray velocity surface, not the normal velocity surface. For uniaxial crystals the ray velocity surface degenerates to a sphere and a spheroid touching the sphere at the ends of the axis.

It will be readily believed that double refraction involves much complicated geometry, and the complete conquest of the subject by Fresnel is one of the greatest feats ever performed in physics. Remarkable effects can be obtained by illuminating crystals with suitably polarized light. We must omit the explanation of many of these effects, which requires a detailed discussion. We can only refer to the curious phenomenon of conical refraction which was discovered theoretically by Sir William Hamilton and afterward verified. When a narrow beam is sent along the axis of a biaxial crystal, the direction for the ray becomes indeterminate so that it can be anywhere on a certain cone. On emergence at the other side this cone is made into a cylinder by the surface refraction, and if this falls on a screen we get a ring of light. Superimposed on this is a narrow dark ring caused by the dispersal of the axial ray into the infinite number of directions represented by the cone.

Double refraction is invariably present in crystals which are not of the regular system, but it is often quite small. Even in a strongly doubly refracting crystal such as calcite the two principal indexes are 1.66 and 1.49 so that their difference is considerably less than the refractive effect of either (which may be represented by its difference from unity). In uniaxial crystals and in biaxial crystals of the orthorhombic system the axes are fixed by the crystal symmetry, though the principal wave velocities may vary with the colour. In biaxial crystals of the monoclinic and triclinic systems the principal axes may vary in position as well, and the most complicated colour patterns may be produced.

Coloured crystals. if they are doubly refracting, usually show the phenomenon of dichroism. or a change of colour with the direction in which the light traverses the crystal. The absorption coefficient varies with the inclination between the light vibrations and the axes of the crystal. just as do the other quantities affecting the propagation of light. Hence the colour, which depends upon the portions of the spectrum that are weakened by absorption, will change with the direction of observation. The commonest example is tourmaline, which is extremely opaque to light of any colour that vibrates perpendicular to the optic axis, but transmits light of a greenish hue rather freely if its vibrations are parallel to that axis. As the crystal is turned from a position in which the light travels perpendicular to the axis to one in which it travels along the axis, the colour therefore changes from green to black. with a series of intermediate hues.

Double refraction also occurs when an isotropic solid is in a state of strain, and indeed the chance strains in badly annealed glass are sometimes a cause of trouble in experiments with polarized light. On the other hand advantage has been taken of the effect: for by making a transparent model, say of a girder, it is possible to find the strains set up in it by the appropriate forces in cases where the shape is too complicated for direct calculation. It is only necessary to illuminate the model with the plane polarized light and to view it through a nicol that is crossed with the polarizer. Light is observed in the regions of strain because the vibrations are rendered elliptical by the double refraction. Another occurrence of double refraction is the Kerr effect—an ambiguous name, as there is a second effect of magnetic type also named after this investigator. When light is sent through the glass of a charged electric condenser. double refraction occurs, so that the component polarized in the direction of the electric force has wave velocity slightly different from that transversely polarized; the effect is proportional to the square of the electric force across the condenser. The extreme rapidity with which the effect follows the applied electric field furnishes a valuable means of suddenly interrupting a beam of light. With nitrobenzene between the plates of a condenser placed between crossed nicols, light will be transmitted when the condenser is charged, but will be extinguished in about 4×10^{-9} seconds when it is discharged. This is the principle of the Kerr electro-optic shutter, which has been used to study the transient phenomena in an electric spark, as well as in the measurements of the velocity of light. *(See* VELOCITY OF LIGHT.) Yet another case, predicted and discovered by W. Voigt, is a very small double refraction when light traverses matter placed in a strong magnetic field. This effect, which is observed when the light travels perpendicular to the field, is associated with magnetic gyration which we shall discuss later.

E. Natural Optical Gyration.— Double refraction is not the only optical effect exerted by crystals. The symmetrical properties of a crystal are of two different kinds, corresponding to rotation and reflection respectively. Most crystals have some symmetry elements of both types, but there are some which only have rotations, so that the crystal is not identical with its mirror image. The simplest geometrical form possessing this peculiarity is the screw, which cannot be superposed on its mirror image. and we therefore liken this type of crystal to a screw. Quartz is such a substance, and there exist two types of quartz crystals, which we may call right- and left-handed. Now circularly polarized light has the same quality of a screw, and we should therefore expect that a right-handed quartz crystal would react differently to right- and left-handed circularly polarized light respectively. It is in fact found that the wave velocities are different, and this is the basis of the theory of optical gyration.

Let us suppose that n_r and n_l are the refractive indexes for the two types of circularly polarized light of frequency ν. Then the right-handed wave will be

$$E_x=A\cos2\pi\nu(t-n_rz/c),\ E_y=-A\sin2\pi\nu(t-n_rz/c),$$

and the left-handed

$$E_x=A\cos2\pi\nu(t-n_lz/c),\ E_y=+A\sin2\pi\nu(t-n_lz/c).$$

Suppose that at the plane $z=0$ we have light polarized along the direction x. This is given by simply adding these two solutions together, and then at any value of z we shall have

$$E_x=2A\cos2\pi\nu\left[t-\frac{n_r+n_l}{2}\frac{z}{c}\right]\cos\pi\nu(n_l-n_r)z/c,$$

$$E_y=2A\cos2\pi\nu\left[t-\frac{n_r+n_l}{2}\frac{z}{c}\right]\sin\pi\nu(n_l-n_r)z/c.$$

This means that at the point z we can regard the light as plane polarized in a direction inclined to x at the angle $\pi\nu(n_l-n_r)z/c$. The phenomenon is actually observed by sending plane polarized light through the medium and seeing how an analyzing nicol must be placed in order to extinguish the light. The gyrational constant is the rotation produced by a thickness of one centimetre of the substance.

In quartz the gyration is very strong, being 217° per centimetre for yellow light, but is complicated by double refraction of the uniaxial type, and it is only for light going very nearly along the crystal axis that it can be observed. There are also crystals of the regular system which exhibit the effect, for example sodium chlorate, and here it is present for all directions. It is also shown by liquids when their molecules contain a chemically asymmetric atom; such a liquid is isotropic in that all directions are equivalent, but is not, molecularly speaking, identical with its mirror image, and so it can and does refract the two types of circularly polarized light differently. Since many sugars contain an asymmetric carbon atom, measurement of the gyration is a very convenient method of estimating the strength of a sugar solution and great practical use is made of it.

VII. THE ATOMIC THEORY OF REFRACTION

We have so far treated refraction as an effect of matter in bulk without inquiry as to how it comes about. The gross effect must be a superposition of the effects of the separate atoms and molecules, and we shall now consider how this superposition takes place. The light arising from an atom may have a great variety of characters. but whatever these are it must have one feature, that the wave is a spherical wave with the atom in its centre. We shall therefore first investigate what types of spherical wave are possible. In discussing diffraction we described a spherical wave emerging from a point source with amplitude inversely proportional to the distance. Though that sufficedto give the outline of the theory. it took no account of polarization, and it must be further refined for our present purpose. We naturally build the complete theory by considering what types of electromagnetic waves can emerge from a point.

A. Types of Spherical Waves.—The transverse nature of light makes it impossible to have a wave going out uniformly in all directions. We give the mathematical form of the simplest possible wave. Let

$$S=\frac{A}{r}\cos\frac{2\pi}{\lambda}(ct-r),\text{ where } r=\sqrt{(x^2+y^2+z^2)}$$

and A is a constant. Then the electric and magnetic forces are given by

$$E_x=\left(\frac{1}{c^2}\frac{\partial^2}{\partial t^2}-\frac{\partial^2}{\partial x^2}\right)S,\quad E_y=-\frac{\partial^2}{\partial x\partial y}S,\quad E_z=-\frac{\partial^2}{\partial x\partial z}S,$$

$$H_x=0,\quad H_y=-\frac{1}{c}\frac{\partial^2}{\partial t\partial z}S,\quad H_z=\frac{1}{c}\frac{\partial^2}{\partial t\partial y}S.$$

If these are worked out they lead to expressions which are rather complicated in general, but simpler for points at a great distance from the source, and it will suffice to discuss the latter case. Consider a large globe, surrounding the source, marked with circles of latitude and longitude, the pole being the axis of x. The observer is on this sphere at angular distance θ from the pole. Then the wave that reaches him will have its electric force polarized so as to vibrate in the north and south direction, and the magnetic force will be east and west and equal in magnitude. The electric force is inversely proportional to the radius of the globe and to the square of the wave length, but, most important of all. it varies as $\sin\theta$, vanishing at the pole and having its maximum at the equator. The actual value is

$$E=\left(\frac{2\pi}{\lambda}\right)^2\frac{A}{r}\sin\theta\cos\frac{2\pi}{\lambda}(ct-r).$$

In fig. 17 (a) the observer takes up various positions on the globe (marked by his colatitude) and looks toward the centre; then the diagram shows the vibration of the electric force that will reach him.

In the classical electromagnetic theory this is the wave which would be emitted by an electron of charge e vibrating with frequency c/λ and small amplitude a along the x axis at the origin, provided that $A=ea$. If the observer were to watch this motion, he would see it in perspective, and the electric force at the observer is proportional to and in the same direction as the apparent motion of the electron. It is very convenient to have a name for this type of wave, including the complete distribution in all directions round the source, and in view of the motion of the emitting electron we shall call it a line wave.

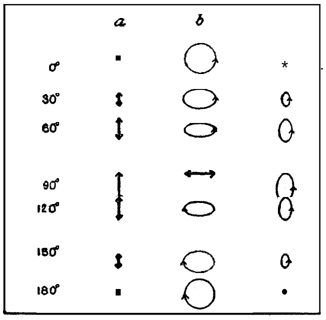


FIG 17 —VIBRATIONS IN SPHERICAL WAVES
The observer, on a sphere in colatitude on the left, looks toward the centre. The amplitude and polarization of light received are shown. (a) Line wave, (b) circle wave, (c) screw wave

If the emitting electron describes a small circle in the y, z plane instead of a line we have what we may call a circle wave. This can be regarded as two superposed line waves along y and z, and having phases differing by a quarter period. The pole of the circle is perpendicular to the poles of both lines. Fig. 17 (b) shows the electric force as seen by the observer for various positions on the globe. Its form again resembles the perspective view he would have of the electron. At either of the poles he receives circularly polarized light, and it is important to notice that they will be of opposite types, one right-handed and the other left-handed. For other directions the light is elliptically polarized and becomes plane polarized at the equator. The intensity is twice as great at the poles as at the equator.

We must also consider a third type of wave which is not so simple. In the electromagnetic equations there is a mathematical symmetry between the electric and magnetic forces, so that we can obtain a solution by interchanging their roles. If we construct a wave by adding to the ordinary line wave a small "magnetic" line wave with the same pole and same frequency, we obtain a wave in which the light is everywhere of the same intensity as for a line wave, but is elliptically polarized with axes in constant ratio and lying in the directions of the circles of latitude and longitude. Such a wave is illustrated in fig. 17 (c). It is important to notice that in this case, unlike the circle wave, the light vector turns in the same direction in both hemispheres. Thus the whole wave has the same screw character and we shall call it a screw wave. The screw wave cannot be emitted by any motion of an electron. It would be emitted if there were a single magnetic pole moving with the electron, but such a thing does not exist, and in fact the wave can arise only from a system itself having the screw character, such as a molecule with a chemically asymmetric atom in it.

B. The Scattering of Light.—When light falls on an atom it sets the electrons in motion and they therefore re-emit light, and the character of this scattered light will depend on the nature of the atom as well as the incident light. But the effect of a single atom is too small to be observable, so that we always have to use a large number and the compounding of their effects produces complications. In fact the scattering of light by matter is a more primitive quality than is refraction, and it is therefore best to reduce everything into terms of scattering before we approach the theory of the behaviour of the single atom. There are several different ways in which an atom may emit light under the stimulus of light. but we can exclude some of them from consideration. Thus certain substances respond by fluorescing; that is to say, absorbing light of one wave length and re-emitting light of a longer wave length. Again, there is the important phenomenon of resonance radiation where the re-emitted light has the same wave length as that absorbed, but where there is no constant phase relation between the incident and scattered light (see FLUORESCENCE AND PHOSPHORESCENCE). Both these phenomena are extremely interesting, but from the present point of view they may be regarded as an absorption and simultaneous re-emission of light, and are outside our scope. We shall also exclude a highly significant type known as Raman scattering, where alterations of wave length occur such that the various frequencies of the scattered light represent combinations between the frequency of the incident light and the different possible frequencies of rotation and vibration of the molecule. These are analogous to the combination tones that are heard when two musical notes are sounded together. Since, however, this phenomenon is intimately related to the structure of molecules it cannot be included in our present account (see RAMAN EFFECT).

The most universal way in which atoms react to light is by the emission of waves of the same frequency as, and having a definite phase relation to, the incident light, and this process, to which we shall limit the name of scattering, is responsible for refraction, double refraction and gyration. In order that all these effects may be explained. we can see one property nhich the scattered waves must always have. The various refractive effects are all due to an interference between the original and the scattered waves, and, since the refraction is independent of the brightness of the light. it follows that the wave scattered by an atom, whatever its other characters. must be proportional in amplitude to the incident force. Another of its properties depends on the fact that for ordinary light the wave length of the light is always far greater than the size of the atom; hence at any instant the atom is practically in a uniform field of force, and so the scattered wave will depend only on the polarization and frequency of the incident wave. but not at all on the direction of its wave front. These conditions must hold for any atom, but apart from them there is great liberty of choice for the form of the scattered spherical wave. We shall see that for some purposes we have to assume circle waves and screw waves, but both ordinary and double refraction are fully accounted for by means of ordinary line waves; moreover for transparent substances the line wave is exactly in phase with the incident. All these results can be deduced by assuming completely general types of spherical waves and then seeing what limitations will give rise to the various refractive effects, but here we shall pursue the opposite course and shall assume the form of the scattered wave and show that our assumption is verified. For the most important case, that of the refraction of a transparent medium, we can summarize our assumptions in the form that under incident light of amplitude E_0 the wave scattered by an atom is a line wave of the form we gave with ρE_0 written for A, and with pole along the direction of E_0. Then p, which depends only on the nature of the atom and on the frequency of the incident light, is the scattering constant of the atom.

C. The Light of the Sky.—The most primitive exhibition of scattering is found not in refraction but in such phenomena as the light of the sky, and it is therefore appropriate to discuss this first. Supposing that the observer looks at a point not very near the sun, the light that he sees will have been scattered through a broad angle, and the phase of the light path, sun–atom–observer, will be different for each atom. Consequently the waves from the separate atoms do not reinforce one another. If the atoms were arranged with perfect regularity their waves would arrive at the eye with regular differences of phase and mould destroy one another so that the sky mould look black; honever the uniform density of gases is due not to systematic regularity but to the unsystematic regularity produced by the enormous number of atoms. The atoms of a gas have no ordered positions, as they have in a crystal, hence the brightness of sky light will depend on compounding a large number of similar waves of quite arbitrary phases and taking the average value of the result. Consider a set of n atoms each of which is giving a wave of the same magnitude, but with phases $\epsilon_1, \epsilon_2 \ldots \epsilon_n$. The resultant amplitude will be proportional to $\cos\epsilon_1+\cos\epsilon_2+\ldots+\cos\epsilon_n$, and the intensity is the square of this. Now the square will consist of terms such as $\cos^2\epsilon_1$ and others such as $2\cos\epsilon_1\cos\epsilon_2$. The latter of these are as likely to be negative as positive, so that they will average out, but the former has average value $\frac{1}{2}$ for each separate term. Thus the average intensity scattered by the n atoms is just n times that scattered by one. If then we want to know the brightness of the sky we only require to calculate the intensity scattered by a single atom and multiply by the number of atoms in the field of view.

We will suppose that N is the total number of atoms in a small solid angle, the illumination from which is to be found. Then, from the formula for line waves, we shall have an intensity proportional to $NE_0^2\rho^2/\lambda^4$, and here E_0^2 is the intensity of the direct sunlight. Now in fact p, the scattering constant of the atom, does not depend very much on the wave length, as long as me only consider visible light, and we can therefore say that the light scattered is inversely proportional to the fourth power of the nave length. This explains why the sky is blue even though sunlight is rather weaker in the blue part of the spectrum than the red. for the wave length of red light is about 1.8 times that of blue, and so factor λ^{-4} is about 10 times as large for blue light as for red.

Another property of the sky light is its polarization. Consider a point of the sky at right angles to the sun. The unpolarized light from the sun may be broken into two polarized components, one of which has electric force pointing at the observer. The line waves induced by this component will have the observer at their poles and so will send no light toward him. He will therefore only receive the light of the other component, and this will be polarized in the direction perpendicular to the line joining the sun to the point observed. At other angles both polarized components are present, one in constant intensity and the other proportional to the squared cosine of the distance from the sun. If the sky is actually observed at right angles to the sun with a nicol, it will be found that the polarization is not complete. This is partly to be attributed to rays that have been scattered several times on their way to the eye, and also to the fact that. though we have spoken only of atoms, the air is mostly cornposed of diatomic molecules, and for these the line wave need not have its pole exactly coincident with the direction of the incident force. There is also usually a complication due to dust, which acts by direct reflection and makes the sky much brighter near the sun than at broad angles.

A most interesting application of the theory of sky light was made by Lord Rayleigh (3rd baron). The barometer shows the mass of the atmosphere, and so, by a direct comparison between the brightness of the sky and that of the sun, it is possible to deduce how much light is scattered by one cubic centimetre of air at ground level. In fact, if N is the number of atoms in one cubic centimetre, we can evaluate $N\rho^2$. Now, as we shall see, we can also find $N\rho$ by a study of refraction, and hence we can estimate N. The process led to one of the earliest good determinations of the fundamental constant of Amadeo Avogadro. the number of molecules in a gram molecule. Similar processes have since been applied in the laboratory, with the advantage that the incident light can be itself polarized. and similar results are obtained.

D. Scattering as the Cause of Refraction.—When we deduce refraction from scattering we are dealing with an incomparably greater effect than in sky light, because here there will be phase relations between the original and the scattered waves. so that we compound the effects of the separate atoms by amplitudes instead of by intensities. We suppose that light waves as they traverse matter have the same velocity as light in free space, but that they set up secondary waves from the atoms which, also proceeding with the velocity of light, interfere with one another and nith the original wave. When the compound effect has been calculated, it is found that it can be expressed by altering the wave velocity of the original nave and disregarding altogether the scattered waves, and in this way refraction is explained.

Take a thin sheet of atoms spread over a plane on which monochromatic light falls perpendicularly. The diagram of fig. 7 will describe the process, provided that we now regard the plane as composed of matter. Each atom will emit a line wave. and the effect at P will consist of the superposition of these waves on the original beam, which is supposed to arrive at P undisturbed. The process is very like Fresnel's discussion of diffraction. though there we imagined that the original nave was suppressed at the plane AB. Suppose that there are N atoms per unit volume, in a thin sheet of thickness l spread over the x,y plane, and let the incident wave be

$$E_x=F\cos\frac{2\pi}{\lambda}(ct-z).$$

The effects that all the atoms produce at P can be summed just as in Fresnel's construction, and the result is an amplitude,

$$-2\pi FNl\rho\frac{2\pi}{\lambda}\sin\frac{2\pi}{\lambda}(ct-z).$$

The important point to notice is that the phase differs by a quarter period from that of the original wave; this is a result of the fact that the scattered waves are in phase with the incident, and is in contrast with Fresnel's construction, in which, in order to get the right result, the phase had to be advanced by a quarter wave length. We now add the two waves together, and, taking advantage of the smallness of the scattered wave, we find

$$F\cos\frac{2\pi}{\lambda}[ct-z+2\pi Nl\rho].$$

If we adopt the ordinary process of refraction and attribute the change of phase to the changed wave velocity during the passage through the thickness l of the sheet of matter, we should say the emergent wave was

$$F\cos\frac{2\pi}{\lambda}[ct-z+(n-1)l],$$

and so we may identify $n-1$ with $2\pi N\rho$. This is the physical origin of refraction. We see also how the reflected wave arises, for the line wave from each atom will be exactly the same at the point which is the image of P in the plane AB as it is at P, and so the total amplitudes of the scattered waves will be the same at the two points; but for the reflected wave there is no interference with the incident light. It is easy to verify that the actual reflected intensity is that which should arise from a thin sheet of refractive index n and thickness l.

We have treated only the small effect of a thin film, and this contains the essence of the process, but it is of course necessary to discuss matter in bulk. Here the scattered wave from every atom acts on every other atom and so complicates the wave scattered by it. Nevertheless the problem proves soluble and leads to a result not very different from the simpler case. The main difference is that we now have $\frac{n^2-1}{n^2+2}=\frac{4}{3}\pi N\rho$; in the special case when $N\rho$ is small, n is near unity, and this reduces to $n-1=2\pi N\rho$ as before. The general solution for oblique incidence verifies all the formulas that are given by the ordinary bulk theory, but the idea of scattering is helpful in seeing directly how reflection and refraction come about. When light falls on a thick slab, the atoms are set in motion and their scattered waves are all in definite phase relations to one another. If we consider a point outside the face of the slab, it will receive all these waves, but those from the interior will have phases spread uniformly round the 360° and so will cancel out. Thus the reflected wave will arise from the atoms in the face where this uniformity ceases to hold. The existence of the polarizing angle becomes immediately obvious, as it is nothing but the rule that in a line wave there is no emission toward its pole, which is perpendicular to the direction of the refracted wave.

The formula $\frac{n^2-1}{n^2+2}=\frac{4}{3}\pi Np$ was discovered by Lorentz (by a rather different method) and becomes the foundation of the theory of dispersion. He deduced an important consequence from it. When a substance can exist in two states, p will be nearly the same for both and N will be proportional to the density, so that, if d is the density of either state, $\frac{n^2-1}{(n^2+2)d}$ should be the same for the two. This relation is verified by comparing the refractive index of a liquid and its vapour. Since their densities often differ by a factor of some hundreds, it is a very stringent test and is often fulfilled to within 1% or 2%. We should hardly expect perfect agreement, because the liquid molecules are being perpetually disturbed by one another, so that there may be a small change in the value of p attached to each molecule.

The explanation of double refraction follows a very similar course. The sheet of matter must now be supposed to react differently under the stimulus of light according as it is polarized along x or along y. In each case there is a line wave emitted with pole along the direction of the incident force, but the amplitudes are different and so the phase changes in the two components of the transmitted wave will be different. The detailed consideration of the effect for matter in bulk is of course more complicated. but leads to Fresnel's normal surface and all its consequences. This part of the theory is complete, but there are difficulties in giving an atomic meaning to ρ, because the adjacent atoms in a crystal are not arranged isotropically and will perturb one another in a complicated manner. As a consequence, the expression $(n^2-1)/(n^2+2)$ ceases to apply; but the full discussion can only be made by a detailed study of the theory of the solid state. With the help of this theory and a knowledge of the arrangement of the atoms in calcite it has been found possible to explain its high double refraction with fair numerical accuracy.

E. Scattering From Absorbing Substances.—A similar process of scattering can be used to explain the action of absorbing substances, but here it is necessary to take the scattered wave in a different phase from the incident. Supposing this phase change to be η, the scattered wave from the thin sheet of atoms will now be

$$-2\pi FNl\rho\frac{2\pi}{\lambda}\sin\frac{2\pi}{\lambda}(ct-z-\eta).$$

If this is added on to the original wave we get

$$F(1-2\pi Nl\rho\sin\eta)\cos\frac{2\pi}{\lambda}(ct-z+2\pi Nl\rho\cos\eta).$$

The first factor means a reduction in amplitude (*i.e.*, absorption), and there is also refraction just as before. Thus by a suitable choice of p and η we can describe the observed behaviour of any absorbing substance. The full theory is best expressed in terms of complex quantities and leads to the equation

$$\frac{(n-i\kappa)^2-1}{(n-i\kappa)^2+2}=\frac{4\pi}{3}N\rho e^{-i\eta},\ (\text{where } i=\sqrt{-1}),$$

so that we can deduce ρ and η from a knowledge of n and κ.

The idea of scattering constants is not really very conveniently applied to metals, because the atoms of a metal are being constantly penetrated by free electrons, so that it is not right to regard each atom as a separate unit. The theory of metal optics is too involved to describe here, but it does show that the conductivity as ordinarily measured for constant electric force can often be applied for infra-red light, though the value is gradually modified at higher frequencies. In fact, silver becomes very nearly transparent at wave lengths near 3,100 Å in the ultra-violet.

F. Natural **Gyration.**—We have seen how gyration arises from the difference between the wave velocities of right- and left-handed circularly polarized light. It is a screw property and can be exhibited only by molecules containing a chemically asymmetric atom. The condition is exactly that which permits of the emission of what we have called a screw wave, and to explain gyration it is necessary only to suppose that, under the influence of plane polarized incident light. the molecule scatters a strew wave. We take as before a thin sheet in the *xy* plane illuminated by plane polarized light,

$$E_x=F\cos\frac{2\pi}{\lambda}(ct-z).$$

Each molecule emits a screw wave which has its axis along x. In any direction a screw wave can be resolved into a main component which is like that of a line wave and a weaker component at right angles and a quarter period behind. Take p for the scattering constant of the line wave and σ for the other component. Then, when we sum all the waves scattered by the molecules, the line waves will compound as before into

$$-2\pi FNl\rho\frac{2\pi}{\lambda}\sin\frac{2\pi}{\lambda}(ct-z)$$

along x, but there will now be a component along y of magnitude

$$-2\pi FNl\sigma\frac{2\pi}{\lambda}\cos\frac{2\pi}{\lambda}(ct-z).$$

If we add these small quantities on to the original wave we find approximately

$$E_x=F\cos\frac{2\pi}{\lambda}(ct-z+2\pi N\rho l),$$

$$E_y=-2\pi N\sigma l\cdot\frac{2\pi}{\lambda}\cdot F\cos\frac{2\pi}{\lambda}(ct-z+2\pi N\rho l);$$

and this means that the light is now plane polarized at angle $-2\pi N\sigma l.2\pi/\lambda$ to the x direction. The rotation is proportional to l, the thickness of the sheet, and the other factors express the gyrational constant. The theory for matter in bulk gives a similar result, but presents it by showing that there are different refractive indexes for right- and left-handed circularly polarized light.

G. **Magnetic Gyration.**—In our discussion of the refraction of isotropic bodies, we saw that plane polarized light might be supposed to stimulate the emission by the atom of a line wave. Sow circularly polarized light can be constructed out of two plane polarized components at right angles and differing by a quarter period in phase, and what we have called a circle wave can be constructed out of two line wares with perpendicular poles and phases differing by a quarter period. Consequently we could have worked out the theory of refraction just as well using circularly polarized light and circle waves, and in discussing magnetic gyration it makes a convenient starting point to do so. When an atom is in the presence of a magnetic field it behaves in a sense as though it were in rotation, about an axis along the field's direction, with velocity proportional to the field strength. We shall see how this comes about when we discuss dispersion, but can explain the gyration without reference to the detailed theory. Ii then the atom is illuminated by circularly polarized light, it will react diiferently according as its magnetic rotation is with or against the rotation of the light vector. We may describe what happens by saying that the atom's scattering constant will no longer be ρ, but $\rho+\tau$ and $\rho-\tau$ ior the two types oi circularly polarized light. Here τ will be proportional to the strength of the field, and it is usually to be regarded as much smaller than ρ.

Suppose that the incident light is

$$E_x=F\cos\frac{2\pi}{\lambda}(ct-z),\qquad E_y=F\sin\frac{2\pi}{\lambda}(ct-z).$$

When the scattered wave from a thin sheet is superposed on this, we have, by the same construction as beiore,

$$E_x=F\cos\frac{2\pi}{\lambda}[ct-z+2\pi N(\rho+\tau)l],$$

$$E_y=F\sin\frac{2\pi}{\lambda}[ct-z+2\pi N(\rho+\tau)l].$$

But if the incident light is of the opposite type it will be

$$E_x=F\cos\frac{2\pi}{\lambda}(ct-z),\quad E_y=-F\sin\frac{2\pi}{\lambda}(ct-z);$$

and the resultant wave will he

$$E_x=F\cos\frac{2\pi}{\lambda}[ct-z+2\pi N(\rho-\tau)l],$$

$$E_y=-F\sin\frac{2\pi}{\lambda}[ct-z+2\pi N(\rho-\tau)l].$$

If we add these two solutions together the incident light is

$$E_x=2F\cos\frac{2\pi}{\lambda}(ct-z),\quad E_y=0,$$

and the transmitted light is

$$E_x=2F\cos\frac{2\pi}{\lambda}(ct-z+2\pi N\rho l)\ \cos\frac{2\pi}{\lambda}(2\pi N\tau l),$$

$$E_y=2F\cos\frac{2\pi}{\lambda}(ct-z+2\pi N\rho l)\ \sin\frac{2\pi}{\lambda}(2\pi N\tau l);$$

so that the plane of polarization has turned through an angle $\frac{2\pi}{\lambda}(2\pi N\tau l)$. This is proportional to the thickness of the sheet and, through τ, to the' strength of the magnetic field. The remaining factors are individual to the substance of which the sheet is made. The constant is oiten called the Verdet constant after one of the earlier investigators who measured it for a number of substances.

The magnetic gyration is usually very small for practicable magnetic fields. It occurs in ail transparent isotropic substances and for light going along the axis of uniaxial doubly rciracting crystals; for other directions it is masked by the double reiraction. There is a very remarkable similar effect, when polarized light is reflected irom the polished pole of a magnet. For perpendicular incidence the plane of polarization rotates, and for other directions there are similar more complicated changes in the rule of reflection. The Kerr effect, as it is called irom its discoverer, is evidently like the magnetic gyration in transparent substances, but its theory is very incomplete.

The two types of gyration, natural and magnetic, are radically different in character, as is shown by the fact that one depends on a screw wave, the other on a circle wave. The consequence is that in natural gyration, if the light is reflected back so as to traverse the sheet again, its direction of polarization turns in each passage like a screw of the same type and so it comes back to its original polarization. On the other hand magnetic gyration is due to a rotation, not a screw, so that if the light is reflected back again it rotates in the same direction as before and the angle of turning is doubled.

VIII. DISPERSION

We have traced the optical effects of matter in bulk to their source in the atoms, and in doing so have found it necessary to use only the ordinary conceptions of the classical theory of dynamics, but as soon as we begin to consider the atoms themselves we get into difficulties, because in fact the atom obeys quite different dynamical rules. These rules, which are the principal subject of the quantum theory (*see* QUANTUM MECHANICS), are fairly well understood, but since our whole practical experience is based on classical dynamics, they are very hard to apprehend in anything but mathematical form; regarded physically they appear to contain an unsatisfying element of irrationality, which is really to be attributed to limitations in our habits of thought. For the purposes of the present subject it is fortunately possible to some extent to avoid these difficulties. The quantum theory gives certain rules, very unlike those of ordinary dynamics, for the intensities and frequencies of the spectral lines emitted by an atom or molecule, and it also predicts how such an atom will behave under the influence of light. Though both these aspects of the theory are quite different from ordinary dynamics, they have this in common with the classical theory, that if we make up a purely classical model to imitate the emission (though in many other properties it will be quite wrong), it will react correctly for the scattering of light. For convenience of calculation we thus imagine that associated with each atom is a phantom virtual atom, which will suffice to work out the optical effects. An actual atom contains only a few electrons, but the virtual atom contains a virtual electron for each line of its spectrum, and the charges on the virtual electrons are usually muck. smaller than the known charge of an electron. Since the spectrum is composed of nearly monochromatic lines, we suppose that each virtual electron is free to execute approximately harmonic vibrations. The relation between the emission and the scattering of light by the atom is then akin to the relation of free to forced vibrations in a harmonic vibrator.

A. Free Vibrations of the Atom.— Let us suppose that we have a virtual electron of mass m vibrating along the axis of x, under a force Kx toward the origin. It will obey the equation

$$m\frac{d^2x}{dt^2}+Kx=0,\ or\ \frac{d^2x}{dt^2}+(2\pi\nu_1)^2x=0\ if\ K=m(2\pi\nu_1)^2.$$

If left entirely to itself such an electron would vibrate with constant amplitude and frequency ν_1 forever; but it cannot be regarded as left alone, because the moving electricity will be perpetually changing the electric forces everywhere in the manner that we have described as a line wave. This wave will carry away enrrgy, which is supplied at the expense of the electron, so that its amplitude must decrease. The electron is always linked with the ether, and it may be shown that the reaction of the ether on it can be represented by introducing a damping term so that the vibration is expressed by

$$m\frac{d^2x}{dt^2}+m(2\pi\nu_1)^2x=\frac{2}{3}\frac{e^2}{c^3}\frac{d^3x}{dt^3},$$

where e is the charge and c as usual the velocity of light. The new term is very small (except for penetrating X-ray frequencies), and the equation may be solved by approximation, and gives

$$x=Ae^{-\frac{1}{3}(e^2/mc^3)(2\pi\nu)^2t}\cos 2\pi\nu t.$$

This represents a vibration which decreases during each vibration by a fraction $\frac{1}{3}\frac{e^2}{mc^3}4\pi^2\nu$, or l/λ where l is $\frac{4\pi^2}{3}\frac{e^2}{mc^2}$; for an ordinary electron it is 3.7×10^{-12} cm., and, as the charge of a virtual electron is usually smaller, the approximation is evidently justifiable for ordinary light of wave lengths about 10^{-5} cm. The line wave emitted by this electron will also be damped with the consequence that, in Michelson's interferometer, when the two light paths differ by a considerable amount the interference will become imperfect. This is in fact observed, but usually for path differences somewhat shorter than might be expected. Ii we imagine the light to be passed through a grating we observe the same phenomenon in a slightly different way; the damping factor gives the line a finite breadth, and in fact spectral lines are nearly aln-ays somewhat broader than is indicated by the theory of purr electromagnetic damping. A variety of causes contributes to this broadening, such as the frequent collisions between the radiating atoms and air molecules, for these collisions will change the phases of the emitted waves and the Doppler effect of the motion of the atoms. which slightlv alters the frequency. Both these effects can be observed directly by alterations of pressure and temperature, but it is uncertain whether they are sufficient causes of the broadening. The whole question is getting very near to the point where the classical conception oi a virtual atom iails, and also to the limits of experimental technique, and all that can be said is that under the most favourable conditions it seems that the damping is not far from the value predicted by electromagnetic theory. We can avoid raising the question by introducing a fictitious damping iactor which replaces the electromagnetic and may write as our equation:

$$\frac{d^2x}{dt^2}+\sigma\frac{dx}{dt}+(2\pi\nu_1)^2x=0,$$

so that the electron's motion is resisted by a small force $m\sigma\frac{dx}{dt}$, and as long as σ is small we do not need to inquire into its origin.

It is necessary next to suppose that the atom contains a number of virtual electrons with different frequencies, and so to adjust their properties that the spectrum lines will occur in the correct relative strengths. Suppose that the first electron, with charge e_1, frequency ν_1, etc., is vibrating with amplitude a_1. Then it emits a line wave, and, at distance r in the equator, we have seen that the intensity will be proportional to $\nu_1^4e_1^2a_1^2/r^2$. In order to compare this intensity with that given by the second electron e_2, we have to consider what their respective amplitudes will be. This requires an assumption, and the appropriate assumption to make (subject to some conditions which we shall not discuss) is the equiparation of energy, that on the average each virtual electron has the same energy. Now the energy of the first electron is $\frac{1}{2}m_1\left(\frac{dx_1}{dt}\right)^2+\frac{1}{2}m_1(2\pi\nu_1)^2x_1^2$, and this is proportional to $m_1a_1^2\nu_1^2$. We thereiore conclude that the intensity of the first line will depend on $e_1^2\nu_1^2/m_1$. It happens that the quantity which is most important in spectrum theory is not the intensity itseli, but the intensity divided by the iourth power of the frequency. This quantity has no name, but is always reierred to as "Einstein's B," by which letter we shall therefore denote it. Then, for the line of frequency ν_s, we so choose e_s and m_s that $e_s^2/m_s\nu_s^2$ is proportional to B_s, and the intensity is proportional to $B_s\nu_s^4$.

B. Forced Vibrations of the Atom.— When the virtual atom is exposed to light there will be an additional force acting on it. The equation of motion of the first electron will now be

$$m_1\frac{d^2x_1}{dt^2}+m_1\sigma_1\frac{dx_1}{dt}+m_1(2\pi\nu_1)^2x_1=e_1F\cos2\pi\nu t,$$

where F is the amplitude of the incident electric force E and ν is its frequency; the direction oi the wave front does not matter. This is the equation which gives the ordinary phenomenon of resonance, and we must consider the form that its solution takes for different frequencies of the incident light. In the first place, σ plays practically no part in the solution when it is small, unless ν is very near ν_1. Excluding that case we have

$$x_1=\frac{e_1}{m_1}\,\frac{F}{4\pi^2(\nu_1^2-\nu^2)}\cos2\pi\nu t.$$

If $\nu<\nu_1$, x_1 is in phase with the electric force E and its amplitude increases strongly as ν approaches ν_1. If $\nu>\nu_1$ the phases are opposite; the amplitude is small for large values of ν, but as ν_1 is approached from above it becomes large (see fig. *18*). There is thus a transitional stage when ν passes through ν_1, and in this stage the amplitude of x_1 has to pass from a large positive to a large negative value. In order to see how it does so we must include the damping term in our equation. There is now a phase difference between x_1 and E, and the solution is

$$x_1=\frac{e_1}{m_1}\,\frac{F}{2\pi\sqrt{4\pi^2(\nu_1^2-\nu^2)^2+\sigma^2\nu^2}}\cos\left(2\pi\nu t-\gamma\right),$$

where $\tan\gamma=\frac{\sigma\nu}{2\pi(\nu_1^2-\nu^2)}$. If ν is much less than ν_1 the phase angle γ is practically zero, and continues so up to values differing from ν_1 by a not very large multiple of σ. From this point on the phase grows rapidly and becomes 90° at $\nu=\nu_1$ and then increases iurther, so that, at an equal distance on the other side of ν_1 it is practically 180°. The amplitude follows the course of fig. *18* nearly up to ν_1, but instead oi becoming infinite it attains a very large maximum at $\nu=\nu_1$ of amount $\frac{e_1}{m_1}\,\frac{F}{2\pi\sigma\nu}$, and then decreases. When well beyond ν_1 it has the same course as in fig. *18*, but with changed sign now because the negative value is allowed ior by the phase. Fig. *19* shows the general features, but it has been necessary to take a comparatively large value of σ in order to show the iorm clearly. In the figure σ is $2\pi\nu_1/5$, whereas for actual spectra it is oi the order of $\nu_1\times10^{-7}$, so that in any diagram which showed the maximum the rest of the figure would be quite invisible. It thus appears that, except for irequencies very near ν_1, the damping can be disregarded, and we shall ior the most part take advantage of this simplification and so make use of the curve of fig. *18* instead of fig. 19.

C. The Dispersion **Formula.**—The motion oi the electron, forced in this may, will cause a line wave to he emitted of which the magnitude is given by multiplying the amplitude of the electron's motion by its charge. Omitting the damping factor, we thus say that the electron has a scattering constant

$$e_1\cdot\frac{e_1}{m_1}\,\frac{1}{4\pi^2(\nu_1^2-\nu^2)}$$

which is proportional to

$$B_1\nu_1^2/(\nu_1^2-\nu^2).$$

The other virtual electrons will give similar effects and they are all to be superposed. Thus the virtual atom will have scattering constant proportional to

$$\rho=\frac{B_1\nu_1^2}{\nu_1^2-\nu^2}+\frac{B_2\,\nu_2^2}{\nu_2^2-\nu^2}+\ldots.$$

This is the best form for theoretical purposes, but experimental work more frequently makes use of wave lengths. Rewriting the equation we have

$$\rho=\frac{B_1\lambda^2}{\lambda^2-\lambda_1^2}+\frac{B_2\lambda^2}{\lambda^2-\lambda_2^2}+\ldots$$

as the dispersion formula, which should apply for any wave length not too close to λ_1, λ_2, etc. The relative magnitudes of the terms are derivable from the intensities of the associated lines in emission spectra. Their absolute values can also be given by carrying the theory somewhat deeper, and we shall touch on this below.

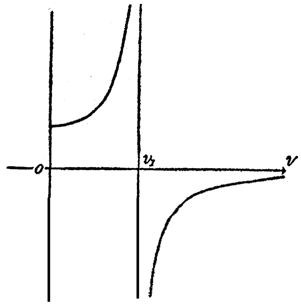


FIG. 18.—THE RESPONSE OF AN UNDAMPED RESONATOR

A periodic force throws a resonator into vibration, and for any frequency of the force the ordinate shows the amplitude of the resonator

We may now consider the march of events when a substance is illuminated by light of increasingly shorter wave length. We will suppose $\lambda_1>\lambda_2>\lambda_3$ . . . . We saw that the reiractive index depends on the product of p and the number of atoms in a cubic centimetre, but, as we have omitted a factor of proportionality already, we may also omit the factor for the number of atoms, and may equate ρ above to $(n^2-1)/(n^2+2)$. For very long waves we shall have practically $(n^2-1)/(n^2+2)=B_1+B_2+$ . . . . Ii n^2 is deduced from this it should agree with the dielectric constant determined by purely electrical means. Though there is little doubt that this would be verified, optical observations are usually lacking ior sufficiently long waves. As λ decreases the first term grows in comparison with the others, because $\lambda^2-\lambda_1^2$ gets smaller more rapidly, and just before λ_1 this term entirely dominates the reiraction. At λ_1 there will be a region of absorption and on the other side the first term will be negative, the rest still positive. As λ decreases further the first term, still negative, shrinks in importance and the second grows until near λ_2 when it becomes dominant. Passing beyond λ_2 it changes sign and later shrinks in importance, its place being taken by λ_3 and so on. Finally when all the lines have been passed, $(n^2-1)/(n^2+2)$ will be negative and proportional to the square of the wave length. For a strict test of the theoretical dispersion against experiment, we should have to work out the value oi n irom that of $(n^2-1)/(n^2+2)$; but for a rough comparison this is not necessary. Where $(n^2-1)/(n^2+2)$ is large, so is n; when the former is negative, n is less than unity; and, if n is plotted against frequency, the curve will have the same general characteristics as has $(n^2-1)/(n^2+2)$. An example of the general course oi the dependence of n on frequency is given without any numerical accuracy in fig. 20. There are supposed to he three lines, of which the middle one is the strongest. In the neighbourhood of each line the rciraction cannot be observed because of absorption. As each line is passed there is a strong decrease in the refractive index, associated with the change of phase oi the corresponding virtual electron by 180°. Whether the refractive index actually becomes less than unity will depend on the breadth of the unobservable region and on the strength oi this line compared with the others. At frequencies higher than the highest frequency of the atom the refractive index will always be less than unity, and such values have been found for X-rays, though, strictly speaking, even here the atom has higher frequencies still.

Much the most striking example of dispersion is the phenomenon called anomalous dispersion, though in iact it is not at all anomalous. There are dyes which strongly absorb certain colours in the spectrum while being transparent to the others; thus if the green is absorbed, the dye will look purple by transmitted light. In consequence of the very strong green absorption there is a reversal in the usual order of refraction. The blue light, which lies on the short wave length side of the green, is much less refracted than the yellow which lies on the side of long wave lengths. Fig. 21 shows with some exaggeration the way in which a prism made of such a colour would fold the spectrum back on itself A similar effect is observed for sodium vapour. Sodium has two very strong lines close together in the yellow, and both of them show anomalous dispersion. A flame containing the vapour is given the form of a prism, and white light is sent through it. This light is then sent through a spectroscope so as to spread out the colours in a direction at right angles to the dispersion of the prism. The colours on opposite sides of either of the sodium lines will be deflected in opposite directions by the prism, so that their images on the photographic plate are shifted up and down. The form of the dispersion curve is thus made directly evident.

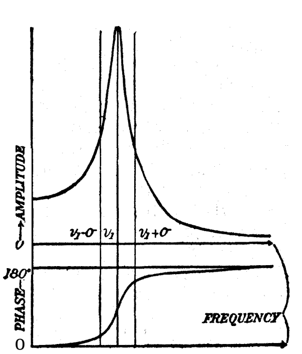


FIG 19 —THE RESPONSE OF A DAMPED RESONATOR, THE ORDINATE OF THE UPPER CURVE SHOWING THE AMPLITUDE, THE LOWER, THE PHASE, OF THE RESONATOR

Because of the brilliance and fineness of the sodium lines, sodium vapour has been used with more success than any other medium in the study of dispersion, and several important results have emerged. It has been found possible to make direct measures of the absorption of light in the immediate neighbourhood of the two lines and so to evaluate the damping factor σ; this was found to be in quite good agreement with the electromagnetic damping factor. Another important experiment consists in finding the absolute value of the scattering constants for these two lines of the sodium atom. The theory of this depends on quantum principles and cannot be given in detail; but, loosely speaking, the two virtual electrons together correspond to a single actual electron, so that, if we can make experiments in which the two lines are indistinguishable, the scattering constant should be given by the use of the ordinary values of e and m. The straightforward way of doing this would be to observe the refraction with light of a very different colour, because then the difference between the influences of two such close lines would he insensible, but this is useless because the refraction itself becomes too small. Indirect means depending on magnetic gyration have been used, and have entirely supported the theoretical prediction that both lines are due to a single electron.

The most accurate measures of reiractive index have been made with transparent substances, substances in which the absorption occurs only far in the infra-red or ultra-violet. To analyze the dispersion the usual procedure is based on the fact that for the inira-red terms, $\lambda^2/(\lambda^2-\lambda_1^2)$ can be expanded in powers of λ^2, while for the ultra-violet terms it can be expanded in inverse powers of λ^2. A formula is thereiore constructed oi the type $A+C\lambda^2+\ldots+E\lambda^{-2}+F\lambda^{-4}+\ldots$, and A, C, E . . . are fitted to the observed values of $(n^2-1)/(n^2+2)$. The term in C corresponds to the infra-red lines, and A, E, F to the ultra-violet. The actual positions of the lines are then found by trial. The infra-red lines, or, more usually, bands, can often be fixed with fair accuracy, both by experiments with rest-rays and by observing the refraction near them; but the ultra-violet are more troublesome, because it is often not possible to get observations very close to the lines Indeed it is usually found that with considerable latitude and can yet give all the observed results with a high degree of accuracy. The whole process is very laborious and has only been carried out for a few substances, such as rock salt and potassium chloride. It is found possible to represent the reiraction by one term for the inira-red and perhaps two in the ultra-violet, together with a third constant term which must correspond to wave lengths so short that $B_s\lambda^2/(\lambda^2-\lambda_s^2)$ does not change perceptibly in value in the whole region accessible to observation. The ultra-violet lines are attributed to electron vibrations of some kind, but those in the infra-red arise through the motions of whole atoms and have been fitted satisfactorily into the general dynamical theory of the crystalline state.

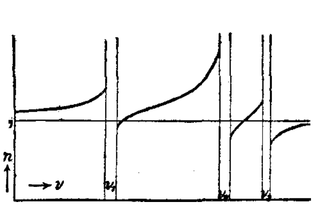


FIG. 20.—A DISPERSION CURVE SHOWING THE WAY REFRACTIVE INDEX DEPENDS ON LIGHT FREQUENCY At ν_1, ν_2, ν_3 there will be absorption

The theory of the refractive indexes of gases is distinctly more advanced, because their emission spectra can be studied without the radical change of state that would be necessary for solids. In the case of metallic vapours, such as sodium, the theory may be considered complete, though its practical verification is somewhat difficult. The spectrum of helium is known, and the measurement of its refraction has led to an interesting result. The lines of all atomic spectra fall into series which converge toward a finite limit λ_h, but beyond this limit there is a region in which there is emission over a continuous range of wave lengths. Corresponding to this it is found that the refraction of helium requires an expression

$$\frac{n^2-1}{n^2+2}=\frac{B_1\lambda^2}{\lambda^2-\lambda_1^2}+\ldots+\int_0^{\lambda_h}\frac{B_x\lambda^2}{\lambda^2-x^2}dx.$$

In the case of the ordinary permanent diatomic gases the spectrum is not so well known, for an electric discharge is required in order that the gas should be made luminous, and this breaks the molecules into atoms. Even without this knowledge, however, one feature can be predicted for a molecule composed of two identical atoms: the atomic vibrations which are of infra-red frequency will have no optical effects at all. This prediction is confirmed by the dispersion formulas which for the permanent gases have only ultra-violet terms.

IX. RECENT VIEWS ON THE NATURE OF LIGHT

In the foregoing account, the principles of optics have been presented as a completed body of knowledge. In so doing, we have entirely disregarded the more recently discovered properties of light that gave rise to the quantum theory. That this could be done rests upon the iact that the above treatment has always concerned rather intense light traversing matter in bulk. Under these conditions the statistical considerations oi the quantum theory may be neglected, and the electromagnetic theory gives a good account of the facts. Only when we leave the macroscopic properties of light and come into the microscopic realm, where we must consider the interaction of faint light with individual atoms, must the theory be revised. The final iorm of this revision was yet to be found in the latter 1950s, but in the search for it our whole point of view with regard to the nature of light, and of matter as well, has undergone a profound change. According to the present view, light has a dual character, such that it may be represented equally well by waves or by corpuscles. The two are merely complementary aspects of one and the same reality. Our discussion has concerned only one aspect of this duality, that of waves. Hence it would not be proper to close without a brief discussion of how photons, the corpuscles of light, have become an integral part of the theory. The logical development of the quantum theory is given elsewhere (*see* QUANTUM MECHANICS), but it will be worthwhile to summarize here the point of view regarding the nature of light that it embodies.

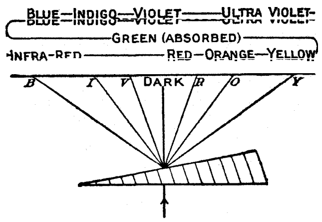


FIG. 21.— ANOMALOUS DISPERSION

The absorption in the green makes the yellow more refracted than the blue

The existence of both wave and corpuscular properties for light was mentioned at the conclusion of our historical summary. It has now been found that electrons, protons and the other elementary constituents of matter show an analogous behaviour in that they also possess wavelike characteristics. A beam of electrons may, with suitable apparatus, be made to exhibit interference, and this property we have seen to be an indisputable proof of the presence oi waves. Since both light and matter may behave either as waves or corpuscles, we must obviously call into question the applicability of models to such basic constituents of nature. All previous experience would lead us to suppose that where a given phenomenon requires two different concepts for its explanation, some crucial experiment could be performed which would decide which of the two is the correct one. In the present case we have been forced to the conclusion that this is impossible. Any given experiment will reveal either the wave aspect or the corpuscular, according to which one it is designed to demonstrate. Thus if light is analyzed by a diffraction grating, the effects are in every detail those predicted by the wave theory. On the other hand ii X-rays traverse the supersaturated vapour of a cloud chamber, tracks of photoelectrons are observed and the localization of energy required to produce these can only be explained as resulting from the annihilation of photons (see CLOUD CHAMBERS). All attempts to design an experiment that could show either property, and hence furnish a decision between the alternatives, have proved to be futile. As was shown by Bohr, the reason for this lies in the unavoidable interaction between the mechanism used for observation and the phenomenon being studied. The quantum theory therefore adopts the novel view that both the waves and the corpuscles are equally real or unreal and that it is meaningless to inquire more closely as to which is the true model to be used.

Quantum theory has further shown that exact calculation of the position and momentum of the particles cannot be made simultaneously, and that the limits of accuracy with which they may be specified are determined by the Planck constant h. The quantitative expression of the fact is the celebrated "uncertainty principle" (*q.v.*) of Werner Heisenberg. For photons and electrons the theory therefore gives no determinate spatial position, but only the statistical distribution, or the probability that they will be found in a given region of space. The reconciliation with the wave theory comes about through the iact that this distribution is calculated by the use of the equations of wave motion. When an interference pattern is produced with light, the density of photons striking the screen, which represents the energy or intensity of the light, is thus distributed in a way governed by the classical wave theory, even though it is impossible to give in detail the path followed by any individual photon. This is, briefly stated, the manner in which the present theory allows for the existence of such contradictory properties as interference and the photoelectric effect. It is a curious fact that the "fits of easy reflection and transmission" with which Newton had to endow his light corpuscles mere periodic in character. One may therefore regard his ideas as a rather vague forerunner of the dual theory established two centuries later.

The development of wave mechanics, which represents the incorporation of the wave aspect into the mechanics of material particles, was originally stimulated by the discovery of the dual character of light. This phase of quantum theory has reached a high degree of completeness, and has been extended by Paul Dirac to include the conditions imposed by the theory of relativity. Unfortunately the progress of the theory of light has been less rapid, and the application of quantum theory to problems of the interaction of light with material particles has been definitely limited. A quantum theory of the electromagnetic field has been formulated by Heisenberg and Wolfgang Pauli which accounts for the existence of photons. It leads to restrictions on the accuracy with which the electric and magnetic fields can be simultaneously measured similar to the uncertainty principle in quantum mechanics. There seems to be no doubt as to the essential correctness of this theory, as long as it is limited to fairly weak electromagnetic fields in empty space. Furthermore if it is restricted to cases of the interaction of light with elementary particles in the first approximation, it is capable of giving a satisfactory account of many experimental facts. Besides the strictly corpuscular properties, such as the photoeffect and Compton effect, which fall naturally into such a theory, many wave properties, such as interference, Doppler effect, light pressure and polarization, are readily interpreted. The theory of dispersion, and of the more recently discovered Raman effect (*q.v.*), have been successfully incorporated within the new theory. The spectral distribution of energy for radiation in thermal equilibrium (Planck's law) is also given satisfactorily provided that the photons are assumed to be indistinguishable from one another. This property is better expressed by saying that the light corpuscles obey the Einstein-Bose statistics, as contrasted with the Fermi-Dirac statistics, which apply to the elementary particles of matter. One of the most striking triumphs of this theory has been in dealing with the conversion of radiation into matter, and vice versa, that occurs in the creation and annihilation of positive electrons.

In spite of these initial successes, which indicate that the quantum electrodynamics is at least as well founded as quantum mechanics, it has become increasingly apparent that both have a limited range of validity. For strong electromagnetic fields and for very short wave lengths, less than the so-called Compton wave length, the theory leads to results that are definitely incorrect. Furthermore it is totally incapable of dealing with the problem of the finite size of the electron. If the theories of light and matter are to be synthesized into a comprehensive whole, it is certain that a fundamentally new approach must be developed in order to attack those phenomena occurring within regions of space comparable with the size of the electron or of atomic nuclei.

The quantum constant h forms the connecting link between the wave and corpuscular concepts, and its size determines the borderline between macroscopic effects where light can be treated as a continuous wave, and microscopic ones where the photon aspect begins to become important. If h were infinitely small, the classical electromagnetic theory would be adequate to account for all optical phenomena, since then we would always be dealing with huge numbers of photons. The same is true when the frequency ν is very small, and the energy $h\nu$ correspondingly small, as in the case of the electric waves from a radio antenna. The electromagnetic theory is entirely self-sufficient in explaining the emission of such radiation, and its absorption by matter. At the other extreme, where h would be large or ν very great, we would have fewer but much more energetic photons and the corpuscular properties of light would be very apparent. The actual value of h, 6.625×10^{-27}, is much nearer the infinitely small on the scale of everyday phenomena, and this explains why the corpuscular behaviour of radiation escaped detection until comparatively recent years. The discovery of X-rays and γ-rays, which lie in the range of very high frequencies (and large photons), made the observation of corpuscular effects inevitable, and hastened our realization of the inadequacy of the wave theory in the microscopic domain.

The fact that a definitive theory of light has yet to be formulated does not detract from the value of the classical electromagnetic treatment given in the present article. The subject matter has been chosen so that this treatment is not only appropriate but rigorously correct in most cases. A broad generalization known as the "correspondence principle" was stated by Bohr in 1916, according to which any quantum theory must give results agreeing with classical theory when the number of quanta (here photons) becomes very great. The difference between the discrete energy states then becomes vanishingly small and they merge into the continuity of classical theory. Thus macroscopic optical phenomena are governed by Maxwell's field theory and macroscopic mechanical phenomena by the mechanics of Newton and Einstein. Only when we encounter problems of the interaction of light with structures of atomic dimensions do they fail, and even here the correspondence principle has acted as an invaluable guide in developing the quantum theory. We may therefore feel confident that however great the changes brought about by a new theory, and however unfamiliar the language, the older work will stand and the new theory will accommodate within itself the wave theory of light.

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(C. G. D.; F. A. Js.)

LIGHT AND RADIATION IN RELATION TO HEALTH. Light and radiation consist of electromagnetic waves which travel at about 186,000 mi. per second in a vacuum, normally propagate in a straight line and are deflected and absorbed by mediums. These electromagnetic waves are classified by frequency vibration and by wave length. The spectrum of these electromagnetic waves includes radiations of wave lengths varying from 0.001 Å (1 angstrom $[Å] = \frac{1}{10{,}000{,}000}$ mm.) to radiations of wave lengths exceeding 100 m. Though all these radiations could be of importance to health, very little is known about the biologic effects of most of them. In medical science the most used and best understood are gamma-rays, X-rays, ultraviolet and infra-red rays All the other radiations have received considerable attention from physicists but comparatively little was known about their biologic effects in the 1950s.

Spectrum of Electromagnetic Waves

	Approximate wave length
Cosmic rays	0.001 Å
Gamma-rays	1.0 Å
X-ray	500.0 Å
Ultra-violet rays	3,000.0 Å
Visible light	6,000.0 Å
Infra-red rays	10,000.0 Å
Hertzian waves	1.0 m.
Radio waves	300.0 m.

Cosmic rays, the shortest and most penetrating of radiation known, are present everywhere on the earth's surface and are more concentrated at higher altitudes. Practically nothing is known of the importance of cosmic rays in health or disease, however.

Visible light has little direct effect on the physiological functions of the individual. However. these radiations penetrate 1–10 mm. of tissue and may increase the temperature of the area penetrated if large energy sources are utilized.

Radioactive elements give off rays which are classed as gamma-rays (very penetrating, short wave length, electromagnetic radiation), beta-rays (negatively charged particles which travel at a speed below that of light) and alpha-rays (positively charged helium nuclei).

X-rays are produced by bombarding a tungsten target with high-speed cathode rays in a vacuum tube. The tungsten target gives rise to electromagnetic radiations called X-rays. The wave length of these radiations depends upon the energy with which cathode rays are propelled to the tungsten target. The greater the energy the shorter is the wave length of the resultant X-rays. X-rays are comparable to the gamma-rays of radioactive elements.

The biologic effect at the site of action of X-rays and of radioactive materials is very similar. Because of vast differences in penetrating power, however, their use in treatment of disease varies greatly. Thus long wave length. less penetrating X-rays are used to treat skin diseases because little penetration is needed; but short wave length X-rays are used to reach internal disorders such as cancer of the stomach.

X-rays as well as gamma-rays, if absorbed in tissues, give rise to electron displacement with resultant electrical charges—a process known as ionization. These radiations are believed to exert their biologic effects by their ionization. Such ionization interferes with the metabolism of the cell resulting in malfunction or death of the cell.

Because some cells are more susceptible than others to the lethal effects of radiation, a selective destruction can be obtained. This fact is employed in the treatment of certain malignant growths because such growths are particularly radiosensitive. In addition to well-known and long-employed radiation therapy with X-rays and radium, radioisotopes have been widely accepted as very useful" in the treatment of leukemia, thyroid disorder, polycythaemia and other diseases. Radioisotopes are artificially created by exposing elements to atomic bombardment. Such radioisotopes as radiophosphorus, radiocobalt and radioiodine are widely used.

The uses of radioactivity in industry are increasing and are creating many problems relating to prevention of overexposure of those working in the industry and those living in the surrounding area.

The Hiroshima and Nagasaki atom bomb explosions with their intense radioactivity exemplified, in miniature, what a war with atomic weapons would mean. It is quite possible that all life on the planet could be destroyed if available atomic resources were applied to that end.

Though there is ample evidence that plants and insects may produce a high incidence of deformed and grotesque descendants secondary to exposures of radioactivity, there was still no evidence in the late 1950s that would justify the application of this observation to humans who have been carefully exposed to the doses and methods that are used in therapy and diagnosis of disease. (This statement should not, however, be taken as a denial of the most serious effect on health which improper exposure to ionizing radiation may have.) Surveys of births in Hiroshima and Nagasaki did not reveal any increased incidence of foetal anomalies in comparison with populations not exposed to an atomic bomb.

There is, however, a significantly higher incidence of leukemia, a fatal blood disease, in people exposed to radioactivity than in those not exposed. Also, excessive radiation applied to the skin or radioactive materials taken internally may lead to the development of cancer.

Though a few experimental conditions have been created in which the destructive effects of gamma-rays and X-rays can be partially counteracted (extracts of spleen, an environment low in oxygen and certain compounds containing sulphur) none of these has been developed to the point where it mould be of practical significance in protection against continuous or mass exposure to radioactivity. The only adequate protection is provided by physical barriers interposed between the radiation source and the subject to be protected. Lead, concrete, and large water tanks are all effective barriers when properly used. The best protection, of course, is to get as far away as possible frsm the source of radiation as the intensity of the radiation diminishes proportionately to the square of the distance.

The maximum amount of radiation to which the total body can be safely exposed has been established as 0.3 of a roentgen per week (a roentgen being the standard unit of measure of ionizing radiation).

As contrasted with the short-wave radiations just discussed, ultra-violet rays may be considered as relatively harmless and quite beneficial though long-term exposure to ultra-violet can also have unfortunate sequels.

The natural source of ultra-violet light is the sun, but only radiations of wave lengths longer than 2,900 Å reach the surface of the earth. Ultra-violet extends in aave length from 1,800 to 3,900 Å. Quartz will filter out all radiation below 1,800 Å and ordinary window glass will absorb any radiation below 3,200 Å (the reason why one cannot develop sunburn behind glass). Human skin absorbs all ultra-violet in the first 1–2 mm. of tissue and all wearing apparel absorbs ultra-violet. Artificial sources of ultra-violet light can be produced by electric arcs between metal and carbon. Low-pressure mercury lamps are effective ultra-violet light sources and are relatively inexpensive.

The amount of ultra-violet that reaches the surface of the earth depends on several factors, including the following: (1) the position of the sun in the sky: the higher in the sky the greater the intensity of ultra-violet light; thus there is a great variation depending on the time of day, the season of the year and the latitude; (2) elevation: the higher the altitude. the greater the intensity of ultra-violet radiation; (3) pollution of the air: smoke, gases and aerial contaminants that fill the atmosphere. especially in cities, greatly diminish the amount of ultra-violet light reaching the ground; and (4) water vapour. On heavily clouded days very little ultra-violet light gets through to the ground. However, on lightly clouded days secondary radiation. skyshine, may deliver large amounts of ultra-violet light to the ground.

The amount of ultra-violet light an object actually receives depends on: (1) direct rays from the sun; (2) reflected rays from the ground (very intense from snow, less intense from water and least intense from coloured, dull surfaces such as grass); and (3) skyshine (diffuse radiation reflected from the sky).

It is generally believed that ultra-violet rays have an invigorating effect on the human body, stimulate the appetite and promote cutaneous circulation. Except for the latter, such claims are difficult to evaluate but may well be true. More specifically it is known that ultra-violet converts ergosterol and its precursors, which are present in the skin, to vitamin D, a compound essential to health and without which children develop rickets. Vitamin D in large doses is an effective drug in the treatment of tuberculosis of the skin and before vitamin D mas used for treating skin tuberculosis, large amounts of ultra-violet light exposure were employed in the management of this disease.

The bactericidal and viricidal properties of ultra-violet light have been well demonstrated and are used rather widely. Ultra-violet light of 2,500 A is the effective bactericidal and viricidal range. Many reports have been submitted concerning the effectiveness of ultra-violet light in sterilizing large rooms. plasma or blood (in which the virus of hepatitis may be carried) and cutaneous surfaces but the absolute value of such procedures has not been entirely substantiated or universally accepted.

One of the most interesting and most publicized harmful effects of ultra-violet light is its role in the cause of cancer of the skin. Fair skinned people and those who sunburn easily and do not tan well are especially susceptible to ultra-violet light induced cancer of the skin. Negroes have a very low incidence of skin cancer compared with Caucasians, probably because of their increased amount of pigment and superficial horny material, both of which filter out ultra-violet light before it reaches the deeper areas of the skin. The incidence of skin cancer is seven times higher in southern than in northern United States and five times higher among farmers than among city workers. Cancer of the skin of body areas not exposed to ultra-violet light is quite rare whereas cancer of the skin of exposed areas (back of hands, neck and face) is very common in Caucasians, especially in the older age groups.

Experimental exposure of mice for Iong periods of time (three–ten months) to ultra-violet light results in cancer of the skin of these mice. These cancers can be prevented if, before each exposure to ultra-violet light, the skin is covered with a compound which absorbs ultra-violet light in the 2,900–3,100 Å range. There is little doubt that ultra-violet light is one of the most important factors in the causation of skin cancer.

The skin reacts differently to different wave lengths within the ultra-violet range. Thus from exposure to 2,500 Å the human skin will only become slightly red and scaly and will not form pigment. At 2,900–3,100 A the skin will become very red, engorged, blister, scale and form pigment subsequent to exposure. At 3,900 Å only a darkening of the skin occurs. This is due to oxidation of preformed melanin rather than the manufacture of new melanin which occurs in the 2,900–3,100 Å range. Melanin is a brownish granular pigment manufactured and deposited within the cells of the epidermis. It is the pigment which largely determines the colour of the skin.

Ultra-violet light may cause severe sunburn in normal people who are overexposed. This is characterized by redness, pain, swelling and sometimes blistering of the skin. Fever, nausea, malaise and systemic illness may follow a severe sunburn.

Many people suffer from severe skin reactions after exposure to very small amounts of ultra-violet light. For example, some people develop cold sores (herpes simplex), some develop hives whereas others may develop eczemalike lesions. Many of these people find complete relief and tolerate large amounts of ultra-violet light if they apply a "sun screen" ointment before exposure. Para-aminobenzoic acid and its esters incorporated in an ointment filter out ultra-violet radiation in the 2,900–3,100 A range.

There are many compounds which when applied to skin in the absence of ultra-violet light give no skin reaction but when applied to the skin in the presence of ultra-violet light cause violent eruptions of the skin. Among these photosensitizers are fluorescent dyes. methoxy psoralens and extracts of a large number of plants. Following these photosensitizing reactions there is frequently intensive pigment formation at the site of the previous eruption. This fact has been applied to the treatment of skin areas uhere more pigment is desired but such attempts at pigment control have not been too successful.

Xeroderma pigmentosum, a rather rare hereditary skin disease in which the individual is extremely sensitive to ultra-violet light, is of interest because sufferers from it develop senile skin which contains many cancers before the victim reaches puberty. The tiniest amounts of ultra-violet light precipitate these changes. Other cutaneous diseases such as lupus erythematosus, a sometimes fatal disease most prominent in young adult females, and porphyria (abnormal fluorescent compounds found in urine, bone marrow. liver and other organs) are definitely aggravated by ultra-violet light. (See also SKIN DISEASES; CANCER.)

Infra-red radiation is more penetrating than ultra-violet light and may be used to increase the temperature of the blood circulating in the skin and of structures lying well beneath the skin. It is most useful in treating disorders of the tendons, joints and muscles which are usually within range of infra-red radiation.

(RD. B. S.)

LIGHTER, a barge employed in ports in loading or unloading the cargoes of ships, the name being derived from the verb "to light"; *i.e.*, to relieve of a burden. The men employed on them are termed lightermen. (See BARGES AND CANAL CRAFT.) Also a small mechanism, used instead of matches. in which a small wheel is twirled against a piece of ferrocerium, throwing off sparks which ignite fluid fed through a cotton wick.

LIGHTFOOT, JOSEPH BARBER (1828–1889), English theologian and bishop of Durham, was born at Liverpool on April 13, 1828. He was educated at King Edward VI school, Birmingham, and Trinity college, Cambridge. He graduated senior classic and 30th wrangler, and was elected a fellow of his college. From 1854 to 1859 he edited the *Journal of Classical and Sacred Philology*. He became tutor of his college (1857), Hulsean professor (1861), chaplain to the prince consort and honorary chaplain to the queen, Whitehall preacher (1866) and canon of St. Paul's (1871). In 1875 he became Lady Margaret professor of divinity in succession to William Selwyn. He had previously written his commentaries on the epistles to the Galatians (1865), Philippians (1868) and Colossians (1875). which marked a new departure in New Testament exegesis in England. Lightfoot was a great grammarian and textual critic; he endeavoured to make his author interpret himself, and by considering the general drift of his argument to discover his meaning where it appeared doubtful. Thus he was able often to recover the meaning of a passage which had long been buried under a heap of contradictory glosses, and he founded a school in nhich sobriety and common sense were added to the industry and ingenuity of former commentators. In 1879 Lightfoot was consecrated bishop of Durham. He continued to work on his editions of the Apostolic Fathers, and in 1885 published an edition of the epistles of Ignatius and Polycarp. collecting also much valuable material for a second edition of Clement of Rome, ahich was published after his death (1st ed.. 1869). His defence of the authenticity of the epistles of Ignatius is an important contribution to that very difficult controversy. He died at Bournemouth on Dec. 21, 1889, and was succeeded in the episcopate by Brooke Foss Westcott, his schoolfellow and lifelong friend who published a sketch of his *Life* (1894).

LIGHTHOUSES. Cnder the general heading of lighthouses this article includes, in addition to a description of marine lighthouse structures and apparatus, some reference to unattended lights, light vessels, lighted buoys, aerial lights, acoustic fog signals and radio and radar aids to navigation. *(See Gnited States,* below, for similar information concerning the U.S.)

A lighthouse is a structure erected to carry a light for the warning or guidance of ships or aircraft.

Early History. — The earliest lighthouses of which records exist were the towers built by the Libyans and Cushites in lower Egypt. beacon fires being maintained in some of them by the priests.

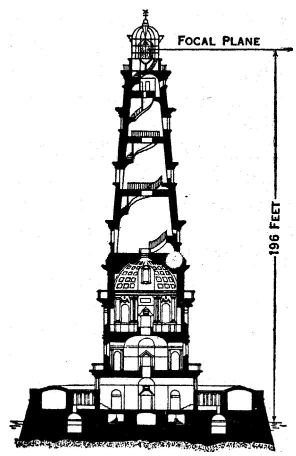


FIG. 1.—CORDOUAN LIGHTHOUSE. EARLIEST EXTANT WAVE-SWEPT TOWER
The lighthouse was begun in 1584 and stands on a rock in the Bay of Biscay near the mouth of the Gironde river

Lesches, a Greek poet (c. 660 B.C.), mentions a lighthouse at Sigeum (now Cape Incihisari) in the Troad, which appears to have been the first light regularly maintained for the guidance of mariners. The famous Pharos of Alexandria, built by Sostratus of Cnidus in the reign of Ptolemy II (283–246 B.c.), was regarded as one of the wonders of the world. A full account of it is given in Hermann Thiersch's *Pharos, Antike Islam und Occident* (Leipzig and Berlin, 1909). The tower, which took its name from that of the small island on which it was built, is stated to have been 600 ft. in height, but the evidence in support of this is doubtful. It was destroyed by an earthquake in the 14th century; the remains are said to have been visible as late as 1350. The name pharos became the general term for all lighthouses, and the term pharology has been used for the science of lighthouse construction. The tower at Ostia was built by the emperor Claudius (A.D. 50). Other famous Roman lighthouses were those at Ravenna, Pozzuoli and Messina. The ancient pharos at Dover and that at Boulogne. later known as La Tour d'Ordre, were built by the Romans and were probably the earliest lighthouses erected in western Europe. ,Both are now demolished.

The light of Cordouan, on a rock in the sea at the mouth of the Gironde, provides the earliest example existing at mid-20th century of a wave-swept tower. Two earlier towers on the same rock are supposed to have been built, the first by Louis the Debonair (c. A.D. 80j) and the second by Edward the Black Prince. The existing structure was begun in 1584 during the reign of Henry III of France and completed in 1611. The upper part of the beautiful Renaissance building was removed toward the end of the 18th century and replaced by a loftier cylindrical structure rising to a height of 207 ft. above the rock (fig. 1). Until the 18th century the source of light was an oak-log fire, and subsequently a coal fire was used for many years. The ancient tower at Corunna, known as the Pillar of Hercules, is supposed to have been a Roman pharos. The Torre del Capo at Genoa originally stood on the promontory of San Berrique. It was built in 1139 and first used as a lighthouse in 1326. It was rebuilt on its present site in 1643 and rises 236 ft. above the cliff. The pharos of Meloria was constructed by the Pisans in 1154 and was several times rebuilt until it was finally destroyed in 1290. On the abandonment of Meloria by the Pisans, they erected the still-existing tower at Leghorn in 1304, which has well borne the brunt of time.

In the 17th and 18th centuries numerous towers, on which were erected braziers or grates containing wood or coal fires, were established in various positions on the coasts of Europe. Among such stations in the United Kingdom were Tynemouth (c. 1608), the Isle of May (1636), St. Agnes (1680), St. Bees (1718) and the Lizard (1751).

The oldest lighthouse in the Gnited States is believed to be the Boston light situated on Little Brewster Island on the south side of the main entrance to Boston harbour, Mass.

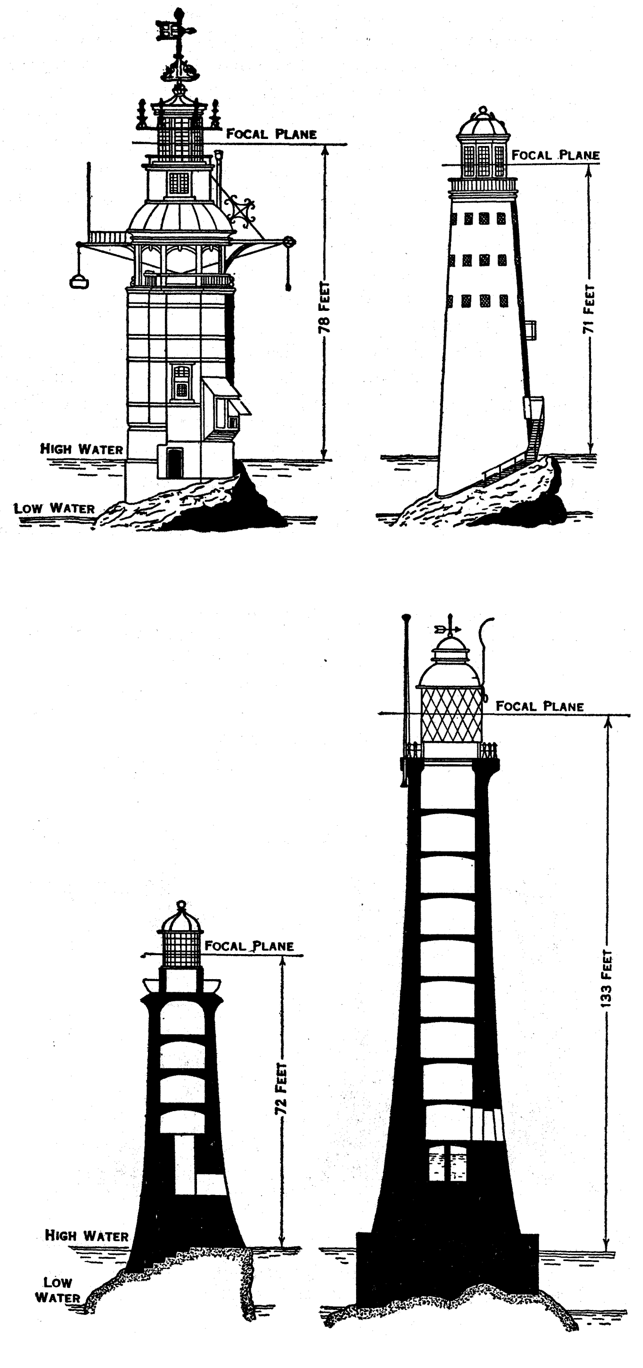


FIG. 2.— THE FOUR LIGHTHOUSES ON THE EDDYSTONE ROCKS
The towers are drawn to the same scale. The first tower was destroyed in the great storm of 1703, and the fourth tower was completed in 1882

It was established in 1716, the present structure dating from 1856. Other early lighthouses on the New England coast were those at Beavertail near the entrance to Newport harbour. R.I. (1749), and Brant point at the entrance to Nantucket harbour (1746). A watchhouse and beacon appear to have been erected on Beacon or Lighthouse Island as well as on Point Allerton hill near Boston before 1673, but these structures would seem to have been in the nature of lookout stations in time of war rather than lighthouses for the guidance of mariners.

LIGHTHOUSE STRUCTURES

The structures of lighthouses may be divided into two classes: (1) those on rocks, shoals or in other situations exposed to the force of the sea; and *(2)* land structures; these last are more numerous.

Wave-Swept Towers.—In determining the design of a lighthouse tower to be erected in a wave-swept position consideration must be given to the physical features of the site and its surroundings. Towers of this description are classified as follows: (1) masonry and concrete structures; *(2)* openwork steel and iron-framed erections on pile or other foundations; (3) cast-iron plated towers; (4) structures erected on caisson foundations.

1. Masonry towers are generally preferred for erection on wave-swept rocks affording good foundation. and have also been constructed in other situations where adequate foundations have been made by sinking caissons into a soft sea bed. Smeaton's tower on the Eddystone rock is the model upon which most later designs of masonry towers have been based, although many improvements in detail hdve been made. In situations of great exposure the following principles in design should be observed: (a) The centre of gravity of the tower structure should be as low as possible. (b) The mass of the structure superimposed at any horizontal section must be sufficient to prevent its displacement by the combined forces of wind and waves without dependence on the adhesion at horizontal joint faces or on the dovetailing of stones introduced as an additional safeguard. (c) The structure should be circular in plan throughout, this form affording the least resistance to wave stroke and wind pressure in any direction. (d) The lower portion of the tower exposed to the direct horizontal stroke of the waves should, preferably, be constructed with a vertical face. The upper portion should be either straight with uniform batter or continuously curved in the vertical plane. External projections from the face of the tower, except in the case of a gallery under the lantern. should be avoided, the surface throughout being smooth. (e) The height from sea level to the top of the tower should be sufficient to avoid the obscuration of the light by broken water or dense spray driving over the lantern. (f) The foundation of the toner should be carried well into the solid rock and secured to it. (g) The materials of which the tower is built should be of high density and of resistant nature. *(h)* The stones used in the construction of the tower should be dovetailed or joggled one to the other in order to prevent their being dislodged by the sea during the process of construction and to afford additional stability. Cement concrete has been used to an increasing extent for maritime structures, including lighthouses, either alone or faced with masonry. Reinforced and prestressed concrete have also been employed.

2. Many examples of openwork steel and iron lighthouses exist. Some typical examples are described below. This form of design is suitable for situations where the tower can be carried on a foundation of iron or steel piles driven or screned into an insecure or sandy bottom; *e.g.,* on shoals, coral reefs and sandbanks or in places where other materials of construction are exceptionally costly and where facility of erection is a considerable advantage.

3. Cast-iron plated toners have been erected in many situations where the cost of stone or scarcity of labour would have made the building of a masonry tower excessively expensive.

4. Cylinder or caisson foundations have been used for lighthouse toners in numerous cases where such structures have been erected on sandbanks or shoals. A remarkable instance is the Rothersand tower. Two attempts were made to sink a caisson in the outer Diamond shoal off Cape Hatteras on the Atlantic coast of the United States, but these endeavours proved futile.

Famous Wave-Swept Towers.—The following are brief descriptions of some of the more important wave-swept toners in various parts of the world.

Eddystone *(Winstanley's* Tower).—The Eddystone rocks. nhich lie about 14 mi. off Plymouth, are fully exposed to southwestern seas. Four towers have been constructed on the reef uhich is submerged at high-water spring tides. The first lighthouse (see fig. 2, upper left) was polygonal in plan and highly ornamented with galleries and projections which offered considerable obstruction to the sea stroke. The work was begun by Henry Winstanley, a gentleman of Essex, in 1696 and finished in 1698. In the following year, in consequence of damage by storms, the tower was increased in diameter from 16 ft. to 24 ft. by the addition of an outer ring of masonry and made solid to a height of 20 ft. above the rock, the tower being raised from 80 ft. to nearly 120 ft. This work was completed in 1700. The lower part of the structure appears to have been of stone. the upper part and lantern of timber. During the great storm of Nov. 26, 1703, the tower was swept away, those in it at the time, including the builder, being drowned.

TABLE I.—*Comparative* Cost of Exposed Rock Towers

Name of structure	Total cost, £	Cu.ft.	Cost per cu.ft. of masonry
Eddystone (Smeaton) (1759)	40,000	13,343	£2 19*s.* 11*d.*
Bell rock, Firth of Forth (1811)	55,620	28,530	1 19 0
Skerryvore, Scot. (1844)	72,200	58,580	1 4 8
Bishop rock (first granite tome;) (1858)	34,560	35,209	19 7
Smalls, Bristol channel (1561)	50,124	46,386	1 1 7
Hanois, Guernsey (1862)	25,296	24,542	1 0 7
Wolf rock, Land's End (1870)	62,726	59,070	1 1 3
Dubh Artach, Scot. (1872)	72,584	42,050	1 1, 6
Longships, Land's End (1872)	43,869	47,610	18 5
Eddystone (Douglass) (1882)	59,255	65,198	18 2
Bishop rock (reconstruction) (1887)	64,889	45,080	1 8 9
Great Basses, Ceylon (1873)	63,560	47,819	1 6 7
Minots ledge, Mass. (1860)	62,500	36,322	1 17 2
Spectacle reef, Lake Huron (1874)	78,125	42,742	1 16 2
Ar'men, Fr. (1881)	37,692	32,400	1 3 3
Fastnet, Ire, (1904)	79,000	62,600	I S 5

Eddystone *(Rudyerd's* Tower).—This lighthouse was begun in 1706 and completed in 1709 (see fig. 2 upper right). The structure consisted principally of oak timbers securely bolted and clamped together. the lower part being filled in solid with stone to add weight to the building. The simplicity of the design and the absence of projections from the outer face rendered the tower very suitable to withstand the onslaught of the waves, but the lighthouse was destroyed by fire in 1755.

Eddystone (Smeaton's Tower).—This famous work, which consisted entirely of stone, was begun in 17j6, the light being first exhibited in 1759 (see fig 2, loner left). John Smeaton was the first engineer to use dovetailed joints for the stones in a lighthouse structure. The stones, which averaged one ton in weight, aere fastened to each other by means of dovetailed vertical joint faces, oak key wedges, and by oak treenails wedged top and bottom extending vertically from every course into the stones beneath it. During the 19th century the tower was strengthened on two occasions; but in 1877, partly because of the undermining of the rock on which the tower was built and the insufficient height of the structure, the Corporation of Trinity House determined on the erection of a new lighthouse in place of it.

Eddystone (J. N. Douglass' Tower).—The site selected for the new Eddystone tower (see fig. 2, lower right) is 120 ft. S.S.E. from Smeaton's lighthouse, where a suitable foundation was found, although a considerable section of the lower courses had to be laid below the level of low water. The base is vertical, 44 ft. in diameter, and all the stones are dovetailed, both horizontally and vertically, on all joint faces, those of the foundation course being secured to the rock by Muntz metal bolts. The lantern is a cylindrical helically framed structure with domed roof, gun-metal astragals and cast-iron pedestal. The optical apparatus in this lighthouse consists of tao superimposed tiers of refracting lens panels. The burners originally fitted in Eddystone tower were of six-wick pattern, but these were replaced in 1904 by incandescent oil-vapour burners. At the time of the completion of the lighthouse two bells, weighing two tons each and struck by mechanical power, were installed for fog-signalling purposes; these were later replaced by an explosive guncotton fog signal. The work of preparing the foundation was begun on July 17, 1878, and the light was first exhibited on May 18, 1882. The upper portion of Smeaton's tower was removed on completion of the new lighthouse and re-erected on Plymouth Hoe, where it replaced an old Trinity House seamark. One of the principal features in the design of the new Eddystone lighthouse tower is the solid vertical base. Heavy seas are immediately broken up or reflected by it, spray alone rising to the height of the lantern gallery. The shock to which the gallery cornice of the old tower was exposed was so great that stones were sometimes lifted from their beds. Its successor presents another point of dissimilarity from Smeaton's structure in that the stones forming the floors consist of single corbels built into the wall instead of stone arches the thrust of which, in the earlier tower, was taken by the walls strengthened by building in chains in the form of hoops. The system of constructing corbelled stone floors was first adopted by R. Stevenson in the Bell rock lighthouse.

Bell Rock.—The Bell rock tower (fig. 3), which lies 12 mi. off the coast of Forfarshire, stands on an exposed reef, dry at low water and submerged to a depth of about 16 ft. at high water of spring tides. The rock is of hard sandstone. The lighthouse was constructed by R. Stevenson in 1807–11.

Skerryvore.—The Skerryvore rocks, 12 mi. off the island of Tiree in Argyllshire, are wholly open to the Atlantic. The tower, 158 ft. in height and designed by Alan Stevenson, was begun in 1838 and finished in 1844.

Bishop Rock.—The lighthouse on Bishop rock, the westernmost landfall rock of the Scilly Isles, occupies perhaps a more exposed situation than any other in the world. The first lighthouse erected there was begun in 1847 under the direction of N. Douglass. The tower consisted of a cast- and wrought-iron openwork structure having the columns deeply sunk into the rock. On Feb. 5, 1850, when the tower was ready to receive the lantern, a heavy storm swept away the whole structure. In 1851 the erection of a granite tower mas begun and the light was first exhibited in 1858. This structure also proved insufficient to withstand the heavy seas to which it was exposed. Soon after its completion the five-hundred-weight fog bell, fixed to the lantern gallery 100 ft. above high-water mark, was washed away and the tower vibrated considerably during storms. In 1874 it was strengthened by bolting continuous iron ties to the internal wall surfaces. In 1881 further signs of damage appeared and the structure was encased from its base upwards with granite blocks dovetailed to each other and to the

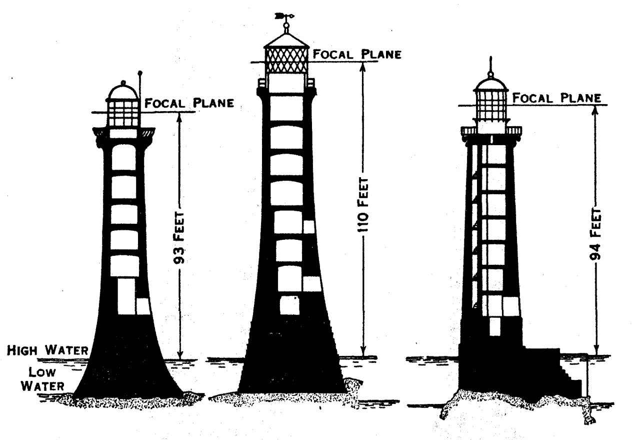


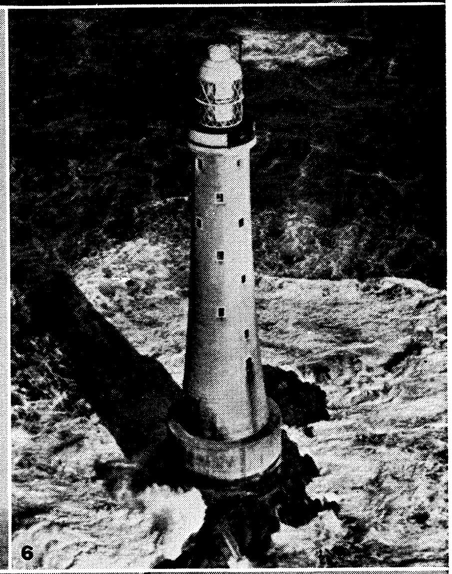
FIG. 3.—SECTIONS OF ROCK LIGHTHOUSES DRAWN TO SAME SCALE

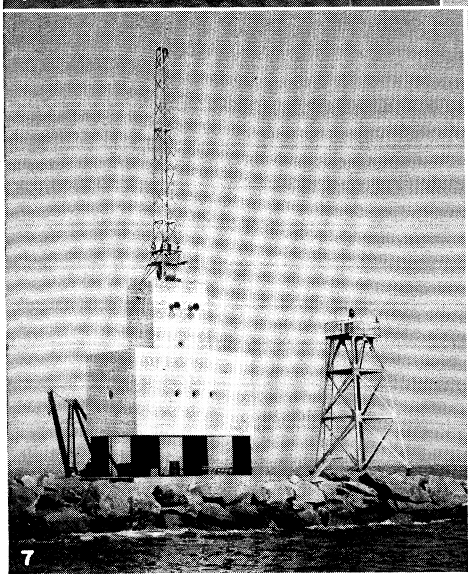
Left to right, Bell rock, off the east coast of Scotland; Wolf rock, off the coast of Cornwall; Ar'men, off the coast of Finistère

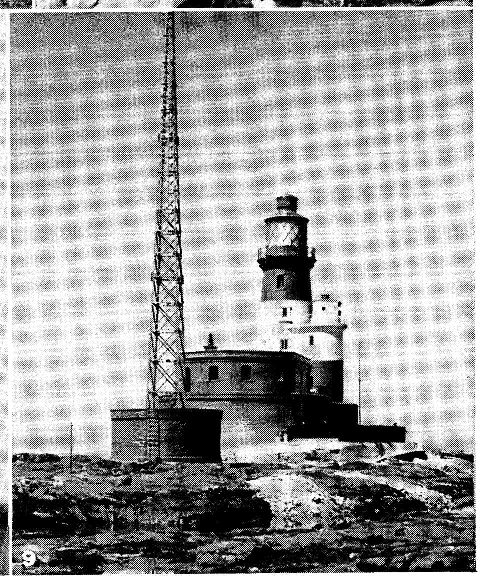
existing work. At the same time the elevation of the light was increased. The work was begun in 1883 and completed in 1887. Profiting by the experience gained in the construction of the new Eddystone tower. Sir James N. Douglass decided to build the lower portion of the improved Bishop rock tower in the form of a cylinder, but with considerably increased elevation (fig. 4).

Wolf Rock.—This much-exposed rock lies midway between the Scilly Isles and Lizard point, and is submerged to the depth of about six feet at high water. The tower was erected in 1862–69 (fig. 3). The lower part of the base has projecting steps or scarcements in order to break up the sea.

Dubh Artach Rock.—The Dubh Artach rock, 35 ft. above high







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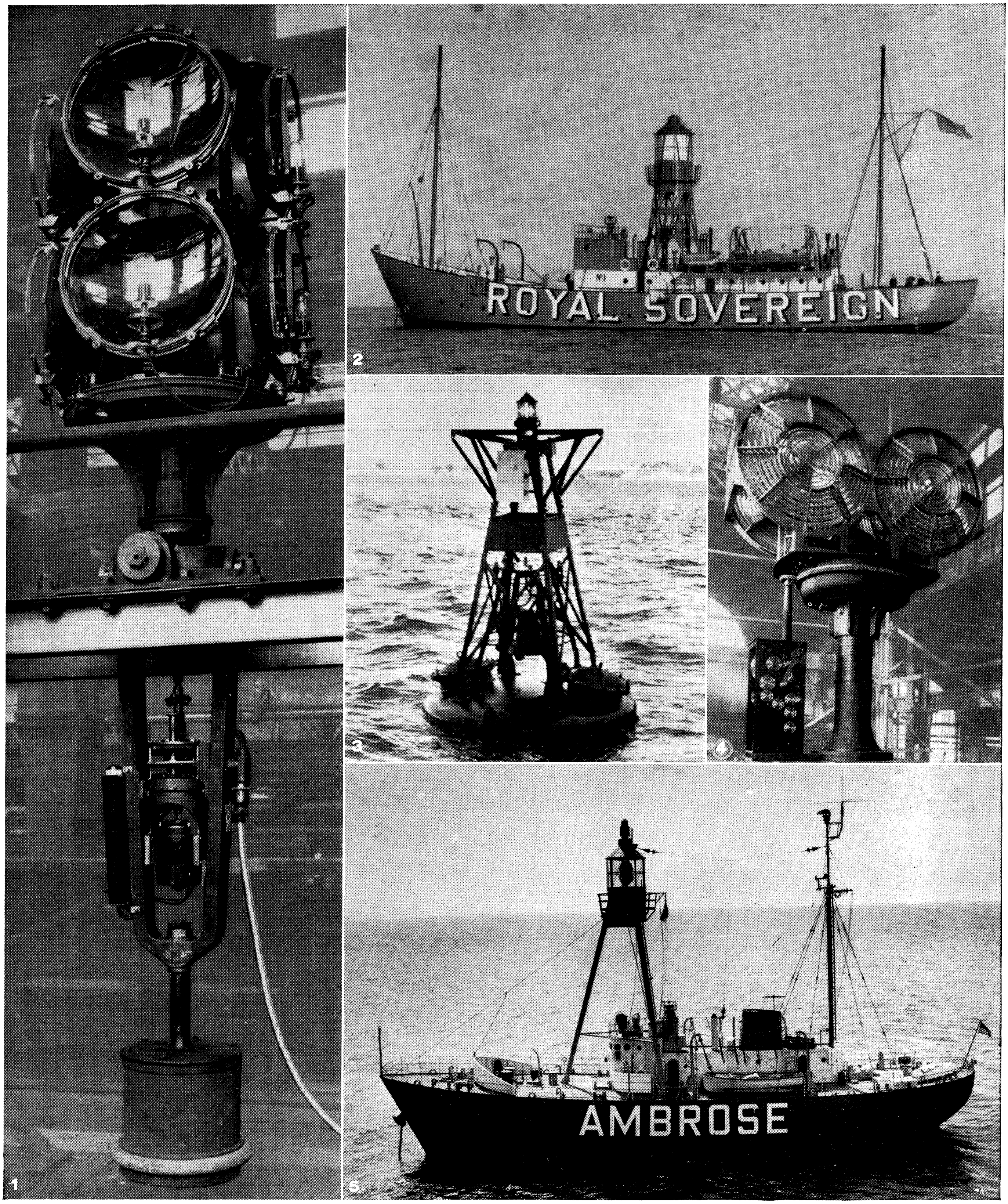
LIGHTHOUSES OF THE U.S. AND GREAT BRITAIN

1. Lighthouse at Boston, Mass., built in **1716**
2. Cape **Hatteras** lighthouse, North Carolina
3. Cape Hinchinbrook light station, Prince William sound, Alaska. The tower rise 235 ft. above the sea and the light is visible for 22 mi.
4. Cape Henry lighthouse, at the entrance of Chesapeake bay. The old lighthouse, first operated in **1792,** is in background
5. Pacific reef light, unattended station with acetylene light; Florida coast
6. Bishop Rock lighthouse, Scilly Isles, Eng.
7. "Robot" light, Long Beach, Calif. The unit is completely mechanical, operating for one month at a time without servicing
8. Kilauea Point lighthouse, Hawaii
9. Longstone lighthouse, Eng., at low tide

LIGHTHOUSES



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LIGHT VESSELS AND OPTICAL EQUIPMENT

1. Catoptric (reflecting) apparatus for light vessels. British
2. "Royal Sovereign." British light vessel
3. Lighted bell buoy. A radio mechanism, operated from a shore station, regulates light
4. Modern dioptric (refracting) lighthouse apparatus, Longstone, Eng.
5. "Ambrose" lightship, stationed at the entrance of New York harbour

mater, is 14 mi. S.W. of the Island of Mull. The tower occupied six years in erection and was completed in 1872. The focal plane is at a level of 145 ft. above high water.

Ar'men.—The masonry tower, erected by the French lighthouse service on the Ar'men rock off the western extremity of the fle de Sein, Finistère, occupied 15 years in construction (1867–81). The rock is barely uncovered at low water and of small area: which made it impossible to construct a tower having a base diameter greater than 30 ft. (fig. 3).

Fastnet. — The first lighthouse on the Fastnet rock, off the south-west coast of Ireland, was a circular cast-iron tower 86 ft. in height completed in 1854 It was erected on the summit of the rock which in 1895 was found to be considerably undermined. In 1899 a granite structure of increased height and founded upon a sound ledge of rock on one side of the higher but undermined portion of the reef, with its foundation laid near high water, was commenced. It was completed in 1904. The focal plane is at a level of 158 ft. above high-water mark.

Maplin.—The screw-pile lighthouse erected on the Maplin Sand in the estuary of the Thames in 1838 is the earliest of its kind and served as a model for numerous similar structures in various parts of the world. The piles, nine in number, were of solid wrought iron with screws four feet in diameter. This structure developed a serious list as a result of scour jo to 60 ft. deep near the piles. The lighthouse was abandoned in 1931 and overturned in a' gale shortly afterward.

Rothersand.—This lighthouse, off the entrance to the Weser river in Germany, is a structure of great interest on account of the difficulties encountered in its construction. The tower had to be founded on a bottom of shifting sand 20 ft. below low mater and in an exposed situation. Work was begun in May 1881, when attempts were made to sink an iron caisson under pneumatic pressure. Because scour removed the sand from one side of the caisson it tilted to an alarming angle, but eventually it was sunk to a depth of 70 ft. below low water. In October of the same year the whole structure collapsed.

Another attempt, made in May 1883, to sink a caisson of biconvex shape, in plan 47 ft. long, 37 ft. wide and 62 ft. in height, met with success, and after many difficulties the structure was sunk to a depth of 73 ft. below low water, the sides being raised by the addition of iron plating as the caisson sank. The sand was removed from the interior by suction. Around the caisson foundation were placed 74,000 cu.yd. of mattresswork and stones. the interior being filled with concrete. The lighthouse (fig. 5) was completed in 188j.

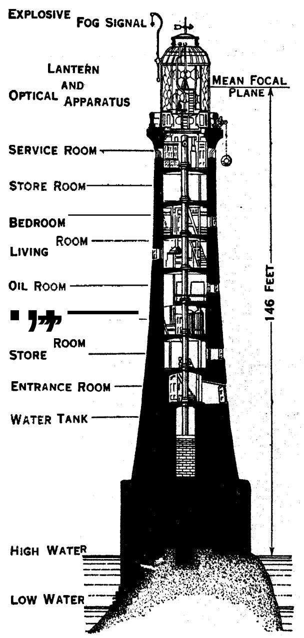


FIG. 4.— BISHOP ROCK LIGHTHOUSE, SCILLY ISLES
This is the second granite tower. The first granite tower was encased and raised in haiaht in 1883–87

Other well-known wave-swept towers are those at Haulbowline rock. Carlingford Lough, Ire., 1823; Héaux de Brehat, Brittany, 1839; Horsburgh, Singapore, 1851; Minots ledge, Mass., 1860; Bayes d'Olonne, Bay of Biscay, 1861; Smalls, Bristol channel, 1861; Hanois, Guernsey, 1862; Daedalus reef (iron tower), Red sea, 1863; Alguada reef, Andaman sea, 1865; Longships, Land's End, 1872; Great Basses, Ceylon, 1873; the Prongs, Bombay, 1874; Spectacle reef, Lake Huron, 1874; Chicken rock. Isle of Man, 1874; Fowey rocks, Fla., 1878; American shoal, Fla., 1880; Wolf Trap. Chesapeake bay, 1887; St. George reef, Calif., 1892; Rattray head, Aberdeenshire, 189j; Beachy head, Eastbourne, 1902; the Graves, Boston, Mass., 1905; and Jument d'Ouessant, Brittany. 1911. See also United Sta es below.

Jointing of Stones in Rock Towers, — Various methods of jointing the stdnes in rock towers are employed in building. The great distinction between the towers built by successive engineers to the Trinity House and other rock lighthouses is that in the former the stones of each course are dovetailed together both laterally and vertically and are not connected by metal or wooden pins and wedges and dowelled as in most other cases. This dovetail method was first adopted at the Hanois rock at the suggestion of N. Douglass. The cement mortar in the joint formed between the faces so locks the dovetails that the stones cannot be separated nithout being broken.

Effect of Waves. — The wave stroke to which rock lighthouse towers are exposed is often considerable During the erection of the tower at Dubh Artach, 14 joggled stones, each of two-tons weight, were washed away after having been set in cement at a height of 37 ft. above high water, and similar damage was done during the construction of the Bell rock tower. The effect of waves on the Bishop rock and Eddystone towers has been noted above.

Land Structures for Lighthouses. — The erection of lighthouse toners and other buildings on land presents no serious difficulties of construction; such buildings are usually of simple architectural character. Besides being built of stone, brick or reinforced concrete, land towers are frequently constructed of cast-iron plates or open steelwork with a view to economy. Fine examples of the former are to be found in many British colonies and elsewhere. that on Dassen Island. Cape of Good Hope, being typical. A cast-iron tower erected at Kijkduin, near Helder, Neth., in 1875 is 197 ft. in height to the focal plane. Many openwork structures up to 200 ft. in height have been built. Examples are the towers erected at Cape São Tomé, Braz., in 1882, 148 ft. to the focal plane; Mocha, Red sea, in 1903, 180 ft.; and Sanganeb reef, Red sea, 1906, 165 ft.

DISTINCTION AND DISTRIBUTION OF LIGHTS, ETC.

The following are the various light characteristics which may be exhibited to the mariner:

Fixed. — Showing a continuous or steady light. Seldom used in modern lighthouses and generally restricted to small port or harbour lights. A fixed light is liable to be confused with lights of shipping or neighbouring shore lights.

Flashing. — (I) Showing a single flash at regular intervals, the duration of light being always less than that of darkness. (2) A steady light with, at regular intervals. a total eclipse, the duration of light being always less than that of darkness.

Group **Flashing.**—Showing at regular intervals a group of two or more flashes.

Occulting. — A steady light with, at regular intervals, a sudden and total eclipse, the duration of darkness being always less than, or equal to, that of light.

Group Occulting. — A steady light with, at regular intervals, a group of two or more sudden eclipses.

Fixed Flashing. — A fixed light varied, at regular intervals, by a single flash of relatively greater brilliance.

Fixed and Group Flashing. — A fixed light varied. at regular intervals, by a group of two or more flashes of relatively greater brilliance.

Quick Flashing. — A light which flashes continuously more than 60 times a minute.

Interrupted Quick Flashing. — A light which flashes at a rate of more than 60 times a minute with. at regular intervals, a total eclipse.

Group Interrupted Quick Flashing. — A light which shows groups of quick flashes, as defined above, separated by relatively longer periods of total eclipse.

Alternating. — Lights having any of the foregoing characteristics and which alter in colour are indicated by the addition of the word "alternating" to the appropriate description. When used alone in describing a light the word indicates two distinct colours alternating without any intervening eclipse, Alternating lights are not to be recommended (see Coloured Lights below).

Colour.—The colours usually adopted for lights are red and green. A nhite light is to be preferred whenever possible because of the great absorption of light by the use of red or green glass screens.

Sectors.—Where coloured lights are used to distinguish cuts or sectors they should be shown from apparatus of fixed section and not from revolving apparatus. In marking the passage through a channel or between sandbanks or other dangers, coloured-light sectors are arranged to cover the dangers, white light being shown over the fairway with sufficient margin of safety between the edges of the coloured sectors next to the fairway and the dangers.

*TABLE 11.—Distances at Which Objects Can Be Seen at Sea, According to Their Respective Elevations and the Eleaation of the Eye of the Observer**

Heights, ft.	Distances, nautical miles	Heights, ft.	Distances, nautical miles
5	2.565	120	12.56
10	3.628	150	14.02
15	4.443	200	16.22
20	5.130	250	18.14
30	6.283	300	19.87
40	7.255	400	22.94
50	8.112	500	25.65
60	8.886	600	28.10
70	9.598	700	30.28
80	10.26	800	32.45
100	11.47	900	34.54
		1,000	36.28

*Example: A light 200 ft. high will be visible 22.50 nautical miles to an observer whose eye is elevated 30 ft. above the water; thus, from the table:

30 ft. elevation, distance visible 6.28 nautical miles
zoo " " " " 16.22 " "
22.50 " "

Source: A. Stevenson

Choice of Characteristic and Description of Apparatus.—In determining the choice of characteristic for a light, due regard must be paid to existing lights in the vicinity. No light should be placed on a coast line having a characteristic the same as, or similar to, another in its neighbourhood unless one or more lights of dissimilar characteristic and at least as high power and range intervene. In the case of landfall lights the characteristic should differ from any other within a range of roo mi. In narrow seas the distance between lights of similar characteristic may be less. Landfall lights are the most important of all and the most powerful apparatus available should be installed at such stations. The distinctive characteristic of a light should be such that it may readily be recognized by a mariner without the necessity of accurately timing the period or duration of flashes. For landfall and other important coast stations flashing dioptric apparatus of the first order (920-mm. focal distance), or its equivalent in power, with high intensities are required. In countries where the atmosphere is generally clear and fogs are less prevalent than on the coasts of Britain, second- or third-order lights suffice for landfalls, having regard to the high intensities available by the use of improved illuminants. Secondary coast lights may be of second. third or fourth order of flashing character, and important harbour lights of third or fourth order. Less important harbours and places where considerable range is not required, as in estuaries and narrow seas, may be lighted by flashing lights of fourth order or smaller size. Where sectors are requisite, occulting apparatus should be adopted for the main light; or subsidiary lights, fixed or occulting, may be exhibited from the same tower as the main light but at a lower level. In such cases the vertical distance between the high and the low light must be sufficient to avoid commingling of the two beams at any range at which both lights are visible. Such commingling or blending is caused by atmospheric aberration.

Range of Lights.—The range of a light depends first on its elevation above sea level and secondly on its intensity. Most important lights are of sufficient power to render them visible at their full geographical range in clear weather. On the other hand there are many harbour and other lights which do not meet this condition.

The distances from which lights are visible, given in lists of lights—except in the cases of lights of low power for the reason given above—are usually calculated in nautical miles as seen from a height of 1 j ft. above sea level, the elevation of the lights being taken as above high water. Under certain atmospheric conditions, and especially with the more powerful lights, the glare of the light (by reflection from the clouds) may be visible considerably beyond the calculated range.

Elevation of Lights.—The elevation of the light above sea level need not, in the case of landfall lights, exceed zoo ft., which is sufficient to give a range of more than 20 nautical miles. For coast lights 150 ft. is usually sufficient. Lights on high headlands are liable to be enveloped in banks of fog at times when at a lower level the atmosphere is comparatively clear (*e.g.*, the old Beachy head light). No definite rule can, however, be laid down, and local circumstances, such as configuration of the coast line, must be taken into consideration in every case.

Choice of Site.—Landfall stations should receive first consideration and the choice of location for such a light ought never to be made subservient to the lighting of the approaches to a port. Subsidiary lights are available for the latter purpose. Lights installed to guard shoals, reefs or other dangers should, when practicable, be placed seaward of the danger itself, as it is desirable that seamen should be able to make the light with confidence. Sectors marking dangers seaward of the light should not be employed except when the danger is in the near vicinity of the light. Outlying dangers require marking by a light placed on the danger or by a floating light in its vicinity.

OPTICAL APPARATUS

Optical apparatus in marine lighthouses is employed for concentrating the rays of light derived from a light source: (1) in the vertical plane only, to show a fixed belt of light all round the horizon, which can be made either flashing or occulting by eclipsing the light or by mechanically interposing a screen; (2) in both the vertical and horizontal planes simultaneously to produce a high-powered beam or cone of light which can be revolved, to show a flashing light, or fixed, to mark an isolated danger or narrow channel where a limited azimuth suffices; and (3) in the vertical plane and afterward in the horizontal plane for diverting or condensing a portion of the fixed belt of light to strengthen a sector.

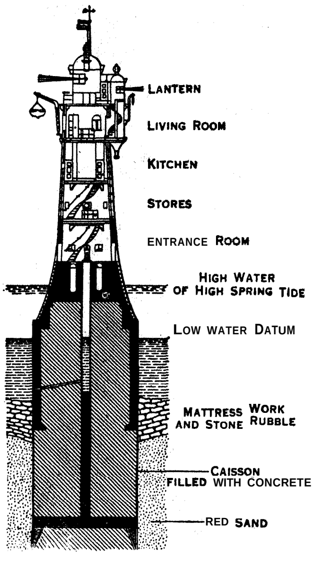


FIG. 5.— ROTHERSAND LIGHTHOUSE. NEAR THE MOUTH OF THE WESER ESTUARY, GER.

Three types of apparatus are used to effect these concentrations: (1) catoptric, in which the rays undergo reflection only at the surface of a mirror; (2) dioptric, in which the rays pass through a glass medium and are bent or refracted as they enter and emerge from it (fig. 8); and (3) catadioptric, in which the rays after entering the glass medium suffer total internal reflection before emerging from it (fig. 7). The object of these several forms of optical apparatus is not only to produce characteristics or distinctions in lights to enable them to be recognized readily by mariners. but to utilize the light rays to the best advantage by their condensation. This is accomplished more effectively by the use of revolving annular lenses than by fixed belts, as greater intensities are thereby attained. Fig. 7 shows in diagrammatic form the various sections and dispositions of glass elements commonly used in lighthouse optical apparatus.

Catoptric System.—Paraboloidal reflectors, consisting of small facets of silvered glass set in plaster of paris, were first used about the year 1763 in some of the Mersey lights by William Hutchinson, who was then dockmaster at Liverpool. Spheroidal metallic reflectors were introduced in France in 1781, followed by paraboloidal reflectors of silvered copper in 1790 in England and France, and in Scotland in 1803. The earlier lights were of the fixed type, a number of reflectors being arranged on a frame or stand in such a manner that the emergent rays overlapped and thus illuminated

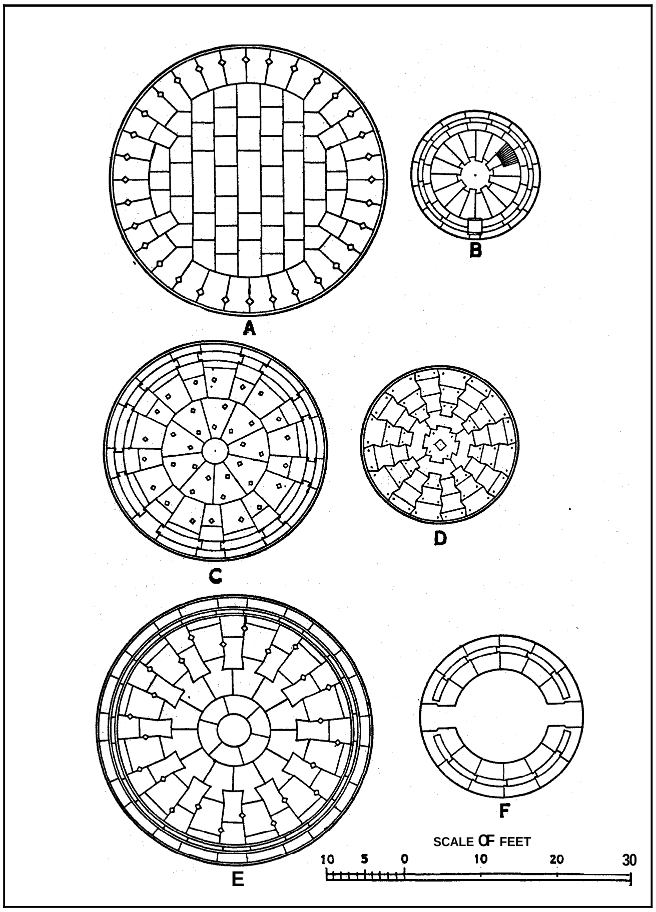


FIG. 6.— COURSES OF STONES OF VARIOUS TOWERS

(A) Dubh Artach, 1st course. (B) Bell rock floor. (C) Wolf, 12th course. (D) Eddystone, 12th course, Smeaton's tower. (E) Chickens, 6th course. (F) Eddystone, 48th course, Douglass tower

the whole horizon continuously. In 1783 the first revolving light mas erected at Marstrand in Sweden. Similar apparatus was installed at Cordouan (1790), Flamborough head, Yorkshire (1806), and at the Bell rock (1811). To produce a revolving or flashing light the reflectors were fixed on a rotating carriage having several faces. A type of paraboloidal reflector is still used for light-vessel illumination.

About the year 1900 reflecting mirrors were used in the Heligoland lighthouse in combination with electric arc lamps.

Dioptric System.—The first adaptation of dioptric lenses to lighthouses was probably made by T. Rogers, who used lenses at one of the Portland lighthouses between 1736 and 1790. The comte de Buffon had in 1748 proposed to grind out of a Solid piece of glass a lens in steps or concentric zones in order to reduce the thickness to a minimum (fig. 8A). The marquis de Condorcet in 1773 and David Brewster in 1811 designed built-up lenses consisting of stepped annular rings. Neither of these designs, however, was intended to apply to lighthouse illumination. In 1822 Augustin Fresnel constructed a built-up annular lens in which the centres of curvature of the different rings receded from the axis according to their distances from the centre, so as practically to eliminate spherical aberration; the only spherical surface being the small central part or bull's-eye (fig. 8). These lenses were intended for revolving lights only. Fresnel next produced his cylindric refractor or lens belt, consisting of a zone of glass generated by the revolution round a vertical axis of a medial section of the annular lens (fig. 8). The lens belt condenses and parallelizes the light rays in the vertical plane only, while the annular lens does so in both planes. The first revolving light constructed from Fresnel's designs was erected at the Cordouan lighthouse in 1823. It consisted of eight panels of annular lenses of 45° vertical aperture and having a focal distance of 920 mm. To utilize the light nhich would otherwise escape above the lenses, Fresnel introduced a series of eight plain silvered mirrors on which the light was thrown by a system of lenses. At a subsequent period mirrors mere also placed in the lower part of the optic. The apparatus was mounted on rollers and revolved by clockwork. This optic embodied the first combination of dioptric and catoptric elements in one design (fig. 9). Fresnel also designed for the Chassiron lighthouse a dioptric lens with catoptric mirrors for giving a fixed light, which was the first of its kind installed (1827) in a lighthouse. This combination is geometrically perfect, but not practically so because of the great loss of light by metallic reflection; this is 25% greater than that resulting. from the use of glass elements. Shortly before his death in 1827 Fresnel devised his totally reflecting or catadioptric prisms (fig. 7) to take the place of the silvered reflectors previously used above and below the lens elements. In these the principle of internal reflection from the face of a glass prism is made use of as well as the principle of refraction. Thus a ray of light falling on the prismoidal ring is refracted as shown in the enlarged detail of the reflecting prism and then'is totally reflected. emerging after a second refraction in a horizontal direction. Fresnel devised these prisms for use in fixed-light apparatus, but the principle was applied to flashing lights by T. Stevenson in 1850. Both the dioptric lens and catadioptric prism invented by Fresnel were still in general use at mid-20th century. the mathematical calculations of the great French designer still forming the basis upon which lighthouse opticians work.

Fresnel also designed a form of fixed and flashing light in which a fixed light. varied by flashes, was produced by placing panels of straight refracting prisms in a vertical position an a revolving carriage outside the fixed-light apparatus. The revolution of the upright prisms periodically increased the power of the beam by condensation of the rays, emergent from the fixed apparatus, in the horizontal plane.

The lens segments in Fresnel's early apparatus were of polygonal form instead of cylindrical, but subsequently manufacturers succeeded in grinding glass in cylindrical rings of the form later generally used. The first apparatus of this description was made by the Cooksons of Newcastle in 1836 at the suggestion of Alan Stevenson, and erected at Inchkeith, Fifeshire. The first dioptric apparatus erected by the Trinity House to show a fixed light was the one formerly at Start point in Devonshire. It was constructed in 1836.

Azimuthal Condensing Prisms.—To condense the rays from a fixed-light apparatus in certain azimuths, T. Stevenson devised in 1850 his azimuthal condensing prisms which have been variously applied in the construction of optical apparatus as, for instance, for the strengthening of coloured sectors. Applications of this system are discussed below (sae fig. 10).

Dioptric Mirror.—An important improvement in lighthouse optical work was the invention of the dioptric mirror by (later Sir) James T. Chance in 1862. This mirror is a modification of a spherical mirror devised by T. Stevenson in 1850, in which double reflection from the internal surfaces of a catadioptric prism was employed. Chance generated the zones of prisms round the vertical axis, separated the elements and set them at increasing radii, thus producing an instrument of practical utility. By the use of the dioptric mirror, rays of light which would otherwise be lost are reflected back through the focus of the source of light and are refracted or reflected with the main rays. This form of mirror was still in general use in the late 1950s. It is constructed for vertical angles up to 100°.

Spherical Lens.—C. A. Stevenson devised in 1888 annular lens panels consisting of lens elements spherical in the horizontal and vertical planes. and these, with equiangular prisms. have been used in a number of apparatus for Scottish lighthouses.

Optical Glass for Lighthouses.— In the early days of lens lights the only glass used for the prisms was made in France at the

St. Gobain and Prémontré works, long celebrated for the high quality of their optical glass. The early dioptric lights erected in the United Kingdom, 13 in all, were made by the Cooksons. who were instructed by Léonor Fresnel, the brother of Augustin. At first they tried to mould the lens and then to grind it out of one thick sheet of glass. The manufacture of lenses was abandoned by

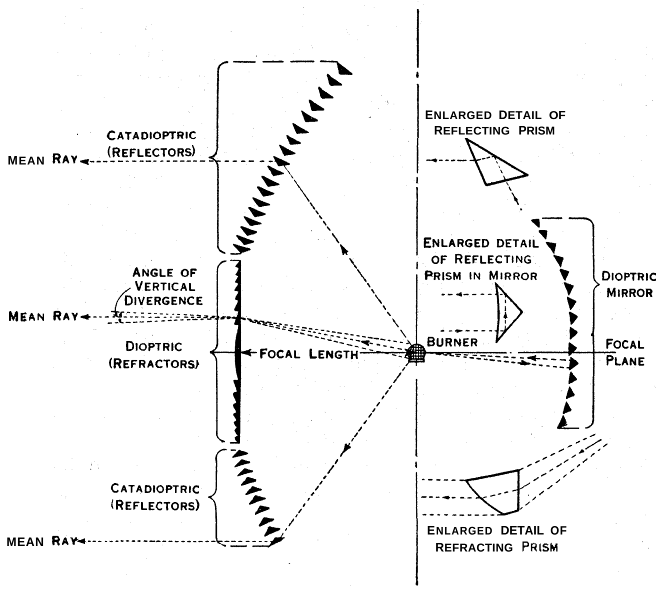


FIG. 7.— DIAGRAM SHOWING THE GLASS ELEMENTS COMMONLY USED IN LIGHTHOUSE OPTICAL APPARATUS. ELEMENTS ARE IN VERTICAL SECTION

Cooksons' successors in 1845 and in 1850 Chance Brothers and company of Birmingham began to make optical glass. assisted by Tabouret, a French expert who had been a colleague of Augustin Fresnel himself. The first light made by the firm was shown at the Great exhibition of 1851. After that time numerous dioptric apparatus were constructed by Chance Brothers, who remained the only manufacturers of lighthouse glass in the United Kingdom.

The glass generally employed for lighthouse optics has a mean refractive index of $\mu = 1.51$. the corresponding critical angle being 41° 30'. Chance Brothers used dense flint glass for the upper and lower refracting rings of high-angle lenses (up to 97° vertical angle) and for dioptric mirrors in certain cases. This glass has a value of $\mu = 1.62$ with critical angle 38° 5′. The use of refracting elements for an angle greater than 60° aperture is not attended by any advantage over reflecting prisms.

TYPES OF LIGHTS

Occulting Lights.—During the last quarter of the 19th century the disadvantages of fixed lights became more and more apparent and they fell into disuse except in the case of the less important harbour and river lights. The necessity of providing a distinctive characteristic led to the conversion of many of the fixed lights into occulting lights, or to their replacement by more modern and powerful flashing apparatus. The occultation of a light is produced either by a cylindrical screen lowered and raised around the burner; or by a revolving screen; or. when some form of gas burner or electric lamp is used. by intermittently extinguishing the light itself. Varying characteristics. comprising one or more occultations, may be procured by means of such contrivances. "Otter" screens are sometimes employed in cases where it is desired to produce different periods of occultation in two or more positions in azimuth, in order to differentiate sectors marking shoals. etc. The screens are of sheet metal blacked and arranged vertically, somewhat in the manner of the laths of a venetian blind, and operated by mechanical means.

Leading Lights.—In the case of lights designed to act as a lead through a narrow channel or as direction lights, it is undesirable to employ a revolving apparatus. Fixed-light optics are used in such cases, generally fitted with an eclipsing mechanism. A typical apparatus of this description is that at Woodman point, Fremantle, Western Australia (fig. 10). The occulting white light covers the fairway and is flanked by sectors of occulting red and green lights marking dangers and intensified by vertical condensing prisms. A good example of a holophotal direction light is that at Suzac lighthouse, Fr. The apparatus consists of an annular lens of 500-mm. focal distance. 180° horizontal angle and 157° vertical, with a reinforcing mirror of 180°. The lens throws a red beam, of about $4\frac{1}{2}°$ amplitude in azimuth and 50,000 candle power, over a narrow channel. The illuminant is an incandescent petroleum-vapour burner. Holophotal direction lenses of this type can only be applied where the sector to be marked is of comparatively small angle. Silvered metallic mirrors of parabolic section are also used for the purpose. The establishment of a direction light frequently renders the construction of separate towers for leading lights unnecessary. If two distinct lights are employed to indicate the line of navigation through a channel or between dangers they must be sufficiently far apart to afford a good lead, the front or seaward light being situated at a lower elevation than the rear or landward one.

Coloured Lights.—Colour is used as seldom as possible as a distinction. entailing as it does a considerable reduction in the power of the light. It is, however, necessary in some instances for differentiating sectors over dangers and for harbour lighting. Alternating colours for flashing lights are not to be commended on account of the unequal absorption of the coloured and bright rays by the atmosphere. Where such a combination has been employed, the red and white beams have been approximately equalized in initial intensity by constructing the lens and prism panels for the red light of larger angle than those for the white beams. As a result of absorption by the red colouring of the glass screen the poner of the red beam varies from 0.15 to 0 3 of the intensity of the white light depending on the colour temperature of the light source and whether 'the filter is flashed with selenium, gold or copper red. The corresponding intensity of green light varies from 0 12 to 0.20 depending upon the colour temperature of the source. When red or green sectors are employed in conjunction with a white light from a fixed apparatus. they should if it is practicable be reinforced by mirrors, azimuthal condensing prisms or other means to raise the coloured beam to approximately the same intensity as the white light. With the introduction of group-flashing characteristics the necessity for using colour as a means of distinction for landfall lights disappeared. In situations such as a river fairway where a large number of buoy or beacon lights have to be provided with distinguishing characteristics, coloured lights are, however, frequently employed.

Group-Flashing Lights.—One of the most useful distinctions consists in the grouping of two or more flashes separated by short intervals of darkness, the group being succeeded by a longer eclipse. Thus two, three or more flashes of, say, half-second duration or less follow each other at intervals of about two seconds and are succeeded by an eclipse of, say, ten seconds. In 1874 John Hopkinson introduced the improvement of arranging the lenses of a dioptric revolving light, together with their panels of reflecting prisms, asymmetrically, setting them at an angle to produce the group-flashing characteristic.

The first apparatus of this type constructed were those at Tampico, Mex. (triple flashing), and the Little Basses lighthouse, Ceylon (double flashing). A modification of the system consists in grouping two or more lenses together and filling the remaining angle in azimuth by a reinforcing mirror. A sectional plan of the quadruple-flashing first-order apparatus at Flamborough head, Yorkshire, is shown in fig. 11.

Hyperradial Apparatus.—In 1885 the Barbier company of Paris constructed the first hyperradial apparatus (1,330-mm. focal distance) to the design of D. and C. Stevenson. Apparatus of similar focal distance were subsequently established at a number of other lighthouses. That at Manora point. Karachi, India (later Pakistan) (1908), is illustrated in fig. 12. The introduction of incandescent oil burners and electric lamps of focal compactness and high intrinsic brightness rendered unnecessary the provision of optics of such large dimensions.

Fixed and Flashing Lights.—The use of these lights. which show a fixed beam varied at intervals by more powerful flashes, is undesirable, though a large number were constructed in the earlier years of dioptric illumination and some were still in existence in the late 1950s. In certain conditions of the atmosphere it is possible for the fixed light of low power to be entirely obscured while the flashes are visible. Thus the true characteristic of the light is vitiated.

Screens and Cuts.—Screens of coloured glass. intended to distinguish the light in particular azimuths, and of sheet iron! when it is desired to cut off the light sharply on any angle. should be fixed as far from the centre of the light as possible in order to reduce commingling, in the first case: and the escape. in the second case, of the light rays caused by divergence. These screens are usually attached to the lantern framing.

Divergence.—A dioptric apparatus designed to bend all incident rays of light from the light source in a horizontal direction would, if the flame could be a point, have the effect of projecting a band or zone of light (in the case of a fixed apparatus) and a cylinder of light rays (in the case of a flashing light) toward the horizon. Under such conditions the mariner in the near distance would receive no light as the rays would pass above the level of his eye and be visible only on the horizon. In practice this does not occur, sufficient natural divergence being produced ordinarily because of the magnitude of the source. When the electric arc or an incandescent electric lamp of small focal diameter is employed it is sometimes necessary to design the prisms so as to produce artificial divergence.

The approximate formula for finding the angle of divergence of the beam is $w=\frac{d}{f}$ radius, or $57\frac{d}{f}$ where w = angle of divergence, d = width of the light source in centimetres for horizontal divergence and height of light source in centimetres for vertical divergence and f = focal distance of the system in centimetres. In fixed dioptric lights there is, of course, no divergence in the horizontal plane. In revolving lights the horizontal divergence is a matter of considerable importance, determining as it does the duration of flash; *i.e.,* the length of time the flash is visible to the mariner.

Feux-Éclairs or Quick-Flashing Lights.—One of the most important developments in lighthouse illuminating apparatus was in the direction of reducing the length of flash, initiated by the French lighthouse authorities about 1891 and shortly afterward followed in other parts of the world. The early *feux-éclairs,* designed by the French engineers and others, usually had a flash of $\frac{1}{10}$- to $\frac{1}{3}$-sec. duration. As a result of experiments carried out in France in 1903–04, $\frac{3}{10}$ sec. was generally adopted as the minimum duration for white flashing lights. If shorter flashes are used the reduction in duration is attended by a corresponding, but not proportionate. diminution in effective intensity. In the case of many electric flashing lights the duration is of necessity reduced but the greater initial intensity of the flash permits this loss without serious detriment to efficiency. The apparent intensity of rhythmic light may be calculated by the Blondel-Rey formula given in clause 11 of British Standard 942, 1949. Red or green requires a considerably greater duration than do white flashes. The intervals between the flashes in single-flashing lights of this character are also small, usually $2\frac{1}{2}$ to j sec. In group-flashing lights the intervals between the flashes are about 2 sec. or even less, with periods of 7 to 1 j sec. between the groups, which may be arranged to show any number up to six flashes, as in the older forms of apparatus. The *feu-éclair* type of apparatus enables a higher intensity of beam to be obtained by reason of the greater ratio of condensation of light, the employment of panels of greater angular breadth than those formerly used being possible with a higher rotatory velocity.

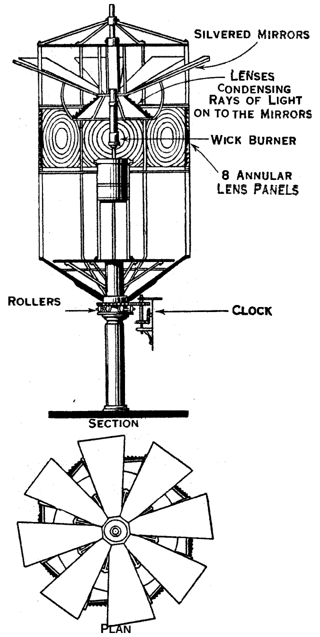


FIG. 9.—FRESNEL'S FIRST REVOLVING LIGHT, ERECTED IN 1823

This apparatus of 920-mm. focal distance, formerly at Cordouan lighthouse, Gironde river, was the first dioptric revolving light to be established

It has been urged that short flashes are insufficient for taking bearings, but the utility of a light in this respect does not seem to depend so much upon the actual length of the flash as upon its frequent recurrence at short intervals.

It was soon found impracticable to revolve an optical apparatus with its mountings, sometimes weighing as much as seven tons. at the higher rate of speed required for *feux-éclairs* by means of the old system of roller carriages, though for a certain number of small quick-revolving lights ball bearings have been successfully adopted. It therefore became almost the universal practice to carry the rotating portions of the apparatus upon a mercury float. This application of mercury rotation mas the invention of O. Bourdelles. The arrangement consists of an annular cast-iron trough containing mercury with a similar but slightly smaller annular float immersed in it and displacing a volume of the liquid metal whose weight is equal to that of the apparatus supported. In all cases provision is made for lowering the mercury bath or raising the float and apparatus for examination.

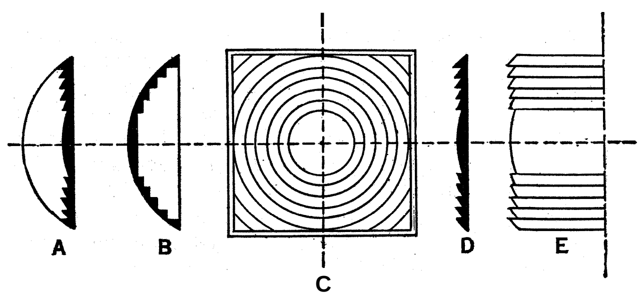


FIG. 8.— THEDEVELOPMENT OF FRESNEL'S LENSES

(A) Buffon's lens; (B) derivation of Fresnel's lens; (C), (D) elevation and section of Fresnel's annular lens; (D), (E) section and half elevation of Fresnel's lens belt

Multiform and Twin Apparatus.—In order to double the power to be obtained from a single apparatus at stations where lights of high intensity were desired, the expedient of superimposing one complete lens apparatus on another was sometimes adopted, as at Bishop rock (fig. 4), Hartland point, Devon, and at the Fastnet lighthouse in Ireland. Triform and quadriform apparatus have also been erected in Ireland. The adoption of the multiform system of lens apparatus involves the use of lanterns of increased height.

Another method of doubling the power of a light is by mounting two complete and distinct optics side by side on the same revolving table. This expedient has been frequently adopted by French designers and a modern example is the small third-order biform optic by Chance Brothers. installed at Longstone in the Farne Islands off Northumberland in 1952, giving an intensity of 2,200,000 candles.

Orders of Apparatus.—Augustin Fresnel divided his dioptric lenses into orders or sizes depending on their focal distance. This division is still used, although two additional orders known as hyperradial, which is rapidly becoming obsolete, and small third order have been introduced. The modern tendency is toward the adoption of optics of third order or less. which with modern electric lamps can give intensities of more than 1,000,000 candle power. The following list gives the focal distance of the several sizes:

Order	Focal distance, mm.
Hyperradial	1,330
First order	920
Second order	700
Third order	500
Small third order	375
Fourth order	250
Fifth order	187.5
Sixth order	150

Lenses of smaller focal distance are also made for buoy and beacon lights.

Light Intensities. — The figures given in the admiralty lists of lights for intensity multiplied by 1,000 give the candle power in candelas. The candela is the international unit of luminous intensity and is equivalent to the former British standard candle. The Hefner candle is equivalent to 0.9 candelas.

Formulas for calculating the intensities of lighthouse beams and beams from cognate projection apparatus will be found in British Standard 942, 1949. Deductions must be made in the case of coloured lights (see *Coloured* Lights, above).

The mathematical theory of optical apparatus for lighthouses and formulas for the calculations of profiles will be found in the works of the Stevensons, Chance, E. Allard, F. L. Reynaud, Hopkinson, C. Ribière and others.

ILLUMINANTS

The earliest form of illuminant used for lighthouses mas a fire of coal or wood set in a brazier or grate erected on top of the lighthouse tower. Until the end of the 18th and even into the 19th century this primitive illuminant continued to be almost the only one in use. The coal fire at the Isle of May light continued until 1810 and that at St. Bees lighthouse in Cumberland to 18.23. Fires are stated to have been used on the two towers of Nidingen in the Cattegat until 1846. Smeaton was the first to use any form of illuminant other than coal fires; he placed within the lantern of his Eddystone lighthouse a chandelier holding 24 tallow candles. each of which weighed $\frac{2}{5}$ lb. and emitted a light of 2.8 candle power. The aggregate illuminating power was 67.2 candles and the consumption was at the rate of 3.4 lb. per hour.

Oil. —Oil lamps with flat wicks were used in the Liverpool lighthouses as early as 1763. A. Argand, between 1780 and 1784, perfected his cylindrical-wick lamp which provides a central current of air through the burner, thus allowing the more perfect combustion of the gas issuing from the wick. The principle of the multiple-wick burner was devised by Count Rumford. Fresnel produced burners having two, three and four concentric wicks. Sperm oil was used in English lighthouses until 1846, but about that year the much cheaper colza oil was employed generally. Olive, lard and cocoanut oils have also been used for lighthouse purposes in various parts of the world.

Table III.—*Particulars of* **Oil** *Burners*

Mantle diameter, mm.	Service intensity, candelas	Intrinsic brightness per sq.cm. of projected area, candelas	Consumption of oil, pints per hour
35	675	53	0.75
50	1,200	52	1.1
75	2,200	50	2.2
100	3,200	48	3.3

The introduction of mineral oil, costing a mere fraction of the expensive animal and vegetable oils, revolutionized the illumination of lighthouses. It was not until 1868 that a burner was devised which successfully consumed hydrocarbon oils. This was a multiple-\lick burner. invented by Captain Doty, which was quickly taken into use by lighthouse authorities. The Doty burner, and other patterns involving the same principle, remained practically the only oil burners in lighthouse use until the last few years of the 19th century.

Coal Gas. —Coal gas was introduced in 1837 at the inner pier light of Troon, Ayrshire, and in 1847 it was in use at the Heugh lighthouse, West Hartlepool. In 1878 cannel-coal gas was adopted for the Galley head lighthouse, County Cork, Ire.. with 108-jet Wigham burners. Sir James N. Douglass introduced gas burners consisting of concentric rings, two to ten in number, perforated on the upper edges.

The invention of the Welsbach mantle placed at the disposal of the lighthouse authorities the means of producing a light of high

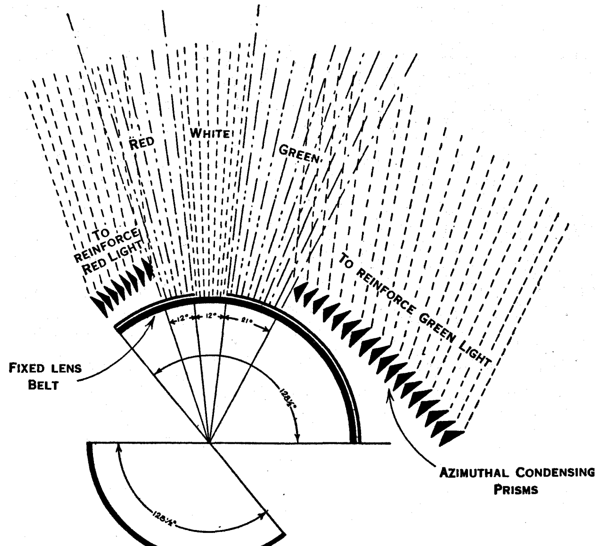


FIG. 10. — WOODMAN POINT DIRECTION LIGHT, FREMANTLE. WESTERN AUSTRALIA

The diagram is a plan of the optical apparatus at the level of the focal plane. The light is condensed and directed over the channel, the dangers at the sides of which are covered by the red and green lights

intensity combined with focal compactness. For lighthouse purposes gaseous illuminants other than coal gas are as a rule more convenient and economical and give better results with incandescent mantles. Mantles have, however, been used with ordinary coal gas in instances where a local supply of suitable types is available.

Incandescent Mineral-Oil Burners. — Incandescent lighting with high-flash mineral oil was first introduced by the French lighthouse service in 1898 at L'fle Penfret lighthouse. The incandescent burners in use in lighthouse services the world over are all made on the same principle, but differ in details. The principle consists in injecting the liquid petroleum under pressure into a vaporizer where it is heated by subsidiary jets and converted into vapour. This vapour issues from a nozzle and, drawing in air, passes into a chamber in the head of the burner where it mixes to form a combustible gas for the incandescence of the mantle; at the same time a small proportion of the gas is diverted to the subsidiary jets. A small reservoir of compressed air — charged by means of a hand-pump — is used for providing the necessary pressure for injection. On first ignition the vaporizer is heated by a spirit flame to the required temperature.

The candle power of apparatus in which ordinary multiple-wick burners were formerly employed is increased more than six times by the substitution of suitable incandescent-oil burners. In 1902 incandescent-oil burners were adopted by the general lighthouse authorities in the United Kingdom. The Hood burner used in the Trinity House service is illustrated in fig. 13. The mantles are of the soft autoform (or self-forming) type which took the place of the collodion mantles employed in the older forms of burner. Particulars relating to the burners in ordinary use are shown in Table III.

Oil **Gas.**—Pintsch's oil-gas system introduced in the 1870s is the prototype of the several methods of gas lighting employed for the majority of buoy and other unattended lights and before the end of the 19th century it was in general use in many countries. Incandescent oil-gas burners were introduced both for buoy and beacon lighting as well as for a few attended lights early in the 20th century. The use of ordinary oil gas necessitates its periodical supply by means of large transport containers in which it is stored at a pressure of from nine to ten atmospheres, a disadvantage which led to its gradual replacement by acetylene or other forms of oil gas (see below).

An oil gas, known by the name of its inventor. Blau, of Augsburg, was employed to some extent. particularly in Germany and the Netherlands, after about 1906 as a substitute for ordinary oil gas. It is produced in retorts in much the same manner as the older variety but at a lower temperature (550°–600° C.) and can be compressed to 100 atm., at which pressure the hydrocarbons are liquefied. This liquid gas is stored and transported in cylinders weighing about 130 lb. and is expanded from them at about nine atmospheres pressure into the body of the buoy or the receivers at the beacon or lighthouse. When it is used with an incandescent mantle of large size an intrinsic brightness of about 2; candle power per square centimetre or about 40% more than ordinary oil gas is obtainable.

Propane came into standard use in France for lighted buoys. It is burned in conjunction with an incandescent mantle and this system is used to some extent in Great Britain.

Acetylene. — Acetylene (*q.v.*) was first experimented with for buoy and beacon lighting about 1896, open-flame burners being used. An incandescent-mantle burner consuming acetylene mas used at the Chassiron lighthouse, Fr., in 1902. Oil gas, enriched by the addition of 20% of acetylene, was for a time used in Germany and the Netherlands for buoy and beacon lighting. It was not, however, until about 1906, when the difficulties associated with its employment had been overcome by the introduction of dissolved acetylene! that the gas came into general use for coast lighting. Acetylene in this form is stored at a pressure of 10 to 15 atm. in cylinders, usually weighing about two hundredweights, filled with a porous material and charged with acetone in the presence of which the gas is dissolved. Because of the higher intrinsic

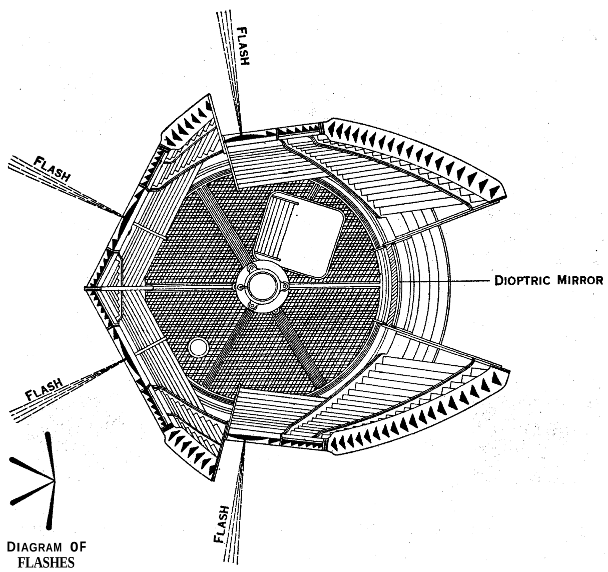


FIG. 11.—FLAMBOROUGH LIGHTHOUSE, YORKSHIRE

Sectional plan of the first-order optical apparatus at focal plane. The light shows four flashes every 15 sec.

brightness of the flame and the convenient transport of the gas it came into common use throughout the world not only for buoy and beacon lighting but also for many coast lights of secondary importance and unattended revolving lights. mantle burners being sometimes employed.

Acetylene generated on the spot on the carbide-to-water principle nevertheless continued to be used by some lighthouse authorities for unattended lights. Comparatively frequent attention in renewing the charge is, however, required in these cases. The intrinsic brightness obtained in some incandescent-acetylene burners is about equal to that of autoform-mantle petroleum-vapour burners.

Electricity. — Electricity for lighthouse illumination mas first experimented with in England in 1858 at South Foreland. Kent, by Trinity House. This mas followed by its adoption at Dungeness, Kent, in 1862 and at Souter point on the coast of Durham in 1871. Both these installations were later abandoned, the former in 1874 and the latter in 1923 when a first-order biform flashing light with incandescent-oil burner replaced it. Electricity was installed at St. Catherine's point in the Isle of Wight in 1888 and was also in use at the Isle of May lighthouse at the mouth of the Firth of Forth from 1886 to 1924. Arc lamps formerly provided the illuminant in all large apparatus, but the development of high-power, gas-filled electric-filament lamps caused their replacement for lighthouse use. British Standard 1546, 1949, Lighthouse Lamps (Electric), lists and gives complete specifications for lamps rated from 100 v. 100 w. to 100 v. 4,500 w. giving an average brightness of from 100 to 1,100 stilbs.

Economies have been effected by the introduction of these lamps combined with automatic electric equipment, and where in addition a local supply of current is available the reduction of maintenance charges at electric stations is considerable. For instance at South Foreland. which became a permanent electric station in 1872, an engineer and four keepers were formerly required to maintain the establishment, which included a steam electric-generating plant. With the introduction of the filament lamp and automatic equipment in 1926 the establishment was reduced to one keeper. High-tension cables were brought from Dover to the lighthouse. The clock machine revolving the lens is wound electrically, and a lamp changer automatically replaces a lamp when the filament of the one in service burns out or brings a stand-by acetylene burner into focus if the electric supply fails. A telltale device in the keeper's quarters warns him if any derangement takes place. The filament lamp is 8,000 candle power, 80 v. and 50 amp., and has a mean intrinsic brightness of 1,000 candles/cm^2. A somewhat similar installation was substituted for the arc lamp at the Lizard (1926), but in this case the current was generated at the lighthouse, the personnel being reduced from five to three. In 1951 this station was converted to mains operation. At 16 other important coast lighthouses, including St. Catherine's (6,000,000 candle power) and Lizard (3,000,000), mains electricity was brought in and electric light introduced in place of the petroleum-vapour burners. The apparatus in the lantern was made automatic.

At a further seven rock stations electric generators were installed and the lights changed over to electric with greatly increased candle power.

All modern Trinity House light vessels employ high-power electric lamps in the multicatoptric optical apparatus.

Electricity was used at the old south lighthouse at La Heve, Fr., in 1863, and after 1897 there were 13 major electric lights on the French coast. Arc lamps were employed and a generating plant, usually steam driven, was provided at each station. The high cost of maintaining such stations prevented any extension of their use on a large scale in France as in other countries; but after 1920 the conversion of some of the then existing electric stations to incandescent-filament lighting was effected. In all places where power could be taken from the public mains the lights were electrified. Gas is sometimes employed for the stand-by burners in French electric lighthouses.

Similar conversions to mains electricity took place in the Netherlands and other countries.

MISCELLANEOUS LIGHTHOUSE EQUIPMENT

Modern lighthouse lanterns usually consist of a cast-iron or steel pedestal. cylindrical in plan, on nhich is erected the lantern glazing. surmounted by a domed or conical roof and ventilator (fig. 12). Adequate ventilation is of great importance, and is provided by ventilators in the pedestal and a large ventilating dome or cowl in the roof. The astragals carrying the glazing are of wrought steel or gun metal. They are frequently arranged helically or diagonally, thus causing a minimum of obstruction to the light rays in any vertical section and affording greater rigidity to the structure. The glazing is usually $\frac{1}{4}$-in.-thick plate glass curved to the radius of the lantern. In situations of great exposure the thickness is increased. Lantern roofs are of sheet steel or copper secured to steel, gun-metal or cast-iron rafter frames. At certain lighthouses it is found necessary to erect a grille or network outside the lantern to prevent the numerous sea birds attracted by the light from breaking the glazing by impact. Lanterns vary in diameter from 5 to 16 ft. or more, according to the size of the optical apparatus. For first-order apparatus a diameter of 14 ft. is usual and 12 ft. for second-order. The lantern. gallery handrails and principal metallic structures in a lighthouse should be connected to a copper lightning conductor carried to a point below low water or terminating in an earth plate embedded in wet ground.

Revolving-light apparatus are rotated by clockwork mechanism actuated by weights or spring driven. The clocks are fitted with speed governors and also warning apparatus to indicate when rewinding is required. Where current is available small electric motors are often employed either for automatic rewinding of the clockwork or for driving the rotating mechanism direct. In modern gaslit apparatus the pressure of the gas is sometimes made use of to revolve the lens table.

At rock and other isolated stations, accommodation for the keepers is usually contained in the towers. In the case of land lighthouses, dwellings are provided in close proximity to the tower. The watch room should be situated immediately under the lantern floor. Oil is generally stored in lead-lined concrete or steel tanks.

UNWATCHED AND UNATTENDED LIGHTS

Electric. — Since 1884, when an iron beacon lighted by an incandescent electric lamp supplied with current from a secondary battery was erected on a tidal rock near Cadiz, Sp., various forms of electric unattended lights have been experimented with. By the end of the 1920s many such lights were in permanent use where current could be obtained from a local supply circuit.

Storage batteries, small automatic generating sets and stand-by gas burners are alternatively provided to guard against the failure of the main supply. Automatic devices are also fitted for changing one lamp for another if the lamp in focus should fail. and for switching in the stand-by apparatus when necessary. Both revolving and fixed optics are used. In the former case the optic is rotated by a small electric motor and in the latter some form of automatic interrupter produces the flashing characteristic. In cases where the optic is too small for a lamp changer to be accommodated, two lenses are employed. one superimposed on the other. In one of the lenses is focused the electric lamp in normal use and in the other the stand-by gas or electric lamp. An example of secondary lights, formerly attended and now converted to electric, is at Burnham in Somerset where two leading lights more than a quarter of a mile apart were so altered in 1928 and are unwatched at night. In this case the optics are of fixed section, and the automatic features include a flashing device for giving the lights their respective characteristics. Major conversions to unwatched electric lights are Southwold, Suffolk (1938, 243,000 candles), and Happisburgh. Norfolk (1948. 15,000 candles).

Other Forms of Beacon Lighting. — Among other systems of unattended beacon lighting; adopted in lighthouse services after about 1880, but now little used, may be mentioned the Lindberg light, a Swedish invention employing a volatile spirit; the Benson-Lee lamp having a carbon-tipped wick; the French permanent-wick la'mp; and the Wigham lamp in which a flat wick immersed in petroleum travelled over a horizontal roller so that the petroleum was volatilized from a constantly renewed surface.

Acetylene Lights. — The gas is provided either by an automatic generator or else in the form of compressed acetylene dissolved in acetone. In order to reduce the consumption and at the same time give a distinctive characteristic to the light, the gas is usually passed through an automatic flashing mechanism which works continuously until the supply is exhausted. Waste of gas during daylight is sometimes obviated by using a sun valve, which is a device to turn off the gas at daybreak and turn it on at dusk. Sun valves depend for their automatic action on the differential expansion of two distinct metals under the influence of light rays or on the difference in the absorption of light rays by black and bright bodies respectively. The movement of a lever arm, brought about by a small movement of the light-sensitive element, actuates a valve which opens and closes the gas supply.

Acetylene in unattended lights is burned either as an open flame or in conjunction with a mantle.

The Aga system of acetylene lighting, developed in Sweden about 1904, has been extensively used both in that and other countries for all classes of unattended lights, including buoys. It was first adopted in England in 1913, together with the Dalen incandescent-mantle burner. This embodies a mix flasher which automatically

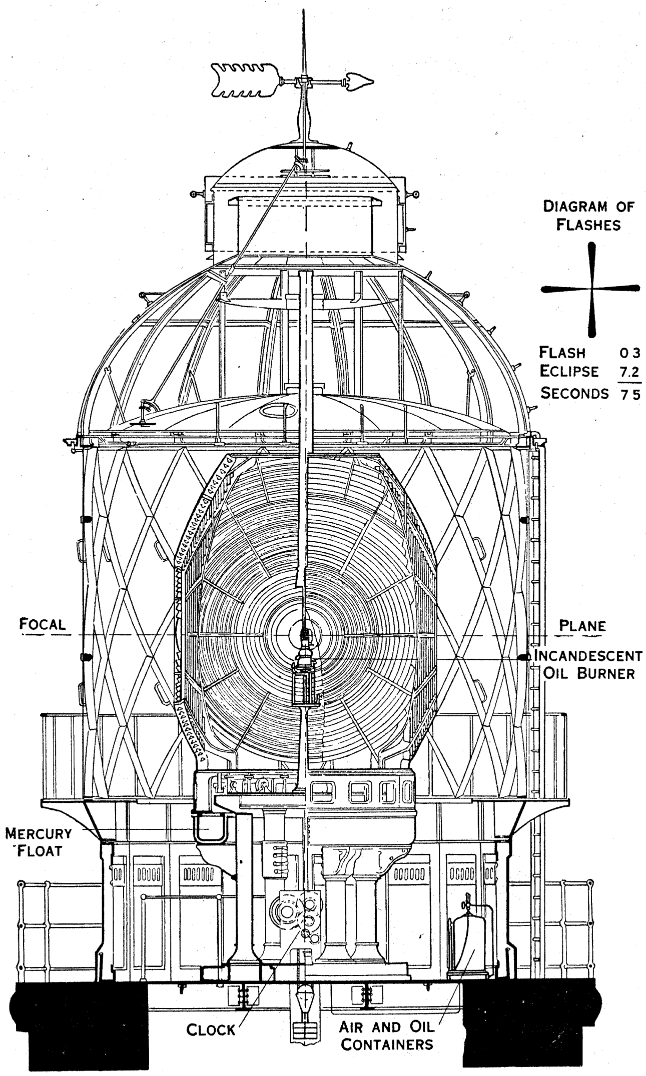


FIG. 12—MANORA POINT (KARACHI) APPARATUS AND LANTERN

The apparatus is of 1,330-mm. focal distance; it is rotated on a mercury float and has an incandescent oil burner at its focus. The right-hand half is shown in elevation and the left-hand as a vertical section

controls the character of the light and regulates the mixing of air and gas for consumption in an inverted soft-mantle burner.

In some unattended lights with acetylene illumination the lenses are rotated by a gas pump as the gas passes to the mixer and burner, the lens table moving on ball bearings or a mercury float. The sun valve automatically controls the duration of lighting; a pilot jet serves to reignite the main burner at sunset; and an automatic changer provides for the replacement of a broken mantle. Incandescent-mantle burners and acetylene equipment have also been installed in a number of lighthouses of secondary importance, formerly attended by keepers and now converted to unwatched or semiwatched lights. Among such in England are the lights at the Rock, Liverpool; Great Ormes head and

St. Tudwall's, Caernarvonshire; Berry head, south Devon; Peninnis head, Scilly Isles; East Usk, Monmouthshire; and Great Castle head, Pembrokeshire. The Menai lighthouse, Anglesey, was fitted with open-flame acetylene equipment. In some cases, where the consumption of gas is large, acetylene generators on the carbide-to-water system have been installed, as at the Farne Island and Bamburgh lights on the coast of Northumberland, and the two first-order leading lights at Hurst, on the mainland opposite the Isle oi Wight.

Acetylene in the dissolved form was, in the late 1950s, the best and most economical illuminant ior entirely unwatched lights when electric current was not available. Its use enabled many unattended lights to be established and maintained at a comparatively small cost in positions where a light attended by keepers would be impracticable as, ior example, on some parts oi the Australian coast.

LIGHT VESSELS

The earliest light vessel established in English waters was that placed at the Nore in the Thames estuary in 1732. The early lightships were small and carried lanterns of primitive construction suspended from the yardarms. Modern light vessels are usually of steel construction and are of various dimensions. The following may be tahen as the limits in the Trinity House service:

Length	112 to 137 ft.
Beam	24 to 25 it.
Depth moulded	15 ft.
Full load displacement	190 to 560 tons

The larger vessels are employed at outside' and exposed stations, the smaller ships being stationed in sheltered positions and in estuaries. The moorings usually consist of three-ton mushroom anchors and 13-in. or 19-in. stud-link cables. The lanterns used in some of the older vessels are eight feet in diameter surrounding the mast upon which they are hoisted at night and lowered to the deck level during the day. Fixed lanterns mounted on a steel lattice structure or tubular mast later displaced the older type. The first English light vessel with fixed lantern was constructed in 1904.

Self-propelled light vessels, some of which are of much larger dimensions than any British light vessel, are employed at the majority of stations in the United States, and there are a few in exposed situations in other countries including France, Sweden, the Netherlands and Germany.

Until about 1895 the illuminating apparatus used in light vessels was almost exclusively oi catoptric form, consisting for the most part of 21-in. silvered paraboloidal reflectors, having mineral-oil burners in focus, hung in gimbals to preserve the horizontal direction of the beam. In a few cases incandescent-mantle burners or electric-filament lamps were substituted for the wick burners in old catoptric apparatus. Dioptric apparatus is provided in some lightships, not only in Britain but in other countries also. The French lighthouse service in 1896 devised the first dioptric revolving light ior a light vessel. This ship, the "Talais,"[1] was lit by an incandescent oil-gas burner. A much larger vessel, the "Sandettié," of 342 tons displacement, was completed in 1902. The new type of floating light mas afterward adopted by other lighthouse authorities, and many vessels constructed on the lines of the "Sandettié" were built during the first decade of the 20th century. In England the first of this class was brought into service in 1905. Some of these vessels were fitted with revolving dioptric lenses suspended in gimbals below the lens table and counterbalanced by a heavy pendulum weight. The apparatus was mounted on ball bearings in some cases and on a mercury float in others, the lenses being revolved by clockwork or gas. Another method of suspending the dioptric apparatus mas developed, the design being a Swedish invention. This device, known as the constant-level table, was fitted in four vessels in the Trinity House service in 1928. In these vessels the illuminant, formerly acetylene employed with a mantle, was changed to electricity. The lens is mounted on a table made to revolve on ball bearings by the gas on its way to the burner. The lens table is balanced, near the centre of gravity, on a pivot in the lantern, and connected by three vertical pull wires to a pivoted counterbalance weight, placed in the hull of the ship at the rolling centre of the vessel, which controls the movement of the upper table. As the motion imparted to the lower balance weight is small, the swinging of the lens table is less than with the former arrangement of pendulum and gimbal suspension. In 1936 Trinity House evolved the multicatoptric pendulum apparatus comprising eight silvered mirrors of 18 in. diameter, illuminated by high-power electric projector type lamps, the optic apparatus heing rotated by electric motor and mounted in gimbals, the pendulum maintaining the light horizontal. This apparatus with subsequent improvements became standard equipment on all new Trinity House vessels. The arrangement oi the mirrors is such that they can readily be regrouped so as to exhibit a range of different characters. By this means modern light vessels can be placed for duty at many different stations according to the needs of the service, and a minimum of spare vessels is required: One such multicatoptric pendulum apparatus was installed in the Ambrose light vessel for the United States coast guard. In the older vessels illumination by oil-gas, incandescent-acetylene or incandescent-oil burners was formerly employed but these were largely replaced by high-powered gas-filled electric lamps.

[1]The "Talais" and another similar vessel constructed in 1899 were later converted into unattended light vessels.

An experimental electric-light installation on board a Mersey light vessel in 1886 proved unsuccessful.

Fog signals, where provided on modern light vessels, are generally in the form of sirens or diaphones worked by compressed air. The compressors were driven by steam or oil engines in the older installations but modern vessels have high-speed diesel engines.

Unattended Light Vessels.—In 1881 an unattended light vessel illuminated by Pintsch's oil gas was constructed for the Clyde. The light was occulting and the vessel carried a gasholder containing a supply of gas under a pressure of six atmospheres sufficient to maintain the light for three months. Bells are often fitted on this class oi light vessel. the clappers being swung by the roll of the ship or worked by a gas-operated machine.

The improvements made in the design and construction of unwatched lights made it possible for some attended lightships in positions of secondary importance to be replaced by unwatched vessels.

Communication Between Light Vessels and the Shore.—As far back as 1886 experiments were instituted at the Sunk light vessel, off the coast of Essex, with the object of providing telephonic communication mith the shore by means of a submarine cable. In spite of great difficulties experienced in maintaining the cables, several light vessels were ultimately equipped with this means of communication, and cables were also laid to many pile lighthouses and isolated rock and island stations.

Wireless telephone installations later superseded all the cable communications with light vessels and rock stations.

LIGHTED BUOYS

Pintsch's oil gas was first used for a light carried on a buoy in 1878. An automatic occulter, worked by the gas passing from the reservoir to the burner, was introduced in 1883. The majority of buoy lights lit by oil gas are fitted with multiple-jet or Argand burners, but incandescent mantles are also employed. Ordinary oil gas has been largely superseded by other forms of gas illumination (*see* above). Gas buoy lights are usually provided mith sufficient storage capacity to run the light unattended ior three months or longer. The lanterns used ior all forms of buoy lighting are self-contained with cylindrical dioptric lenses of fixed-light section usually 150 to 37j mm. diameter. Some oi the largest types of gas buoy in use have an elevation from water level to the focal plane of more than 26 ft. and a beam intensity of more than 1,000 candle power. One buoy, placed at the entrance to the Gironde in 1907, has an elevation to the focal plane oi 34 ft.

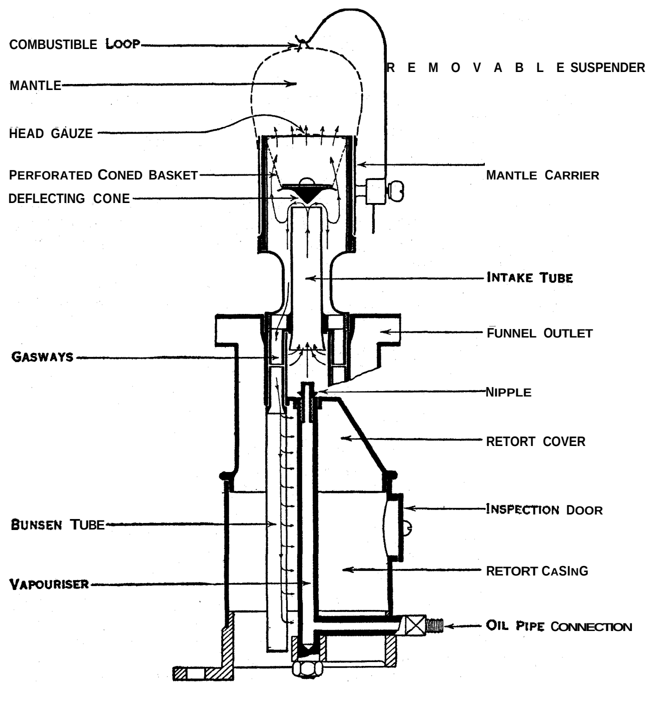


FIG. 13.— HOODPETROLEUM-VAPOUR BURNER

Spar buoys may be adopted for locations mith strong tides or currents.

Gas Buoys.—Although experimental work mas done as early as 1896, acetylene gas was first regularly used for buoy lighting early in the 20th century when automatic water-to-carbide generators were employed in Canada for producing the gas, the generators being placed in the buoy body. This system never gave entirely satisfactory results and its use was attended by danger oi explosion. It was superseded almost everywhere by the dissolved acetylene system first applied to buoy lighting in Sweden. The normal acetylene buoy equipment maintains the light without recharging up to 12 months (fig. 1;) and is adopted as standard in the Trinity House service. Propane filled direct into the buoy body is used in France in coniunction with an incandescent mantle.

Electric Buoys.—Buoys have been fitted with electric lights both fixed and occulting. Six spar buoys were laid down in the Gedney channel, Lower New York bay, in 1888. The wear and tear of the cables, by which current was supplied from a shore station, caused considerable trouble and expense, and the lights were replaced by gas-lighted apparatus in 1904. Electric buoys were also used extensively in Germany early in the 20th century. With the advent of reliable long-service batteries electricity became widely used by some authorities, the lanterns being equipped with automatic lamp changers in case of lamp failure.

Bell and Whistling Buoys.—Bells or whistles are frequently fitted to gas buoys as well as to unlighted marking buoys. An acetylene-lighted whistle buoy is illustrated in fig. 1;. Bells may be wave actuated in which case little or no warning may be given under dead calm conditions. A definite character may be obtained by the use of a CO_2-operated bell-striking mechanism.

(N. G. G.; J. P. Bo.; P. W. H.)

AERIAL LIGHTS

The light beacons provided to aid aircraft crews at night fall into two categories: aeronautical beacons, a term which embraces so-called aerodrome beacons and identification beacons; and hazard beacons. In some countries special light beacons are provided to assist aircraft to follow certain routes but this function has now largely been replaced by radio navigational aids and the use of lights for this purpose in the United Kingdom has been discontinued.

Aerodrome beacons show either as a continuous succession of white flashes of equal duration or white flashes alternating with coloured flashes of equal duration, the intensity of flash being such as to render them visible in clear weather at night up to ranges of 30 nautical miles. Beacons of this type are always sited near aerodromes, the coloured flash heing green when they are located near a land aerodrome and yellow when they are positioned near a water aerodrome.

Identification beacons emit a relatively low-powered coloured light which shows as a sequence of flashes conforming to two letters of the international Morse code Beacons of this type are almost invariably sited on aerodromes, a different letter combination being allotted to each aerodrome. When the light serves a land aerodrome the colour of the flash is normally green but may be red; when it is located at a water aerodrome the colour of the flash is yellow

Hazard beacons are used for marking objects which by virtue of their height and location constitute a possible serious danger to aircraft in flight. The beacon shows a succession of red flashes and is employed in situations where it is necessary to mark an object more conspicuously than would be achieved by the normal method of affixing to it a number of steady red lights.

One form of beacon, which is in general use both as an aerodrome beacon and as a hazard beacon, comprises an optical system consisting of a 100-v $2\frac{1}{4}$-kw. projector lamp in conjunction with four 20-in diameter prismatic lenses. An automatic lamp changer is incorporated, which in the event of failure of the main lamp immediately brings a stand-by lamp into position and automatically switches it into use The lantern housing the optical system and the lamp-changing mechanism is rotated at three revolutions per minute by a $\frac{1}{2}$-h p. repulsion start induction motor and thus gives 12 flashes of light per minute.

Another type of beacon widely used as an aerodrome beacon comprises an outer optic consisting of a condenser lens system of 375-mm. focal distance made up of two vertical panels with their axes arranged at 180° and an inner optic consisting of a dioptric drum lens system of 187.5-mm. focal distance. The light source which is at the common focal point of the inner and outer optical system consists of a a-kw. 60-v. gas-filled incandescent lamp which is replaced automatically in the event of failure. The vertical distribution of beam intensity is shown in fig. 16.

Identification beacons differ irom the types described above in that, being required to be seen at short ranges only, they do not incorporate any optical system. The type in most general use comprises a number of 30-mm. diameter, cold cathode mercury arc discharge lighting tubes mounted in the form of a truncated cone on a fabricated-steel structure. The tubes are energized from a three-phase supply at high voltage derived irom a series of step-up transformers. The coded flash is obtained by means of a motor-driven character disk operating a heavy-duty three-phase contactor connected to the low-tension side of the mains transformer. Such a beacon is normally rated at about three kilowatts, though at London airport, for example, the beacon used is rated at seven kilowatts. (X.)

FOG SIGNALS

The introduction of coast fog signals is of comparatively recent date. They were, until the middle of the 19th century, practically unknown except so far as a few isolated bells and guns were concerned. In times of fog the mariner can expect no certain assistance from even the most efficient system of coast lighting, since beams of light of high power are frequently entirely dispersed and absorbed by the particles of moisture forming a sea fog of even moderate density at relatively short distances from the shore. The careful experiments and scientific research which have been devoted to the subject of aerial-acoustic fog signalling have produced much that is useful and valuable to the mariner, but unfortunately the practical results which had been obtained at mid-20th century were not as satisfactory as might be desired because of: (1) the very short range of the most powerful signals yet produced under certain unfavourable acoustic conditions of the atmosphere; (2) the difficulty experienced by the mariner in judging at any time how far the atmospheric conditions are against him in listening for the expected signal; and (3) the difficulty in locating the position of a sound signal by phonic observations. The future of marine fog signalling may lie in the direction of radar and radio beacons, but it is unlikely that acoustic signals will be dispensed with even if reduced in number.

Bells and Gongs are the oldest and, generally speaking, the least efficient forms of fog signals. Under very iavourable acoustic conditions the sounds are audible at considerable ranges. On the other hand, two-ton bells have been inaudible at distances of a few hundred yards. Bells are frequently used for beacon and buoy signals. When employed in conjunction with a lighted beacon they are sometimes rung mechanically either by clockwork or by compressed CO_2 gas. Electric striking mechanism has also been employed where current is available.

Explosive Signals.—Guns were long used at many lighthouse and light-vessel stations in Great Britain, and continued to be used at some stations in other countries. In 1878 sound rockets charged with guncotton were first employed at Flamborough head and were afterwards supplied to many other stations.[1] The nitrated guncotton or tonite signals in general use at rock and other lighthouses where accommodation is limited are hung at the end of an iron jib or pole attached to the lantern or other structure, and fired by means of a detonator and electric battery. An example will be noticed in the illustration of the Bishop rock lighthouse, the jib being attached to the lantern (fig 4). Sometimes the explosive is combined with aluminum in the charge to give a brilliant flash in addition to the detonation.

The acetylene fog gun is an automatic or semiautomatic signal in which a mixture of air and acetylene is exploded at short intervals in a gun chamber. It is economical in working cost and occupies little space, but its power cannot be compared with that of a compressed-air siren. The admission of air and acetylene is controlled by an automatic gas valve and the charge is fired by a spark. Signals can be sounded as frequently as every ten seconds.

An acetylene gun was established at the Dubh Artach rock lighthouse in 1912. The gun continues in action without attention from the time when it is started until it is stopped by the keeper. The gas is generated automatically on the carbide-to-water principle.

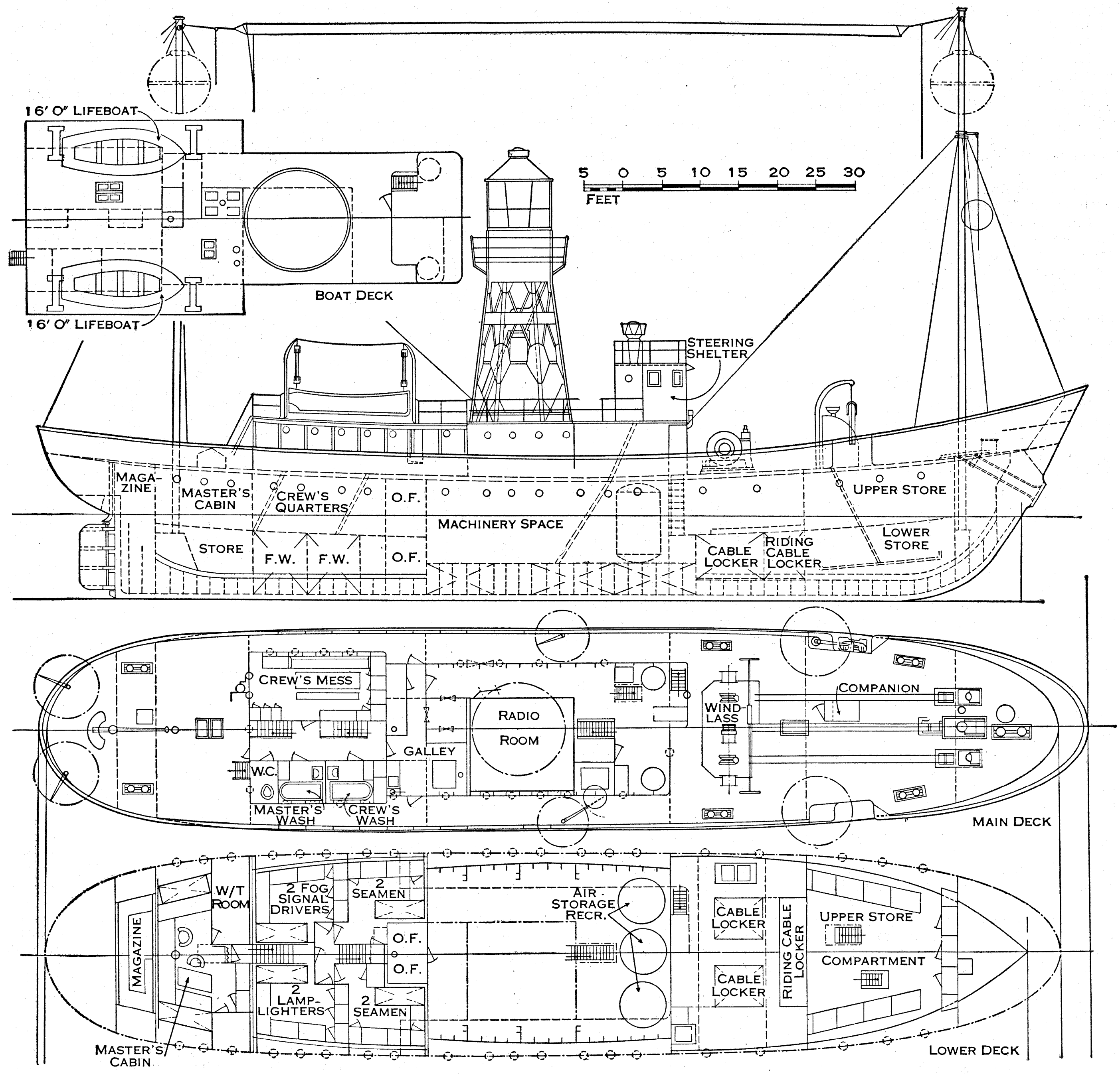
On the Clyde there are two isolated beacon structures which are equipped with automatic guns started and stopped by wireless control from Gourock pier. Several other stations in Scotland and elsewhere are provided with these guns.

Whistles and Reed Horns.—Whistles, whether sounded by air or steam, are not used in Great Britain although they have beer, employed as fog signals in the United States, Canada and Sweden. It has been objected that their sound bears too great a resemblance to steamers' whistles; and they are wasteful of power.

Reed horns, in their original form, where the invention of C. L. Daboll, an experimental one of his manufacture being tried in 1851 by the United States lighthouse board. The reed horn was adopted by Trinity House in 1862 after being improved by W. Holmes and many examples from his designs remained in use at secondary stations in Britain and America. Normally they are sounded at a pressure of 15 lb. per square inch with air furnished by power-driven compressors, semidiesel engines being commonly used in modern installations. When operated by hand the working pressure is five pounds per square inch.

Sirens and **Diaphones.**—These are considered to be the most efficient aerial sound signals which can be obtained for lighthouse purposes. One or other of them is usually employed when first-class signals are required and space is available for the accommodation of the necessary plant. Both are compressed-air instruments, but differ somewhat in operation. The diaphone, in its modern form the more powerful instrument, was invented in Canada by J. P Northey about 1903, and consists of a piston reciprocating in a cylinder, around both of which are cut circumferential slots or ports. The piston is fitted with an operating head to which air is admitted, first on one side and then on the other, for giving to it the reciprocating motion. As the slots in the two units pass and repass one another, air is being admitted through them to produce the impulses or sound waves, and upon the number of times these ports open and close each second depends the note. In the case of the siren the piston revolves in the cylinder instead of having a reciprocating motion, but otherwise the principle of air admission is the same in both instruments. Each is fitted with a trumpet horn or resonator and the working air pressure is 3j lb per square inch for the diaphone and 25 lb. per square inch

[1]The Flamborough head rocket was superseded by a siren fog signal in 1908.



COURTESY, TRINITY HOUSE, LONDON

FIG. 14.— GENERAL PLAN OF BRITISH LIGHTSHIPS

for the siren. The diaphone note is usually about 180 vibrations per second or F sharp in the tenor clef; it terminates with a quick descending note termed the grunt at the end of each blast. This grunt is a valuable distinctive feature as it can sometimes be heard when the remainder of the signal is inaudible.

To provide the air for these instruments compressing machinery and large capacity air storage receivers are required. In some Trinity House installations two instruments with their axes approximately 120° apart horizontally are fitted for distributing the sound over a wide arc. In the diaphone installations at Flamborough, Hartland point, Devon, and Sherries, off Anglesey, the mouths of the two trumpets are placed on a common vertical axis with their centres half a wave length apart, to give effect to the theory propounded by the 3rd Lord Rayleigh that vertical dispersion of sound was by this means avoided. A similar arrangement was introduced at some French stations. Experimental work was being carried out in the 1950s on horns of exponential and hyperbolic form designed to give directional qualities to the signal. Fog signals equipped n-ith exponential horns hare been set up in France and in Great Britain.

The siren in a primitive iorm was invented by John Robison (1739–1805). Cagniard de la Tour evolved the disk iorm and gave it the name of siren. The first steam siren was patented by Brown of New York. The cylindrical form and the centrifugal governor commonly used are credited to G. H. Slight.

Nautophones.—The nautophone is a form of aerial-acoustic instrument which consists of an electrically vibrated diaphragm sounding a high note. An electric emitter of this type was installed at St. Anthony's point, Cornwall, in 1954. This instrument comprises two diaphragm units each with two horns set at an angle of 90°, mounted vertically one above the other; a note of 300 cycles per second is emitted. Such instruments are widely used in Scandinavian countries and elsewhere.

Multihorn electric fog signals were being experimented n-ith in Great Britain in the 1950s. They have been installed in the United States and elsewhere.

Submarine Bell and Oscillator Signals.—As early as 1841 J. D. Colladon conducted experiments on Lake Geneva to test the suitability of water as a medium for transmission of sound signals and was able to convey distinctly audible sounds through water for a distance of more than 21 mi. It was not until 1904, however, that any successful practical application of this means of signalling was made. Submerged bells were used principally in connection with light vessels and were struck by clappers actuated by pneumatic or electrical mechanism. They mere also fitted to buoys and beacon structures and placed on the sea bed. In the first case the bell was actuated by the motion of the buoy and in the others by electric current, transmitted by cable from the shore.

The oscillator or electromagnetic submarine fog signal mas actuated electrically from the lightship to which it mas attached or irom the light station with which it was connected. The instrument, which came into use during World War I, comprised a vibrating diaphragm of large dimensions, and its principle of operation mas similar to that of a telephone. It sent out a high note to which could be given a characteristic code notation. The instrument was fitted in several light vessels in European and American waters. The underwater range of the oscillator has been known to exceed 50 mi. as compared with 10 mi. for the bell.

To take full advantage of the signals thus provided it was necessary for ships approaching them to be fitted with special receiving microphones installed below the water line and in contact with the hull plating. The signals were audible by the aid of earpieces similar to ordinary telephone receivers. Not only could they be heard at considerable distances and in all conditions of weather, but their direction in reference to the moving ship could be determined approximately. These signals became obsolete and were superseded by radio aids. (N.G.G.; J. P. Bo.; P. W. H.)

RADIO AIDS TO NAVIGATION

Radio Beacons.—Beiore World War II the most widely used marine navigational aid was the shore-based medium-frequency radio beacon, in the range 200-400 kc. per second. Reception of signals irom two or more oi these beacons by the use of direction-finding aerials fitted in a vessel enable the vessel's position to be found relative to the charted sites of the transmitters. Although the determination of position is not rapid, and errors map occur at night or at low ranges as a result of interference by radio waves reflected by the ionosphere, the system continued to be extensively used. Each beacon consists of a medium-frequency transmitter radiating modulated continuous-wave signals which are keyed with the identification letters of each station.

From Aug. 1, 1953, by international agreement a series of stations were put into operation along the Atlantic seaboard from Gibraltar to Norway. These stations, of which there are 64 in the United Kingdom and Ireland, transmit on one or other of 14 frequencies in the frequency band 285 to 315 kc. per second. Generally they are grouped in two ways: (1) in navigational groups oi six in which each station radiates for one minute in six recurrently 24 hours a day; or (2) in marker groups of two or three which radiate for a one minute period in turn and which are arranged to come into operation only in fog. Adjacent groups are arranged to transmit on different frequencies so as t~ avoid interference and the note frequency is varied according to the station between 354 and 1,052 cycles per second, thus making identification more certain.

The composition and length of the radiated signal is as follows: (1) the identification signal (two letters) transmitted from three to six times for approximately 22 sec.; (2) a long dash lasting for 25 sec.; (3) the identification signal transmitted once or twice for approximately 8 sec.; (4) a silent period of at least 5 sec.; total 60 sec.

All stations have a radiated field strength of 50 μv per metre (root mean square value over water) at the nominal range of the station which varies from 20 to 200 mi. according to its location. Each transmitter is put into operation and closed down automatically by a clock which is capable of maintaining an accuracy of at least two seconds per day.

All units, including the coding mechanism, are duplicated and automatic alarms are fitted to indicate the failure oi any particular unit.

In addition to the omnidirectional type of beacon, a number of rotating-beam systems at medium frequency are in use, typified by the Oriord Ness, Suffolk, installation. This enables bearing to be found without the need for a direction-finding loop aerial by measurement of the time interval between a transmitted timing signal and the occurrence of a signal minimum at the vessel.

Shore-Based Radar Auxiliaries.—During and after World War II the development of radiolocation systems took place at an unprecedented rate. The most widely used system, now known as radar (*q.v.*), is fitted in the majority of vessels oi 10,000 tons and more. Normally no shore-based installation is required but auxiliary equipment may be added to targets which have poor reflecting properties for radar signals. Radar systems may be of two types:

1. Passive Reflectors.—To increase the radar detection range of small targets such as buoys and fishing vessels, or of targets which have a shape unsuited to efficient radar reflection such as tapered lighthouses, metal reflectors may be fitted to the structure. These may be dihedral, consisting of two perpendicular flat sheets with their common edge vertical! or trihedral corner reflectors, consisting of three flat sheets, mutually perpendicular, which reflect a radio beam back in the direction from which it came on the same principle as the cat's-eye reflectors familiar to motorists. By this means, buoy detection range can be increased from perhaps two-three miles to six-ten miles. Large dihedral reflectors may be set up on coast lines which have no clearly identifiable features when viewed on a radar screen.

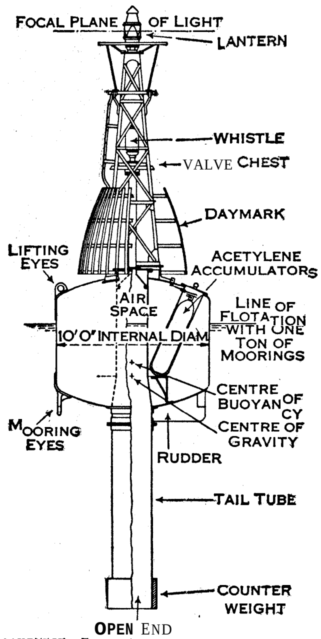


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FIG. 15.—HIGH FOCAL PLANE ACETYLENE-LIGHTED WHISTLE BUOY

Generally of all mild steel construction, the buoy weighs about 9) tons, complete with four dissolved acetylene accumulators and daymark superstructure

2. Radar Beacons.—Direct transmission of radar signals from certain important sites, such as channel-marking buoys, can give large detection ranges. Experimental work has been carried out on ramarks, which transmit continuously, and on racons, which transmit on reception of a radar signal from a vessel nearby. In the latter case, both bearing and range of the racon from the vessel are obtainable, and the signal may be given a code pattern, visible on the radar display ior identification purposes. In the United States such beacons have been extensively used, but require the addition of extra units to the radar set of each vessel. In Britain it was decided to avoid this necessity by ensuring that the racon transmits a signal which can be received by any ship's radar in the "merchant radar" band of frequencies, 9,320–9,500 mc. per second. This requires the transmission simultaneously or in sequence of the entire band of frequencies. In the mid-1950s equipment of this type had reached the trial stage, but no permanent installation existed.

Hyperbolic Navigational Aids.—The difference in time of arrival of radio signals from two fixed sites may be measured at the vessel in order to determine a position line on which the vessel is located. The line joining all positions at which the same time interval is measured is approximately a hyperbola, one of a family all having food at the transmitter sites. If a second position line is obtained from a second pair of transmitters, a fix is obtained ior the vessel which may be read from specially prepared charts. This principle is adopted in a number of radio navigational aids requiring shore-based transmitters and special receiving installations in the vessel. The most commonly used systems are:

1. Loran.—This system was developed in the United States during World War II as a long-range aid, and employs pulsed transmissions at a carrier frequency of about two megacycles per second. Time intervals between corresponding pulses from pairs of transmitters are measured by a special cathode-ray tube display technique. Reflections from the ionosphere appear at night but are separable and may even be used ior measurement at long ranges. Performance is generally much better over sea than over land. The effective range is about 750 mi. by day and 1,400 mi. by night. Extensive chains of Loran transmitters cover the eastern American seaboard, Greenland, Iceland, the Hebrides and Shetlands and the North sea, and are primarily used by the United States navy and Atlantic passenger liners.

2. The Decca Navigator.—This system has been more widely adopted in Europe. Continuous-wave signals at frequencies near 100 kc. per second are transmitted, time-difference measurements being replaced by phase-difference measurements which are directly and continuously indicated on dials. Because oi ambiguity which arises when the measured phase differences exceed 360°, approximate position must be known when starting

TABLE IV.—*Light* and Fog Signal Authorities, British Isles, *1954*

Authority	Lighthouses		Light vessels		Acoustic fog signals		Bells	Radio beacons
	More than 1,000 candle power	More than 200 and less than 1,000 candle power	Manned	Unmanned (light floats not included)	Explosive	Sirens, diaphones, reef horns, electric, etc.		
Trinity House	80	6	35	1	13	66	9	22
Commissioners of northern lighthouses	109	36	—	2	1:	40	4	9
Irish lights commissioners	75	12	8	—	16	19	—	9
Mersey Docks and Harbour board	4	26	1	—	1	3	16	1
Clyde Lighthouse trust	3	14	—	—	2	3	2	2
Humber conservancy	4	11	5	—	—	2	3	1
Other local lighting authorities	57	66	2	1	3	75	65	

Note: Lighted buoys and some harbour and river lights of minor character are not included in the above list.

the equipment. To assist in this, and to give a permanent check on approximate position, lane-identification transmissions are made periodically. Fixes are obtained more simply than with Loran, but errors occur when ionospheric reflections are strong, viz., at long ranges and by night. The official limit of range is 240 mi. but much larger ranges are often obtainable without error. In 1954 three chains of transmitters were in operation in Britain, covering the whole area of the British Isles, the English channel and the North sea. Further chains were in use in France, Denmark and Germany and more European chains were being planned. (*See* also NAVIGATION.) (K. H. G.)

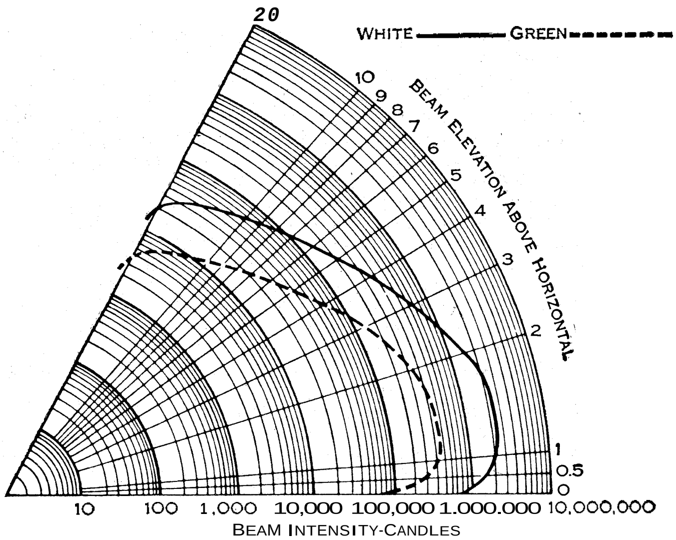
LIGHTHOUSE ADMINISTRATION

The principal countries of the world possess organized and central authorities responsible for the installation and maintenance of coast lights and fog signals, buoys and beacons.

British Isles.—In England Trinity House is the general lighthouse authority. The Corporation of Trinity House or, according to its original charter, the "Master Wardens and Assistants of the Guild Fraternity or Brotherhood of the most glorious and undivided Trinity and of St. Clement, in the Parish of Deptford Strong, in the county of Kent," existed in the reign of Henry VII as a religious house with certain duties connected with pilotage, and was incorporated during the reign of Henry VIII. In 1565 it was given certain rights to maintain beacons, etc., but not until 1680 did it own any lighthouses. After that date it gradually purchased most of the ancient privately owned lighthouses and erected many new ones. The act of 1836 gave the corporation control of English coast lights with certain supervisory powers over the numerous local lighting authorities, including the Irish and Scottish boards. The corporation consists of a master, deputy-master and 23 "elder brethren" (11 of whom are honorary), together with an unlimited number of "younger brethren" who, however, perform no executive duties. In Scotland and the Isle of Man the lights are under the control of the commissioners of northern lighthouses, constituted in 1786 and incorporated in 1798. The lighting of the Irish coast is in the hands of the commissioners of Irish lights, formed in 1867 in succession to the old Dublin Ballast board. The principal local light authorities in the United Kingdom are the Mersey Docks and Harbour board and the Clyde Lighthouse trustees. The three general lighthouse boards of the United Kingdom, by the provisions of the Mercantile Marine act of 1894, are subordinate to the ministry of transport and civil aviation, which controls all finances.

On Jan. 1, 1954, the lights and fog signals in service under the control of the several authorities in the British Isles were as shown in Table IV.

In the Trinity House service at shore lighthouse stations where there is no fog signal there are usually two keepers, and at rock stations four, one being ashore on leave. At a shore fog signal station there is an additional keeper. The crews of light vessels as a rule consist of 11 men, 3 of them and the master or mate going on shore in rotation.



BY COURTESY OF MESSRS. CHANCE BROTHERS

FIG. 16.—VERTICAL DISTRIBUTION OF BEAM INTENSITY (STATIONARY) OF AN AERODROME BEACON

Other Countries.—The lighthouse authority of France is known as the Service des Phares et Balises (which is controlled by the Administration des Ponts et Chaussées) and was set up in 1792. The Commission des Phares was set up in 1811. The director of the Service des Phares et Baiises is secretary to the Commission des Phares. The service controls marine signalling throughout the French union; *i.e.,* about 1,000 lights in France and 600 overseas. In Denmark, Austria, the Netherlands, Italy, Sweden, Norway and many other countries the minister of marine has charge of the lighting and buoying of coasts; in Belgium the public works department controls the service, and in Spain the lighthouse service is established on lines similar to that of France. In Canada the coast lighting is in the hands of the minister of marine, and in most of the other British dominions and colonies the public works departments have control of lighthouse matters.

For the lighthouse service of the U.S. *see* below.

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(N. G. G.; J. P. Bo.; P. W. H.)

UNITED STATES

The first lighthouse in the United States, a tall masonry tower, was built in 1716 by Massachusetts at the entrance to Boston harbour. The original Colonies on the Atlantic, largely dependent on water traffic, gave early attention to lighthouses. Congress, in 1789, immediately after the national government's organization, provided for lighthouses and buoys, 12 having been built by the colonial governments. In 1852 congress established the lighthouse board, substituting for it in 1910 the lighthouse service. On July 1, 1939, the lighthouse service was consolidated with the U.S. coast guard in the treasury department.

The problems of lighthouse construction are similar everywhere in the world, but the Great Lakes and North Atlantic ice action, southern coast hurricanes and some earthquake areas need particular attention. The United States has about 30 important lighthouses on submarine or unusually exposed sites, some involving difficult engineering; only a few of these are wave-swept lighthouses of primary significance. The following are important or typical wave-swept U.S. lighthouses:

Minots Ledge (1860), south of Boston harbour, is built on a reef, bare only at low water, exposed to the Atlantic's sweep; its construction took about five years. Steps were cut to receive the foundation. The conical-shaped tower is of granite, the first 40 ft. solid, base 30 ft. diameter, the light elevated 8; ft. The stones are dovetailed in each course, connected vertically by bonding bolts, and eight long iron posts pass through the lower courses into holes in the ledge. This station was changed to automatic operation in 1947.

White shoal (1910) marks a shoal in northern Lake Michigan. A timber crib 72 ft. square, towed to the site and filled with stone, was sunk in 22 ft. of water; this supports concrete pier, tower and light 125 ft. above water. Martin reef (1927), in northern Lake Huron, has a similar substructure.

On the Great Lakes important structures on submarine foundations mark shoals, usually replacing the original lightships. Timber crib foundations, economical and satisfactory in fresh water, are favoured. Another type consists of concrete caissons towed to site, sunk on bottoms previously levelled and filled in with stone; *i.e.,* Lansing shoal (1928), Lake Michigan. Spectacle reef (1874) in Lake Huron and Stannard rock (1882) in Lake Superior have cofferdams in protecting piers, the former for a stone tower on rock, the latter for a wrought-iron cylinder foundation pier fitted to rock and concrete filled.

Sabine bank (1906), marking a sandbank about 14 mi. off the Gulf coast, is a cast-iron tower and substructure standing in 18 ft. of water. The iron caisson was towed to the site and sunk 20 ft. in sand by pneumatic process, the only U.S. lighthouse foundation so placed in the open sea. There are others in protected waters. This station was changed to automatic operation in 1923.

Pacific reef (1921) marks the outer edge of coral reefs off the southern Florida coast. It is supported by nine iron piles, each driven nine feet into the coral reef. The piles pass through and are partially supported by iron disks four feet in diameter resting on the coral surface. In seven feet of water, it supports an iron openwork structure. Although only an automatic acetylene light, 4; ft. high, it illustrates recent practice; it was built at moderate cost. Six other lights along the Florida reefs, on similar foundations, are notable structures, the tallest being Sombrero Key (1858), 160 ft.

Tillamook rock (1881), a stone structure on a small rock islet a mile off the Pacific coast south of the Columbia river's mouth, is the most notable lighthouse on the western United States coast because of its position on extremely exposed rock, in deep water and open to the Pacific sweep. Landing is impossible directly on the rock and can be made only by hoisting from a boat. Seas sometimes break over the lantern, 133 it. high. St. George reef (1891) off the California coast is in a similarly difficult position.

Many lighthouses in water were formerly built on screw-pile foundations. One, Sand Key light (1853), Fla., is 120 ft. high. Of many handsome masonry lighthouses along the coast, especially the low-lying Atlantic seaboard, Cape Hatteras is the highest, 193 ft. Reinforced concrete has been extensively used to construct light towers, wharves and buildings. The most notable is Navassa Island light (1917) on a desert West Indian island; tower 162 ft., cylindrical shaft 15 ft. diameter. Another primary light of reinforced concrete is Kilauea point (1913), Hawaii. The tower, 52 ft. high, is on a cliff.

Apparatus, Illuminants and Other Characteristics.— U.S. practice is similar to standard world practice, but there are some diverging developments. Concentrating light by using rapidly revolving lenses with few panels and superior illuminants gives beams of sufficient power with smaller lenses. No lenses larger than third order (500 mm., 20 in. radius) were installed after 1913. Numerous large lenses were replaced by more efficient optical apparatus.

The primary light standard, the electric incandescent lamp, using commercial current generated at the station, has replaced the older kerosene oil-vapour apparatus. Incandescent electricity is most satisiactory because of its power, convenience and adaptability. It is efficient to electriiy certain stations for illuminant, operating sound fog signal and radio beacon and lighting buildings.

Electricity is very convenient for signals controlled remotely, as those near jetty ends. Small plants or primary cells generate electric energy ior minor lights. The principal difficulty in putting incandescent electric lamps in old lenses is the too concentrated light source and insufficient divergence of beam. This may be overcome by various methods.

Batteries and acetylene gas compressed in cylinders are used for unwatched, automatically operated lights of minor importance. All new installations are made with batteries, and acetylene aids are gradually being replaced by electric aids. By the mid-1950s about 97% of all lighted aids to navigation were automatic. Automatic apparatus extended lighthouse facilities to remote regions like Alaska.

The distinguishing of principal coast lights by flashing or occulting characteristics and the elimination of fixed lights progressed steadily. Characteristics are simple and are quickly and easily recognized without timing. Preierred limitation is that a single light flash be not less than 0.2 sec. in duration. An exception to this limitation is permitted in the instance of rapidly recurring flashes.

Colour is valuable for reasons of distinctiveness against a background of competing lights, for identification or for imparting a definite meaning. The illumination is reduced. approximately 80% where colour other than white is used which is a serious drawback. Red, green and white are the oniy three colours of lights used in the United States lighthouse system.

Uniformity of Buoyage.— The United States has long had a fairly standardized system to show the relation of buoys to channels, by colours, shapes and numbers, this system having in part been prescribed by lam in 1850. International uniformity in buoyage and lights would add safety and convenience to navigation. Limited but important action on this at the International Marine conference, Washington, D.C., 1889, resulted in considerable uniformity.

The United States system, based largely on the 1889 conference, is: for vessels coming from sea, red buoys, .conical-shaped (nun), even numbers on right side of channel, cylindrical black buoys, flat tops (can), odd numbers on left side; horizontal red- and black-banded buoys mean shoals or dangers; vertical black and white stripes show clear channels; with coloured lights, red on right and green on left of entrances or channels, but white may be on either side.

Colour and shape to mark the relations of buoys to channels are in nearly world-wide use; shape alone is not enough, because it is not readily applicable to important classes of buoys, such as lighted, whistle, bell and spar. Colour is the most obvious, readily applied characteristic. The American buoyage system, light characteristics and apparatus are as simple as possible, in order to avoid coniusion and to be more definite and reliable.

Lightships are placed on foggy coasts to mark outstanding dangers or port approaches. The first was placed in Chesapeake bay (1820).

Fixed structures on shoals or lighted buoys replaced many lightships originally placed in inland waters. Great Lakes lightships were thus being gradually retired, only one, on Lake Huron, being maintained in the mid-1950s. There were 27 lightship stations, with 9 relief ships. Of these, 23 mere located off the Atlantic and Pacific coasts, where it is impracticable to build lighthouses but where lights are vital to traffic. Nantucket lightship, for example, moored in 32 iathoms 50 mi. from land, guards shoals to the north, and most transoceanic vessels approaching the United States Atlantic coast steer for this vessel, one of the world's most important seamarks. A full-powered vessel, 148 ft. long, with an authorized complement of 20 men, it has a flashing incandescent electric light of 20,000 candle power, compressed-air diaphone iog signal and a radio beacon synchronized with the fog signal for distance finding. It is an oil-burning steam vessel. Most lightships have diesel engines and five ships have diesel-electric propulsion.

Ambrose lightship, at the entrance to New York harbour, shows a powerful white light the intensity of which is increased, as visibility conditions get poorer, from a minimum of 250,000 candle power in fair weather to more than 2,000~000candle power in bad weather.

Lightships moored in the sea off the Atlantic coast, exposed to tropical hurricanes and other severe storms, receive special attention as to vessel design and moorings to ensure station permanency. Severe storms have sometimes torn lightships from their moorings. For greater security, cast-steel chain and mushroom anchors up to four tons are used.

BUOYS.—The great length and intricacies of the U.S. coasts require more than 22.000 buoys. The increase in lighted buoys is a notable advance. In the mid-1950s more than 3,000 lighted buoys mere on station, of which about half were operated by acetylene gas compressed in tanks set in the buoy pockets and half by batteries. Steel buoys of various sizes are extensively used to mark channels and shoals. Wooden spars are being replaced advantageously by small inexpensive steel buoys. In the mid-1950s there were more than 900 bell buoys, about 300 whistle buoys and 140 gong buoys. All new buoys then being constructed had radar reflectors built integrally into the superstructures to increase the reliability of detection by radar-equipped vessels.

All buoys and moorings are relieved at least biennially, old buoys brought to depots, cleaned and repainted. Their great number makes this an important and time-consuming task.

Sound Fog Signals.— Radio beacons (see below) are the most effective fog signal. Various types of sound signals, using compressed air or electricity, are employed, but their value is limited because of their short and undependable range and the impracticability of taking accurate bearing on them. But sound iog signals nevertheless remained indispensable. Steam whistles, once used extensively, mere replaced by more efficient apparatus. Variously actuated electric sirens, air horns and bells serve for minor sound signals.

A number oi automatic fog signals operated by carbon dioxide gas or electricity are located in areas where only a moderate signal is required during the foggy season each year. Nearly all fog signal machinery and apparatus is installed in duplicate for greater reliability.

Radio Beacons.— These stations emit distinctive identifying coded tone radio signals. When used with radio direction finders, usually installed on board ships or in aircrait, they enable navigators to take bearings on targets with known charted positions. They were the first generally available means ever provided ior taking accurate bearings on invisible targets at considerable distances.

The first successiul radio beacons were placed at three stations near New York in 1921. The system grew in the United States and outlying territories to include almost 200 by the mid-1950s. These radio beacons are classed as follows:

Class A, having a normal useful range of 200 mi.
Class B, having a normal useful range of 100 mi.
Class C, having a normal useful range of 20 mi.
Class D, having a normal useful range of 10 mi.

A navigator skilled in the use of the radio direction finder can, with favourable conditions, obtain radio direction finder bearings accurate to within two degrees.

The radio beacon transmitters transmit on an even frequency in the frequency band between 285 and 315 kc, (1052.6 to yj2.4 m.). Signals are usually transmitted ior one minute and off for two minutes throughout each hour of fog or low visibility. Durinp clear weather signals are usually transmitted one minute on and two minutes off ior one or two ten-minute periods oi each hour. This scheduling enables synchronized groups oi stations to operate on the same radio frequency without interierence and requires accurate timing of the transmissions. During clear weather and between regular scheduled clear weather transmissions, any station operating in a group will transmit continuously when requested by the navigator for the purpose of calibrating radio direction finders.

During these calibrating transmissions; regular scheduled transmissions of one minute on and two minutes off are resumed during the regular scheduled operating period. Stations not operating in a group transmit continuously upon request for the duration of a calibrating period. At some stations, special radio direction finder calibrating transmitters are installed. These transmitters are placed in operation at the request of the navigator and remain in operation as long as calibrating signals are desired. These special calibrating transmitters are adjusted to transmit on an even frequency in the band between 285 and 315 kc. and on 480 kc. This provides for calibrating the radio direction finder on a frequency in the regular radio beacon band and on the international frequency of 500 kc.

Class D radio beacons transmit continuously.

For the use of aircrait equipped with automatic radio direction finders, some radio beacons are adjusted to send continuous carrier signals with identifying characteristic tone modulation applied for one minute on and two minutes off throughout the 24-hours. A few other selected stations are adjusted to send continuous carrier signals with identiiying characteristic tone modulation applied continuously throughout the 24 hours. All other radio beacons transmit keyed, continuous carrier, characteristic tone modulated signals.

Administration.— The maintenance of aids to marine navigation is a function of the United States coast guard, having been placed under that organization on July 1, 1939, and consists of the maintenance of lighthouses, lightships, radio beacons, fog signals, buoys and beacons on all navigable waters of the United States, the Great Lakes, the Mississippi river and its tributaries, Puerto Rico, the approaches to the Panama canal, the Hawaiian Islands and Alaska.

The chief administrative officer is the commandant of the coast guard, with headquarters at Washington, D.C. Under his direction the functions of establishment, construction, maintenance and operation of aids to navigation are carried on through administrative and engineering divisions in Washington and by the various district offices. Because of the wide geographic distribution of aids to navigation on the seacoasts, the Great Lakes and the navigable rivers of the United States, with an aggregate coast line of more than 40,000 mi., the field work of the service is carried on by district organization? There are 12 coast guard districts, carrying on lighthouse work as well as other functions of the coast guard. Each district is under the supervision of a commander, assisted by a suitable engineering and administrative force and equipped with the necessary supply and buoy depots and with suitable vessels for the maintenance of the navigational aids.

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LIGHTING. Man in his social and economic development has been engaged in continuous effort to utilize the hours of darkness through the application of artificial illumination to human needs. Methods of producing light remained primitive and crude in design over long periods of time, and, when new and improved methods were introduced, the use of the earlier forms continued so that at no time has one method completely replaced another. In the middle of the 20th century more than half of the world's inhabitants still had only flame sources for artificial light.

Artificial illumination is obtained as a result of combustion, incandescence or electric discharge with or without fluorescence. Sources of light may be divided into three classes: (1) vegetable and animal fatty substances; (2) carbonaceous matters, gases and oils; and (3) electrical.

Light as a physical phenomenon is discussed in the article LIGHT, while its perception is dealt with in VISION.

This article is divided into the following sections:

I. HISTORICAL DEVELOPMENT

The earliest form of artificial illumination was the fire used by primitive man for warmth and for protection against wild beasts, and flaming faggots from the campfire mere the first torches. From this beginning, thousands of centuries before written history, the torch in various forms has continued as a source of illumination throughout the world.

The flambeau of the middle ages, carried by pedestrians at night, was a torch consisting of twisted fibre coated with some inflammable substance. These torches provided the earliest form of street lighting, being fastened in metal holders to the outside walls of houses. Pieces of resinous wood, stuck between the stones of the fireplace, gave forth bright but smoky flames for lighting the homes of early New England.

Unusual sources of artificial illumination are the glowworms, beetles and fireflies supposedly confined in lanterns in the West Indies or stuck in wax in shallow saucers in Java. Oily carcasses of various animals with wicks drawn through them have been used; the penguin has been most frequently used in this manner.

1. Oil Lamps.—The earliest prehistoric lamp dates to the Mousterian Age. This was a hollowed piece of stone, very crude, found at Le Moustier, Fr., in 1928. Terra-cotta lamps of 7000–8000 B.C. have been found on the Mesopotamian plains, and Egyptian and Persian copper and bronze lamps of about 2700 B.C. have been discovered at various times.

By 1000 B.C. an advancement in lighting efficiency was provided by a nick of vegetable fibre burning in a saucer-type vessel holding olive or nut oil, and by 500–400 B.C. oil lamps had come into general domestic use. Roman lamps of unglazed and glazed terra cotta had tno or more spouts, and later bronze and iron lamps were introduced. with designs becoming more elaborate. About 100 B.C. the Romans developed the first true lantern of horn, cylindrical in form with a perforated top. Vegetable-oil lamps were in general use among the early Jews, Greeks and Romans.

The first record of mineral-oil lamps was made about A.D. 50 when Pliny mentioned this use of oil found on the Adriatic shores. Japanese history in A.D. 615 mentions "burning water" and Marco Polo wrote in the 13th century of Baku oil springs furnishing oil satisfactory for lighting purposes.

Early attempts were made to improve the efficiency of oil lamps. About the latter half of the 1st century A.D., Heron of Alexandria devised a lamp in which pressure of brine acting through a column of air raised the oil to the wick. In 1490 Leonardo da Vinci added a cylindrical glass chimney fitted into a glass globe filled with water. The light burned steadily, and through lens action the work surface was brightly lighted for night study. Da Vinci also devised water lenses for correcting near vision, the first recorded analysis of the fact that seeing is a combination of light and vision.

Various types of oil lamps were used through the 14th to 17th centuries, but with little improvement of efficiency. The Betty lamp of the Pilgrims (1620), a metal receptacle with a wick lying in a slot and protruding from one side, was equipped for hanging from mantelpieces or shelves. Fish oil was the chief illuminant.

In 1784 the Swiss physicist Aimé Argand patented a lamp with round burner and tubular wick and a chimney for directing and regulating the flow of air to the flame. An accident led to the discovery that a round glass chimney reduced flickering, and the Argand lamp marked the greatest advancement in artificial illumination to that date. In 1800 Bertrand G. Carcel added a clockwork pump for raising and feeding oil to the wick and, because of the steadiness of the light produced, the Argand lamp in this form became a photometric standard. Benjamin Franklin discovered that two wicks side by side a small distance apart gave more light than two single-wick lamps.

Distilled coal oil produced by James Young in 1850–51 was an improvement, but the discovery of petroleum by Edwin L. Drake in 1859 provided an inexpensive illuminant of high lighting efficiency. and the crude-oil lamp mas practically superseded. In the following 20 years an average of 80 patents per year were granted for various types of improved oil lamps. One of the most important was the duplex burner lamp introduced in 186j by Joseph Hinks. In 1868 the Wells light combined an oil spray with vaporized oil through the use of pressure, giving a highly luminous flame, the principle used in modern flare lamps. The Kitson lamp of 188j was a pressure-type lamp using platinum mantles, replaced later by Welsbach mantles.

During the latter half of the 19th century oil lamps underwent many changes and improvements intended to make them more attractive for domestic use and more efficient for industrial purposes. They were mounted on elaborate bases and the oil reservoirs were decorated; some were designed for suspension from ceilings and others were portable. The latter designs carried over into the 20th century, and the kerosene lamp with a flat wick in a perforated metallic holder and a plain glass chimney came into extensive use in rural districts.

2. Candles.—The use of candles dates as far back as the beginning of the Christian era, and candlemaking is probably one of the oldest industries of mankind. Among aboriginal races in Africa oily nuts were burned in clay saucers; later they were strung on twigs, thereby providing continuous illumination.

In A.D. 100 Greek and Roman true candles were made of flax threads coated with pitch or wax, although the Phoenicians are credited with the first use of wax candles about A.D. 400. The candle was not in as common use as the oil lamp for several centuries, but returned during the middle ages. Throughout the 16th to 18th centuries and until the discovery of petroleum, candles provided the only method of artificial illumination available to people of average means. Their use has been closely related to religious ceremonies and customs throughout Christian history. The earliest candles were rush piths dipped in tallow. Later, splinters of wood, also dipped in tallow or beeswax and called kindle lights, mere used. Homemade candles of Pilgrim days were of tallow. The whaling industry in the 18th century brought spermaceti into use. The spermaceti candle, because of its clear, steady flame, was used as a standard measure for artificial light, the term "one candle power" being based on the light given by a pure spermaceti candle weighing one-sixth of a pound and burning at the rate of 120 grains an hour. The development of stearine in 1823 and of paraffin in 18jo furnished improved materials for candles.

Candleholders have assumed various forms. The Prickett chandelier introduced in Italy in 1492 was a multiple-spiked holder mounted in groups around a decorative figure on the wall, with mutton-fat candles forced on the spikes. In the 15th century crystal chandeliers with small cups for holding wax candles lighted homes, ballrooms and public gathering places. Of these candles, 120 would have been required to equal the light of one 100-w. electric lamp, and the number required to illuminate a large room produced considerable heat. Candles in elaborate chandeliers were used for illumination of the house of commons in England as late as 1834, and their replacement by gas was strongly opposed by members. With the advent of gas as an illuminant, the use of candles was gradually confined to church ceremonies, decorative domestic purposes and festive occasions.

3. Gas.—Ancient records of Egypt and Persia provide numerous instances of spontaneous discharge of combustible gases from fissures in the earth. Natural gas was employed as an illuminant by the Chinese centuries before the Christian era. The gas was brought to the surface from beds of rock salt 1,500 to 1,600 ft. deep, conveyed through bamboo pipes and used for lighting salt mines and homes in Szechwan province.

In 1664 near Wigan, Lancashire, Eng., John Clayton discovered a pool of natural gas near a coal mine, and later described satisfactory experiments in extracting coal gas by distillation. In 1726 Stephen Hales reported that 158 g. of Newcastle coal would yield 180 cu.in. of "inflammable air," and in 1733 Sir James Lowther sent specimens of distilled coal gas to the Royal society for experimentation.

In 1784 Jean Pierre Minckelers first used gas for lighting. Contemporaneously, in Paris, Philippe Lebon experimented with distillation of gas from various materials for domestic use, and in 1799 Lebon patented a "thermo-lampe," using gas distilled from wood.

The first extensive use of illuminating gas is ascribed to William Murdock, who. in 1792, lighted his home in Redruth, Cornwall, Eng. The gas was produced in large iron retorts and conveyed 70 ft. through metal pipes. In 1798 Murdock installed gaslighting in a factory near Birmingham, Eng., and soon was providing gas commercially for several shops in the vicinity.

The new illuminant was denounced as dangerous and impractical, slowing its adoption. Through the efforts of F. A. Winsor, a German, the first public installation of gaslights was made in London in 1807. For dispelling the public prejudice against illuminating gas, Winsor is referred to as the father of gaslighting. Westminster bridge, London, was illuminated by gas in 1813; Paris adopted gas for street lighting in 1818; and most cities in England and Europe soon had gaslighting systems. The first domestic use of gas in the Cnited States was in 1806, when David Melville, of Newport, R.I., lighted his home and the street directly in front. The first interior commercial use mas in the New theatre, Philadelphia, Pa., where gaslights were installed in 1816.

Between 1820 and 1880, many improved burners were developed, the batwing or fishtail type being most commonly used. The Bunsen burner was invented by Robert Wilhelm von Bunsen in 1855, and in 1879 William Sugg developed the Sugg-Argand burner giving an economical light of high intensity. Carl Auer von Welsbach experimented for ten years on the Welsbach mantle, and his system of lighting was first exhibited in London in Feb. 1887. By 1900 incandescent gaslighting was firmly established.

The Welsbach mantle consisted of a cylinder woven of sea-island and Egyptian cotton soaked in a solution of 99% thoria and 1% ceria. After various manufacturing processes, a metallic-oxide skeleton remained, and in use the mantle was suspended over a Bunsen burner so that the metallic oxides composing the mantle were heated to incandescence, emitting a brilliant greenish light. By using varying combinations of rare earths in solution for impregnating the mantles, different colours of light could be obtained. Welsbach mantles have continued in use with various types of lamps.

4. Acetylene Gas.—Although the existence of this gas had been known since 1836, its manufacture and use as an illuminant was first described by Henri Moissan in 1892. Simultaneously,

in the U.S., Thomas L. Willson demonstrated that acetylene gas obtained by immersion of calcium carbide in water produced an intense white light. By 1909, 290 towns in the U.S. were lighted by acetylene gas. Later its use was confined to emergency lighting in remote areas. An acetylene light can be charged, lighted and then left unattended for six months or more.

5. Pintsch Gas.—Originally developed for lighting railroad cars by Julius Pintsch of Germany, this gas was used in Europe for many years, and was introduced into the U.S. in 1866. By 1910 there were 93 Pintsch gas works in the U.S., Canada and Mexico. It was used extensively on steamships and for lighthouses. Similar to Pintsch gas were the numerous bottled gases developed in subsequent years to provide illumination with Welsbach-type mantles in areas where electricity was not available.

By 1911 conversion of gas fixtures for use with electricity had begun, and soon electricity was rapidly replacing gas for general illuminating purposes. In England and Europe, however, gas enjoyed aide use for a number of years longer; in 1926 the earlier electric street lighting in Paris was replaced by high-pressure gas lamps, automatically lighted and controlled.

6. Electric Lamps.—In 1650 Otto von Guericke of Magdeburg, Ger., discovered that light was produced by electricity or by electrical excitation. He demonstrated that when a globe of sulfur was rotated rapidly and friction was produced by pressure of the hand during rotation, a luminous glow could be observed. About 1706, the Englishman Francis Hauksbee (Hawksbee) used this discovery, together with a glass globe exhausted by means of a vacuum pump also invented by Guericke, to produce the first electric light. When the globe was rotated at high speed, then rubbed with the hand, it emitted a faint glow of light. In 1802 Sir Humphry Davy demonstrated that strips of platinum or other metals could be heated to incandescence electrically and would give off light for some time. In 1809 he used a battery of 2,000 cells to pass a current through two charcoal sticks four inches apart nhich produced a brilliant arch-shaped flame, thereafter called the arc light.

Throughout the 19th century, development of the arc lamp and the incandescent lamp were parallel. The earliest recorded attempt to make an incandescent lamp was in 1820, when De la Rue enclosed a platinum coil in a piece of evacuated glass tubing. In 1840 Sir William Robert Grove of England lighted an auditorium with feeble, impractical lamps using platinum coils heated to incandescence and covered by inverted tumblers in glass dishes partly filled with water. The cost of the current consumed by the installation was estimated at several hundred dollars a kilowatt hour.

In 1841 Frederick de Moleyns of Cheltenham, Eng., obtained the first patent granted for an incandescent lamp. His lamp was unique, consisting of an evacuated glass sphere containing powdered charcoal nhich bridged the gap between two platinum wires or filaments. Light was produced by passage of current through the platinum filaments, heating the charcoal to incandescence. However, the globe blackened quickly and the lamp was short-lived.

In 1845 Thomas Wright of London obtained the first patent for an arc lamp, and in the same year a young Ohio inventor, J. W. Starr, obtained a British patent for two incandescent electric lamps. Edward G. Shepard in 1850 constructed a lamp using incandescent charcoal. The same year Sir Joseph Swan, English physicist, devised carbon filaments of paper.

During the latter part of the 19th century many scientists tried to produce electrical illumination on a practical commercial basis, and there are records of occasional use of electric lamps throughout the period. In 1849 an opera scene in Paris was illuminated by electric light. In 1856 the French engineer C. de Chagny patented a novel platinum-filament lamp for mines, and in 1857 the first commercial installation of an electric arc light was made in the lighthouse at Dungeness, Eng.

In 1872 Alexandre de Lodyguine, a Russian physician, made a lamp having a V-shaped piece of graphite for a filament, operating in a glass globe filled with nitrogen gas. Two hundred of these lamps were installed about the Admiralty dock in St. Petersburg, but unreliability of operation and cost made them impractical for general use. A contemporary, S. A. Kosloff, used multiple rods of graphite operated in nitrogen. None of the foregoing lamps was practical.

In 1876 Paul Jablochkov, a Russian electrical engineer, introduced the Jablochkov candle, marking an epoch in artificial illumination. The Jablochkov candle was an arc lamp having parallel carbon rods separated by porcelain clay, which vaporized during burning of the arc. Alternating current was used to ensure equal rates of consumption of the two points of the rods. This lamp was widely used commercially. First installation of arc lamps for public lighting in the U.S. was in 1879 when the public square in Cleveland, O., was lighted by a system of 12 Brush carbon arc lamps developed by Charles F. Brush.

Before the Edison incandescent carbon-filament lamp was patented in 1880, numerous scientists directed their efforts toward production of a satisfactory incandescent lighting system, outstanding among them being Sir Joseph Wilson Swan, English physicist. In 1850 Swan had devised carbon filaments of paper; later he used cotton thread treated with sulfuric acid and mounted in glass vacuum bulbs. Utilizing this type of lamp, called the "electric glow lamp," he gave a large-scale public exhibition of electric lighting at Newcastle, Eng., in 1880.

Final development of the incandescent lamp was the result of concurrent work by Swan and Thomas A. Edison, with important contributions by St. George Lane-Fox and William E. Sawyer. The invention of a completely practical lamp ordinarily is credited to Edison, who began studying the problem in 1877 and within a year and a half had made more than 1,200 experiments. Concurrently, recognizing that the series wiring systems then used for arc lights would not be satisfactory for incandescent lamps, Edison directed much effort toward development of dynamos and other necessary equipment for multiple circuits.

On Oct. 21, 1879, Edison lighted a lamp containing a carbonized thread for the filament. The lamp burned steadily for two days. Later he learned that filaments of carbonized paper visiting card (Bristol board) would give several hundred hours' life. Soon carbonized bamboo was found acceptable and was used as the filament material until 1894. Extruded cellulose filaments were introduced in 1894. The first complete incandescent lighting system was publicly demonstrated at Edison's laboratory in Menlo Park, N.J., on Dec. 21, 1879.

The first commercial installation of Edison's lamp was made in May 1880 on the steamship "Columbia." This installation, consisting of 115 lamps, was operated successfully for 15 years. In 1881 a New York city factory was lighted with Edison's system, and the commercial success of the incandescent lamp was quickly established. More than 150 other installations were made in the following two years. In 1882 the Pearl street generating station in New York city was put into service, and is considered the forerunner of the great central stations subsequently developed. In England an exhibition of electric lighting was held in 1882 at the Crystal palace, and by this time incandescent lamps had been installed in numerous public buildings.

When the incandescent lamp was introduced as a public illuminant, fear was expressed that it might be injurious to the eyesight, particularly when used for long periods by indoor workers. In 1898 the oculists of London petitioned parliament to pass laws against the use of unshaded lights, and consequently research was instituted on various types of shades and reflectors. One of the earliest reflectors used commercially was the one-piece silvered glass reflector developed by E. L. Haines and installed in show windows in Chicago and other cities in the U.S.

Closely related to the incandescent gas mantle, and suggested by it, was the Nernst glower, unique among illuminants of its time as the first practical attempt to substitute some other incandescent substance for carbon filaments. Patented in 1901 by H. W. Nernst of Germany, it utilized a filament composed of oxides of rare-earth elements heated to incandescence by passage of electrical current. Mixtures of two or more oxides were found to be most satisfactory, and in 1905 the commercial Nernst glower consisted of 85% zirconia and 15% vitria. The Nernst lamp did not achieve wide use, but investigations carried out to improve it had considerable effect on the development of the incandescent lamp.

Welsbach invented the first commercial metal-filament lamp, but the osmium employed was extremely rare and expensive. The first applications nere in Berlin and Vienna in 1899, but manufacture was discontinued in 1907 when the tungsten lamp appeared. Werner von Bolton, a Russian chemist, discovered the possibility of using tantalum for lamp filaments about 1902, and in 1906 the tantalum lamp was put on the market in the U.S., but disappeared from use about 1913.

In 1904 Willis R. Whitney of Schenectady, N.Y., produced the heat-treated or metalized carbon-filament lamp, with a higher degree of efficiency than any previous incandescent lamp But scientists were concerned with the most efficient conversion of electrical energy into light, and the discovery of tungsten as a material for filaments seemed to achieve this goal. The tungsten-filament lamp represented the greatest advance ever made in the quality and efficiency of incandescent lighting. and quickly replaced carbon, tantalum and metalized carbon filaments for commercial use.

The first tungsten-filament lamps. introduced in the US. in 1907 made use of pressed tungsten, manufactured by a process perfected by Alexander Just and Franz Hanaman of Vienna. By 1910 William D. Coolidge of Schenectady, N.Y., discovered a process for producing drawn tungsten filaments. greatly improving the strength of tungsten lamps. This process was patented in 1913.

In 1913 Irving Langmuir of Schenectady. N.Y., discovered that use of inert gases inside the incandescent lamp bulb would retard filament evaporation, giving increased efficiency. Nitrogen alone was first used, but later lamps used argon and nitrogen in varying proportions, depending on the wattage. Low first cost, ease of maintenance and adaptability gave the gas-filled lamp such importance in the lighting field that other incandescent lamps practically disappeared. Other significant milestones included dumet seal wire (an iron-nickel alloy) developed in 1913; tipless lamps in 1919; inside-frosted bulbs in 1925; photoflash lamps and the copper-to-glass seal in 1930; and vaporized-aluminum reflector lamps in 1936. A further improvement introduced in 1937 was the coiled-coil type of filament for general service lamps.

Tungsten-filament lamps were developed in a variety of sizes and shapes. for domestic and commercial use and for some highly specialized purposes. By 1935 they were available in shapes varying from the common pear-shaped or round bulb type to tubular forms several feet long. A very small lamp, known as the "grain o' wheat" lamp, having a bulb only 2 mm. in diameter and 8.7 mm. long, became valuable to the medical profession. providing a light source for internal investigation and surgical work. A lamp smaller than the "grain o' wheat" lamp was being regularly supplied. and lamps with built-in reflectors were in wide use. Inside silica coatings had improved the diffusing qualities without loss in lamp efficiency.

7. Electric Discharge Lamps.—The observations of Jean Picard in 1675 and Johann Bernoulli about 1700 indicated that light could be produced by agitated mercury. Early research in the field was done about 1850 by Heinrich Geissler, German physicist who invented the Geissler tube, by means of which was demonstrated the phenomenon of luminosity accompanying the discharge of electricity through rarefied gases. An English professor, John T. Way. demonstrated the first mercury arc in 1860; and John Rapieff of London and the French scientist M. Jamin made further contributions in 1879 and 1882 respectively.

In 1887 Geissler tubes were used largely for laboratory demonstrations, but in 1897 tubes of various colours were used successfully for a display commemorating the Diamond Jubilee of Queen Victoria of England.

The Moore tube, developed by Daniel McFarlan Moore between 1891 and 1904 along the principle of the Geissler tube, made use of nitrogen to produce a yellow light and of carbon dioxide for a pinkish-nhite colour approximating daylight. Moore tube lights were most widely used for colour matching, and the first commercial installation was made in a Newark, N.J., store in 1904. The Moore tube was difficult to install and repair, and a complicated valve mechanism was required to maintain the gas at the correct pressure.

The mercury-vapour lamp, originated by L. Arons of Germany in 1892, was not manufactured on a commercial basis. Peter Cooper-Hewitt marketed the mercury-arc lamp in 1901, its efficiency proving to be two or three times that of the contemporary incandescent lamp. Its chief limitation was its peculiar colour quality, with light rays concentrated in three restricted spectral regions and with a complete absence of red. Introduction of other gases failed to produce satisfactory results until Cooper-Hewitt devised a fluorescent screen which converted some of the excess blue and green light and a little of the yellow into red, thereby materially improving the colour. The first practical installation of the Cooper-Hewitt lamp was in the composing room of the *New York Evening* Post in 1903. Creating a nearly shadow-free light and less glare, the lamp immediately found wide use for industrial lighting in the U.S.

Cooper-Hewitt also developed the quartz tube mercury lamp, used extensively in biological research. A later form of the quartz tube lamp. based on research carried on by C. Bol and others in the laboratories of the Philips company in Eindhoven, Neth., led to exploitation in Europe of a small water-cooled or capillary type of mercury-arc lamp, developed in 1935. Subsequently the U.S. type of this lamp was used primarily for photographic work and for searchlights

Research in the use of rare gases for illumination purposes was continuous. In 1910 Georges Claude experimented with electric discharge tubes containing neon, argon, helium, krypton and xenon, and within a decade the neon sign industry had developed. The novel effects obtainable with neon tubes gave them wide use for advertising purposes, their extreme adaptability, high luminosity and brilliant colours making them particularly suitable in this field. Efficiency of light production by use of neon tubes was too low for general illumination, and none of the colours was satisfactory for interior lighting.

A promising source of illumination among electric discharge lamps was the high-intensity sodium-vapour lamp, although it was not satisfactory for commercial or domestic use because of its characteristic yellow colour. Major applications were for highway lighting and general outdoor lighting where colour rendition was not important; and by mid-20th century sodium-vapour lamps were being used for highway lighting and illumination of bridges and vehicular tunnels all over the world.

In 1934 the low-voltage fluorescent lamp was under development in the U.S. Fluorescent and phosphorescent phenomena had been recorded centuries earlier, and many scientists had worked on fluorescent sources. Offering a highly efficient low-power source in various colours, the fluorescent lamp afforded the nearest approach to "cold" light ever devised in practical form. Fluorescent lamps produce light not by heating a filament to incandescence but by fluorescence of certain chemicals when excited by ultraviolet energy.

The early fluorescent lamp consisted of a low-pressure mercury arc of about 15 w. in a cylindrical glass tube coated inside with mineral salts having fluorescent qualities (phosphors). The efficiency and colour of the light were determined by the vapour pressure and the particular chemicals used. Fluorescent lamps were introduced commercially in 1938, and their rapid application on a large scale marked a major development in the field of artificial illumination. In the following year numerous permanent installations were made, and general lighting by these lamps was completed in two large factories in the U.S. Fluorescent lighting was an integral part of the decorative scheme of the New York and San Francisco world's fairs in 1938 and 1939.

During the ensuing years research designed to improve fluorescent sources was carried on extensively, and low- and high-voltage fluorescent lighting found many new applications in interior lighting and luminous decorative design. The adoption of fluorescent lighting was relatively rapid for industrial plants, stores and offices, but not until 1942 was it used to any extent for home lighting, although many specialized applications had been made. In 1944 experimental installations of fluorescent lamps for street lighting were made, and many installations were made in subsequent years. Other developments included rapid-start lamps, which eliminated the disturbing initial flicker; dimming and flashing circuits for special applications; and high-frequency systems which eliminated the need for expensive lamp ballast units. Intensive efforts also were devoted toward increasing lamp efficiency and light output so that the number of lamps needed in a given installation could be reduced.

II. MODERN ELEGTRICAL LIGHT SOURCES

A. Arc Lamps

By mid-20th century the atmospheric arc lamp was used chiefly in large-wattage units for searchlights, for projections calling for a high intensity and concentrated source, and for other special applications requiring small but powerful sources of blue and ultraviolet energy. The colour of the arc light may be controlled to some extent by use of various materials in the electrodes.

Arc lamps may be classified as: (1) low-intensity arcs, using solid carbon or neutral-cored electrodes and producing light by the incandescence of the electrode; (2) flame arcs, using mineralized carbon electrodes and producing the light from a luminous arc with some incandescence at the electrode ends; (3) high-intensity arcs, where much of the light comes from the gaseous region immediately in front of the carbon.

When arc lamps operating at atmospheric pressure are operated in parallel, it is necessary to control the flow of current by a ballast or series inductance. Arcs have a negative volt-ampere characteristic and operate at voltages lower than the starting value. Arc lamps must be equipped with automatic mechanisms for starting the arc and adjusting the electrodes. The maximum brightness obtained depends upon the size of the carbons and operation of the arc, and brightnesses exceeding 1,300,000 candles per square inch have been recorded with high-intensity arcs. The carbon-arc lamp operates at an efficiency of from 40 to 65 lumens per watt (l.p.w.). The objectionable noise and unsteady operation of the earlier types were overcome. Special arc electrodes and construction are used for wave-length standard measurements, and the line at the red end of the cadmium arc (6432.5696 Å) has been so accurately measured that the standard of length could be reproduced by using this wave length as a base.

Low-intensity arcs are used for motion-picture projection, photoengraving illumination and other photochemical effects, therapy, ultraviolet irradiation, black-light effects, etc. Uses for the flame arc are related to the spectral characteristics which result from the electrode material used; for example, carbons cored with cerium compounds produce light closely approaching natural sunlight.

High-intensity arcs are widely used for searchlights and large area floodlights and for coloured motion-picture photography and projection. Properly positioned with respect to a large parabolic mirror, the high-intensity arc makes possible searchlights of very narrow beam spreads and intensities exceeding 1,000,000,000 cp.

B. Incandescent Lamps

Edison developed a 100-w. carbon-filament lamp having an efficiency of 1.6 l.p.w. and a life of 600 hr. This efficiency was sufficient for the early lamp to compete with existing flame sources, but within 50 years manufacturers were offering 100-w. lamps with an efficiency of 16.4 l.p.w. and a life of 750 hr.

1. Losses.—Losses in the incandescent lamp are caused by: (1) heat conduction by lead-in wires and filament supports; (2) heat conducted and convected to the gas of gas-filled lamps; (3) voltage loss in the leads; and (4) light absorption by the glass and the base. After lamps have been in service, the lamp produces less light because of (1) decreased power consumption as the filament becomes thinner because of tungsten evaporation and (2) bulb blackening. Higher-temperature filaments produce whiter light and increased efficiency lamps, and progress has been marked by increased filament temperatures. Drawn tungsten wire, because of its favourable radiating characteristics, low rate of evaporation, high melting point, high tensile strength and ductility, became the preferred material for lamp filaments. This metal is available in sufficient quantity for all lighting needs; filaments for 75,000 40-w. or 1,000 500-w., 115-v. lamps can be made from one pound. No readily available substance exists with the efficiency of tungsten for converting electrical energy into light with no reservations as to cost, manufacturing difficulties or other considerations. The introduction of automatic machines into the manufacture of incandescent lamps aided in the production of a superior, uniform lamp at a nominal cost; and the high quality of the lamp is maintained by rigid specifications and tests.

2. Gas-Filled and Vacuum Incandescent Lamps.—Air is exhausted from the lamps to eliminate oxygen, thereby preventing filament vaporization. Air seepage into an incandescent lamp causes rapid deterioration of the filament.

Attempts to introduce inert gases into the carbon lamp for increasing filament temperatures failed because the resultant losses by conduction neutralized filament temperature gains.

The first major improvement of the tungsten lamp was the introduction of an inert gas into the bulb. Nitrogen was first used because the rarer gases were too expensive to obtain; however, by improved processes enough argon became available so that the atmosphere surrounding the filament is composed of 88% argon and 12% nitrogen. Krypton has lower heat conductivity than either nitrogen or argon, but it is too scarce and expensive to be used generally. Because the gas used must be very pure and free from moisture, getters are used during lamp manufacture for removing harmful gases and water vapour.

Higher lamp efficiency can be obtained by increasing the size of the filament because the protective sheath of hot gas is of nearly constant thickness. Coiling the filament made gas-filled lamps practical, and the next step in reducing filament loss was an apparent increase in filament size produced in 1935 by winding the coiled filament around a mandrel. The coiled-coil filament thus formed had an additional 10% to 15% increase in efficiency.

Materials used for lead-ins and supports were improved and the number of supports reduced until end losses from these sources had been reduced to about 2%. Elimination of a support increased the efficiency approximately 0.5%. In the 40-w. lamp, supports were reduced from 11 in the vacuum tungsten lamp to 3 in the gas-filled lamp.

3. Mechanical Features.—The incandescent lamp is an assemblage of a mount, a glass bulb and a base. Standard-voltage lamps of 40 w. or larger contain gas which permits higher filament temperature and thus improved efficiency. The complete mount for a standard large lamp consists of: (1) the stem which carries the molybdenum support wires held in a glass button at the end of the stem; (2) the exhaust tube; (3) the tungsten filament; and (4) lead-in wires. In the press (the sealing point at which the wires pass through the glass) the lead-in wires are made of a nickel-iron core clad in copper, this combination having the same coefficient of expansion as glass; nickel lead-ins are used from the press to the filament, and copper from the press to the base. In some of the larger sizes a mica disk on the stem protects the stem press, stem and socket from the excessive temperature by retarding the circulation of hot gases from the filament when the lamp is burned base up. The base is used for the connection to the electrical circuit. To open the circuit and protect line fuses when the filament arcs, many sizes of lamps have a small fuse just outside the stem press on the mount.

The filaments are supported in many ways for various types of duty. The filament form determines the position in which the lamp may be burned and its resistance to vibration. The filament form also controls the incandescent plane important in projection service. The base of the lamp adapts it to the holder of the equipment, and is cemented except where greater strength and higher base temperatures require a mechanical base without cement. When the screw lacks carrying capacity in large lamps, it can be replaced by the bipost base which forms a pin-type positive connection and accurate location of the light source. In other cases when precise filament positioning is essential, prefocus bases are used so that lamps may be interchanged in an optical system with the filament remaining in the same place. Bayonet, disk and pin bases are used on smaller types and tubular lamps.

Many shapes and sizes of glass bulbs are employed, depending on the wattage and service intended. The bulbs may be clear, coloured, inside-frosted or coated with diffusing or reflecting materials.

4. Spectral Quality of the Incandescent Lamp.—The light emitted from the incandescent lamp is deficient in blue radiation and strong in the red, the exact distribution depending on filament temperature. If additional radiation is desired in the blue region. lamps are operated at voltages higher than normal, resulting in shorter lamp life. The enclosing bulb influences the spectral distribution, the daylight lamp using coloured glass for correcting this region (blue-green glass); this lowers lamp efficiency about 35% because of the light absorbed by the glass.

5. Other Factors Affecting Light Output.—The electrical frequency of the system supplying the incandescent lamp will influence its output. The light from a lamp filament varies as the current decreases from maximum to zero. This is noticeable at the lower frequencies, but invisible to the unaided eye for 60-cycle systems. The larger the lamp. the more carry-over there will be. A 40-w. lamp has 13% variation at 60 cycles, while a 500-w. lamp has only 2%, and the same sizes range from 29% to 6% with 25 cycles. Flicker in lighting will be noticed if a 3% change of voltage is applied for a two-cycle duration.

Lamps should be operated at the voltage for which they were designed. though at ordinary rates for electric energy the cost of producing light is often less if lamps are burned at increased voltage. A 10% increase of voltage gives the following results: watts 116%, lumen output 135% and considerably reduced lamp life. A 10% decrease of voltage causes an 85% wattage consumption, gives 71% of lumens and increased lamp life. The selection of rated life for a lamp is determined by a balance between lamp cost, power cost and cost of maintenance and overhead.

As the temperature of the filament was increased, lamp brightness was also increased, so the bulb of the lamp was given special treatment. Early enameling processes were inefficient and increased the collection of dirt. Inside frosting provided reasonable diffusing and reduced the light output less than 1%, compared with 5% to 20% for outside coatings. Later, silica coatings gave excellent diffusion mith virtually the same light output as with inside frosting.

A certain amount of blackening inside the bulb is inevitable and is removed in some of the high-intensity short-life lamps by sealing coarse tungsten powder inside the bulb. By shaking the lamp at intervals, the inside of the bulb can be scoured by the tungsten particles, increasing both the light output and useful life of the lamp. In some lamps the vaporized tungsten is removed by passing the hot gases, carrying the vapour from the filament through a screen above the filament.

C. Gaseous Vapour Lamps

1. Low-Pressure Mercury-Vapour Lamps.—The Cooper-Hewitt source was the first of the commercial low-pressure lamps. These have been built in zoo-w. to 1,600-w. sizes using mercury vapour at 1 to 2 mm. pressure and a mercury cathode. The tubes had a rated life of 4.000 hr., but poor colour characteristics. The tube operated on either A.C. or D.C., but auxiliary equipment was required for starting and operating. Few low-pressure Cooper-Hewitt lamps are still in service. An 85-w. Cooper-Hewitt fluorescent lamp which was introduced around 1938 used phosphors on the inner surface of the tubular bulb. Called the R.F. fluorescent lamp. it operated as a full-wave rectifier, giving no stroboscopic effect. R F. lamps are still being made, but largely for replacement purposes.

Much experimental work has been done in an effort to correct the poor colour quality of the mercury arc. The combination of Cooper-Hewitt tubes with incandescent lamps was an additive method of colour correction. Although this correction did not produce a colour-matching light, it did produce a soft white light which for a time found favour in commercial and industrial fields. For adaption to desired luminaire design, tubes were produced in straight, round and square forms mith a possibility of obtaining U and M tubes. Pleasing results were obtained with a ratio of 2 w. of incandescence to 1 w. of mercury-vapour light. The development of the fluorescent lamp with its excellent colour and light control possibilities superseded this more complex and expensive means of producing a pleasing colour quality in lighting.

2. High-Pressure **Mercury-Vapour** Lamps.—The radiation from a mercury arc changes with pressure, and ranges of pressure up to about 280 atm. have been investigated. At high pressures the spectral lines of mercury radiation are no longer sharp but are broadened, giving a background radiation. This broadening is greater toward the red end of the spectrum, which improves colour quality, although it still does not give a balanced spectrum.

One disadvantage of this source is that it requires a starting time ranging from a few seconds for one special 1,000-w. unit to approximately 7 min. for the 400-w. A-HI type. Any interruption requires a repetition of the starting cycle. Although efficient in itself, mercury lighting is often used in combination with incandescent lighting to ensure continuity of light and to correct the colour of the light source by additive means. The combination should be made on an equal-lumen basis between the high-pressure mercury and incandescent lamps.

Table I gives the characteristics of the general high-pressure mercury lamps a hich, besides being used for general lighting, have many special applications.

Table I.—Characteristics of General Service Higlz-Pressure Mercury-Vapour Lamps

watts	Lumens at 100 hr.	Lumens per watt*	Rated	Starting time (min.)	Restart time (min.)	Pressure (atmospheres)	Brightness (c./sq.mm.)
100	3,300	33	1,000	3	3	8	7
250	11,000	44	4,000	10	4		4.6
400	15,000	37	4,000	7	7	1.2	1.4
400	20,000	50	3,000	8	5		5.1
3,000	120,000	40	5,000	8	7	0.7	1,0

*Efficiency of the lamp only. To compare with the inrandescent lamp it is necessary to reduce the lumens per watt, because of transformer loss, approximately 20%.

†For five burning hours per start. In many cases rated life is increased for less frequent startings.

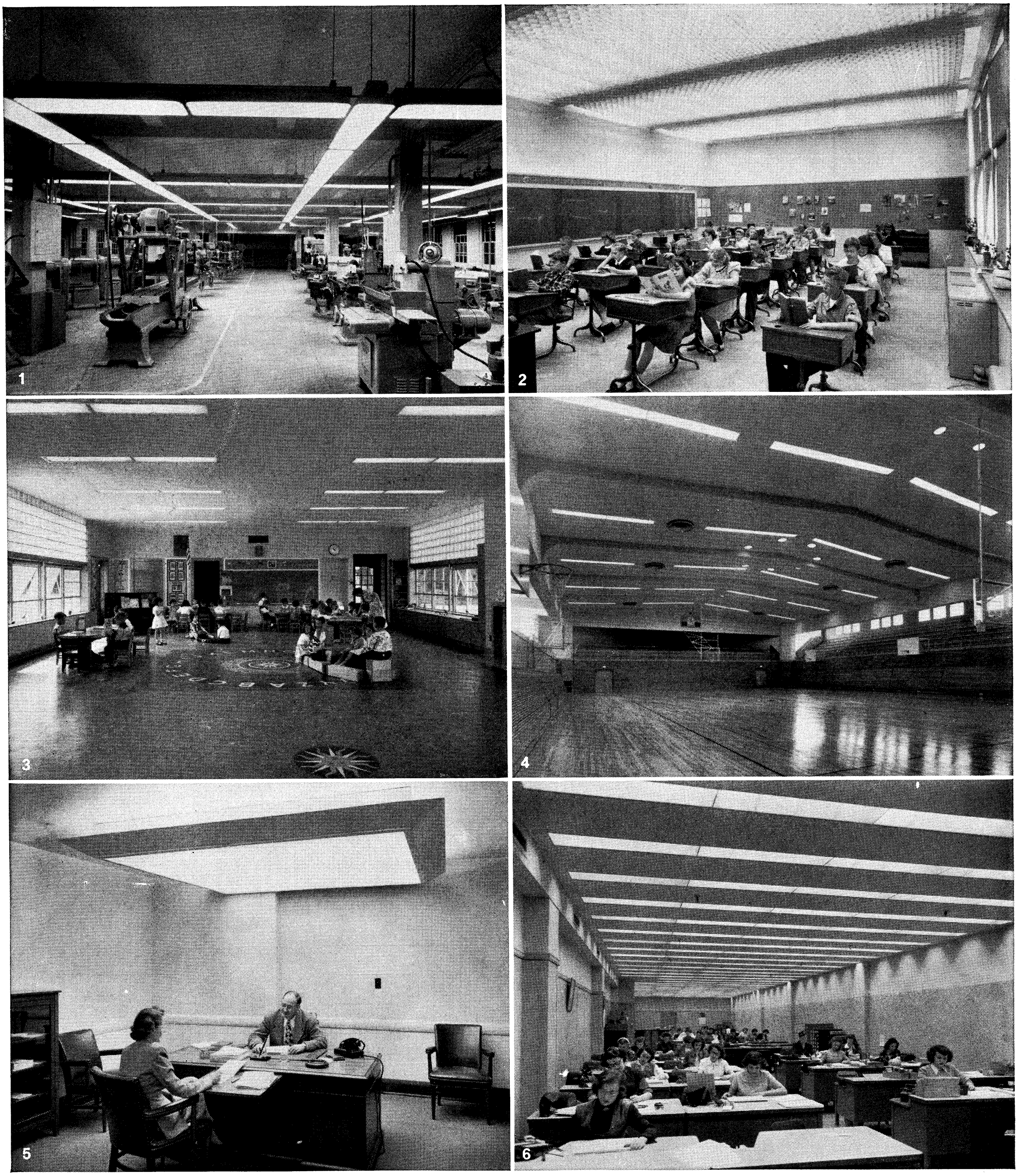
The 1,000-w. lamp with its quartz envelope enclosed in a water jacket is one of the brightest compact lighting units available. It is a relatively cool light because the heat is conveyed away by the circulating water. Initially there are 65,000 lumens or 65 l.p.w., and the rated life is 75 hr. It requires 4 sec. for starting and 2 sec. for a restart, and operates at 110 atm. with a brightness of 300 candles per square millimetre. The same lamp is rated at 900 w. when air-cooled.

3. Other Gaseous-Vapour Discharge Lamps.—In addition to the principal types of discharge lamps there is a subsidiary group of special lamps which includes photochemical, ozone, germicidal, black-light, glow and sunlight lamps, flash tubes and high-voltage neon lamps. The first four are not light sources, strictly speaking, although they do emit some visible light; however, they are produced by light-source manufacturers and are customarily installed by lighting engineers.

Photochemical Lamps.—The characteristic ultraviolet radiation of mercury-vapour discharges is useful for many photochemical processes, such as testing the fastness of dyes and the weathering of paints, water disinfection, photographic reproduction and ultraviolet therapy. Cylindrical mercury-vapour lamps, with walls of quartz or of glass especially compounded to transmit ultraviolet, are manufactured in sizes from a50 to 3,000 w. The quartz types emit energy below 2,800 Å, and the lamps must be shielded from the eyes. Photochemical lamps operate with ballasts similar to those employed with standard mercury-vapour types.

Ozone-Producing Lamps.—There are mercury-vapour lamps that consume 4 w. and operate at 10.5 v. The bulb of the lamp transmits radiation at 1.849 Å, producing ozone which eliminates odours by combining chemically with odorous constituents in the air.

Germicidal Lamps.—The radiation at 2,537 Å produced by this type of lon-pressure mercury-vapour lamp is the most effective in producing germicidal action.

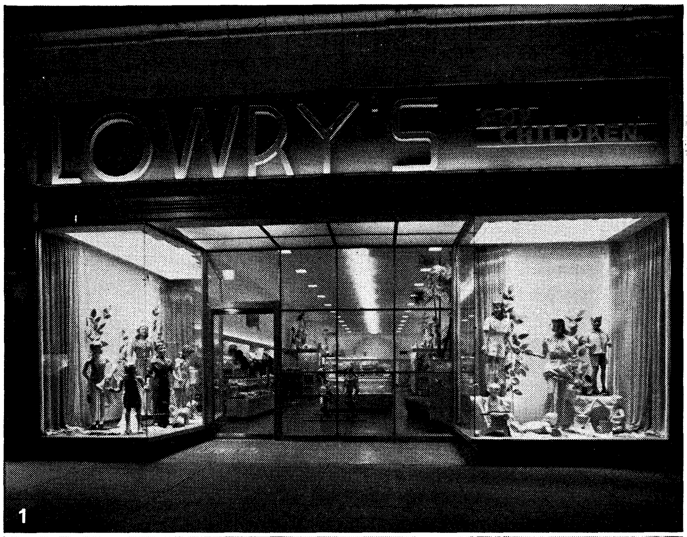


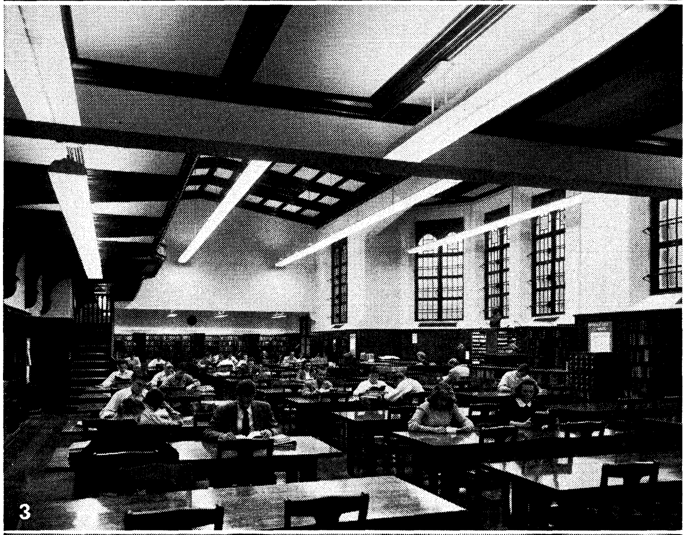
BY COURTESY OF LAMP DEPT., GENERAL ELECTRIC COMPANY

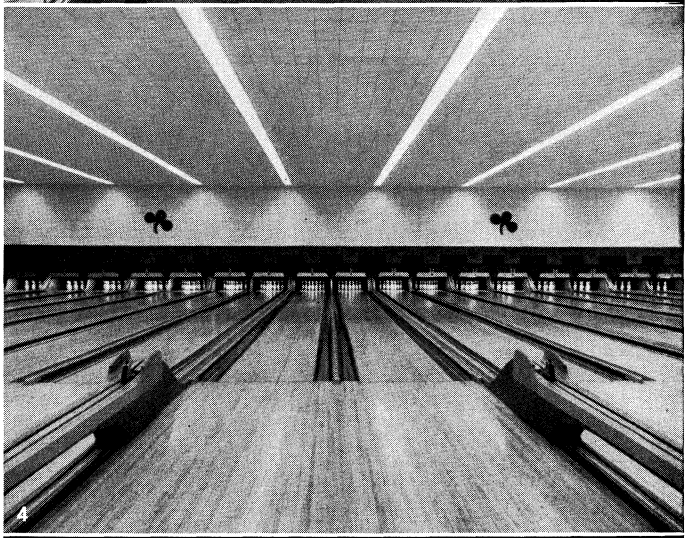
LIGHTING FOR VARIOUS KINDS OF INTERIORS

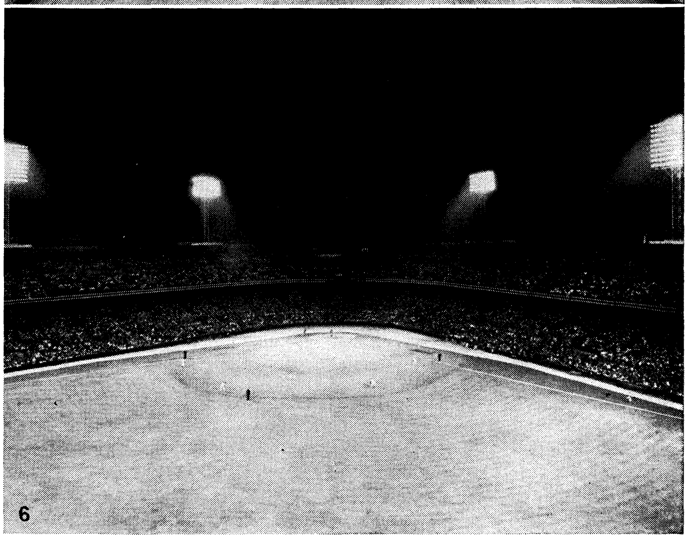
1. Continuous rows on 10-ft. centres light a factory room. Each reflector contains two 40-w. fluorescent lamps mounted approximately 9½ ft. above the floor. Rows at right angles form a grid pattern, producing 80 foot-candles maintained in service on the work plane
2. Public-school classroom lighted with 72-in. fluorescent lamps located above metal louvers which extend from wall to wail. The illumination level is 60 foot-candles
3. Kindergarten room of an elementary school with two-lamp glass-covered troffers to provide 30-35 foot-candles in service. The artificial lighting supplements natural light entering through the glass blocks on both sides of the room
4. Recessed fluorescent units provide almost 50 foot-candles for a high-school gymnasium, with filament downlighting luminaires for additional light at the centre and at the baskets
5. Large louvered unit over the desk area of a private office. Twelve 96-in. fluorescent lamps on 8-in. centres produce 125 foot-candles, and cove elements on the side add to the general lighting of the office
6. Recessed troffers in continuous rows at right angles to the nominal direction of view deliver 60 foot-candles of lighting for a general office. Each troffer unit contains a single 40-w. fluorescent lamp

LIGHTING









BY COURTESY OF (1-5) LAMP DEPT., GENERAL ELECTRIC COMPANY, (6) WESTINGHOUSE ELECTRIC & MANUFACTURING COMPANY, LAMP DIVISION

MODERN LIGHTING **ARRANGEMENTS**

1. Shop windows lighted by 40-w. fluorescent and 150-w. integral-reflector lamps above louver grid ceilings, producing 750 foot-candies. The central panels are transilluminated with fluorescent lamps

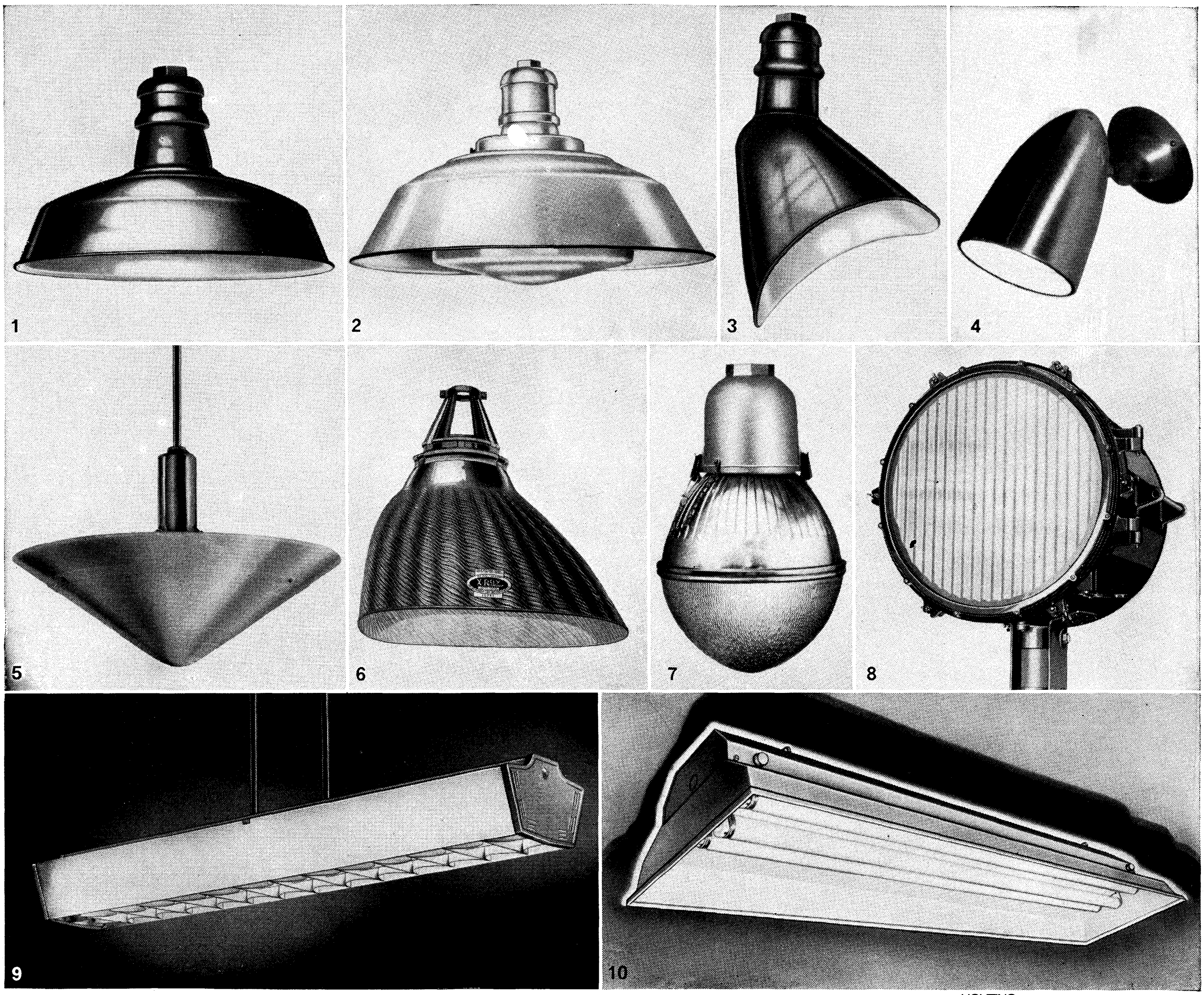
2. Store interior using fluorescent- and filament-lamp general lighting of 40 foot-candles with showcases and wallcases illuminated bv built-in fluorescent lamps giving about 100 foot-candles. Filament lamps with integral reflectors provide higher brightness and colour patterns for featured displays

3. Louvered fluorescent luminaires containing 40-w. lamps furnish direct and indirect lighting for a library. The resultant illumination is 40 foot-candles in service

4. Single-lamp trough reflectors recessed in the ceiling of a bowling alley to provide about 15 foot-candles of illumination. Supplementary units over the pins give 60 foot-candles for good visibility

5. Television studio using adjustable fluorescent lighting units mounted on a trolley channel to supplement the general illumination produced by the luminaires recessed in the ceiling

6. Major league baseball at night, played under 780 1,500-w. floodlights mounted on 8 towers 150 ft. in height to provide intensity of 185 foot-candles on the infield, 120 on the outfield (Shibe park, Philadelphia, Pa.)



BY COURTESY OF (4, 7) LAMP DEPT , GENERAL ELECTRIC COMPANY. (5) WESTINGHOUSE ELECTRIC & MANUFACTURING COMPANY, (6) THE CURTIS LIGHTING INCORPORATED, (9) THE F. W. WAKEFIELD BRASS CO., (10) BENJAMIN ELECTRIC MFG COMPANY

VARIOUS TYPES OF STANDARD LIGHTING UNITS

1. A porcelain enamel steel reflector known as the RLM Dome. Made to uniform minimum specifications by many manufacturers, it is of high-quality construction, has an efficiency of at least 70%, uses inside frosted or white bowl lamps preferably, and is usually mounted 9 to 12 ft. from the floor
2. The Glassteel Diffuser — similar to fig. 1 but producing a more diffused light as a result of the lamp-enclosing glass globe. Used at medium low mounting, for general industrial areas
3. An elliptical angle reflector used for lighting vertical and inclined surfaces, usually constructed of porcelain enamel steel. In general the above three industrial units are available for 100- to 1,000-w. lamps
4. Housing for a 150- or 300-w. integral-refiector lamp of the type widely used in store lighting
5. An open top luminous bowl unit for indirect lighting. The prevailing trend in office, school and similar commercial applications is toward semi-indirect and indirect units which can produce high intensities with minimum glare discomfort
6. One of many varieties of show window reflectors. Individual design is based on the aeneral proportions of show windows, with due consideration for both horizontal and vertical illumination
7. Luminaire for business and arterial streets
8. A special type of outdoor unit — an airport landing field floodlight whose output must be spread over large horizontal areas, usually employing 3,000- or 5,000-w. lamps
9. A typical commercial fluorescent lighting unit
10. A 3-lamp, 40-w. closed-end industrial fluorescent unit

BY COURTESY OF (1, 2, 6) LAMP DEPT., GENERAL ELECTRIC COMPANY, (3-5) WESTINGHOUSE ELECTRIC & MANUFACTURING COMPANY, LAMP DIVISION

MODERN HOME LIGHTING ARRANGEMENTS

1. Living room. The window valance uses one 20-w. and two 40-w. fluorescent lamps mounted on a channel behind the shielding strip. A 40-w. fluorescent lamp covered by a frosted glass panel is recessed in the mantel
2. The recessed box in the overhang (three 25-w. filament bulbs) is especially effective with this simple architectural treatment
3. A kitchen entirely lighted by fluorescent lamps. Sink, range and work counters are locally lighted. In the section over the sink two 30-w. fluorescent lamps are recessed and covered by glass. Under the front edge of the cabinets are single 15-w. fluorescent lamps
4. Across the top of the recess are two rows of three 30-w. fluorescent tubes covered by frosted glass and a valance of fabric. The niches are lighted by long, slender fluorescent tubes mounted vertically in the front and at the sides of each niche. These tubes are 42 in. long (approximately 25 w. each)
5. General lighting is produced from a continuous cove that conceals an unbroken line of fluorescent lamps (10 w. per running foot). The sectional davenport is backed by a fluorescent-lighted ledge
6. Ceiling luminaire for a dining room using a 150-w. integral-reflector lamp to send light directly down to the table area. Fluorescent lamps in the window valances supply general room illumination

Black-Light Lamps.—These emit radiation from 3,200 Å to 4,000 Å, beyond the visible range, that produces fluorescence in certain chemicals (see LUMINESCENCE). The lamps have been used in such divergent applications as advertising displays, theatrical productions, the identification of minerals, crime detection, medical and chemical research, and industrial inspection for quality control. Black-light lamps are available in all sizes in ahich mercury-vapour lamps radiating ultraviolet are made; however, the radiation from any mercury-vapour lamp can be used if a proper filter eliminates the visible light.

Glow Lamps.——Electrodes sealed in a small bulb filled with neon or argon gas produce lamps that will work on voltages as low as 60 D.C. or 42 A.C. The lamps are used as signal, pilot, indicator and night lights. They have a low current consumption and a life ranging from 3.000 to 25,000 hr.

Sunlight Lamps.——Mercury lamps equipped with special glass bulbs to transmit the middle ultraviolet energy generated by the vapour discharge are used to produce sun tan. Various types of mercury sun lamps are available; the most popular for home use is a 275-w. lamp with built-in reflector and self-contained filament ballast for operation on standard 110- to 125-v. X.C. circuits. More powerful sources of erythema-producing ultraviolet are employed for solaria and other specialized applications. Fluorescent sun lamps use phosphors which convert the resonant 2,537-Å energy generated in the arc to longer ultraviolet wave lengths.

Flash *Tubes.*—Straight or coiled sections of glass or quartz tubing, filled with a rare gas and discharged across capacitors, produce a brief flash of white light for high-speed photography. Xenon is the gas most frequently used. Voltages from 800 to several thousand are accumulated on the capacitors by a D.C. rectifier, and a high-voltage pulse initiates the brilliant flash which produces up to 90,000,000 peak lumens and lasts from $\frac{1}{1000}$ to $\frac{1}{1,000,000}$ sec. For ordinary operation a tube lasts thousands of flashes. The power supply depends on the size of the flash tube; several hundred pounds of equipment are necessary for the larger models, while portable lightweight power packs are available for the smaller flash tubes. With special auxiliary equipment, flash tubes can be flashed repeatedly, some at frequencies up to 30,000 per second.

High-Voltage Neon Lumps.—The neon lamp is associated with the cold-cathode group, with the luminescence produced by an electrical discharge through gases. These lamps are efficient when of considerable length and contain a high percentage of neon gas, giving the characteristic orange-red colour. To obtain other colours, mercury, argon, carbon dioxide and xenon are used, and coloured glass tubes are used in conjunction with the gases. The voltages range from 8,000 to 12.000 v. The operation of the high-voltage cold-cathode and the high-voltage hot-cathode fluorescent lamp is the same except at the cathodes, where the cold-cathode lamp has the higher voltage loss.

TABLE 11.—Comparative Data on Light Sources

Source	Candles per sq.in.	Lumens per watt	Luminous efficiency (%)
Sun	- -		16
Candle	3.5	0.1	
Kerosene flame	9.0	0.3	
Gas flame	2.7		
Acetylene flame	40	0.7	
Welsbach mantle	31		
Carbon arc	92×10^3	7	1.1
Flaming arc	5×10^3	17	2.7
Magnetite arc	4×10^3	90	14.5
Mercury arc	8×10^2	12.7	2.0
Cooper-Hewitt	20		
Cold-cathode			
Red	0.5		
Green	0.16		
Blue	0.1		
Hot-cathode, 40-w.			
Warm white	4.2	63	9.7
Daylight	3.5	53	
Soft white	2.9	44	
Carbonfilament	340	2.6	0.42
Gemfilament	615	4	
Nernst glower	1,660		
Tantalum filament	750		
Tungsten filament (vacuum)	1,328	10	1.6
Tungsten filament (gas!, 500-w.	7,500	19.8	3.2
Tungsten filament, coated lamp, 25-w.	11		
Tungsten filament, inside frost, 25-w.	22	10.5	1.69

Prior to the introduction of the fluorescent coating, sign tubing had little application for illumination purposes, its low lumen output being used for signs and to create luminous patterns. With mercury vapour and fluorescent coating, and depending on diameter, current rating and length, efficiencies approaching those of standard hot-cathode fluorescent lamps are obtainable. The units are from 4 to 10 ft. long and are connected in series to operate from 1,000- to 15,000-v. transformers.

D. FLUORESCENT LAMPS

The fluorescent lamp is a glass tube coated on the inside with a phosphor (fluorescent chemical) and filled with mercury vapour, with a small amount of argon to facilitate starting. After starting the current is carried essentially by the mercury vapour. The design adjustment is such that the desired resonant radiation of mercury at 2,537 Å is produced. Small coils of 'tungsten wire (electrodes) are sealed into each end and these filament cathodes are coated with an active electron-emissive material.

The ultraviolet radiated from the conducting mercury gas excites the phosphor which radiates light in the visible region. Different mixtures of the powders forming the phosphors control the colour of the emitted light. Most lamps are white when unlighted; the gold and red lamps have a pigment coating on the bulb interior to give the desired colours. In the 40-w. fluorescent lamp approximately 1% of the light is delivered directly by the mercury vapour. Of the input wattage 20.5% is converted into visible radiation, nearly three times that from the 40-w. incandescent lamp, which delivers only 7.4% of its wattage in the visible region.

1. Operation.— The operation of the preheat-start fluorescent lamp requires two switches, one for normal on-off switching of the primary power as in the incandescent lamp; and the other for closing the circuit on the cathodes for an instant. allowing the cathodes to preheat, then opening, producing an inductive voltage which causes the arc to strike.

In the typical circuit shown in fig. 1(A), the sockets hold the lamp; the ballast (a coil of wire wound on an iron core) furnishes the inductive "kick" to start the arc and limits the flow of current through the arc; and the filter reduces feedback into the electric supply circuit which may cause radio interference; the starter, wired across the lamp sockets (terminals T_1 and T_2), may be any of three types. The glow switch (fig. 1[B]) consists of a bulb containing neon or argon gas and a bimetallic switch element. When power is applied, the voltage is high across the terminals, and the glowing gas heats the bimetallic switch, closing it; this places the lamp cathodes into the circuit. heating them and reducing the voltage across the glow switch; the switch opens, and the inductive "kick" from the ballast strikes an arc through the lamp. The glow switch remains open while the lamp is in operation because the voltage across its terminals is too low to cause a glom.

The non-blink starter (fig. 1[C]) functions in much the same manner as the glow-switch starter except that an additional locking switch is provided; this removes the lamp from the circuit if it fails to function properly after a few attempts at starting. When the lamp is replaced, the starter may be returned to service by pressing the reset button, which protrudes through the end of its case.

The thermal-switch starter (fig. 1[D]) consists of a bimetallic switch, normally closed when power is off. In starting, a small heating element opens this switch after a brief period during which the lamp cathodes heat; the inductive "kick" from the ballast starts the lamp, and the operating current holds the switch open.

Circuits have been designed for the elimination of starter switches, which are always a source of operating trouble. Several standard sizes of hot-cathode fluorescent lamps are available for instant-start service without starters.

The fluorescent lamp has high efficiency, up to 73 l.p.w., but introduces several operating characteristics which necessitate a lighting installation less simple in theory and function than that

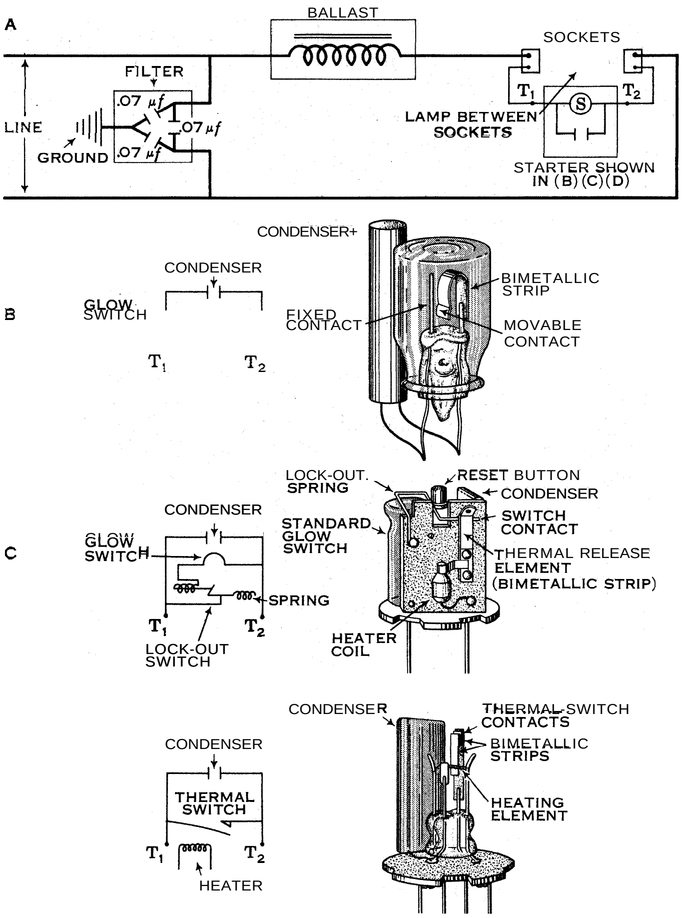


FIG. 1.— (A) DIAGRAM OF TYPICAL LAMP CIRCUIT, (B) GLOW-SWITCH STARTER. (C) NON-BLINK STARTER. (D) THERMAL-SWITCH STARTER (SEE TEXT)

needed for the incandescent lamp.

2. Characteristics.— Diameter and length of the fluorescent lamp depend upon several factors. Design has been centred about $\frac{5}{8}$-in., 1-in., $1\frac{1}{2}$-in. and $2\frac{1}{8}$-in. tubes for the lower voltages; and $\frac{3}{4}$-in., 1-in. and $1\frac{1}{2}$-in. tubes for instant starting at higher voltages. Long lamps are more efficient than short ones, other conditions being equal. The fluorescent lamp is more sensitive to surrounding temperature than the incandescent lamp; many sizes of fluorescent lamps generate light most efficiently when the surrounding air is 70° to 80° F. The lamp voltage divides between the electrode drop (12 to 18 v.) and the voltage gradient, which is the voltage per inch of tube required to neutralize the ions at the walls, plus the conversion of the energy into radiation. For preheated-cathode operation, the open-circuit voltage should be at least twice the lamp voltage. Somewhat higher ratios are required for instant-start lamps.

When a single lamp is being used, the stroboscopic effect caused by the vapour discharge being extinguished twice during each cycle is annoying in some operations. This may be eliminated by using two lamps in the same or adjacent luminaires, with the circuit so arranged that the lamps do not produce their minimum output at the same time. This effect is different from swirling, a type of lamp flicker which is also annoying. The swirl may appear in a new lamp or at any time in its life, but disappear as suddenly as it occurred.

The fluorescent lamp can be the cause of radio interference caused by direct radiation, radiation from the electric supply or feedback from the line. Proper filtering will minimize the last two causes, while removal of the radio from the field or proper screening will eliminate the first.

Failure of the lamp to function properly may lie within the lamp itself, in the auxiliary or in the starter. The safest rule to follow in correcting the fault is to eliminate by replacement with spare parts which should be available, in the order of starter, lamp, then ballast; but under no circumstances should the lamp be left in operation if trouble develops.

3. Economic Consideration.— Economic consideration of the fluorescent lamp requires a close study of the cost of both equipment and power. The first cost of fluorescent lamps is relatively high as compared with incandescent lamps of equivalent wattage, but their operating costs are relatively low for a given light output. Replacement of incandescent lamps by fluorescent lamps ordinarily gives two to four times as many lumens per watt.

Since fluorescent lighting systems create less heat, they are valuable in conjunction with modern air-conditioning systems and they are also of great usefulness where colour matching or coloured lighting is required.

Because of the various ways in which efficiencies may be stated, many claims have been made concerning fluorescent lamps, but it is necessary to include all the losses in the auxiliary with the lamp wattage to arrive at a correct evaluation. Brightness of the fluorescent lamp is much less than that of the incandescent lamp, but it is still so bright that neither the eye nor the work should be directly exposed to it.

TABLE III.—Characteristics of "Cool White" Fluorescent Lamps

Watts	Life (hr.)	Lumens	Length (in.)
For use with starters			
4	4,000	100	6
6	6,000	210	9
8	6,000	330	12
13	6,000	700	21
14	6,000	540	15
15	7,500	730	18
20	7,500	1,000	24
25	7,500	1,600	33
30	7,500	1,890	36
40	7,500	2,500	48
90	7,500	5,150	60
Instant start (no starter used)			
40	7,500	2,500	48
40	6,000	2,500	60
Rapid start (no starter used)			
40	7,500	2,500	48
High output (no starter used)			
60	7,500	3,250	48
85	7,500	5,200	72
105	7,500	7,300	96
"Power groove" (no starter used)			
107	—	6,000	48
155	—	9,300	72
200	—	11,000	96
"Slimline" (instant start)			
17.5–32.5	7,500	1,480	42
25.5–48	7,500	2,450	64
24.5–48.5	7,500	2,550	72
32–65	7,500	3,550	96
38	7,500	2,300	48
55	7,500	3,600	72
74	7,500	5,050	96
"Circline" (rapid start)			
22	7,500	930	8¼" O.D.
22	7,500	1,550	12" O.D.
40	7,500	2,200	16" O.D.

Any comparison of lighting systems must be on the basis of equal quality of lighting (see Table III).

III. ILLUMINATING ENGINEERING

In applying lighting to any task, consideration must be given to both the human and the mechanical elements involved. In the design of a lighting installation, the opinions and requirements of the eye specialist, the architect and the interior decorator must be considered, as well as the control and the amount of lighting. A successful lighting system must be a part of the building or activity for which it has been designed.

1. Measurement of Light.—Light is measured by its capacity to produce a sensation. The eye interprets this sensation in that region of the electromagnetic spectrum which extends from 7,600 Å to 3,800 A. The eye does not respond equally to the radiant energy in this octave, responding more efficiently to the green and yellow than to the reds, blues and violets. (See also VISION.)

There are three units of special importance in the application of lighting in practice: the lumen (unit of luminous flux). the foot-candle (ft.-c.) (one lumen incident per square foot) and brightness. Brightness is measured by foot-lamberts (ft.-L.) for surfaces of low intensity and by candles per square inch for sources of high intensity. In the metric system the corresponding units are the lux (one lumen incident per square metre), and the lambert (one lumen per square centimetre) for brightness. The lumen is used in lighting calculations, while field measurements are made of illumination (foot-candles) and brightness (ft.-L. or candles per square inch).

Illumination is measured by means of a light meter (foot-candle meter), usually of the photoelectric type.

Measurements of brightness are made with some form of brightness meter which the observer is required to adjust for photometric balance. In the past, average illumination was relied upon to a great extent, but the modern tendency is to give serious consideration to brightness, and future design will continue in this direction.

2. Lighting Environment. — The act of seeing depends upon visual acuity, the size of the object and its brightness, the contrast between object and background, and the length of time the object is exposed for viewing. The first essential to proper seeing conditions is that the eyes be corrected; the second essential is the proper amount and quality of lighting.

Period of Exposure. — If the object is large and long periods of time are allowed for exposure, the task can be adequately lighted with little illumination, but for small objects and short exposure periods, the illumination must be correspondingly increased. If the amount of illumination varies, the retina will still retain an image with no consciousness on the part of the observer that the lighting is not continuous if the flicker is rapid. Motion-picture projection bears witness to this fact. However, sudden changes of light at long intervals will cause blurring of moving objects, which becomes more pronounced at low foot-candle levels of illumination. The stroboscopic effect from fluorescent lamps and the 25-cycle flicker are examples of a lack of continuity of light.

Size of Object. — The size of an object establishes the lighting requirements. By size is meant visual size, which is a combination of dimensions of the smallest detail which must be observed and the distance of the object from the eye. More foot-candles are needed for smaller objects, all other factors being equal. The normal eye can distinguish any object which subtends an angle of 1′. This is an important factor in the design of signs which are to be seen from some distance.

Contrast. — An object is seen more clearly if background and object are of different colours. A white object against a black background can be more readily seen than a black object against a black background. This fact is utilized in industry to obtain contrast between the machine and its moving parts, the material being worked and the surround (visual field).

Brightness. — Brightness leads directly to the visibility of the object. A very dark object requires more foot-candles for illumination than one with a high reflection factor. For many years foot-candles of illumination were the index to lighting design and specifications, and failure to recognize the importance of reflection factor led to faulty lighting. More attention is being paid to the brightness of the task and its surroundings in design.

Glare. — When brightness becomes irritating it is recognized as glare. Glare contributes more to the poor quality of a lighting system than any other factor. Glare may depend upon several conditions present in the lighting system: (1) high brightness of the source; (2) high brightness contrast between the source and the background; (3) location of the source in the field of view; (4) the total volume of the light entering the eye; and (5) the time of exposure to the brightness source. The correction of any one of these contributing factors becomes simple when it is considered individually. Because of the injurious effect of glare, either direct as from a source, or reflected from some object which reflects a specular image, bare lamps exposed in any plane should never be used. It is of prime importance that all forms of glare be controlled properly.

Investigation and experience have established principles for studying the installation in order to control glare. These are not recommended as precise, but are suggestive of order of evaluation: (1) the light output of a source cannot be increased as fast as its area, but it is safe to increase the output as fast as the diameter; (2) increasing the foot-candles ten times in a room permits only doubling the brightness of the light source; (3) doubling the mounting height of a unit allows a lumen output of approximately three times that used previously; (4) brightness ratio of adjacent areas should be within limits of ten to one; (5) there should be more light on the work than at the eye; (6) each light in a row makes the same contribution to glare. All, these specifications are based on equal comfort from the lighting system.

Proper *Amount* of Lighting. — The severity of the task is the first index to the amount of light required. Lighting may be specified as: (1) For severe and prolonged tasks with details small, contrast low and speed of operation high, 100 ft.-c. or more should be used, best obtained by supplementary lighting. (2) For installations in which speed is not a factor and the object is small, 50 to 100 ft.-c. should be used, and again should be obtained by supplementary lighting. (3) For normal industrial and commercial tasks, 20 to 50 ft.-c. will suffice and may be supplied by a well-designed general lighting system; where economy is a factor supplementary lighting should be used. (4) For most recreational needs and ordinary tasks which are not prolonged throughout the working day, 10 to 20 ft.-c. from a general lighting system is satisfactory. (5) Where seeing is important but not prolonged, the contrast good, the object fairly large and the speed of movement slow, j to 10 ft.-c. from a general lighting system is specified. (6) Levels of less than 5 ft.-c. should be specified only for casual and nonhazardous passageways. This is obtainable with a relatively cheap general lighting installation, since for this use the quality of the lighting is of minor importance.

Considering the high foot-candle level to which the eye is accustomed out-of-doors, it is logical to believe that the eye will function best under high foot-candle levels of properly controlled light; that is, light in which quality of distribution approaches that of the out-of-doors. Control of the surround requires a reduction in the foot-candles. The spectral quality of the light source has no influence on seeing, although it does affect the psychological atmosphere; and modern light sources do not emit enough of the harmful wave lengths so that repeated exposures are injurious (this does not hold true, of course, for special lamps such as those emitting ultraviolet). As was the case with the incandescent lamp, the fluorescent lamp when first introduced drew accusations that its light injured the eyes, but any instances of injury or discomfort have been traceable directly to poorly designed lighting systems.

The craft of illuminating engineering has developed more on the basis of rising economic standards and increasing technical control of light than on the ability of the human eye to tolerate light. As methods of controlling light advanced and costs permitted, the amount of illumination has been increased, and successive recommendations of engineering societies have called for higher illumination values.

TABLE IV.—*Specifications for Lighting*[C]

Type of task	Brightness (in ft.-L.)	Foot-candles	
		60% Task reflectance	6% Task reflectance
Most difficult .	420 and up	700	7,000
very difficult .	120–420	200–700	2,000–7,000
Difficult . .	420–120	70–200	700–2,000
Ordinary . .	18–42	30–70	300–700
Easy . . .	18 and below	30 and below	300 and below

*Based on the research by H. Richard Blackwell, director, Vision Research laboratory, University of Michigan, Ann Arbor.

Research on "visual capacity," initiated in 1950 by H. Richard Blackwell of the University of Michigan, Ann Arbor, resulted in a series of 4-min. standard test objects of equivalent degrees of contrast. These equivalent contrast values, divided into five general levels of task difficulty and taking into account brightness and reflectance, lead to foot-candle specifications for any seeing task (see Table IV). The method offers a reliable gauge for determining the need for proper lighting, but this in turn must be adjusted to take account of control of the lighting and the economic feasibility of the required illumination.

Colouv *and Shadow.*—Colour and shadow are not necessarily factors in seeing but are of importance in recognition of objects. Colour must be treated carefully when used in conjunction nith light. If coloured light is used, white or neutral gray makes the best surround. With the incandescent lamp, usually considered as white light, the spectral distribution of the output must be considered when colours are to be extenuated or are to appear in their natural intensity.

Moods are suggested and depth perception is affected by colours. Although the lighting specialist is not to assume the functions of the artist or the decorator, it is necessary in the application of lighting to recognize the effect light has upon colour and atmosphere and to proceed accordingly.

Shadows may be either detrimental or helpful, depending upon the task to be performed. For decoration the shadow removes the monotony of a uniform lighting system and adds atmosphere to areas of relaxation, as in the home. In industry the shadow facilitates inspection tasks, emphasizes surfaces in relief and thereby improves visual conditions. Where there is moving machinery or the work lies within a single plane, shadow is detrimental both to safety and visibility. Small concentrated sources will produce harsh, severe shadows, while large area sources of low brightness will produce, for practical purposes, a shadowless surface. Between these two extremes are gradations adaptable to specific types of tasks. Shadow control on stair treads, at corners and on moving machine parts is an important application of light to safety.

Surround.—The surfaces which the eye encounters as relaxation areas from a severe task should be properly prepared and illuminated both for light reflection and psychological effect. Brightness of the surround should be at least 10% of the brightness of the task, although research has shown that, if it is feasible, the task and the surround should be equally bright.

Ceilings should have a reflection factor of 75% or more, and side walls of from 50% to 70%. Any trim above 30 in. from the floor may be as dark as desired up to a small percentage of the wall surface. The use of narm and cool colours in shades or tints makes little difference if the reflection factors are correct.

Factors Controlling Effectiveness of a Lighting System.—These factors should be considered carefully when analyzing a lighting system: (1) The quantity of light should be such as to produce a desired brightness for the severity of the task. (2) There should be no direct glare from the light source, and the reflected glare should be reduced to a minimum. This can be aided by selection of equipment and work surfaces producing no specular images. (3) Uniformity of the lighting should be controlled. For tasks in one plane, such as writing, drawing and reading, a shadow-free light is desirable. For tasks in three dimensions. such as relief work and inspection, a nonuniform light may be better. (4) Illumination of the surround is essential for the relief of eye strain by providing the proper atmosphere for eye relaxation.

The amount of illumination has been so strongly stressed that frequently quality of lighting is sacrificed by lack of consideration of the elements outside the brightness of the light falling on the task. A lower foot-candle level with proper control is better than a high foot-candle level improperly controlled.

3. Light Control.—Primitive light sources required no shielding, and there was no attempt to control artificial lighting until the 13th century, when mirrors were placed behind the Venetian stand lamp, the *lucerna*. In 1490 Leonardo da Vinci introduced control by refraction, and in 1745 polished metal reflectors were used in the *reverbere*. For the most part, however, control of light belongs to the 20th century.

Classes of Substances.—Transparent materials are not effective with modern light sources because the bare source has a brightness which must be controlled. Transparent material can be used nith lighting equipment having very low candle porer; however, this class of equipment is more for decorative effect than for lighting, and when used for lighting as well as decoration the quality of light is very poor.

Translucent materials are more widely used than any other light-control substance, and the introduction of plastics into this field in 1933 marked a new stage of light-control development. Translucent glasses of the denser types (opal and alabaster) are used for light backgrounds, while the configurated, decorated, structural and architectural glasses are used for decoration where atmosphere rather than illumination of a task is important. The flashed opal, cased, enameled and light opal glasses have a relatively high transmission and good diffusing qualities. These latter two classes of glass have been widely used in the better grade of lighting glassware and luminous elements.

Opaque materials are used primarily as reflectors and shields. Reflectors for beam control should have a high reflection factor, and usually some form of protected metal film or treated metal is used, silver and aluminum ranking high for this application. For industrial equipment, white enamel and paints on opaque surfaces give high reflection with reasonable maintenance and replacement.

Light-Beam *Control.*—There are three ways in which the light beam may be controlled: (1) reflection, (2) transmission and (3) refraction. The opaque materials are of the reflection type, and the translucent of the transmission type. Refraction is redirection of light caused by surface shape of the transmitting material. One of the most efficient means of control is by use of prisms, but control in one direction may cause bright spots in others, if not properly designed.

Nature of the Surface.—Light may be diffused by transmission or reflection from a surface, and diffused light is very acceptable for lighting purposes. Redirected light or even scattered light has its merits in the instance of the special reflector, but may cause specular images or highlights producing objectionable reflected glare. It is recommended that all lighted surfaces within the line of vision (walls and equipment) be of the diffusing type.

Optical *Control.*—Where accurate control of the light is desired, as in projectors or searchlights, optical reflectors or lenses may be used and for fine control these devices must be accurate. For automobile headlights and floodlights the control lenses and the reflectors may be made by molding the glass and drawing or spinning the metal.

Luminaire and Installation.—The design of the lighting equipment and the character of the room and cleanliness are controlling factors in lighting efficiency and light distribution.

Lighting equipment is classified into five groups, as shown in Table V.

TABLE V.—*Lighting Equipment*

Classification	Approximate light distribution	
	% Upward	% Downward
Direct	0–10	90–100
Semidirect	10–40	60–90
General diffusing	40–60	40–60
Semi-indirect	60–90	10–40
Indirect	90–100	0–10

The dimensions of the room and the colour of the ceiling and side walls, as well as the efficiency, depreciation and candle-power distribution of the equipment, control the output. In design the equipment is classified by a coefficient of performance (utilization factor) designating the control in the room of the light from the luminaire; and the coefficient of utilization, which includes the luminaire efficiency and therefore designates control from the lamp to the work surface. These coefficients may be determined accurately for specific equipment or may be grouped into classes for practical use.

Classification of Outdoor Equipment.—Lighting units for outdoor service are classified as floodlights when the area is not restricted in pattern. and may have broad. medium or narrow beams. The broad-beam equipment is used where the surface to be illuminated is in the immediate area; narrow-beam equipment is used for more distant areas. For a controlled beam the projector or searchlight is used, the first lacking the optical accuracy of the latter. Rotating or fixed equipments used for signal systems are classified as beacons.

4. Design **of** Lighting Installation. — There are two methods of lighting design. the point-by-point and the lumen. Each has its specific use, and the accuracy attained with each is satisfactory for practical purposes. The point-by-point method is used to determine the illumination at a point from a specific lighting equipment for which the distribution curve is known. Where there is no interreflection, the point-by-point method gi es the total illumination on the surface at the point; but in an enclosure interreflections will increase the illumination. The point-by-point method is accurate for outdoor lighting, for calculation and design of supplementary lighting and for down lights in interiors. The lumen method is satisfactory for determining the illumination within enclosures and is the procedure accepted in the designing of interior illumination. This is a method of determining average illumination and not specific illumination at a point. Although the method is relatively simple, it considers room proportions, col-

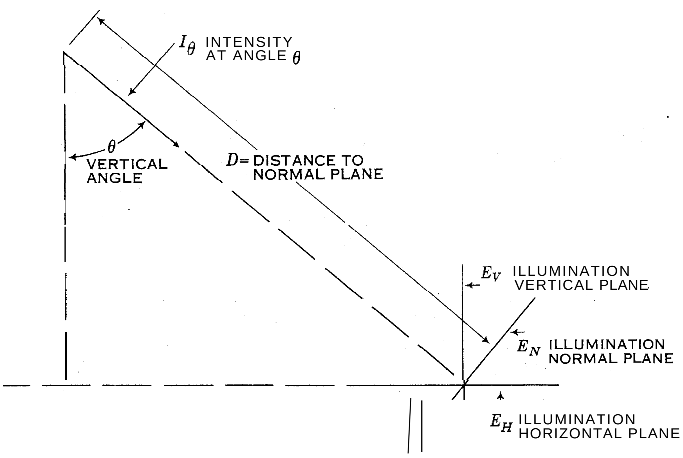


FIG. 2.— POINT-SOURCE ILLUMINATION CALCULATIONS

oration of the room, efficiency of the equipment, type of equipment to be installed and conditions contributing to the depreciation of the lighting system, such as operation and the presence of dirt. The method is based upon empirical data obtained by careful research into the actual performance of lighting systems in controlled installations.

Point-by-Point Method. — This method assumes that for actual conditions the source of light may be considered a point source when the illumination is to be determined on a surface that is at least five diameters from the light source.

The illumination on a point at a distance d from a source (fig. 2) is directly proportional to the intensity of the source and inversely to the square of the distance. This is the illumination on a surface normal to the incident beam of light. When the horizontal or the vertical illumination is desired, the illumination on the normal is corrected by the cosine of the vertical angle for the horizontal and by the sine of the vertical angle for the vertical illumination. Determination of the normal illumination (fig. 2)

$$E_N = \frac{I\theta}{d^2} \tag{1}$$

horizontal illumination,

$$E_H = E_N \cos\theta \tag{2}$$

vertical illumination,

$$E_V = E_N \sin\theta \tag{3}$$

Lumen Method. — The general expression for the determination of the necessary lamp size is:

Lumens per outlet =

$$\frac{\text{Area per outlet X foot-candles}}{\text{Efficiency X utilization factor X maintenance factor}} \tag{4}$$

The following steps are necessary in the logical solution of a specific determination:

1. Have a simple but complete sketch of the room to be lighted, with information as to its use, location and dimensions and any special information as to the placing of work surfaces and machines, with the bay dimensions of the ceiling pattern and the nature of any beam structures at the ceiling.

2. Determine the number of units and the spacing of the units. It is good practice to arrange the units symmetrically and to space the units at the corners of squares dividing the room into a symmetrical pattern. Where beams or other obstructions are present the pattern of outlet arrangement should conform to the general ceiling pattern. Outlet spacing should not exceed 1.5 times the mounting height above the work surface for units of the direct, semidirect and general diffusing type; and not more than twice the height of the ceiling above the work surface for the semi-indirect and indirect units. The spacing to the side wall should be approximately one-half the spacing between units. From the layout with the location of the lamps marked, it is possible to determine the area per outlet.

3. The amount of illumination must be determined for the specific task to be performed. The general requirements previously given will determine in general the foot-candles. To determine the best practice for an installation, reference should be made to the recommendations of engineering societies.

4. Equipment must be chosen for the particular task to be performed. In industrial installations the equipment must usually be relatively inexpensive and easy to clean, and will be of the direct or semidirect type, as the ceiling and walls cannot be expected to reflect much of the light. For commercial installations diffusing types are preferable. In either instance the more successful lighting is obtained where the light source is large and of low brightness. In the indirect system of lighting the ceiling acts as a reflector. Use of luminous elements and cove lighting attains lighting conditions similar to that of indirect lighting. The introduction of the fluorescent lamp requiring many tubes to obtain the desired foot-candles gives a light distribution comparable with an indirect lighting installation. The practice of using bare fluorescent lamps without proper light control will produce lighting with distressing glare while indirect lighting will not.

5. The efficiency and the utilization factor (or their product, the coefficient of utilization) must be determined for the type of equipment chosen. The room proportion, room coloration and type of equipment enter into this coefficient. The manufacturer of the equipment can supply this information for the specific equipment chosen, or values may be chosen for the general type, given in widely published tables. Considering the very light ceiling, and a fairly light side wall colouring, the utilization factors average approximately 0.5 for direct equipment, 0.3 for semi-indirect equipment and 0.25 for indirect equipment. High coefficients are associated with large and light rooms, and the lower coefficients with small and dark rooms. The over-all efficiency utilization factor of a lighting system is relatively poor.

6. The maintenance factor (one minus depreciation factor) is an estimate of the cleanliness of the location and the maintenance of the lighting system. This factor ranges from 60% in relatively poor conditions to as high as 75% under favourable conditions. Direct equipment will maintain better lighting under the adverse conditions of normal industrial usage than will the semi-indirect or indirect lighting systems, which are generally used for commercial purposes.

Having determined the quantities to substitute, the result given is the number of lumens required per outlet (equation 4). From manufacturer or laboratory data a lamp or a number of lamps may be selected which will most nearly approximate the required lumens. These lamps are rated in watts and should be so specified. Since the lumen output is constantly being changed in the manufacture of lamps, it is desirable to refer to the latest tables of lumen output.

The foregoing is applicable to the design for incandescent installations in which lamps in the larger sizes emit approximately 18 to 20 l.p.w.

Lumen Method and *Fluorescent Lighting* Design.—The only difference in applying equation (4) to fluorescent lamp installations is that the total area is used instead of the area per outlet, thereby determining the total number of lumens required in the lamp output. After the lamp has been selected, the number required is determined from the output of the individual lamps. Equipment to house the lamps and the arrangement of the lamps is then guided by the number of lamps needed. This design method is not as direct as for the incandescent system, and usually more trials will have to be made to get a satisfactory arrangement.

Design of *Luminous* Ceilings.—An important development of the 1950s was the introduction of glass and plastic luminous ceilings, either solid or louvered, with lighting sources above them. These simulate artificial skylights and, when properly designed and installed with correct baffling so as not to expose the eye to too large an expanse of lighted surface, represent the best in artificial lighting so far attained.

If a room is large and high, the illumination will be equivalent in value to the brightness of the lighting unit in foot-lamberts. Design of the lighting system embodies design of the light unit as well. The illumination obtained is expressed by:

$$\text{Foot-candles} = \frac{\text{Total lumens} \times \text{utilization factor} \times \text{maintenance factor}}{\text{Total room area}} \qquad (5)$$

The efficiency and the utilization factor are determined for a specific design, and the manufacturer has this information available. Spacing does not enter into the problem since the units are placed in the room either from wall to mall or with a border around the unit which is very narrow with respect to the total ceiling dimensions.

Either incandescent or fluorescent lamps may be used as a source to illuminate the ceiling. If the space above the ceiling is deep enough, the largest types of lighting units may be used, even industrial equipment with very large incandescent or fluorescent lamps.

Cove Lighting.—Where the lighting equipment is concealed by coves, with the ceiling and upper wall used as a luminous surface, the system may be designed by the lumen method. Good reflecting equipment will have an efficiency of approximately 70% while the cove itself may show efficiencies ranging from 25% to 40%. Recessed coves and coves close to the ceiling will have utilization factors of 0.35.

Coves placed too close to the ceiling will give an uneven illumination, a ratio of 1 ft. from the ceiling to every 5 ft. of lighted surface being the minimum that should be used. Plaster coves, finished with the wall and ceiling surface, are very inefficient and will give spotty lighting. The use of reflectors increases cove efficiency, and with the correct design the coves can be moved closer to the ceiling. Where control is obtained by use of some form of prismatic lens it is possible to mount the light source against the ceiling. Relief decorations must be crosslighted to eliminate undesirable shadows and produce uniform lighting.

Luminous Architectural Elements.—Luminous elements are applicable both to the exterior and interior of buildings. The term is applied to large, low-brightness lighting sources under which it is correct to consider all forms of indirect lighting as well as architectural elements. The correct application of this type of lighting demands close study, with consideration of the design of the structure as a whole. Luminous elements may take the form of panels, recesses, cavities, niches, pylons, columns, pilasters, parapets, spandrels, soffits, beams, coves, coffers or moldings, or may be incorporated into any architectural design. The light may be controlled by diffusing glass, reflectors, louvers or grillwork or by design of the element shape.

The lumen method is used in the design of the luminous element. Projecting elements have utilization factors of 0.5 and maintenance factors of 0.75, while the flush types have utilization factors of 0.7. Efficiency varies from 10% to 90% depending on the reflection material, the shape and the transmission mediums. In brightness the element should be so proportioned that when it is in direct exposure to the eye it does not exceed 75 ft.-L. If the element is on the ceiling and at such an angle as not to be directly exposed to the eye, a brightness of 500 ft.-L. is allowable. For exteriors the brightness depends upon the illumination of the surroundings and ranges from 30 to 400 it.-L, on buildings to as high as 600 ft.-L. in letter strokes for signs, on applications for which luminous elements are used extensively.

Glass blocks.—Used in structures for decorative purposes and lighting, glass blocks may be considered as luminous elements and must be so designed. The blocks will have transmission values ranging from 10% to 85%. Their obscuring value varies inversely as their efficiency. The transmission of an individual block cannot be considered, as the transmission value of a wall or surface built of glass blocks is largely controlled by the construction. These surfaces may be constructed for both daytime and night use. The lighting equipment must not interfere with light transmission during the day and must be so placed that the rudiments of good lighting are not violated.

It is commonly accepted by the lighting specialist that the providing of illumination is the least successful function performed by windows. Glass blocks allow light to enter but eliminate the normal view from the window. Sunlight falling upon glass blocks will produce a brightness surface which must be controlled, and the removal of a window which can be opened makes it necessary to remove the building heat by some other means. Consideration of glass walls or surfaces exposed to the outside requires careful co-ordination of functional design by the architect and the illuminating engineer.

Floodlighting—Floodlighting should be designed to produce an effective harmony with the object to be lighted. Daylight effect cannot be reproduced by floodlights, and the effect produced must be studied carefully. The simple straight lines of modern structures are excellent subjects for floodlighting. Statues and monuments should be lighted in collaboration with the artist, while recreational areas and sports fields should be lighted to satisfy the requirements of those participating in the particular sport.

In locating equipment, the surrounding buildings, topography, area to be lighted and economical aspects of the installation must be considered. If not located directly on the building to be illuminated, the equipment may be located on adjacent buildings, electric service poles, street lighting standards (for buildings not higher than three floors), in shrubbery or trees or on poles installed for the purpose. On the building itself, ledges, cornices and parapets will provide concealment. When sports areas, construction and airstrips are lighted it is usually necessary to supply towers, poles or special mounting elements.

For illumination at a distance, narro -beam equipment is used, ranging from searchlights with optical control to standard narrow-beam (15° or less) equipment. For near areas, broad-beam (30° and over) equipment is used. Intermediate ranges and surface areas may use medium-beam (16° to 29°) equipment. The lumen method of design is used for determination of the average illumination with a standard maintenance factor of 0.7 and the output is determined from the beam lumens of the equipment. Since little if any light can be obtained by interreflection, such light as does not strike the specific area to be illuminated is lost. There must be provision for control of the "spill light" which may become objectionable, and there must be about 10% overlapping of beam pattern so as to attain some degree of uniformity. Tables of recommended foot-candles should be used, and buildings with reflection factors of 20% or less will prove uneconomical to illuminate.

5. Operation and Maintenance of Lighting Systems.— The success of a lighting system depends upon selection of the proper installation and lighting source and upon maintenance. The lighting source should be the most economical, determined from first cost of the equipment, its installation and the power and labour costs in the community where the installation is to be made. Frequently there may be a choice of several schemes and systems which will be adequate and satisfactory as to lighting quality; and no general rule can be applied which definitely determines any combination as superior.

For "seeing," even the monochromatic lights seem to prove equally efficient and comfortable to users. Research has not been able to determine any one source quality which is superior to another for the usual seeing tasks. When colour matching is involved in production, daylight sources of artificial light have proved more satisfactory than natural daylight. No artificial source for ordinary lighting, either incandescent or fiuorescent, radiates wave lengths which under continued usage are harmful to the eyes; neither has it been found that any of these, including daylight sources, has superior qualities for seeing.

Lamp Selection.—The general service lamp, in the voltage rating of the electric system, satisfies the usual conditions. For severe tasks under conditions of vibration, heat, extremes of weather, and unusual position, the type of lamp designed for the particular service should be selected. Special usage lamps vary in their base construction, cementing and filament suspension.

Proper *Voltage.*—Since the electric lamp is critical to the applied voltage, to be efficient, lamps should be operated at their rated voltage. To maintain the voltage at the lamp it is necessary to install adequate wiring systems. The voltage at the lamp, when the system is fully loaded, should not deviate more than 2%. Wiring systems that are inadequate are expensive for reasons of output loss and extra losses in the wiring system. A 120-v. incandescent lamp burned at 11j v. gives only 86.4% of the normal lumen output and will be operating at 92.3% efficiency. The fluorescent lamp is even more critical to voltage change than the incandescent lamp, to the extent of becoming inoperative at incorrect voltages.

Maintenance.—From the first hour that a lighting system begins to operate it deteriorates through darkening of the lamp, dirt accumulation on the lighting equipment and general depreciation of the reflecting surfaces. When this depreciation of the system reduces the initial illumination about 30% it is necessary to consider some form of maintenance. The loss can be partially restored by renewing the darkened lamps, cleaning the equipment and, if these fail, by either washing or painting the reflecting surfaces. A schedule of washing equipment monthly and walls every two years (this requires painting every six years) is satisfactory in the average commercial installation. The installation must be designed so that maintenance is possible at low unit costs.

The "smashing point" of lamps, at which it is economical to replace the lamp even though it is still operative, is reached when the lumen output of the lamp has been reduced to the point at which the cost of energy consumed per 1,000,000 lumen-hours exceeds the average cost of light produced up to that time, including initial cost of lamp and energy.

Study has shown that the renovated lighting system could gain 12% by repainting of reflecting surfaces, 20% by cleaning and 19% by using new lamps with proper voltage ratings, a total of 51%.

IV. SPECIFIC LIGHTING APPLICATIONS

World-wide interest in artificial illumination gathered momentum with the beginning of the 20th century. Great expositions held in many parts of the world featured spectacular lighting, using the latest developments. Festivals of light were held in many cities. Widespread interest was shown in the psychological and physiological aspects of higher levels of illumination as related to human welfare, one evidence of this being the adoption in 1937 of a factories bill in England containing provisions for compulsory adoption of standards of lighting in all factories and workshops.

Artificial illumination has been accepted as an architectural medium, and lighting is no longer a thing of utility alone, but an intrinsic part of the architectural design of buildings. Specialized types of lighting for various industrial, agricultural and domestic fields have been investigated and adopted.

1. Home Lighting.—Entrance lighting should be such as to illuminate the person outside the door. The front entrance may have a bracket or soffit light which not only illuminates the entrance but contains an illuminated house number. Back entrances and grade entrances should be lighted along the same principles. The lighting should be such that all stairways and offsets in the approaches are illuminated for safety.

Hall lights should be simple in construction and properly selected to become a part of the passage area. Selection and location of equipment should be such that it is not unsightly from above if located where it can be seen from a stairway. The average hall can be adequately lighted with 40- to 80-w. equipment.

Living Room Lighting.—There should be a central fixture with 150 w. or more, and bracket lighting may be used for both decoration and useful lighting. Portable lamps usually make up a major portion of the working light, and floor types should have from 150 w. to 500 w., with table types using from 100 w. to 150 w. Built-in lighting may be used for lighting recesses or dark areas and if properly planned may reduce the need for portable lights. If there is more than one entrance to the room, lighting should be controlled from each entrance.

Dining *Room Lighting.*—The dining table being the centre of interest in this room, illumination of the table surface is the principal function of dining room lighting. When used for dining purposes only, little attention need be given to any requirements other than desires of the occupants, but it is often necessary that the dining room table serve as a study centre or work surface. When this is the case, illumination from either the centre fixtures or portable lamps must be increased and controlled for this purpose.

Choice of equipment for the dining room is similar to that for living rooms, and all outlet and switching requirements are the same. Suspended centre fixtures should be from 30 to 36 in. above the table top. Some form of "down lighting" should be used to illuminate the table when set. A minimum of 150 w. should be used in a central fixture.

Kitchen, Launduy, Workshop and *Garage Lighting.*—The utility areas need the illumination level specified for the difficulty of work to be performed in them. The equipment can be less decorative and less expensive, but it must have equal if not better lighting characteristics than for other areas of the home.

The kitchen should have a central light of 150 w. or more in incandescent lighting or equivalent light output from fluorescent lamps. Each of the work surfaces (stove, sink and counter surfaces) should be independently illuminated. A minimum of 40 w. each for these supplementary lights will usually prove satisfactory. Shadows caused by using a central fixture alone are annoying and may be dangerous.

In the laundry, direct lighting equipment is inexpensive and efficient. In the home workshop this same type of lighting, either incandescent or fluorescent, can be used over the workbench or where some constructive hobby is in progress. The garage, coal-storage area and furnace room each require adequate light, not so much for work purposes as for safety. There should be an outlet available for a portable lamp.

Bathrooms.—The important light centre in the bathroom is the mirror, which may be illuminated by an encircling light or by side brackets providing shadow-free light on the person reflected and not upon the mirror. Fluorescent lamps in the brackets distribute the light most evenly. The light in the bathroom should be controlled by a switch located away from any grounded plumbing or other grounded metallic conductor. For economy in the small bathroom, the bracket light may be the only one, but a ceiling light is desirable and in the large room it is essential. Ceiling lights of 100 w. and bracket lights of 60 w. for incandescent and 15–20 w. for fluorescent are satisfactory. If fluorescent lamps are used, the larger-diameter tubes are of a lower brightness and, therefore, better. Switches should be located at each door. An additional convenience is a night light which may be incorporated in the switch assembly or as an additional baseboard light.

Bedrooms.—Since the modern bedroom is frequently used for sewing, reading, writing and study purposes, as well as for sleeping, the lighting must be adapted to these various needs. A ceiling fixture with a relatively low brightness should be installed to reduce glare. This is particularly important for rooms to be occupied by children. For small rooms the ceiling fixture should use a 40-w. lamp and for large rooms 100 w. should be used. If all or part of the furniture is of the built-in type, lighting equipment may be incorporated in the design at a relatively low cost. Bracket lights for mirrors and dressing tables and trough lights for full-length mirrors are desirable. Supplementary lighting may be obtained by portable lamp stands or pin-up lamps installed over the bed, either of which should provide sufficient illumination for reading. Closets should have a simple but adequate lighting system, usually a bracket light with a pull-chain socket and a 60-w. lamp. Drop cords should not be used because of the danger of fire if clothes come in accidental contact with the lighted lamp. Door switches can be used for turning the light on and off.

2. School and Public Building Lighting. — Although children attend school during daylight hours, it is during the season of the year in which days are short and frequently cloudy, requiring additional artificial light to illuminate the desks farthest from the window to a minimum level, though not equal to that at the window. In sight-saving rooms, artificial illumination is necessary even on the brightest day to illuminate writing boards and desks more than ten feet from the window. In elementary grades the eyes are subjected to tasks incompatible with the natural accommodation of the eye. Poor lighting will influence the posture of the student, who seeks positions of least discomfort for the eyes and at the same time attempts to balance out strains upon body muscles. Every effort should be made to furnish the amount of illumination that is needed, the light being given off from the source and secondary surfaces in such a way as to eliminate all elements of discomfort. High levels of illumination without proper control are more detrimental than properly controlled low levels.

The amount of lighting should range from 50 ft.-c. for the sight-saving room (and in some instances for drafting rooms which are to be used for long periods) to 5 ft.-c. for passageways and locker rooms. The average classroom should have a minimum illumination of 30 ft.-c. For high over-all efficiencies ceilings should reflect 75% of the light and side walls 50% to 60%. Matte finishes should be used on all surfaces, and any glass doors, glass in picture frames or any other specular material should be eliminated to avoid reflection of images to any other position in the room. Desk tops and floors should have light, matte finishes.

Natural lighting seems essential in the school, not so much because of the light itself as for the psychological atmosphere which is created by windows. Orientation of the building controls the benefits to be obtained from the lighting. Orientation depends upon climatic and seasonal conditions, and no standard rules can be applied. Rooms with unilateral lighting are least difficult to control. Lighting should come from the left, rather than the right and front of the room. Window structures should be reduced to a minimum so as to avoid casting shadows. Even in corner rooms there is little value to windows in the rear of the room. The top of the window should be as near the ceiling as possible, not less than a distance above the floor equal to one-half the room width. To increase the glass area in a room it is better to add height than width. The glass area should be as large as possible, not less than 18% of the floor area when starting 3 ft. from the floor, or 16% when starting 4 ft. from the floor. These percentages are for rooms in which all glass area is exposed to the sky; if trees or buildings obscure the light, the glass area is increased proportionately.

Window light control must intercept the direct sunlight and diffuse it throughout the room, eliminate the glare from any exterior surfaces and control the relative illumination at different points in the room. The venetian blind, which may be classified as a louver control, may be used to deflect the light to the ceiling, thereby diffusing the light over the room, at the same time intercepting the direct or annoying reflected light from the outside. A double shade, drawing up and down from the centre of the window, is also employed as a light-control device. To use projection equipment the room may be darkened by a second set of dark shades running in light-sealing guides.

3. Office Lighting. — Severe and prolonged visual tasks in the office dictate the recommendation of 50 ft.-c. of illumination for auditing, accounting, operating business machines, transcribing, bookkeeping, drafting and designing. For general office work involving moderately fine detail, better contrast conditions and intermittent work periods, 30 ft.-c. is a satisfactory illumination level. In addition, careful attention should be given to lighting quality by reducing light source brightnesses in the direction of the eyes and minimizing brightness ratios in the field of view. Glossy work surfaces should be avoided, especially glass desk tops. Small area local lighting is often unsatisfactory because of the strong contrast produced in illumination. However, properly designed supplementary lighting can improve the visibility of operations at business machines.

Large or moderate-size general offices where workers are oriented in various directions require careful attention to minimize annoying direct glare. In general, the brightness of luminaires should not exceed 400 ft.-L. in the 45° zone below horizontal. Equipment with luminous glass or plastic sides should usually be oriented for endwise viewing. Recessed direct-lighting luminaires, called troffers, are frequently used for office lighting. For best appearance and comfort such luminaires should ordinarily be mounted for crosswise viewing of the rows. Suspended luminaires with opaque sides are also usually most comfortable when viewed crosswise and frequently have the best appearance when so oriented. Intermittent rows can be used to break up the "bowling alley" impression of long rows of luminaires, and lighting equipment sufficiently low in brightness can be arranged in rectangular and other patterns for added interest.

All office room surfaces should have light-coloured matte finishes to help minimize reflected glare and to provide the best environmental conditions. Desk tops should reflect 30%–35% of the light; ceilings 85%; walls 50%–60%; furniture 30%–35%; floor 20%–30%; and woodwork and trim 30%–35%.

4. Library Lighting. — The development of higher-efficiency lamps and improved luminaires for controlling and utilizing light started the trend toward adequate overhead general lighting of library reading rooms, rather than table lamps. The latter, however, may properly supplement general illumination to give added light at individual study tables where the occupancy is relatively infrequent. Such table lamps should be designed to minimize shadows and reflected glare. Book stacks have been successfully lighted with rows of concentrating louvered reflectors containing one-inch diameter fluorescent lamps. The reflector is slotted to emit light at the higher angles, thus providing good illumination for top shelves and good uniformity of lighting for the bottom shelves.

5. Retail Shop Lighting. — Lighting practice in shops and other merchandising interiors is based on the principle that the more customers see, the more they buy. The shopper is on a visual exploration trip through the store, and his attention is directed to objects of higher brightness. This concept calls for steps of brightness, using higher values for the most important sales areas or the particular featured displays which the merchant wishes the shopper to see.

Steps of brightness are ordinarily achieved by controlling the illumination level over specific areas of the store. For wide aisles, lobbies and other circulation areas, 15 to 30 ft.-c. are considered adequate. For general sales areas, 30 to 50 ft.-c. are prescribed. For displays in cases, on shelves and counters, 70 to 150 ft.-c. are recommended to draw attention to the merchandise, while 150 ft.-c. and more are employed for feature displays which stimulate impulse buying and influence circulation through the store.

Illumination for circulation and general sales areas is ordinarily provided by overhead general lighting systems. All types of luminaire distributions described previously are applicable for store lighting; and the lighting engineer can frequently orient such luminaires to influence the flow of traffic, fit the layout of the store equipment, increase apparent store dimensions and suit the unique architectural characteristics of the interior.

Treatment of the display window is an important phase of lighting for selling. Steps of brightness are appropriate, and both filament and fluorescent equipment are usually needed to secure these desirable brightness patterns. Wide use has been made of incandescent lamps with built-in reflectors for accenting featured items of merchandise.

6. Theatre Lighting. — The marquee which identifies the entrance often contains light sources to provide a high foot-candle level at the box office. The lobbies or passageways between the street and the foyer should have an illumination of 20 ft.-c. In the foyer an illumination level of ten foot-candles is considered adequate. This lower level helps make the adaptation to the relatively dark auditorium, where 0.1 ft.-c. is recommended during a performance. A brightness of approximately one foot-lambert on surfaces next to a motion-picture screen will add to the comfort conditions by relieving brightness contrast. The auditorium lighting equipment should be flexible enough to permit illumination levels in the order of five foot-candles during intermissions.

7. Church Lighting. — Illumination systems for church auditoriums should be keyed to both the architecture involved and the type of church service. An average in-service illumination level of five foot-candles is frequently recommended, with supplementary illumination on the pulpit or rostrum to focus attention during portions of the service. In many cases provision is made for switching or dimming the auditorium lighting systems. Local illumination is needed at the altar, and additional light on art glass windows will bring out their beauty and colour.

8. Industrial Lighting. — Good lighting in industry should correlate with plant safety, improved quality of product, increased production with decreased costs, better use of floor space, better seeing conditions for employees, more cleanliness and neatness, better supervision of the work and less eyestrain, and with a decrease of labour turnover because of improved morale.

Because it is necessary to see easily and accurately and often quickly, the glare, diffusion, direction and distribution of the light must be given special consideration and definitely controlled. Where severe tasks are performed or where economics does not justify a high level of illumination, extensive use must be made of supplementary light. Attention must be directed toward specular images and veiling glare. This must be controlled by using large low-brightness lighting equipment or systems.

Light colours will give high utilization factors, and painting of recessed work areas of machines will, by interreflection, illuminate details of the work. Use of colour contrast is an aid to speed and safety in production. For ceilings and side walls light colours should be used; for machines, a corresponding reflection factor in a contrasting colour, so that masses, either moving or stationary, can be recognized. White-reflecting surfaces should be used on all enclosures tending to cast a shadow on the task.

Recommended levels of illumination in industrial plants are based on the difficulty of specific visual tasks involved. The finest precision work involving poor contrast for long periods of time will call for 100 ft.-c. or more, while 30 ft.-c. are ordinarily prescribed for more ordinary seeing tasks involving only moderately fine details, normal contrasts and intermittent work periods. Other foot-candle levels between the values mentioned are appropriate for intermediate difficulty of the visual task. General lighting systems often used to attain 20 to 40 ft.-c. include industrial-type reflectors for fluorescent lamps, dome or diffuser-type incandescent luminaires and integral-reflector filament lamps. For 40 to 60 ft.-c., fluorescent lamp reflectors or high-bay luminaires employing filament lamps or combination filament-mercury systems are often employed. The method frequently used to obtain 60 to 100 ft.-c. of general lighting is a grid system of fluorescent lamp luminaires, where continuous rows of luminaires run in two directions. This latter technique minimizes annoying shadows and gives a pleasing appearance, and the relatively large-area, low-brightness luminaires provide good visibility for metal scales and machine-tool dials.

Where the seeing task requires more light than the overhead general illumination system provides, or if some directional quality is needed, supplementary lighting should be incorporated. Luminaires designed for this service are of two types: (1) those which supplement the general lighting in a limited area; and (2) the small concentrated units which direct light at a specific, difficult visual task. With either type, care should be exercised that bright work and dark surroundings do not produce discomfort through great contrast. Such brightness ratios should not exceed ten to one.

Natural lighting should be utilized to the greatest possible extent. Lighting from a window decreases very rapidly, the horizontal illumination falling from 200 ft.-c. near the window to 5 ft.-c. at 20 ft. from the window. Although windows present a surface of low brightness or are reduced to one of low brightness by controlling means, the extent of the surface in itself produces deleterious glare effects. A worker should never face directly into a window, because even a large low-brightness surface becomes annoying with time. Saw-tooth, monitor or skylight illumination in modern factory construction offers better light control than large glass side walls. Natural lighting should be considered in proportioning the room in factory design. If one wall contains windows, the room should have a depth perpendicular to this wall of less than twice the window height above the floor. When two parallel sides have windows, the room depth should not exceed six times the window height. Monitor window width should be one-half the monitor width. The height of the saw-tooth window should be one-third the span. As a general rule, window area should be approximately one-third the floor space.

When using natural lighting, glare from windows, as well as that produced by any object on the outside, must be controlled. Because daylight is so variable this lighting must be used in conjunction with proper arrangement and switching of artificial light. Photoelectric control of lighting circuits is desirable to maintain a minimum level of illumination at machines. When portions of the shop must be lighted by artificial lighting, and the remainder uses natural lighting, it is necessary to have the illumination in the artificially lighted area much brighter than normal night lighting because of excessive brightness contrast between the areas under the two arrangements. Industrial plants are being built without windows and operated entirely under artificial lighting with satisfactory results. Windows are not considered good lighting sources by illuminating engineers; however, windows have a psychological value.

9. Street Lighting. — Street lighting design should lead to recognition of the presence of an object and not necessarily to distinguishing fine details. Objects on the street or highway are discerned by silhouette when the illumination on the object is lower than the background, as when the object lies between two approaching cars; the reverse silhouette occurs when the object is more brightly lighted than the background, which requires relatively high illumination, usually in the vicinity of the lighting equipment. If details and colour of the object are discernible very high illumination is responsible. When the object emits specular light the visibility is caused by glint. Shadow and shadow pattern are important in recognition of the presence of an object. This effect depends upon the amount of relief and the angularity of the light.

Utilization and recognition of these factors are more important in adequate street lighting than production of the equivalent of daylight. The problem requires the best visibility consistent with a relative low cost per unit of light. Some traffic centres require more than usual visibility lighting, because of the presence or congregation of pedestrians. In these localities both the pedestrian and the driver must quickly discern objects with enough distance of visibility to react safely.

Equipment should direct the greater portion of the light toward the street, not skyward or into adjoining properties. Sufficient spill light should illuminate the sidewalk for protection and travel. There should be a proper adjustment between mounting height, spacing and lamp size. Mounting height may vary from 20 to 30 ft. and will depend upon glare, foliage interference and appearance. High mountings are associated with wider spacing and larger lamps, thereby reducing the first cost and operating cost. In residential districts, lower mounting heights, though not desirable, are used because of foliage. The spacing-mounting height ratio should not exceed eight to one. Lighting standards may be placed opposite one another or staggered on the two sides of the street: in alleys and outlying side streets, standards along one side of the street may be used. The equipment should either eliminate glare, or the time exposure to glare should be reduced to a minimum. Avoidance of pavement surfacing which does not reflect light mill aid street lighting; even black surfaces can be improved by correct top dressing.

Streets are classified according to the volume of maximum night traffic per hour (going both ways). Class divisions recommended are: (1) very light traffic, (2) light traffic, (3) medium traffic. (4) heavy traffic. (5) very heavy traffic and (6) heaviest traffic. ranging from 150 vehicles per hour and fewer to 4.000 per hour and more. The street illumination, for average values. ranges from 0.1 ft.-c. to 1.5 ft.-c. Business districts, street intersections, boulevards and park drives. alleys, bridges. traffic circles, tunnels and other unusual problems must be subjected to a detailed analysis and lighting specified to meet the needs. See also Index references under "Lighting" in vol. 24.

BIBLIOGRAPHY.—For information concerning past practice and later illumination techniques, consult the publications and periodicals of the American and British Illuminating Engineering societies. Illumination practice in the U.S. is summarized in the IES *Ligizting Handbook.* Detailed information can be found in: John O. Kraehenbuehl, *Electric Illumination,* 2nd ed. (1951) ; Howard M. Sharp, *Introduction* to *Lighting* (1951) ; C. L. Amick, *Fluorescent Lighting Manual,* 2nd ed. (1947) ; W. B. Boast, *Illuminating Engineering,* 2nd ed. (1953).

(J. O. K.; C. L. A.)

LIGHTNING. It is an accepted belief that lightning is a secondary phenomenon brought about by the abnormal meteorological conditions always associated with thunderstorms. However, lightning strokes have been observed on what appeared to be a clear day (giving rise to the expression "a bolt from the blue") and lightning also has been observed in connection with tornadoes, volcanic eruptions, dust storms and snowstorms. (See also THUNDER; THUNDERSTORM.)

This article, which deals with both the nature of lightning and protection against it, is divided into the following parts:

As one of the most impressive of natural phenomena. lightning has been not only a subject of scientific investigation but a source of fear, superstition and myth. Some of the nonscientific aspects of the subject may be found in the article LIGHTNING, FOLKLORE OF.

I. FORMS OF LIGHTNING

There are many forms of lightning. such as sheet, streak, bead, ribbon, forked, heat and globular (ball) lightning.

Sheet lightning, as the name implies, appears as a discharge over a considerable area, usually in clouds between the upper and

BY COURTESY OF U.S. WEATHER BUREAU

LIGHTNING FLASH AND SHEET LIGHTNING BEHIND DENSE CLOUDS

lower atmosphere. It is differentiated from the usual streak form by the area involved and its persistence. Little is known about this type of lightning discharge.

Streak lightning is the type normally observed and is the type dealt with by most investigators. The types called ribbon, bead. heat and forked lightning are probably of the same character. Such lightning strokes may or may not have branches and may occur between clouds. or between cloud and earth, or between a cloud and the surrounding atmosphere.

Bead lightning is seen in photographs as consisting of more or less regular increases and decreases in illumination along the stroke path. These may be related to the step leader mechanism. F. Wolf suggested that bead lightning is a special brush arc, the luminous masses of which develop from the centres of brush discharges resulting from a preceding lightning stroke. Such strokes are seen very infrequently.

Photographs have been taken with still cameras which show that the wind may blow the path of the lightning discharge along for distances of the order of 40 ft. or more. Such a stroke with several successive components gives an appearance in the photograph, or as observed visually, which has been called ribbon lightning.

Forked lightning is an apparent subdivision of the lightning into two or more simultaneous paths at the earth end. It is quite certain that in many such cases a change in path takes place between successive current peaks. This has been demonstrated photographically.

Heat lightning is the name often applied to streak lightning far enough away so that no thunder is heard.

Globular, or ball, lightning has been the subject of much discussion for many years. some maintaining that it was an optical illusion resulting from the retention of vision in the eye or the result of faulty observation; while others maintained that the rather considerable evidence on the part of many observers, some of whom certainly appeared to be well qualified, left no doubt as to the existence of ball lightning.

In 1924 and again in 1931 W. J. Humphreys published a request to those who had seen ball lightning to provide him with a detailed account of what they had seen. A total of 280 replies were received and studied by Humphreys, who stated in 1936 that not one was unmistakably "ball" lightning; *i.e.*, a slowly moving, more-or-less globular luminous mass, luminous because of its electrified condition. On the other hand, Walter Brand. in Germany. from 600 accounts of ball lightning selected 21 j which appeared to substantiate its existence. Ball lightning may be described as a luminous ball. often blood-red in colour. with an average diameter of 20 cm. When it emerges from the cloud traveling toward the earth, its velocity may he as high as roo m per second, while near the earth its velocity is much slower. being one to two metres per second. Usually. the ball explodes after an average life of 3 to 5 sec. F. Wolf suggested the possibility that ball lightning is the result of incomplete bead lightning associated with very small values of current.

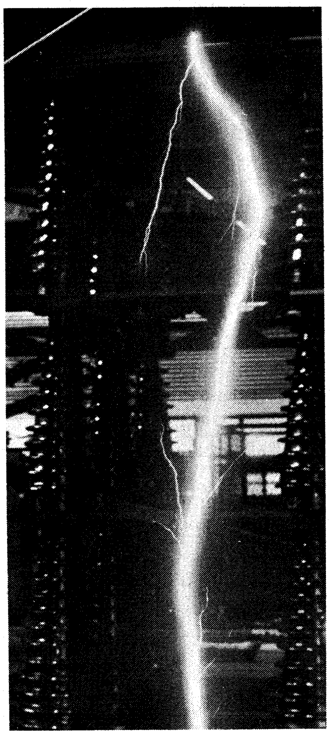
However, Wolf closed his discussion with the thought that the phenomenon is obscure and no really reliable explanation has been developed.

II. EFFECTS OF LIGHTNING

1. Thunder. — It is probable that thunder is caused largely, if not entirely, by a sudden increase in pressure as a result of heating, disassociation and ionization along the path of the lightning stroke. These pressure effects are well demonstrated in the blowing out of windows in buildings in which heavy discharges resulting from lightning take place. These pressure effects are commonly observed in connection with lightning damage to nonconductors. The multiplicity of current peaks, each producing its own pressure wave, coupled with the effect of length of stroke and reflections, all combine to produce the various sounds associated with thunder.

Several strokes of lightning were observed to the Washington monument, Washington, D.C., in April 1885, but no sound of thunder was heard. The same condition was observed in connection with strokes of lightning to the Empire State building in New York city, and it was concluded that with an upward initial leader stroke, not followed by downward leader current peaks, the rate of rise and decay of current may be slow enough so that the sound of thunder is not heard. On this basis thunderless strokes would occur only to tall structures.

Thunder is ordinarily heard only for distances of the order of about 15 to 18 mi. Gunfire can, of course, be heard under favourable conditions for much greater distances.



BY COURTESY OF GENERAL ELECTRIC COMPANY

ARTIFICIAL LIGHTNING PRODUCED IN A LABORATORY BY A DISCHARGE OF ABOUT 2,000,000 V.

2. Effect on Persons. — Persons struck by lightning have been revived by artificial respiration. It is worth pointing out that a person struck does not carry a charge, as many persons have thought, making it unsafe to touch him after he is struck by lightning. The usual result of being struck is electric shock or burns or both, and the usual first-aid measures should be applied. In the United States approximately 400 persons are killed each year by lightning, and an estimated 1,000 injured. The majority of these casualties are in the rural areas and small towns.

At times there have been reports of markings on the skin of persons struck which resemble trees or other objects. That the markings take such forms is the result of chance, and they merely represent the flow of current. That treelike burns are observed is not surprising, since it can be demonstrated in the laboratory that impulses similar to the wave shape of lightning currents will produce similar markings on sheets of insulating material over conducting material. To some degree this corresponds to the insulating properties of the skin over the conducting flesh underneath.

3. Effect on Aircraft. — The burns on planes indicate a preference for the flow of lightning current from wing tip to wing tip or from nose to tail. At times a stroke to a plane is preceded by long streamers from the nose. and fields have been sufficiently intense so that streamers have been observed across the windshield.

Based on evidence obtained from holes burned in the skin of planes it seems quite certain that strokes to planes are at times carried along by the plane for distances of the order of 200 to 300 ft. or even more. this being the distance the plane traveled while the stroke was in contact with the plane.

Aside from minor damage to the skin of metal planes, lightning may blind pilots for a brief period; magnetic effects may upset the compensation of magnetic compasses; and radio equipment may be damaged if not properly protected. Occupants of metal planes struck by lightning are seldom aware that the plane has been struck, and occasionally even pilots do not know the plane has been struck until ground inspection discloses the presence of surface burns. Strokes to planes are almost unknown at temperatures below 0° F., although E. J. Minser presented data which showed increased susceptibility to strokes at freezing temperatures and a few degrees above.

There is some accumulated evidence to indicate that as planes become larger and/or fly faster, the susceptibility to lightning strokes increases. Trailing antennas are sometimes destroyed by lightning, and their presence tends to increase the likelihood of a lightning stroke to the plane.

4. Damage Resulting from Lightning. — Lightning has a dual character since. as a rule, it consists of current peaks which may have a very high rate of current rise and current magnitude up to the order of 200,000 amp. (see *Occurrence* of *Lightning,* below); and, in the same stroke, currents as high as 500 amp. which may flow for fractional parts of seconds. The current peaks give rise to the explosive and magnetic effects, while the continuing current is largely responsible for the thermal effects. When conductors are carrying electricity, forces are developed because of the magnetic field which tend to crush the conductor. This has been termed the "pinch" effect. Lightning currents are often great enough to crush tubular conductors because of this effect.

Small conductors, such as radio aerials, may be completely destroyed by high lightning currents. In fact, no. 14 (American wire gauge) rubber-covered copper conductors have been changed into rubber tubes by the elimination of the conductor by a lightning discharge, without burning the rubber appreciably. These effects have been duplicated in the laboratory using high-current discharges of but a few microseconds duration.

Lightning current through nonconducting or semiconducting materials, such as stonemasonry or wood, gives rise to explosive effects.

The continuing current part of the stroke is normally responsible for fires caused by lightning, although of course if the material in the path of the stroke is highly combustible, fire may be caused by current peaks alone.

III. OCCURRENCE OF LIGHTNING

Nearly all theories of thunderstorms invoke some mechanism by which falling raindrops, snow or hail become charged in some manner with one sign of electricity. while the air and the smaller drops capable of being carried up by the rising columns of air associated with the storm are charged in the opposite sense. The separation of electricity proceeds until differences of potential are produced sufficient to result in a lightning stroke. *(See* ELECTRICITY. ATMOSPHERIC.)

Several theories have been advanced to account for the manner in which charges arise in thunderclouds. Perhaps the two most important were by C. T. R. Wilson and G. C. Simpson. Wilson's theory is based on the presence of large numbers of ions in the atmosphere coming in contact with drops of water polarized by the earth's electric field and in combination with the upward movement of air currents.

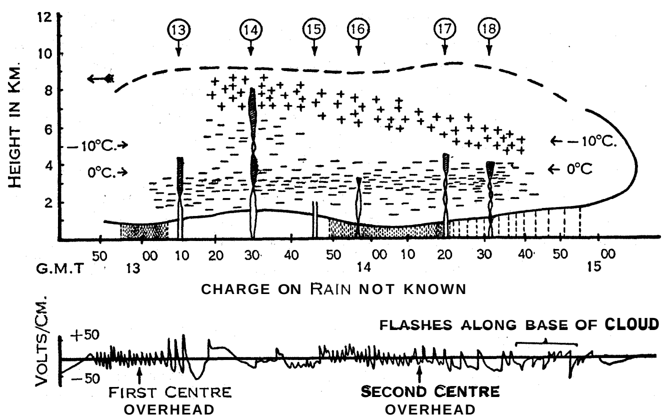
1. Wilson's Theory. — In each cubic centimetre of the atmosphere there are normally present about 1,000 positive and 800 negative small ions which have a mobility of about 1 cm. per second in a field of 1 v. per centimetre, together with 1,000 to 80,000 large ions of smaller mobility. According to Wilson, these ions are greatly increased in number by the strong electric fields attending a thunderstorm. The positive ions move toward the earth and the negative ions away from the earth, the velocities being dependent upon the field strength through which they are passing. For the electrification process to start, Wilson considered that the action of the earth's normal electric field polarizes the raindrops by induction, the lower side having a positive charge and the upper side a negative charge.

Drops falling toward the earth faster than the positive ions cannot be overtaken by them, and positive ions overtaken by the falling drops will be repelled from the lower surface. Such falling drops, however, will overtake and attract negative ions to the lower surface so that eventually the larger falling drops become negatively charged. The presence of these negatively charged drops in the lower regions of the cloud will add to the earth's field above them, increasing the polarization of drops above them and thus hastening the building up of electrical charges in the cloud. At the same time, drops moving more slowly than the positive ions will be overtaken by them, with the result that the drops become positively charged. Wilson suggested that the preponderance of positive rain may be explained on a similar basis, since the drop leaving the cloud would be in a more intense field because of the cloud, with the result that the lower side of the drop would be negative and would attract to itself positive ions, thus giving an indication of positive rain on the earth's surface.

2. Charges on Rain. — The first observations on the charge carried down by the rain were made by J. Elster and H. Geitel (1899) and by H. Gerdien (1903) and led to the coriclusion that more negative than positive electricity was precipitated by this cause. However, Simpson (1909) in a long series of measurements made at Simla, India, concluded that a much larger precipitation of positive than of negative occurs; and his conclusions were supported by many observers in various parts of the world. The currents carried to the ground by the rain are usually of the order of 10^{-12} amp. per square centimetre; and the amount of electricity per cubic centimetre of the precipitated water is usually less than one electrostatic unit.

3. Simpson's Theory. — Simpson's theory rests on the experimental fact that when falling drops of water are caused to break on a rising current of air, the water drops become positively charged, while the air becomes negatively charged. The negative charges are carried away by the velocity of the air current. The positively charged drops of water do not move away so easily, and the small drops recombine and fall back, only to be broken up again with a still higher positive charge. The air with its negative charges passes out into the main body of the cloud, which becomes negatively charged. In regions of the cloud where the vertical velocity exceeds 8 m. per second, no drops can fall and there will be no accumulation of electrical charge. This condition is presumed to exist in the front of the cloud.

Since many data have been obtained from many sources which agree that about 90% of the direct (cloud-to-ground) strokes are



SIMPSON AND SCRASE, "PROCEEDINGS," ROYAL SOCIETY OF LONDON (1937)

FIG. 1. — DISTRIBUTION OF CHARGES IN A THUNDERCLOUD AND ON RAIN WITH GRADIENTS AT GROUND SURFACE

Charts represent data collected during a violent thunderstorm which lasted nearly 2 hr. In the upper chart are shown the results of soundings numbered 13 to 18 made with balloons released at a fixed point. Records were obtained by using suitable instrumentation lowered to the earth by parachutes. Measurements of ground gradient shown in the lower chart began at 12:40 G.M.T. The large arrow (upper left) indicates the storm's travel past the observation point

from a negative cloud, Simpson and F. J. Scrase undertook to investigate the distribution of charge, using free balloons equipped to measure electrical gradient, relative humidity and atmospheric pressure. Temperatures were calculated from surface measurements. The results indicated that, typically, the thundercloud has most of its lower side negatively charged, the upper regions being positively charged, as shown in fig. 1.

Simpson and Scrase finally came to the conclusion that the boundary between the positive charge in the upper portion of the cloud and the negative in the lower portion is well below the freezing point and generally below $-10°$ C. In this part of the cloud would be ice crystals, to which Wilson's theory could not apply, according to Simpson and Scrase. As an example of somewhat similar conditions they pointed out that strong electrical fields had been found in polar regions resulting from blown snow; and Simpson suggested that the ice crystals become negatively charged and the air positively charged. Returning now to the cloud, the falling crystals leave the upper part positively charged, and the lower part negative. It is pointed out, however, that this theory has not been confirmed by satisfactory laboratory experiments. Simpson and Scrase suggested that there may be two mechanisms, one for the ice crystals and another for the part of a cloud where water drops are present.

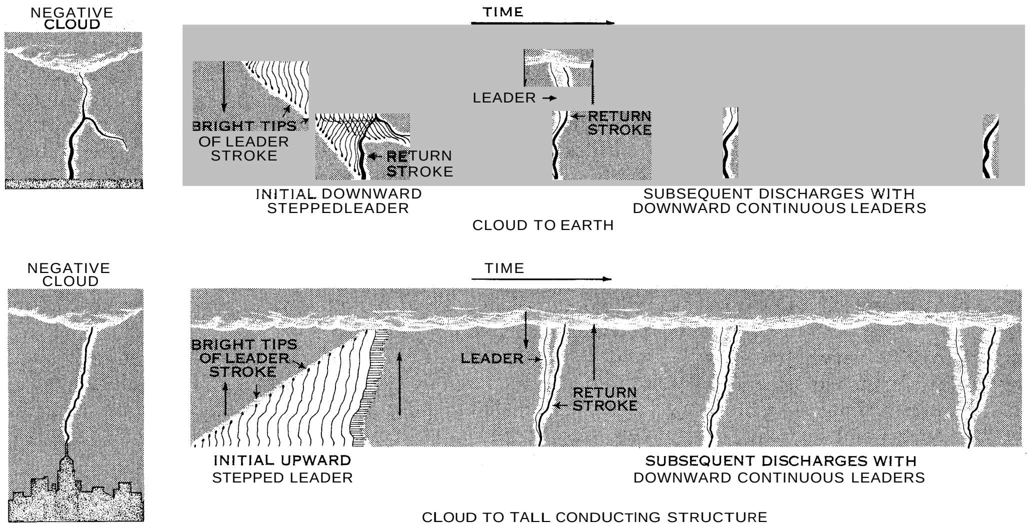
4. Mechanism of Lightning Discharge. — As the negative charge builds up in the lower portion of the cloud, positive charges appear on the earth's surface underneath by induction. As the charged clouds are blown along by the wind, the positive charges on the earth's surface move along in similar fashion. Since these positive charges are attracted to the negative charges in the cloud, they will move up any conducting or semiconducting object on the earth's surface, such as, for instance, transmission line towers, church steeples or trees, producing a corona discharge called St. Elmo's fire, providing the gradient is sufficiently high. However, St. Elmo's fire may be observed when thunderstorms are not present.

Cloud-to-Cloud Strokes. — Relatively little is known about cloud-to-cloud strokes since they result in very little damage to structures on the earth, although they also cause radio disturbance and may produce disturbances by induction in low-tension electrical systems because of the release of the so-called bound charge. Cloud-to-cloud strokes seem to have the same initial step leader mechanism but no return stroke. B. F. J. Schonland, S. J. Malan and H. Collens (1935), working in South Africa with the Boys camera (in which the film is moved rapidly with respect to the lens system), showed that cloud discharges to air which did not reach the earth took place; in which, in some cases, step-type leaders were photographed, while in others the continuous or dart-type leaders were observed. In neither case was a return stroke observed. In a study of cloud field changes reported in 1938, Schonland, Hodges and Collens identified pulsations of the same kind as found for step leaders with similar time intervals, the change of cloud field being a simple slow rise to its maximum value. Presumably these were air discharges or discharges within a cloud.

There is no reason to believe that cloud-to-cloud strokes will not have the same general mechanism. The progressive nature of cloud-to-cloud strokes is often slow enough to be plainly discernible to the eye.

There is no evidence to indicate that cloud-to-cloud strokes produce the high rates of current rise associated with cloud-to-earth strokes. The existence of thunder, however, indicates a rapid rate of rise, though no doubt one much slower than that found for current peaks in cloud-to-earth strokes. It is quite certain that airplanes are struck more often by cloud-to-cloud than cloud-to-earth strokes; and the nature of the burns on the metal skin of planes indicates the presence of the low-current-magnitude, long-time type of discharge. The maximum number of coulombs from such burns was estimated to be at least 300.

Cloud-to-Enrtlz Strokes.——Schonland and his associates found that the lightning stroke was initiated by a streamer which proceeded toward the earth in a series of steps. The process is illustrated in the upper part of fig. 2. The steps were about 50 m.



BY COURTESY OF GENERAL ELECTRIC COMPANY

FIG. 2.— MECHANISM OF TWO LIGHTNING DISCHARGES

From photographs by (left) still cameras and (right) high-speed Boys camera

in length with an average travel velocity of about 50 m. per microsecond (μ sec.). The average interval between each step was of the order of 50 μ sec., although a tendency for longer intervals was observed as the step leader approached the earth. The time required for this initial leader to reach the earth may be as great as 0.01 sec., although the time is usually much shorter, perhaps .002 sec.

The presence of a very brilliant illumination moving from the earth toward the cloud, through the channel established by the step leader, at a velocity of about 30 m. per microsecond. was shown on the photographic film as the lightning stroke reached the earth. A tendency was observed by Schonland for the illumination to decrease as the so-called return stroke approached the cloud. Successive current peaks, called a multiple stroke, may follow in the same path. These, however, are preceded by a continuous downward leader having a velocity of propagation of 1 to 23 m. per microsecond. These continuous leaders, upon making contact with the earth, are also followed by a return stroke having a velocity from 20 to 140 m. per microsecond. As many as 40 successive current peaks in one lightning stroke have been photographed.

Many strokes show branching, or what are sometimes called streamers. The Boys camera photographs show that such streamers are in general a part of the initial mechanism of choosing a path which is most attractive as viewed from the tip of the downward-moving leader; and that frequently more than one path appears sufficiently attractive to give rise to streamers. The successive current peaks, if-present, do not generally show the existence of the streamers, since the conduction established between the cloud and earth by the time the first successive current peak occurs is sufficient to preclude the continuance of such streamers.

By reference to the upper part of fig. 2 it will be noted that the streamer appearing in the still-camera photograph is not found to be associated with any of the current peaks except the first.

It has been suggested that the initial step leader is accompanied by a "pilot streamer" having a velocity of about 0.5 m. per microsecond. Its existence has not been shown photographically, the conclusion being held that the luminosity was too low to record its existence.

Earth-to-Cloud Strokes.— K. B. McEachron showed that approximately 80% of the lightning strokes to the Empire State building (1.250 ft. high) in New York city, were initiated by the building. as indicated in the lower part of fig. 2. The same step mechanism was photographed as already described, except that it began at the building and progressed to the cloud. with about the same velocities as already given for the cloud-initiated stroke. The upward leader stroke was not followed by a return stroke from the cloud, probably as the result of the low mobility of charges in the cloud compared to the conducting earth. which does produce the return stroke following contact by a downward leader. Instead, current of a low magnitude, perhaps a few hundred amperes. continues to flow; this may die out but is more often followed by one or more successive current peaks, as shown in fig. 2. These succeeding current peaks, as in the case of the cloud-initiated stroke, are preceded by the continuous downward leader and followed by the return stroke.

Continuing Current.— In many cases McEachron was able to obtain cathode-ray oscillograms of the current peaks in photographed strokes, as well as slow-speed oscillograms calibrated to record the continuing current between current peaks. For strokes to the Empire State building, the results indicate that current peaks are always connected with continuing current. G. D. McCann and J. J. Clark, on the other hand, indicate the possibility of the current's falling to zero between current peaks, the maximum time interval they recorded being 23,000 μ sec.

Stroke *Path*.—The path of the lightning stroke seems to be determined by conditions existing between the end of the downcoming initial leader at the end of each step and the surrounding atmosphere. The electrostatic field between the end of the leader and the earth follows smooth lines, but the path of the lightning stroke is very often crooked. The same observation may be made concerning man-made lightning discharges in the laboratory.

The lightning stroke mechanism is different from that in the laboratory, where a substantially uniform field may be obtained between spheres, or even with the nonuniform field between pointed electrodes spaced 1j or 20 ft. apart. However, under certain conditions it is possible to produce the leader mechanism with laboratory discharges of even shorter lengths than indicated.

Direction of Propagation— Clayden Effect.— The direction of branching of a lightning stroke is the direction of propagation of the initial step leader which makes possible the determination of direction of propagation from still-camera photographs of lightning. The evidence seems quite clear that with structures up to 200–300 ft. in height all strokes are cloud-initiated: but as the structure height increases the percentage of earth-initiated strokes will increase. Occasionally, photographs are taken in which the streatners or branches may appear black while the stroke itself appears normal. 'This is a photographic reversal called the Clayden effect and results from the different conditions of exposure for the main stroke compared to the streamers.

Source of Peak *Currents*.—Oscillographic data show that current peaks may rise to crest in times as short as one microsecond, nhich precludes the possibility of the sudden increase in current coming from the cloud because this time is much too short; rather the evidence, largely photographic. indicates that the downward initial leader from a negative cloud lays down a negative charge in the space surrounding the discharge channel as the leader approaches the earth.

The evidence further indicates that the stroke current builds up rapidly at the earth end because of the neutralization of the space charge surrounding the stroke channel when contact is made with the earth. Beginning at the ground end first. the space charge is neutralized progressively backward toward the cloud, giving rise to an increased luminosity traveling from the earth to the cloud, called the return stroke. It is believed that the return stroke constitutes the decreasing portion, or tail, of the current peak. The average time to decay to one-half of crest current is of the order of 40 μ sec., which is comparable to the time taken for the increase in luminosity to reach the cloud in many cases.

Just when the crest of a current peak is reached with relation to its life history in space is not known, but McEachron and W. A. McMorris suggested that it occurs at the moment of contact of downward leader and the earth, the front or rise of the current peak being the result of the flow of negative charges away from the point to be struck as the leader traverses the last few hundred feet of travel to the earth. However, C. E. R. Bruce and R. H. Golde believe that the peak current is too large to be accounted for in this manner and suggest that the crest current is not reached until after the return stroke has progressed a few hundred feet on its way toward the cloud.

The electric field at the earth's surface may be very intense, as shown by photographs taken showing upward-branched streamers from the earth's surface. That such streamers are not seen more frequently is not surprising, because the ground end of lightning strokes is seldom seen and much less frequently photographed; and in most cases the observer is too far away to obtain a proper record.

Cloud *Potential.*—It was suggested by C. F. Wagner and McCann that cloud potentials are of the order of 20,000,000 v., based on a gradient of 50 to 100 v. per centimetre shown by Simpson and Scrase in fig. 1, the calculation being made for a cloud height of 10,000 ft. Bruce suggested that no well-defined potential is necessary to initiate the self-propagating discharge; and indicated that in the case of lightning flashes to the Empire State building the average cloud-to-earth field is probably only of the order of 50 v. per centimetre.

5. Wave Shape of the Lightning **Stroke.**—Two methods of recording lightning current wave shapes have been used: (1) measuring the current directly as it flows through a structure struck by lightning using current- and time-recording equipment; and (2) measuring the current indirectly at a distance from the stroke through electromagnetic effects or optically. Practically all of the reliable data available have been obtained by the first method, although some work has been done using the second. Data concerning magnitude and polarity as functions of frequency of occurrence of strokes to transmission towers and conductors have been obtained in several locations throughout the world.

Direct measurements of the wave shape of the current peaks have been made using either a cathode-ray oscillograph or the fulchronograph (see below). In connection with the determination of electrical stresses within transformers because of lightning, it is generally necessary to be able to determine the rate of rise of current for times at least as short as one microsecond and to record the current flow for times at least as long as 70–100 μ sec., or at least to half current value for most strokes.

This mas accomplished by McEachron for strokes to the Empire State building and by I. S. Stekolnikov and C. Valeev for strokes to captive balloons in the U.S.S.R., using cathode-ray oscillographs. In addition, McEachron provided a "crater lamp" oscillograph capable of being initiated within 20 μ sec. and of recording over a second of time or even longer. Such dual recording is necessary because of the nature of the lightning stroke; *i.e.,* because it consists of long-time low-current components and short-time current peaks which may have a high magnitude. Using a special nonlinear resistance shunt, a current range from 50 to 100,000 amp. could be recorded.

The fulchronograph described by Wagner, McCann and E. Beck depends for its operation upon permanently magnetizing a series of small steel strips to a degree proportional to the lightning current flowing at the instant the particular strip is rotated into the field of the magnetizing coils. As used, 408 steel strips mounted in the periphery of an aluminum wheel are rotated between narrow coils through which the lightning current to be measured is passed. The "high speed" and "low speed" fulchronographs, with wheels revolving at 3,450 r.p.m. and 60 r.p.m., respectively, give values of current based on measurement of the residual flux, thus giving current values at time intervals of 43 μ sec. and .0025 sec., respectively. Such a measuring means is too slow to record the rapid rise of current in the front of a current peak; and thus the fulchronograph is supplemented by making use of circuits in which inductance or capacitance is used in combination with resistance, so that the maximum current flowing in the circuit bears a calculable relation to the rate of current rise of the lightning current peak. This maximum current leaves a record of its magnitude by the degree of magnetization remaining in cobalt steel strips properly associated with the current-carrying conductors.

Such steel strips with proper mounting are frequently called magnetic links. Although the fulchronograph does not give such complete information as the cathode-ray oscillograph, it has the advantage of much lower cost; so a much greater volume of data may be obtained in a given period of time for a given cost of instrumentation.

6. Crest Current.—Typical of the data obtained using the magnetic link described by C. M. Foust and J. T. Henderson is the group of curves shown in fig. 3. The magnetic links are arranged on the electric power transmission towers in such fashion that

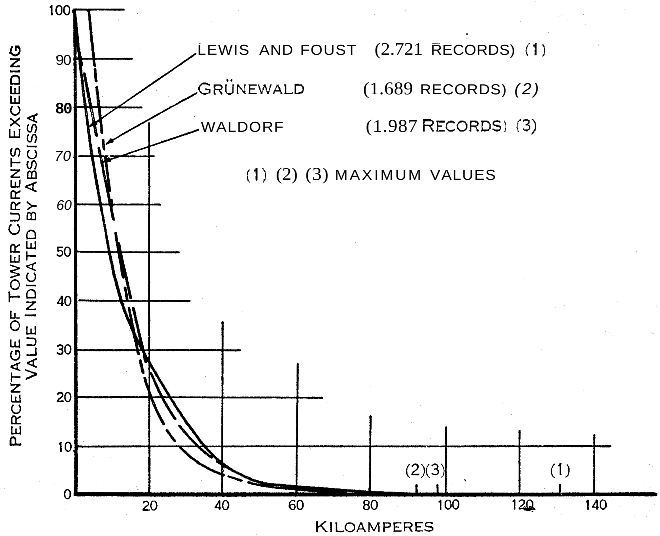


FIG. 3.— LIGHTNINGCURRENTS IN TRANSMISSION LINE TOWERS AS MEASURED WITH MAGNETIC LINKS

they are permanently magnetized by the passage of the lightning current through the associated tower leg or legs.

Although the results obtained between 1936 and 1944 indicated close agreement, lightning investigations conducted after 1954 indicate that they may be in error and probably are on the low side.

The curves showing tower currents which may be expected are very essential data to be used in connection nith the design of electric power transmission lines. in determining the number of insulators and the tower footing resistance, if overhead ground wires are to be used for the protection of the line against lightning. To determine the stroke current from the tower leg measurements, the tower currents nhich are believed to have occurred in the various towers during the same stroke are added together to secure a value for the stroke current.

The magnetic link data cannot give any information concerning individual current peaks making up the entire stroke except to indicate the maximum peak; however, the cathode-ray oscillograph and the fulchronograph do give detailed data concerning the current peaks and the entire stroke. In general, the values obtained by oscillograph and fulchronograph for peak currents to high structures are less than the transmission line tower data of fig. 3. The differences may be accountable partly to the effect of the taller structures and partly to the relatively small amount of oscillograph and fulchronograph data.

IV. DATA ON LIGHTNING DISCHARGES

1. Duration of the **Total** Stroke.—There is wide variation in the results given in fig. 4 by the various investigators, which is no doubt partly explained by differences in equipment used. Most of the data were obtained photographically, such results being

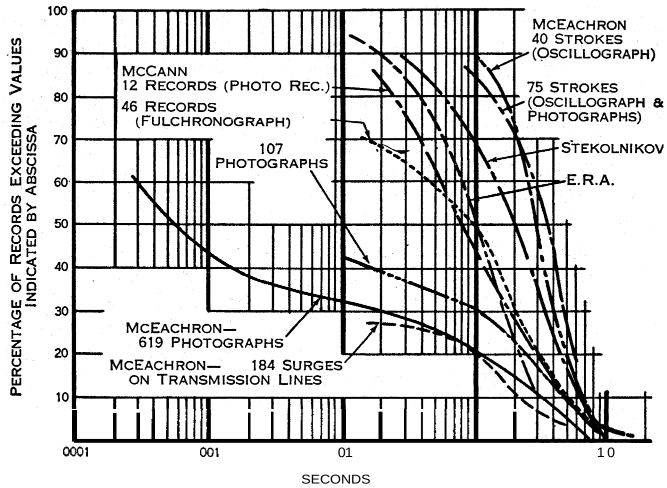


FIG. 4.— TOTAL DURATION OF LIGHTNING STROKES TO GROUND
(All photographs are of strokes to open ground)

greatly affected by lens and film speed, distance to the stroke and visibility. The Empire State building data (McEachron), taken oscillographically, showed a minimum duration of 0.1 sec. and a maximum of 1.6 sec.

The shortest duration was .0003 sec. which was obtained photographically at Pittsfield, Mass. The bulk of the data seemed to indicate an average duration of perhaps .01 sec.

2. Charge of the Total Stroke.— The data presented in fig. 5 are confined to measurements made on the stroke itself, the current and time being measured by fulchronograph or oscillograph. The maximum number of coulombs measured was 165, with an indicatedaverage of about 18 coulombs. It should be remembered that these values were measured in strokes to relatively tall structures and indicate the charge at the ground end of the stroke. Bruce and Golde pointed out that for the upward leader type of stroke the space charge neutralized by the current in the stroke is added to the charge in the cloud; while with the downward leader type the neutralized space charge is subtracted from the cloud charge. This is of some importance when considering the change in cloud charge as the result of direct strokes. However, the difference occurs only on the initial leader, since, as can be noted from fig. z, all leaders after the initial one are downward, whether to a tall structure or to ordinary terrain. Wagner and McCann suggested that lower coulomb values may be found to structures of lower height, which in general agrees with Bruce and Golde. However, as pointed out by the latter, the upward initial leaders

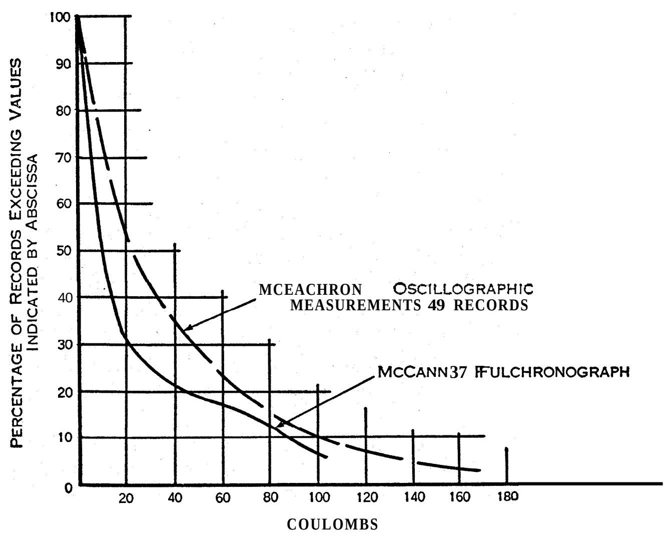


FIG. 5.— TOTAL STROKE CHARGES MEASURED AT THE GROUND TERMINAL OF LIGHTNING STROKES

for strokes to the Empire State building suggest that the distortion of the field caused by the building was sufficient to trip off the flash before it would have occurred to ordinary terrain, so that the charge might be expected to be smaller and not greater than in the normal case.

3. Polarity.— It has already been pointed out that strokes predominantly bring down negative charges to the earth. W. W. Lewis and Foust found that 93% of their records of strokes to transmission lines were negative polarity, while S. K. Waldorf and H. Grunewald found in transmission towers 82% and 86%, respectively. McEachron and McMorris found 63% of distribution lightning arrester current negative; and I. W. Gross and McMorris reported 88% negative for station lightning arresters applied to transmission lines. These results seemed to indicate a higher percentage of positive polarity as the current values became smaller, which might not be entirely an indication of positive current peaks in the stroke, but rather of induced currents resulting from the release of bound charges on the lines resulting from sudden changes of negative cloud fields. Thus, a negative stroke to some other point than the line involved would be registered as a positive record on the line being studied. This means that the percentage of negative strokes was probably higher than the direct measurements indicated.

Since all of the data on which the preceding statement was based were taken with the magnetic link, the presence of more than one polarity in the current would not necessarily be recorded.

Of the 49 strokes recorded oscillographically to the Empire State building during the years 1937–40, 84% were entirely negative; but no stroke was entirely positive. Of the eight strokes having positive current peaks, four are known to have begun negative; two others probably did; and of the remaining two, one, which had a positive peak of 58,000 amp. followed by three negative peaks, lacked definite information as to the beginning polarity. Wagner, McCann and Beck, using the fulchronograph, recorded 12 direct strokes, all initiated by negative discharges, but two had subsequent positive current peaks. Thus, current peaks of both polarities are occasionally present with a strong tendency for such strokes to begin negative.

As the stroke progresses backward into the cloud, successive centres of charge are tapped. As a rule these are all negative, but the data just presented show that occasionally positive centres of charge are reached, as indicated by the polarity changes recorded. Thus, the current-time record supplies data concerning the electrical structure of the cloud.

4. Diameter of the Lightning Channel.— Data on the diameter of the stroke channel have been obtained photographically and by measuring holes made in paper under controlled conditions. Data of this type have been obtained in the field with natural lightning and in the laboratory.

According to J. W. Flowers the light emitted and the current flow may not necessarily coincide in time, and the light may persist for times of the order of 10 μ sec. The start of light emission and the start of current flow are not separated by more than a few one-hundredths of a microsecond. Thus, for discharge currents in sparks or lightning channels which do not vary too rapidly, the distribution of the radiated light reveals the discharge channel. Flowers further states that the light radiation is proportional to the current in the channel; and suitable photographic methods of determining channel boundary indicate that the channel attempts to attain a constant value of about 1,000 amp. per square centimetre, provided the current is maintained for a sufficient time. According to Flowers, when the current is increasing rapidly the current density is greater and the channel expands at an explosive rate.

On this basis, if the current persists at 10,000 amp. for 100 μ sec. the channel diameter would be about 3 cm. Flowers suggested that 3–5 cm. may be about the maximum diameter attained.

From an analysis of a photograph of a multiple-lightning stroke, Schonland measured the diameter for 11 components and obtained an average of about 16-cm. diameter, with a range from 11 to 23 cm. P. L. Bellaschi, on the other hand, measured in the laboratory a column of 10 to 15 cm. in diameter for a 140,000-amp.

discharge. This checks Flowers' value of 1,000 amp. per square centimetre assuming that the discharge lasted long enough. However, this is not likely for such a high current peak in a natural lightning discharge.

V. PROTECTION AGAINST LIGHTNING

A. Protection of Structures

Protection of ordinary buildings from direct strokes of lightning is generally accomplished through the use of the lightning rod system originally developed by Benjamin Franklin. Essentially, such a system consists of pointed air terminals mounted on the ridge of gable roofs or around the edge of flat roofs and on chimneys and other elevated places likely to be struck, and connected together and grounded (in British usage, earthed) in such a fashion that lightning making contact with any of the air terminals will be safely conducted to the earth without damage to the structure.

Contrary to popular belief, lightning rods do not act to prevent lightning strokes but rather exert a local influence to direct strokes to the air terminals and thence safely to the earth. The "Code for Protection Against Lightning" (which is the United States bureau of standards *Handbook H-46* and which will hereinafter be referred to as the U.S. code) states that the separation between air terminals should not be more than 25 ft. and that the height of the air terminal need not be more than 10 in. above the object to be protected. The air terminals may be somewhat higher in the case of the flat roof.

The U.S. code also specifies that not less than two down conductors should be used, and that they should be connected to the earth at points as widely spaced as possible. If the building is longer than 110 ft., an additional down conductor is to be used for each additional 50 ft, in length.

The U.S. code states that lightning rods may be made of copper, corrosion-resistant alloys, copper-clad steel and galvanized steel. Conductors may be in the form of cable, tube, strip, rod or other shape of solid cross section. As to size, copper cable conductors should weigh not less than 187.j lb. per 1,000 ft., no wire of the cable being less than no. 17 (American wire gauge); if copper tubing is used, the wall thickness should not be less than no. 20. If galvanized steel is used, the net weight of steel is not to be less than 320 lb. per 1,000 ft.

It is important that all fastenings be secure and permanent in character. It is not necessary that lightning conductors be insulated from the building to which they are attached; in fact, lightning conductors are sometimes carried through walls or partitions; however, from the point of view of inspection there is advantage in having such conductors exposed.

Joints are of particular importance since they need to be made mechanically and electrically secure. Poor joints can be a source of sparks, and occasional inspection of the entire system is desirable to be sure that it is in good condition. Suitable precautions should be used, such as lead covering, where conductors or air terminals are likely to be subject to corrosion because of local conditions.

Ground connections should be provided for each of the down conductors, either through the use of driven rods or buried plates, or by conductors in trenches, the choice to be determined largely by local conditions. If a water pipe enters the building, at least one down conductor should be connected to it at a point just outside the entrance to the building. The importance of proper attention to good ground connections cannot be overemphasized. If the structure is located on rock where a good ground connection is not attainable, the use of a network of wires, called a mat, underneath and surrounding the structure is effective. This mat should be connected to the down wires in lieu of a ground connection, the desired result being to keep all parts of the structure and surrounding earth at substantially the same potential in the event of a stroke to the lightning rod system. Such a mat should be connected to the best ground connection available.

It is important that the various ground connections required for radio, telephone and power circuits, as specified by the various codes which apply, be followed. Large metal objects which are situated within a protected structure and which come within six feet of a conductor of the lightning rod system should be connected to it, and if farther away should in general be independently grounded.

British practice, as described in the British *Code* of *Practice* entitled "Protection of Structures Against Lightning" (published by the British Standards institution), is not materially different in principle from that described, but does vary in detail. More emphasis is given to the use of masts or single vertical conductors for the protection of both buildings and areas. Surrounding such a vertical conductor is a cone of protection described in terms of the ratio of the base radius of such a cone to its vertical conductor height. The U.S. code states that a ratio of 1:1 has been found satisfactory in important installations and up to a ratio of 2:1 in less important cases. The British code considers only the 1:1 ratio In providing a protection plan for structures of different heights using masts, it is desirable to work out the various intersecting cones to be sure that no object to be protected projects out through the cone.

In some situations more efficient use can be made of material by connecting the tops of masts together with overhead wires, in ahich case a wedge or tent of protection results. This method makes possible lower masts, thus reducing hazards to aircraft.

The question is often asked: "Do nearby trees offer lightning protection?" In general they represent a hazard, because the tree if struck would probably side-flash to the structure, the tree not being a good conductor. A lightning rod in the tree properly grounded would give the expected protection, interconnection being made between ground terminations at tree and structure. Isolated buildings, such as farm buildings, are more likely to be struck than buildings of similar size in towns or cities; and, of course, assistance in case of trouble is much less adequate, thus making lightning protection more necessary.

Steel-frame buildings do not need special lightning protection for their occupants or contents of the buildings. When considerable masonry extends above the steel frame of the building, damage may occur because of lightning. resulting in debris being thrown into the streets below. Protection in the form of air terminals or metal copings connected to the building steel would prevent lightning damage to the top of such structures.

B. Protection of Electrical Apparatus

In general, the electrical apparatus to be protected from the effects of lightning is connected to overhead circuits directly or through cable. Such apparatus usually consists of insulated electrical conductors wound around cores of magnetic steel which are usually grounded. To prevent the failure of such apparatus because of lightning it is necessary to limit the voltage applied to the insulation between conductors and also to that between conductors and those parts connected to the earth.

In the case of rotating apparatus (motors, generators) the nature of the construction is such that it is necessary to limit the rate of voltage rise between terminals and ground to prevent the overstressing of between-conductor insulation. This is accomplished by connecting suitable capacitors between the terminals and ground. The insulation between conductors and ground is protected by limiting the crest value of the lightning surge with lightning arresters.

Transformers may be designed in such a manner that the stresses between conductors and those between conductors and ground are co-ordinated so that limiting the crest value of the surge is all that is required.

Other station apparatus may also be protected by a voltage limiter, which is usually a lightning arrester or a gap. Perhaps the most serious disadvantage in the use of the gap is that circuit breakers must operate to interrupt any power current to ground following a lightning flashover. Such operation usually means an interruption to service.

1. Lightning Arresters.—A lightning arrester is a device nhich has the property of reducing the voltage of an impulse applied to its terminals; is capable of interrupting any system power current (follow current) which may flow through the arrester immediately following the lightning discharge; and which restores itself to its original condition. The arrester usually consists of a gap arrangement in series with a resistor which has the property of decreasing its resistance exponentially as the current through it increases. This nonlinear resistor and associated gap device are usually assembled in a suitable porcelain housing and provided with means for mounting. The gap device keeps the nonlinear resistor substantially disconnected from the A.C. power circuit except at the time when potentials appear having a magnitude sufficient to cause the gap device to become conducting, thus allowing the lightning current to flow to ground.

Since the system current would continue to flow through the arrester following such a lightning discharge, means must be provided to interrupt the flow of such system follow current; this is accomplished through the use of the gap device. The nonlinear resistor must have a sufficient resistance at normal system potential to limit power follow current to a value which can be interrupted by the gap device; and yet this resistance must become low enough to permit lightning currents of 20.000 amp. or more to flow without the voltage drop becoming so great that protection is not afforded to associated apparatus with an adeauate margin of safety. Such nonlinear resistors have the property of decreasing their resistance so that each time the applied voltage is doubled the current flow will be increased on the order of 12 or more times. All of them depend to a degree upon carborundum for their nonlinear resistance properties.

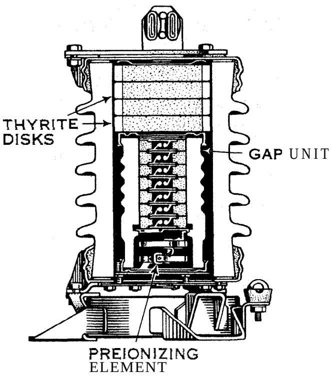


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FIG. 6.—CUTAWAY DRAWING OF 11.5-KV. THYRITE ARRESTER UNIT

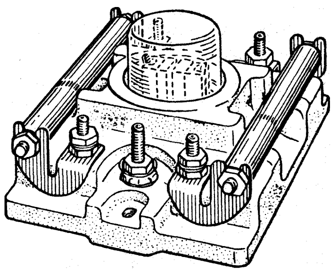
Arresters for high-voltage circuits usually consist of a series of arrester units stacked vertically above one another. The construction of a single 11.5-kv. unit is given inrthe cutaway section shown in fig. 6. The Thyrite disks taken together represent the nonlinear resistor, shown in the upper part of the porcelain container. The gap unit, within its own sealed container, consists of an assembly of several small gaps, the voltage distribution of which is controlled by parallel-connected resistors having special characteristics. Such gap devices are designed to divide the applied potential proportionately under normal power conditions, but to upset the voltage distribution between gaps when subjected to overvoltages because of lightning, thus resulting in breakdown of the gap device at lower levels of lightning voltage than would otherwise occur.

2. Protection of A.C. Rotating Apparatus.—The protection of A.C. rotating apparatus connected to circuits exposed to lightning constitutes a special problem because of the relatively low dielectric strength of the windings. To reduce the electrical stresses between adjacent turns of conductors, a reduction in the rate of rise of applied voltage, and consequently in the turn-to-turn stress, is secured by using capacitors connected line-to-ground. The voltage applied to the terminals is limited by a lightning arrester. In addition, the use of an auxiliary arrester on the incoming circuit at a distance of 1,500 ft. will result in a still lower potential at the generator or motor terminals.

3. Protection of Miscellaneous Electrical Equipment.—Lightning arresters are available for the protection of other equipment such as watt-hour meters, railway apparatus and other applications of a special nature. Power cables are generally protected by distribution-type arresters, but if long enough or if a sufficient number are connected in parallel, they may not need arrester protection.

The protection of D.C. motors is accomplished through the use of low impedance capacitors of four microfarads connected line-to-ground. There are also in use many aluminum-cell arresters consisting of aluminum plates, the surface of which is coated with a thin film of aluminum hydroxide, immersed in an electrolyte.

4. Protection of Communication Circuits and Apparatus.—Communication circuits: both telephone and telegraph, may have lightning potentials greatly in excess of their normal potentials impressed upon them either by induction or through contact by direct strokes. Without protection, damage to circuits or connected apparatus may occur, resulting in interference to service over the circuits. Conductors in metal-sheathed cables, particularly those which have no connection with overhead wire, are well shielded against lightning effects and are less subject to lightning effects than exposed overhead wires. In areas subject to lightning it is general practice to install protective devices on communication circuits to minimize lightning effects.



BY COURTESY OF BELL TELEPHONE LABORATORIES, INC.

FIG. 7.—PROTECTOR BLOCK WITH FUSES FOR COMMUNICATIONS CIRCUITS

Protectors are usually located at or near the communication apparatus and the customer's premises, at the junction of overhead wire and metal-sheathed cable, and in central offices on the line side of the apparatus.

Most lightning protective devices are constructed on the principle of providing a path to ground in the case of abnormal potentiais on the circuit, but no path to ground for the normal communication potentials. A higher potential, such as might occur from lightning, causes the devices to discharge the overvoltage harmlessly to ground. The insulation being protected is designed to withstand adequately potentials up to that at which the protective device discharges.

Fig. 7 shows a type of protector commonly used at telephone subscribers' stations. It consists of fuses and carbon protector blocks suitably assembled on a porcelain base. The protector blocks consist of two parts, one a carbon block which is connected to the earth, and the other a porcelain part which has a carbon insert connected to the line wire. When paired, a gap of a few one-thousandths of an inch exists between the carbon parts, and discharge across the gap will begin when the potential exceeds about 400-v. crest. Other materials and forms of gaps are also used. including the use of gaps enclosed in a partial vacuum.

The fuses are used to disconnect the subscribers' equipment in the event that a power wire comes in contact with the communication circuit. In such an event the carbon-block gap will discharge to earth, causing the power current to blow the fuse connected between the protector block and the incoming circuit.

Protection used at the junction of overhead wire and metal-sheathed cable is frequently installed in a weatherproof housing containing protective gaps for ten communication circuits or one cross arm of the overhead line. In this case fuses are not generally used.

For radio and television receivers equipped with outdoor antennas, protection is commonly afforded by a simple form of lightning arrester with an air gap that provides a path between antenna and ground in the event of high voltage on the antenna.

C. Protection of Power Transmission Lines

Overhead transmission lines depend for their successful operation on the electrical strength of the air. At supporting structures, such as steel towers or wood poles, the conductors are supported by porcelain or glass insulators of either the suspension or pin type. The design of these insulators is such that in the event of the application of high transient voltage, such as results from lightning, the insulator will arc over externally rather than puncture.

Such a flashover may allow system current to flow, since the electrical strength of the air has been momentarily greatly reduced; and such poner current flow. if continued long enough, will result in an interruption to service and may burn the conductors involved and perhaps damage insulators externally so they may have to be replaced.

Lightning may strike the suspended conductors of the transmission line at any point and may involve more than one conductor. There are two general methods of protection in use. The most common, especially for high-voltage lines, uses overhead ground wires arranged to shield the line conductors from lightning strokes. The second method employs means to prevent the flow of system current, which might follow a lightning flashover, from causing a trip-out or interruption to service; this is done by limiting the power current as to time or magnitude or both.

1. Overhead Ground Wires.—The purpose of the overhead ground wire is to divert the lightning stroke to itself, thus preventing contact with a line conductor, and also to conduct the current of the stroke to the earth. This is not sufficient, however, since the current of the stroke must get to the earth through the resistance of the tower footing; and this resistance may be high enough to cause the tower to rise in potential to such a degree that a flashover may take place between the tower and the line conductors. Thus, the location of the ground wires, the flashover values at the tower and in the span, and the tower footing resistance are all important in determining the proper performance of the line under lightning conditions when using overhead ground wires.

For double-circuit lines with vertically arranged conductors on either side of the tower, two overhead ground wires can be used, one above each of the outermost conductors at a distance approximately equal to the spacing between the conductors. For single-circuit, horizontally arranged lines, two overhead ground wires can be placed above and about midway between vertical planes through the outside and middle conductors, and above the plane of the conductors at a height of about two-thirds the spacing between them.

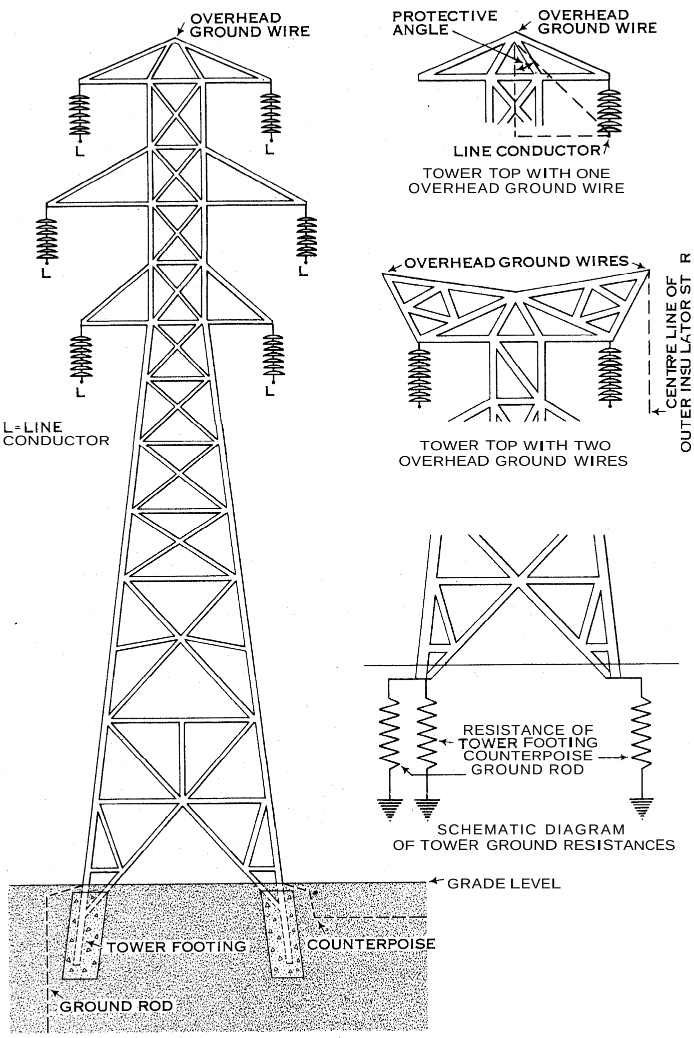


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FIG. 8.—DOUBLE CIRCUIT TOWER SHOWING SUGGESTED GROUND WIRE LOCATIONS, USE OF DRIVEN GROUND AND COUNTERPOISE

In tests on models, it was found that with a protective angle of 50° to 60° and a cloud height 10 times that of the ground wires, the strokes to line conductors would be limited to 1% of the strokes to the ground wire. To take into account such factors as wind, earth resistivity: variable cloud height and topography, a tolerance of 20° is suggested, which would indicate a protective angle of about 30°. An angle of 45° has been used on many transmission lines with satisfactory results (fig. 8).

At the tower there should be proper co-ordination between flashover of the supporting insulator and clearances to the steel, or down wires from the ground wires if wood structure is used. In some designs where use is made of wood to increase the insulation strength of the supporting structure, means are provided for bringing down the connection from the ground wire in such fashion that the wood is not short-circuited.

2. Tower Footing Resistance.—The voltage across an insulator string is $E = IR(1 - C)$, where I is the lightning current in the tower, R is the tower footing resistance and C is the coupling factor between the overhead ground wires and the conductors. The coupling factor, usually between 0.2 and 0.4, is dependent upon the number, configuration and spacing of the conductors and is influenced by the presence of corona. As a rule the designer does not have much opportunity to increase the coupling and thus reduce the voltage across the insulator, since such factors as electrical clearance, tower height and conductor size are determined largely by other considerations.

The designer may increase the flashover voltage between the line conductors and the ground wire and tower, which usually means more insulators and larger and higher towers; and/or he may reduce the tower footing resistance. The latter may be accomplished by connecting the tower base to ground rods driven into the earth, and/or to conductors buried approximately 18 in. under the surface of the earth. Such a buried conductor is called a counterpoise and may be continuous between towers, or may be less than a half span in length and arranged either parallel to the line or radial with respect to the tower.

3. **Wood Pole** Lines.—Many wood pole lines in all voltage classes up to 161 kv. have been in successful operation. If equipped with overhead ground wires and bonded and grounded hardware and down wires on the poles, they may be treated as steel towers from the lightning point of view. Many operators have used the insulation value of the wood cross arms, in which case the minimum insulation strength may be designed to be the air flashover between the conductor and nearest down wire. To prevent shattering as a result of direct strokes of lightning, the wood is often bridged by air gaps, using a ratio of about three feet of wood to each foot of parallel air gap.

See ELECTRICITY, ATMOSPHERIC; ELECTRICITY; ELECTRICITY, CONDUCTION OF; ELECTRIC POWER; see also references under "Lightning" in the Index volume.

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LIGHTNING, FOLKLORE OF. Lightning, which is usually feared in primitive cultures, has been generally associated with the appearance of a god or considered a manifestation of the god's power or wrath.

God's control over lightning is frequently mentioned in the Old Testament. Job is asked the rhetorical questions: "Who hath divided a watercourse for the overflowing of waters, or a way for the lightning of thunder" and "Canst thou send lightnings, that they may go, and say unto thee, Here we are?" (Job xxxviii, 25, 35). Before God commanded Moses to climb to the top of

Mount Sinai, according to Exodus, chapter 19 "there were thunders and lightnings, and a thick cloud upon the mount. . . ."

In ancient Greece, thunder and lightning were considered omens of Zeus. The thunderbolt was said to have been cast by him, and any place which lightning struck was sacred. Salmoneus (*q.v.*), legendary king of Elis, often attempted to imitate Zeus by driving his chariot at full speed to imitate thunder while he burned torches to represent lightning. To hear thunder on the right before a battle was a favourable omen.

The Romans, however, considered thunder heard on the left the favourable omen. They also associated their god Jupiter with lightning and thunder. Good or evil fortune was predicted by thunder heard before an undertaking, and there was also a class of "neutral" lightning which did not predict success or failure.

To the Persians, lightning was an indication of divine wrath. Herodotus reports this view: "Said Artabanus, the adviser of Xerxes, 'Thou seest how the Deity strikes with thunderbolt those beasts that tower above their fellows, but the little ones worry him not; and thou seest also how his missiles always smite the largest buildings and trees of such kind; for God loves to truncate all those things that rise too high. Thus, too, a large army may be ruined by a small one, when God in his jealousy hurls a panic or a thunderbolt, through which they are shockingly destroyed; for God permits none but himself to entertain grand ideas.'"

Sir James Frazer (*q.v.*) in his Golden Bough tells of many superstitions in various cultures concerning trees which have been struck by lightning. The Thompson Indians of British Columbia used wood from a tree that had been struck by lightning to make incendiary arrows, or they attached splinters of such wood to their arrows. The Wendish peasants of Saxony and the Thonga of South Africa refused to use wood from such a tree as fuel, but the fire from a tree that had been struck by lightning was welcomed by the Winamwanga of Northern Rhodesia. Like the Maidu Indians of California, they believed that lightning was the personification of their god, and they revered it.

Myths concerning thunderbirds or persons are common among some North American Indians. The Tlingit, on the northwest Pacific coast of North America, believe that lightning is caused by the flash of the thunderbird's eye as he winks; other groups explain that lightning is the weapon of such a bird or person.

In general folklore, lightning never strikes the same place twice. The sound of thunder, according to natives in some parts of Australia, brings turtles out of the water to lay eggs.

In some parts of Germany it became customary during the Easter season for the people to char in a consecrated bonfire sticks of beech, walnut and oak, which were throughout the year burned during thunderstorms or placed on the roof of the house to protect it from being struck by lightning. It was also believed in several provinces of France that a charred Yule log, or *tréfoir,* which had been lit on Christmas Eve and burned daily until Twelfth-night, could, if stored under a bed, protect the house from lightning and a number of other misfortunes.

LIGHTNING BUG, the name often given in the United States to the firefly (*q.v.*).

LIGHTNING INSURANCE: see FIRE INSURANCE.

LIGHTSHIP: see LIGHTHOUSES.

LIGHT-YEAR, an astronomical unit of length, the distance traveled by light in the course of one year, being equivalent to about six million million (6×10^{12}) miles. The distance of stars may be measured in terms of this unit or in terms of the parsec (*q.v.*), which is about 3.26 light-years.

EIGNE, CHARLES JOSEPH, PRINCE DE (1735–1814), soldier and writer, came of a princely family of Hainaut, and was born at Brussels in 1735. He distinguished himself at Breslau, Leuthen, Hochkirch and Maxen, and after the Seven Years' War rose to the rank of lieutenant field marshal. An intimate friend and counselor of Emperor Joseph II, he lived luxuriously on his estates! returning to his military duties during the War of the Bavarian Succession, and again in 1784. During his travels in Europe he was a prominent figure both in society 'and in scholastic circles. In 1787 he was with Catherine II in Russia, accompanied her in her journey to the Crimea, and was made a Russian field marshal by the empress. In 1788 he was present at the siege of Belgrade. Shortly after this he was invited to place himself at the head of the Belgian revolutionary movement, in which many of his relatives took part, but he declined. He was given the rank of field marshal (1809) and an honorary command at court, where he lived in comparative luxury devoting himself to literary work. He lived long enough to characterize the proceedings of the congress of Vienna with the famous mot: "Les *Congrès* danse *mais* ne *marche* pas." He died at Vienna on Dec. 13, 1814.

His collected works appeared in 34 volumes at Vienna during the last years of his life (*Mélanges militaires, littéraires, sentimentaires*), and selections were published in French and German, and in English (1927).

Ligne's grandson, EUGENE LAMORAL DE LIGNE (1804–1880), was a distinguished Belgian statesman.

LIGNITE. In North America, coals having a moist mineral-matter-free heat content of less than 8,300 B.T.U. per pound are called lignite. Moisture content (as received) varies from 20% up to 60%. The classifications of other countries are overlapping. Some European lignite would be classified "subbituminous" in the U S Most brown coals in Europe would be classified as lignite. Lignite is generally younger geologically than higher-rank coal.

Approximately 4,000,000 tons of lignite are mined annually in the United States, largely by open-pit methods. North Dakota and Texas are the largest producers. Assured U.S. reserves total more than 463,000,000,000 tons, about 15% of the nation's total solid fuels reserves on a B.T.U. basis. About 95% of total tonnage is located in North Dakota, South Dakota and Montana.

The fuel is used by local utility, industrial and domestic consumers fairly close to the mine site. It is adaptable to firing in stokers of the overfeed type, in pulverizers and in cyclone furnaces. It can be shipped and stored in the same manner as higher-rank coals. Because of its greater liability to oxidation and to spontaneous combustion, it requires more careful compaction in stockpiles than coals of higher rank. Crushed lignite can be stored for periods of two or three months without compaction when treated with small quantities of oil.

Lignite (brown coal) resources are a major factor in the development of eastern and southeastern Europe. About one-third of the output is briquetted for domestic and industrial heating. Another one-third is used for power generation. The remainder is used by chemical and carbonization processes. See also COAL AND COAL MINING. (W. A. McC.)

LIGONIER, JOHN (JEAN LOUIS) **LIGONIER,** EARL, cr. 1766 (1680–1770), British field marshal, came of a Huguenot family settled in England. He served throughout Marlborough's campaigns in Flanders (1702–10). In 1720 he became colonel of the "Black Horse" (later the 7th dragoon guards), a command which he retained for a period of 29 years. At Fontenoy Ligonier commanded the British foot, and acted throughout the battle as adviser to the duke of Cumberland. During the "Forty-Five" he was called home to command the British army in the Midlands, but in Jan. 1746 was placed at the head of the British and British-paid contingents of the Allied army in the Low Countries.

Ligonier was present at Roucoux (Oct. 11, 1746) and, as general of horse, at Val (July 1, 1747), where he led the charge of the British cavalry. His horse was killed and he himself taken prisoner, though exchanged in a few days. With the close of the campaign ended Ligonier's active career, but (with a brief interval in 1756–57) he occupied various high civil and military posts to the close of his life. In 1766 he became field marshal.

See Combes, *J. L. Ligonier, une étude (1866)* and the histories of the 7th dragoon guards and grenadier guards

LIGUORI, SAINT ALFONSO MARIA DE' (1696–1787), Italian doctor of the church, was born at Marianella, near Naples, on Sept. 27, 1696, the son of Giuseppe de' Liguori. He studied law. passed his examination for the doctor's degree at the age of 16 and practised law for eight years. Giving up the bar, he was ordained priest in 1726. In 1732 he founded the Congregation of the Most Holy Redeemer. commonly called the Redemptorists. In 1762 he became bishop of Sant' Agata de' Goti, about

30 mi. from Naples. He resigned this bishopric in 1775 and died on Aug. 1, 1787. He was canonized in 1839 and declared a doctor of the church in 1871. In 1950 he was named patron of moralists and confessors by Pope Pius XII. His feast is celebrated on Aug. 2.

Liguori wrote extensively. By 1953 his works had gone through about 18,000 editions and had been translated into 60 languages. They fall into three classes. (1) The first, in the field of moral theology, is headed by his *Tlteologia moralis*. This first appeared in 1748 and went through nine editions in his lifetime and more than 60 subsequently. He summarized it in *Praxis confessarii*. Another work in this class is *Homo apostolicus*. (2) The second class embraces his ascetical and devotional writings for priests, religious and lay persons. This includes *Visits to the Blessed Sacrament*, *The True Spouse of Christ* (for nuns) and *Selva* (for priests) and *The Glories* of *Mary*. The last is one of the most influential and widely used manuals of Marian devotion, and it helped to shape the Marian doctrine. (3) The third class contains his dogmatic writings, such as *The History of Heresies*, his works on the infallibility of the pope and those on the power of prayer. This last theme he stressed so constantly that he is sometimes called the "doctor of prayer."

Liguori was also a celebrated preacher, a musician and a poet. He composed and put to music many hymns which are still favourites among the Italian people. His Christmas hymn "Tu Scendi dalle Stelle" is as closely associated with Christmas in Italy as are "Adeste Fideles" and "Silent Night" in other countries.

In theology Liguori is known as the principal exponent of equiprobabilism, a system of principles designed to guide the conscience when one doubts whether he is free from, or bound by, a given law. The system is based on the legal axiom, "in doubt the presumption favours the possessor." Applying it to doubts of conscience, Liguori laid down these three principles: (1) In a doubt with equally probable reasons pro and con, a person is free from the obligation of the law if he has been free from it hitherto, for freedom is in possession and the presumption favours the possessor. (2) In a doubt with equally probable reasons pro and con, a person is bound to keep the law if he has been bound to it hitherto, for the law is in possession. (3) In a doubt when the reasons for the obligation of the law are considerably more probable than those for liberty, the law must be kept.

Collected editions of St. Alfonso Liguori's works have been published in Italian, French, German. Dutch and English. For bibliographies, *see* M. de Meulemeester, *Bibliographie générale des écrivains Rédemptoristes*, 3 vol. (1933–39) and *Histoire sommaire de la Congrégation du Très-Saint-Rédempteur* (1950); as well as A. Sampers, "Bibliographia Xlphonsiana," *Spicilegium Historicunt C. SS. R.*, pp. 248–271 (1953).

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(RA. J. M.; F. J. C.)

LIGURES BAEBIANI, a settlement of Ligurians in Samnium. Italy. The towns of Taurasia and Cisauna in Samnium had been captured in 298 B.C. by the consul L. Cornelius Scipio Barbatus, and the territory of the former remained Roman state domain. In 180 B.C. 47,000 Ligurians from Luna (Ligures Xpuani), were transferred to this district. and two settlements were named after the consuls of 181 B.C., the Ligures Baebiani and the Ligures Corneliani.

The site of the former town lies 15 mi. N. of Beneventum, on the road to Saepinum and Aesernia. The site of the other settlement—that of the Ligures Corneliani—is unknown.

LIGURIA, a modern region of Italy containing the provinces of Genoa, Imperia, Savona and La Spezia. and once forming the republic of Genoa. It lies between the Ligurian Alps and the Apennines on the north. and the Mediterranean on the south, and extending from the frontier of France on the west to the Gulf of Spezia on the east. Its northern limits touch Piemonte and Lombardia, while Emilia and Tuscana fringe its eastern borders, the dividing line following as a rule the summits of the mountains.

The area of Liguria is 2.089 sq.mi. Pop. (1961) 1,717,630, as compared with 1,075,760 in 1901. The railway from Pisa skirts the entire coast of the territory, throwing off lines to Parma from Sarzana and Spezia, to Milan and Turin from Genoa and to Turin from Savona; there is also a line from Ventimiglia north to Cuneo and Turin by the Col di Tenda. Its sparsely peopled mountains slope gently northward toward the Po, descending, however, abruptly into the sea at several points; the narrow coast district is famous under the name of the Riviera (*q.v.*).

The principal products of Liguria are maize, wine, oranges. lemons, fruits, olives and potatoes, though the olive groves are being rapidly supplanted by flower gardens. In the mountains the forests are important and considerable hydraulic power is also derived from the streams and used for railway traction; etc.

Copper, manganese and iron pyrites are mined. Sardinian lead is smelted at Pertusola on the Gulf of Spezia. The principal industries are ironworks: foundries, iron shipbuilding, engineering and boilerworks (Genoa, Spezia,' Sampierdarena, Sestri Ponente, etc.), railway signals (Savona) and the manufacture of cottons and woolens.

The inhabitants have always been adventurous seamen—Columbus, for example, was Genoese—and the coast has several good harbours, Genoa, Spezia and Savona being the best. In educational and general development, Liguria stands high among the regions of Italy.

Archaeology and Philology.—In earlier times the Ligurians occupied a much more extensive area than the ninth Augustan region of Italy. For instance, Strabo gives earlier authorities for their possession of the land on which the Greek colony of Massalia (Marseille) was founded; and Thucydides speaks of a settlement of Ligurians in Spain who expelled the Sicani thence. Southward their domain extended as far as Pisa on the coast of Etruria and hrretium inland in the time of Polybius (ii, 6). Seneca (*Cons. ad Helv.* vii, 9), states that the population of Corsica mas partly Ligurian. (For the archaeological side of the question *see* GOLASECCA.) Archaeological evidence shows them to have been a part of the "Mediterranean race:" and confirms the tradition as to the area they occupied.

The Bronze Age rock engravings near Ventimiglia (*q.v.*) are interesting. Their culture was much modified in the Iron Age by a Celtic invasion, after which the two peoples mere inextricably mixed.

On the linguistic side some fairly certain conclusions have been reached. One may note the frequency of the suffix *-asco-* (and *-usco-*) both in ancient and in modern Ligurian districts, and as far north as *Caranusca* near Metz. and also in the eastern Alps and in Spain. Most of the Ligurian proper names (*e.g.*, the streams, *Vinelasca, Porcobera, Comberamea; mons Tuledo; Venascum*) have a definite Indo-European character, as have those preserved in Latin inscriptions of the Ligurian districts, such as the *Tabula Genuatium* (C.I.L. I, 584) of 117 B.C. A complete collection of Ligurian place and personal names combined with the inscriptions of the district is printed in *The Pre-Italic Dialects*, edited by *R.* S. Conway and J. Whatmough. There is strong evidence in these names that the language spoken before the Roman conquest was Indo-European, and belonged to those languages which preserved the original q as Latin did, and did not convert it into *p* as did the Umbro-Safine tribes. The same is probably true of Venetia (*see* VENETI) and of an Indo-European language preserved on inscriptions found at Coligny and commonly referred to the Sequani.

The "Lepontic" inscriptions found in a small area (50 mi. by 3j mi.) round the lakes of Como, Lugano. Maggiore and Orta, are also Ligurian, with Celtic affinities. The Ligurian ethnica show the prevailing use of the two suffixes *-co-* and *-ati-*, which there is reason to refer to the pre-Roman stratum of population in Italy. (*See* VOLSCI.)

The Ligurians were eventually restricted more and more to the county adjoining the Gulf of Genoa, and at last they occupied only an area bounded by the upper reaches of the Po and Ticino on the north, the Arno on the east. and the Alps and the Var on the west. They are described as thin and wiry, short of stature and dark complexioned, hardy and warlike people winning a difficult livelihood from the soil, but also interested in commerce, and some of them daring seafarers.

The Ligurian coast became gradually subject to the Romans, and the road along it must have been correspondingly prolonged: up to the end of the Hannibalic war the regular starting-point for Spain by sea was Pisae; in 195 B.C. it was the harbour of Luna (Gulf of Spezia), though Genua must have become Roman a little before this time! while, in 137 B.C. C. Hostilius Mancinus marched as far as Portus Herculis (Villafranca), and in 121 B.C. the province of Gallia Narbonensis was formed and the coast-road prolonged to the Pyrenees. In *14* B.C. Augustus restored the whole road from Placentia to Dertona (Via Postumia), and thence to Vada Sabatia (Via Aemilia) and the River Varus (Var), so that it thenceforth took the name of Via Julia Augusta. The other chief roads of Liguria were the portion of the Via Postumia from Dertona to Genua, a road from above Vada through Xugusta Bagiennorum and Pollentia to Xugusta Taurinorum, and another from Augusta Taurinorum to Hasta and Valentia. The names of the villages—Quarto, Quinto, etc.—on the south-east and Pontedecimo on the north of Genoa allude to their distance along the Roman roads. Even the Roman Liguria, forming the ninth region of Augustus, was thus far more extensive than the modern, including the country on the north slopes of the Apennines and Maritime Alps between the Trebia and the Po, and extending a little beyond Xlbintimilium. On the west Augustus formed the provinces of the Alpes Maritimae and the Alpes Cottiae. Towns of importance were few, owing to the nature of the country. Dertona was the only colony, and Alba Pompeia, Augusta Bagiennorum. Pollentia. Hasta, Aquae Statiellae. and Genua may also be mentioned; but the Ligurians dwelt entirely in villages, and were organized as tribes. The mountainous character of Liguria made the spread of culture difficult; it remained a forest district, producing timber, cattle, ponies. mules, sheep. etc. Oil and wine had to be imported, and when the cultivation of the olive began is not known.

The arrangement made by Augustus lasted until the time of Diocletian, when the two Alpine provinces were abolished, and the watershed became the boundary between Italy and Gaul. At this time we find the name of Liguria extended as far as Milan, while in the 6th century the old Liguria was separated from it, and under the Lombards formed the fifth Italian province under the name of Alpes Cottiae. In the middle ages the ancient Liguria north of the Apennines fell to Piedmont and Lombardp, while that to the south, with the coast strip, belonged to the republic of Genoa.

LI HUNG CHANG (1823–1901), Chinese soldier and statesman. was born on Feb. *16.* 1823 at Hofei, in Ngan-hui. In 1847 he became a Chin-shih, or graduate of the highest order, two years later entering Hanlin university. He raised a regiment of militia against the Taiping rebels, thus earning the good will of the commander-in-chief, Tseng Kuo-fan. In 1859 he was transferred to the province of Fu-kien, where he was given the rank of taotai, or intendant of circuit. But at Tseng's request Li was recalled to take part against the rebels. He found his cause supported by the "Ever Victorious Army," which, after having been raised by an American named Ward, was finally placed under the command of Charles George Gordon. With this support Li gained victories which led to the surrender of Suchow and the capture of Nanking. For these exploits he was made governor of Kiangsu, was decorated with the yellow jacket. and was created an earl. An incident connected with the surrender of Suchow left a lasting stain upon his character. By an arrangement with Gordon the rebel wangs, or princes, yielded Nanking on condition that their lives should be spared. In spite of the assurance given them by Gordon, Li ordered their instant execution. This breach of faith so enraged Gordon's indignation that he seized a rifle and would have shot Li if he had not saved himself by flight, On the suppression of the rebellion (1864) Li took up his duties as governor, but on the outbreak of the rebellion of the Nienfei, a remnant of the Taipings, in Ho-nan and Shan-tung (1866) he was ordered again to take the field, and suppressed the movement. A year later he was appointed viceroy of Hukwang, where he remained until *1870*, when the Tientsin massacre led to his transfer to the scene. He was appointed to the viceroyalty of the metropolitan province of Chihli, where he actively repressed anti-foreign sentiment. For his services he was made imperial tutor and member of the grand council of the empire, and was decorated with many-eyed peacocks' feathers.

To his duties as viceroy were added those of the superintendent of trade, and from that time until his death, with a few intervals of retirement, he practically conducted the foreign policy of China. He concluded the Chifu convention with Sir Thomas Wade (1876), and thus ended the difficulty caused by the murder of Mr. Margary in Yunnan; he arranged treaties with Peru and Japan, and he actively directed the Chinese policy in Korea. On the death of the emperor T'ungchi in 187j he effected the *coup d'état* by which the emperor Kwang Su was put on the throne under the tutelage of the two dowager empresses; and in *1886*, on the conclusion of the Franco-Chinese war, he arranged a treaty with France. When viceroy of Chihli he had raised a large, well-drilled and well-armed force: and spent vast sums both in fortifying Port Arthur and the Taku forts and in increasing the navy. For years he had watched the successful reforms effected in Japan, and he feared and hated a conflict. But in *1894* events forced his hand, and war broke out. Both on land and at sea the Chinese forces were ignominiously routed, and in 1895, on the fall of Wei-hai-wei, the emperor sued for peace. Li represented the emperor at the Shimonoseki conference.

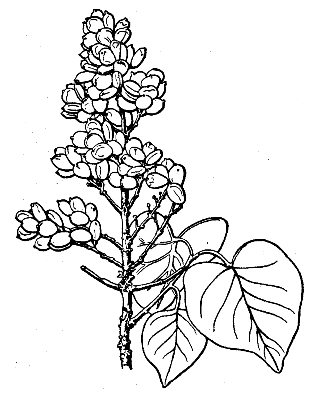
With great diplomatic skill Li pleaded the cause of his country, but finally had to agree to the cession of Formosa. the Pescadores, and the Liaotung peninsula to the conquerors, and to the payment of an indemnity of 200.000.000 taels. By a subsequent arrangement the Liaotung peninsula was restored to China, in exchange for an increased indemnity. During the peace discussions at Shimonoseki an attempt was made on his life. He was wounded, but soon recovered.

In 1896 Li represented the emperor at the coronation of the tsar. and visited Germany. Belgium. France, England and the Cnited States of America. For some time after his return to China he was virtually constituted minister for foreign affairs; but in 1900 he was transferred to Canton as viceroy of the two Kwangs.

The Boxer movement induced the emperor to recall him to the capital, and the peace of Sept. 1901 was largely secured by his efforts.

He died on Nov. 7, 1901. He left three sons and one daughter.

LILAC (*Syringa vulgaris*), a shrub of the family Oleaceae. The genus contains more than 25 species of ornamental hardy deciduous shrubs and trees, native in eastern Europe and temperate Asia. They have opposite, generally entire leaves and large panicles of small regular flowers, with a bell-shaped calyx and a four-lobed cylindrical corolla, with the two stamens characteristic of the family attached at the mouth of the tube.



FROM COOPER AND WESTELL, "TREES AND SHRUBS OF THE BRITISH ISLES" (DENT & SONS LTD.)

BRANCH OF THE LILAC (SYRINGA VULGARIS) SHOWING FRUIT

The common lilac is said to have come from Persia in the 16th century, but is doubtfully indigenous in Hungary. the borders of Moldavia. etc.

Two kinds of *Syringa*, viz. *alba* and *caerulea*, are figured and described by John Gerard (*Herball*, 1597), which he calls the white and the blue pipe privets. The white is the common privet, *Ligustrum vulgare*, which, with the ash tree, *Fraxinus excelsior*, are the only members of the family found wild in Great Britain.

The "blue pipe privet" is the lilac: as both figure and description agree accurately with it. It was carried by the European colonists to northeast America, and is still grown in gardens of the northern and middle states.

There are many fine varieties of lilac, both with single and double flowers; they are among the commonest and most beautiful of spring-flowering shrubs.

The Persian lilac' of gardens (S. *persica*), also known as the Chinese or Rouen lilac, a small shrub 4 to 6 ft. high with intense violet flowers appearing in May and June, is much cultivated for ornament.

FROM COOPER AND WESTELL, s AND SHRUBS OF THE BRITISH ISLES" (DENT & SONS, LTD.)

BRANCH OF THE LILAC (SYRINGA VULGARIS) SHOWING INFLORESCENCE

Of other species, *S. josikaea* from Transylvania, has scentless bluish-purple flowers; S. cmodi, a native of the Himalayas, is a handsome shrub with large ovate leaves and dense panicles of purple or white strongly scented flowers. Lilacs grow freely and flower profusely in almost any soil and situation, but when neglected are apt to become choked with suckers which shoot up in great numbers from the base.

They are readily propagated by means of these suckers. By far the most handsome lilacs, of which there are hundreds of varieties, are of hybrid, mostly French origin. Notable collections of these are found at Rochester, N.Y., and at the Arnold Arboretum, Jamaica Plain, Mass.

Syringa is also a common name for the mock orange, which are unrelated shrubs of the genus Philadelphus. (N. Tr.)

LILBURNE, JOHN (1614–1657), English democrat and republican, leader of the Levellers (*q.v.*). The younger son of a Durham gentleman, Lilburne was apprenticed to a London cloth merchant. At an early age he joined the underground opposition to Charles I's personal government, and helped to smuggle in and circulate pamphlets printed in the Dutch republic. For this he was in Feb. 1638 sentenced by the Star Chamber to be fined £500, whipped, pilloried and imprisoned until he submitted. He used the pillory as a rostrum, until Archbishop Laud had him gagged. He remained in prison until the Long parliament liberated him in Nov. 1640, Oliver Cromwell speaking on his behalf.

On the outbreak of civil war, Lilburne was commissioned as a captain. Taken prisoner at Brentford, he would have been condemned to death had not parliament forced his exchange by threatening reprisals. In April 1645, when he resigned his commission rather than take the covenant, Lilburne was a lieutenant colonel.

Henceforth his activities are inseparable from those of the Levellers. He wrote innumerable pamphlets. The special contribution of Lilburne ("Free-born John") was his vindication of the legal rights of Englishmen. He quoted Sir Edward Coke almost as often as the Bible, and was even criticized by his fellow Levellers William Walwyn and Richard Overton for attaching exaggerated importance to Magna Carta ("that mess of pottage"; "but a beggarly thing").

Lilburne ultimately came to agree that the existing constitution and law were inadequate to defend the birthright of the common man. He advocated manhood suffrage and extensive law reform, since "the poorest that lives hath as true a right to give a vote as well as the richest and greatest" (London's Liberty in Chains, 1646, p. 4). Past laws were justified only if they accorded with reason—*i.e.,* he abandoned the common-law appeal to precedent and custom.

Lilburne fiercely criticized first the Presbyterian parliament and then the Independent leaders of the army for not meeting the Levellers' demands. He was frequently arrested, but his popularity was such that juries invariably acquitted him. When on trial in Oct. 1649 he insisted that juries were judges of law as well as of fact, the judges being "but the Norman Conquerors intruders."

In 1650–52 Lilburne with John Wildman helped inhabitants of the Isle of Axholme to oppose a drainage scheme which impaired commoners' rights. Banished by parliament in 1652, Lilburne returned in 1653 after the dissolution of the Rump. He was put on trial, and his acquittal by a London jury was the occasion of a great demonstration which affected the troops and worried the government. So Lilburne was kept in prison until 1655. By then he had turned Quaker, and was prepared to give security for good behaviour.

Lilburne died at Eltham, Kent, on Aug. 29, 1657.

See M. A. Gibb, John Lilburne the Leveller (London, 1948); J. D. Hughes, "The Drainage Disputes in the Isle of Axholme," The *Lincolnshire Historian*, vol. ii (Lincoln, 1954). (J. E. C. H.)

LILIACEAE, in botany, a family of Monocotyledons belonging to the series Liliiflorae, and generally regarded as representing the typical order of Monocotyledons. The plants are generally perennial herbs growing from a bulb or rhizome, sometimes shrubby as in butcher's broom (*Ruscus*) or treelike as in species of Dracaena, Yucca or Aloe. The flowers are with few exceptions hermaphrodite, and regular with parts in threes, the perianth which is generally petaloid occupying the two outer whorls followed by two whorls of stamens, with a superior ovary of three carpels in the centre of the flower; the ovary is generally three-chambered with a number of anatropous ovules on axile placentas. The fruit is a capsule splitting along the septa (septicidal), or between them (loculicidal), or a berry; the seeds contain a small embryo in a copious fleshy or cartilaginous endosperm. Liliaceae is one of the larger families of flowering plants containing about 2,700 species in 233 genera being approximately one-eighth of the Monocotyledons; it is of world-wide distribution. It contains many useful plants (onion, leek, garlic) and garden plants (lily, tulip, hyacinth). The plants show great diversity in vegetative structure, which together with the character and mode of dehiscence of the fruit affords a basis for the subdivision of the family into tribes, eleven of which are recognized. The following are the most important tribes.

Melanthioideae.—The plants have a rhizome or corm, and the fruit is a capsule. Many are north temperate and three are represented in Britain, viz. Tofieldia, an arctic and alpine genus of small herbs with a slender scape springing from a tuft of narrow ensiform leaves and bearing a raceme of small green flowers; *Narthecium* (bog asphodel), herbs with a habit similar to *Tofieldia,* but with larger golden-yellow flowers; and Colchicum, a genus with about 30 species including the meadow saffron or autumn crocus (*C. autumnale*). Colchicum illustrates the corm-development which is rare in Liliaceae, though common in the allied family Iridaceae. Gloriosa, well known in cultivation, climbs by means of its tendril-like leaf-tips; it has handsome flowers with recurved orange-red or yellow petals; it is a native of tropical Asia and Africa. *Veratrum* is an alpine genus of the north temperate zone.

Asphodeloideae.—The plants generally have a rhizome bearing radical leaves, as in asphodel, rarely a stem with a tuft of leaves as in *Aloe,* very rarely a tuber (*Eriospermum*) or bulb (Bowiea). The flowers are borne in a terminal raceme, the anthers open introrsely and the fruit is a capsule, very rarely, as in Dianella, a berry. Asphodelus (asphodel) is a Mediterranean genus; Simethis, a slender herb with grassy radical leaves, is a native of west and southern Europe extending into south Ireland. Anthericum and *Chlorophytum,* herbs with radical often grass-like leaves and scapes bearing a more or less branched inflorescence of small generally white flowers, are widely spread in the tropics. Other genera are Hosta, native of China and Japan, cultivated in the open air in Britain; Hemerocallis, a small genus of central Europe and temperate Asia—*H. flava* is known in gardens as the day lily; *Phormium,* a Sew Zealand genus to which belongs New Zealand flax, *P. tenax,* a useful fibre-plant; *Kniphofia* (red-hot poker), South and East Africa, several species of which are cultivated; and Aloe. A small group of Australian genera closely approach the family Juncaceae in having small crowded flowers with a scarious or membranous perianth; they include Xanthorrhoea (grass-tree or black-boy) and Kingia.

Allioideae.—The plants grow from a bulb or short rhizome;

the inflorescence is an apparent umbel formed of several shortened monochasial cymes and subtended by a pair of large bracts. The largest genus *Allium* has about 325 species—7 are British. *Agapanthus* or African lily is a well-known garden plant; in Gagea, a genus of small bulbous herbs found in most parts of Europe, the inflorescence is reduced to a few flowers or a single flower; G. *lutea* is a local and rare British plant.

OM H. J. ELWES, "MONOGRAPH OF TH GENUS LILIUM"
LONG-FLOWERED WHITE LILY (LILIUM LONGIFLORUM). A, SCALY BULB, WITH TWO SMALL BULBS

Lilioideae.—Bulbous plants with a terminal racemose inflorescence; the anthers open introrsely and the capsule is loculicidal.

It contains about 30 genera, several represented in Britain. The typical genus *Lilium* and Fritillaria are widely distributed in the temperate regions of the northern hemisphere; *F. meleagris,* snake's head, is found in moist meadows in some of the southern and central English counties; *Tulipa* contains about 50 species in Europe and temperate Asia, and is specially abundant in the dry districts of central Asia; *Lloydia,* a small, slender alpine plant, widely distributed in the northern hemisphere, occurs on Snowdon in Wales; Scilla (squill) is a large genus, chiefly in Europe and Asia—*S. nutans* is the blue-bell or wild hyacinth; *Ornithogalum* (Europe, Africa and west Asia) is closely allied to *Scilla—O. umbellatum,* star of Bethlehem, is naturalized in Britain; *Hyacinthus* and *Muscari* are chiefly Mediterranean; *M.* racemosum, grape hyacinth, occurs in sandy pastures in the eastern counties of England. To this group belong a number of tropical and especially South African genera, such as *Albuca, Urginea, Drimia, Lachenalia* and others.

Dracaenoideae.—The plants generally have an erect stem with a crown of leaves which are often leathery; the anthers open introrsely and the fruit is a berry or capsule. It contains a small number of genera, several of which, such as *Yucca, Dracaena* and Cordyline include arborescent species in which the stem increases in thickness continually by a centrifugal formation of new tissue; an extreme case is afforded by Dracaena *Draco,* the dragon-tree of Teneriffe. *Yucca* and several allied genera are natives of the dry country of the southern and western United States and of Central America. Dracaena and the allied genus *Cordyline* occur in the warmer regions of the Old World.

Asparagoideae.—Plants growing from a rhizome; fruit a berry. Asparagus contains about 120 species in the dryer, warmer parts of the Old World; it has a short creeping rhizome, from which springs a slender, herbaceous or woody, often very much branched, erect or climbing stem, the ultimate branches of which are flattened or needle-like, leaf-like structures (cladodes), the true leaves being reduced to scales or, in the climbers, forming short, hard, more or less recurved spines. *Ruscus aculeatus* is butcher's broom, an evergreen shrub with flattened leaf-like cladodes, native of the southerly portion of England and Wales; the small flowers are unisexual and borne on the face of the cladode; the male contains three stamens, the filaments of which are united to form a short stout column on which are seated the diverging cells of the anthers; in the female the ovary is enveloped by a fleshy staminal tube on which are borne three barren anthers. Poly*gonatum* and Maianthemum are allied genera with a herbaceous leafy stem and, in the former axillary flowers, in the latter flowers in a terminal raceme; both occur rarely in woods in Britain; P. *multiflorum* is the well-known Solomon's seal of gardens, so called from the seal-like scars on the rhizome of stems of previous seasons, the hanging flowers of which contain no honey, but are visited by bees for the pollen. *Convallaria* is lily of the valley; Aspidistra, native of the Himalayas, China and Japan, is a well-known pot plant; its flowers depart from the normal arrangement of the family in having the parts in fours (tetramerous). Paris, including the British Herb Paris (P. quadrifolia), has solitary tetra- to poly-merous flowers terminating the short annual shoot which bears a whorl of four or more leaves below the flower; in this and in some species of the nearly allied genus Trillium (chiefly temperate North America) the flowers have a fetid smell, which together with the dark purple of the ovary and stigmas and frequently also of the stamens and petals, attracts carrion-loving flies, which alight on the stigma and then climb the anthers and become dusted with pollen; the pollen is then carried to the stigmas of another flower.

Luzuriagoideae are shrubs or undershrubs with erect or climbing branches and fruit a berry. Lapageria, a native of Chile, is a favourite greenhouse climber with fine bell-shaped flowers.

Smilacoideae are climbing shrubs with broad net-veined leaves and small dioecious flowers in umbels springing from the leaf-axils; the fruit is a berry. They climb by means of tendrils, which are stipular structures arising from the leaf-sheath. Smilax is a characteristic tropical genus containing about 210 species; the dried roots of some species are the drug sarsaparilla.

The two tribes Ophiopogonoideae and Aletroideae are sometimes removed from the Liliaceae and placed in the family, Haemodoraceae. The plants have a short rhizome and narrow or lanceolate basal leaves; and they are characterized by the ovary being often half-inferior. They contain a few genera chiefly old world tropical and subtropical. The leaves of species of *Sansevieria* yield a valuable fibre and the tubers of *Ophiopogon japonicus* are edible. *See* K. Krause in Engler and Prantl, *Die Natürlichen Pflanzenfamilien,* ed. 2, 15a:227–386, fig. 81–161 (1930).

LILIENCRON, DETLEV VON (1844–1909), German poet and novelist, was born at Kiel on June 3, 1844. He entered the army and took part in the campaigns of 1866 and 1870–71, in both of which he was wounded. He retired with the rank of captain, and spent some time in America. On his return (1882) he entered the civil administration at Kellinghusen in Holstein, where he remained till 1887. After some time at Munich, he settled in Altona and then at Altrahistedt, near Hamburg, where he died on July 22, 1909. He first attracted attention by the volume of poems *Adjutantenritte und andere* Gedichte (1883), which was followed by several dramas, a volume of short stories, *Eine Sommerschlacht* (1886), and a novel! *Breide Hummelsbüttel* (1887). In the collections of short stories which appeared under the titles *Unter flatternden Fahnen* (1888), *Der Mäcen* (1889) and *Krieg und Frieden* (1891), he gave powerful, realistic studies of war. Liliencron is one of the greatest of modern German lyric poets; his *Adjutantenritte,* with its fresh original note, broke with the well-worn literary conventions which had been handed down from the middle of the century. His other volumes of lyrics mere Der *Heidegänger* (1893), *Neue Gedichte* (1893), *Bunte Beute* (1903), and the posthumous Gute *Nacht* (1909). To this poetical work should be added the humorous epic in *Ottava rima, Poggfred* (1896; re-written and extended 1904). Liliencron's genius was essentially lyric. He has many exquisite lines, and many perfect stanzas, but few perfect long pieces. In much of his work the influence of the quiet landscape of Holstein is evident.

Liliencron's *Sämtliche Werke* were published in 14 vols. (1904–05), and edit. by R. Dehmel (8 vols., 1911–13). See studies by H. Spiero (Berlin and Leipzig, 1913, bibl.); H. Maynz (1920); I. Wichmann (1922). His published correspondence includes *Ausgewählte* Briefe (ed. Dehmel, 2 vols., 1910); *Liliencrons* Briefe an seinen *Verleger* (ed. W. Friedrich, 1910); *Unbegreiflich Herz,* letters to his first wife (ed. H. Spiero, 1925).

LILIENTHAL, OTTO (1848–1896), German inventor and aeronaut, was born at Auklam on May 23, 1848. With a view to studying the problem of equilibrium, Lilienthal made careful observations of the flight of birds, and succeeded in constructing an aeroplane in which a gliding flight could be maintained. Although his work was improved upon by Pilcher, to Lilienthal belongs the credit of demonstrating the superiority of arched over flat surfaces and of reducing gliding flight to regular practice. He made over 2,000 glides in safety, but on Aug. 9. 1896, his machine was upset by a sudden gust of wind, and he was killed near Rhinow. He was the author of a valuable book, Der *Vogelflug* als Grundlage der

Fliegekunst (1889).

LILITH, a female demon of Jewish folk-lore, equivalent to the English vampire. The personality and name ("night-monster") are derived from a Babylonian-Assyrian demon Lilit or Lilu. Lilith was believed to have a special power for evil over children. The superstition was extended to a cult surviving among some Jews even as late as the 7th century A.D. In the Rabbinical literature Lilith becomes the first wife of Adam, but flies away from him and becomes a demon.

LILLE, a city of northern France, capital of the Nord *département,* 154 mi. *N.* by E. of Paris on the Northern railway. Population (1954) 190,078. Lille lies in a rich agricultural and industrial plain on the right bank of the Deûle. In 1030, Count Baldwin IV of Flanders surrounded with walls a little town which had arisen around the castle of Buc. In the first half of the 13th century. the town obtained communal privileges. Destroyed by Philip Augustus in 1213, it was rebuilt by Joanna of Constantinople, countess of Flanders, but besieged and retaken by Philip the Fair in 1297. After having taken part with the Flemings against the king of France, it was ceded to the latter in 1312. In 1369 Charles V, king of France, gave it to Louis de Male, who transmitted his rights to his daughter Margaret, wife of Philip the Bold, duke of Burgundy. Under Burgundian rule Lille prospered and its merchants were at the head of the London Hansa. Philip the Good made it his residence. With Flanders it passed from the dukes of Burgundy to Austria and then to Spain. After the death of Philip IV of Spain, Louis XIV reclaimed the territory and besieged Lille in 1667. He forced it to capitulate, but preserved its liberties. In 1708, after an heroic resistance, it surrendered to Prince Eugène and the duke of Marlborough. The treaty of Ctrecht restored it to France.

In World War I Lille was first reached by advance German patrols in Aug., 1914. It was afterwards re-occupied by the French, but they retired again early in Oct., the serious defense of the city not being part of the general plan of campaign. After several days' bombardment the Germans entered on Oct. 12, 1914, and remained till Oct., 1918, when they were outflanked by the Allied capture of neighbouring towns. The deportation of a large number of citizens in 1916 was the culminating point of tyranny suffered by the people of Lille under war conditions.

The city was a favourite resort for German officers on leave, as it was not shelled by the Allies, although it was within range of the guns.

Lille is the headquarters of the I army corps, and has an enceinte and a pentagonal citadel, one of \-auban's finest works, west of the town, across the Defile. Before 1858 the town, fortified by Vauban about 1668, occupied an elliptical area of about 2,500 yd. by 1,300, with the church of Notre Dame de la Treille in the centre. but the southern ramparts and ditches were replaced by the Boulevard de la Liberte, a straight line from the goods railway station to the citadel. The new enceinte encloses the old communes of Esquermes, Wazemmes and Moulins-Lille, the area of the town being thus more than doubled and boulevards and squares added. The district of St. André to the north is the only elegant part of the old town. Outside the enceinte populous suburbs surround the city and on the north and east demolition of fortifications and rapid building are making Lille expand towards Roubaix and Tourcoing. At the demolition of the southern fortifications, the Paris gate, erected in 1682 in honour of Louis XIV, after the conquest of Flanders, was preserved. On the east are the Ghent (1617) and Roubaix (1622) gates, in Renaissance style, in bricks of different colours. On the same side the Noble-Tour is a relic of the mediaeval ramparts. There are water gates for the canal of the Defile and for the Arbonnoise, which extends into a marsh in the southwest. The citadel, with barracks and arsenal, is surrounded by public gardens. The churches possess valuable pictures and the modern cathedral of Notre Dame de la Treille has an ancient statue of the virgin, an object of pilgrimage. Lille was made a bishopric in 1913. The Bourse (17th century) is built round a courtyard; the Hôtel d'Aigremont, the HBtel Gentil and other houses are in the Flemish style; the HBtel de Ville was destroyed in the explosion of a munition dump in 1916 but a part of an old palace of Philip the Good (15th cent.) near to it still remains. The Palais des Beaux-Arts contains a museum and picture galleries including a unique collection of original designs of the great masters and a celebrated wax model of a girl's head usually attributed to some Italian artist of the 16th century. Many pictures were removed before the French evacuated Lille in 1914 and the galleries were largely restored after the end of the war in 1918. The large military hospital was once a Jesuit college.

Lille is the seat of a prefect and has tribunals of first instance and of commerce, a board of trade arbitrators, a chamber of commerce and a branch of the Bank of France. It is the centre of an académie (educational division) and has a university with faculties of laws, letters, science and medicine and pharmacy, together with a Catholic institute comprising faculties of theology, law, medicine and pharmacy, letters, science, a technical school, and a department of social and political science. There are also a higher school of commerce, a national technical school. schools of music and fine arts, and the industrial and Pasteur institutes.

The chief industries are the spinning of flax and the weaving of cloth, table-linen, damask, ticking and flax velvet. The spinning of flax thread for sewing and lace-making is specially connected with Lille. The manufacture of woollen fabrics and cotton-spinning and the making of cotton-twist of fine quality are also carried on. There are important printing establishments, state factories for the manufacture of tobacco and the refining of saltpetre and very numerous breweries, chemical, oil. white lead and sugar-works, distilleries, bleaching-grounds, dye-works, machinery and boiler works. Plant for sugar-works and distilleries, military stores, steam-engines. locomotives, and bridges of all kinds are produced by the company of Fives-Lille. Lille is one of the most important junctions of the Northern railway, and the Deûl canal affords communication with neighbouring ports and with Belgium. Trade is chiefly in the raw material and machinery for its industries, in the products thereof, and in the wheat and other agricultural products of the surrounding district.

LILLEBONNE, a town of France in the Seine-Maritime *département,* $3\frac{1}{2}$ mi. *N.* of the Seine and 24 mi. E. of Le Havre by the Western railway. Pop. (1954) 5,396. It lies in the valley of the Bolbec at the foot of wooded hills. Lillebonne—under the Romans, Zuliobona—was the capital of the Caletes in the time of Caesar. by whom it was destroyed. Rebuilt by Augustus, it became an important focus of Roman roads, but was later ruined by barbarian invasion. The remains of ancient baths and of a great theatre have been brought to light, and many Roman and Gallic relics found. The medieval fortifications were built of materials from the theatre. The church of Notre-Dame has a 16th century tower and portal; the donjon of a 13th century castle stands in the park. The principal industries are cotton-spinning and the manufacture of calico and candles.

LILLIBULLERO or LILLIBURLERO, the name given to a song popular at the end of the 17th century, especially among the army and supporters of William III in the war in Ireland during the revolution of 1688. The tune appears to have been much older, and was sung to an Irish nursery song at the beginning of the 17th century. The attribution to Henry Purcell is based on the very slight ground that it was published in *Music's Handmaid,* 1689, as "A new Irish Tune" by Henry Purcell.

The doggerel verses have generally been assigned to Thomas Wharton, and deal with the administration of Talbot. earl of Tyrconnel, appointed by James as his lieutenant in Ireland in 1687. The refrain of the song *Lilliburlero bullen* a *la* gave the title of the song. Wharton claimed he had "sung a king out of three kingdoms" and Burnet says "perhaps never had so slight a thing so great an effect." The air was introduced uith success by Gay (*q.v.*) into *The Beggar's Opera.*

LILLIE, FRANK RATTRAY (1870–1947), **U.S.** zoologist who demonstrated that fertilization involves the interaction of specific substances borne by the egg and sperm (fertilizin theory), and that embryonic sex differentiation is controlled by sex hormones circulating in the blood between fetal cattle tains (freemartin theory). Born in Toronto, Ont. on June 27. 1870. he nas educated at the University of Toronto and The University of Chicago (Ph.D., 1894). Returning to The University of Chicago in 1900, he became professor of embryology in 1906 and distinguished service professor in 1931. He served as chairman of the department of zoology (1910–31) and dean of the division of biological sciences (1931–35). Through his leadership (1908–42) the Marine Biological laboratory (Woods Hole, Mass) was built into a research institution of international distinction.

Lillie was founder and first president of the Woods Hole Oceanographic institution. He served as president of the National Academy of Sciences (1935–39) and was anarded its Agassiz medal in 1940. His books include Development of the Chick (1908, 1919), Problents of Fertilization (1919) and The *Woods* Hole Marine Bzological Laboratory (1944). He died in Chicago on Nov 5, 1947.

For a full account of Lillie's career see Biological *Memoirs,* National Academy of Sciences, vol. 30 (1957). (B. H. W.)

LILLO, GEORGE (1693–1739), English dramatist whose tragedy The London *Merchant,* or *the* History of George *Barnwell* (1731) revived an interest in domestic themes and influenced the sentimental drama of France and Germany, was born in London. Feb. 4, 1693. the son of a Dutch jeweler. He was for many years a partner in his father's business. His first piece *Silvia,* or the *Country Burial* (1730), a ballad opera, was produced at Lincoln's Inn Fields. The London Merchant, produced by Colley Cibber at Drury Lane, is founded on "an excellent ballad of George Barnwell, an apprentice of London who . . . thrice robbed his master, and murdered his uncle in Ludlow." Lillo had gone back to the Elizabethan domestic drama of passion of which the anonymous *Yorkshire* Tragedy is a type. Scoffing critics called it, with reason, a "Newgate tragedy" but it was regularly acted for many years at holiday seasons for the moral benefit of the apprentices. The last act contained a scene generally omitted on the London stage, in which the gallows actually figured. In 1734 Lillo celebrated the marriage of the Princess Anne with William IV of Orange in Britannia and Bataaia, a masque.

His other dramas were: *The Christian* Hero (1735); Fatal Curiosity (1736); an adaptation of *Pericles, Prince of* Tyre entitled *Marina* (1738); and *Elmerick,* or Justice *Triumphant* (1740).

Lillo died in London. Sept. 3. 1739. His unfinished version of the anonymous Elizabethan tragedy Arden of *Feversham* was completed by Dr. J. Hoadly and produced in 1759. His *Dramatic Works,* with *Memoirs* of the *Author* by *Thomas* Dacies were published in 2 vol., 2nd ed. (1810).

See E. Bernbaum, The Dranza of Sensibility (1915).

LILLY, WILLIAM (1602–1681), English astrologer immortalized as Sidrophel in Samuel Butler's Hudibras, was born on Mav 1. 1602. at Diseworth in Leicestershire, and was educated at the school of Ashby-de-la-Zouch. In April 1644. he began publishing his astrological almanacs. which received serious attention from some of the most prominent members of the Long Parliament. Like all successful astrologers. he tempered the indications given by the aspects of the heavens with his knowledge of current events, with the result that his predictions often showed a sympathy with the parliament. For this reason, and because he misjudged the scientific revolution that spread so rapidly in England during the 17th century. Lilly fell into disrepute after the Restoration.

He died at Hersham Surrey, on June 9. 1681. (0. J. E)

LILY, WILLIAM (1468?–1522), English Renaissance scholar and classical grammarian, was born at Odiham Hampshire. about 1468. After graduating at Oxford university he traveled in the south and east of Europe, during which time he studied Greek. He became the personal friend of William Grocyn. Thomas Linacre and Sir Thomas More. After teaching privately in London he was appointed high master of Dean Colet's refoundation of St. Paul's school (1512–22). He died in 1522.

Lily was a pioneer of Greek learning in England and one of the authors of the Latin grammar which bears his name. In 1540 Henry VIII ordered it to be used in all English grammar schools. In the Anglican canons of 1604 the bishop. when visiting a school, was directed to ask if the "Royal Grammar" was used.

Lily's *Grammar* was severely criticized by schoolmasters, and numerous revisions were made which corrected errors, eliminated needless complications and contributed useful additions. The most important criticism concerned the Latin syntax "by which children have been usually put upon learning the construction of a language, they were unacquainted with, from rules given them in that very language." Thus English translations of the rules and the syntax were made by William Haine of Merchant Taylors' school (1637). Richard Busby (1659) and many others. Charles Hoole published an edition in 1651 with an English translation on the left-hand pages.

Editions incorporating recognized emendations were also published at Cambridge (1634 and 1630) and at Oxford (1636 and 1687). John Ward's edition (1732) was commonly used in 18th-century English schools. Revised in 1758 and appropriated by Eton college as the Eton *Latin Grammar,* it was finally superseded ten years later by the *Public School* Latin *Grammar.*

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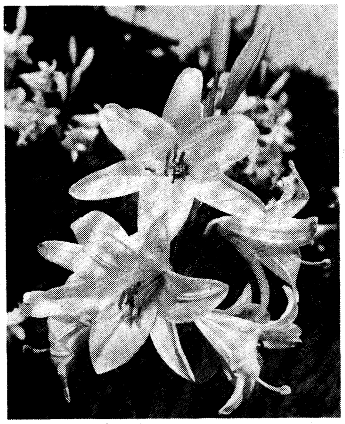
LILY (Lilium), the typical genus of the family Liliaceae, embracing about 80 species, all confined to the northern hemisphere and widely distributed throughout the north temperate zone. The earliest in cultivation were described in 1597 by John Gerard, who figured eight kinds of true lilies, including L. *candidum* and a variety. *bizantinum;* two umbellate forms of the type L. *bulbiferum,* named L. *aureum* and L. *cruentum latifolium;* and three with pendulous flowers, apparently forms of the martagon lily. Parkinson. in his Paradisus (1629), described five varieties of martagon. six of umbellate kinds. together nith one American. L *canadense.*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MADONNA LILY (LILIUM CANDIDUM), KNOWN FROM ANTIQUITY

The Madonna lily. L. candi*dum,* was one of the commonest garden flowers of antiquity, appearing in the poets from Homer on, sharing popularity with the rose and the violet. Roses and lilies are thought to have entered Greece from the east by nay of Phrygia, Thrdce and Macedonia Mythologically the white lily Rosa *junonis* (called Madonna in the late 19th century) was fabled to have sprung from the milk of Hera. As the plant of purity it was contrasted with the rose of Aphrodite.

The word krinon (lily), on the other hand, included red and purple lilies. The red lily was that best known in Syria and Judaea, and the lily of the Old Testament may be conjectured to be a red lily from the simile used in Song of Solomon v, 13 ("His lips are lilies!') unless the allusion is to the fragrance rather than to the colour. The "lilies of the field" (Matt. vi, 28) are quite certainly Anemone coronaria, the poppy anemone, which is common in Palestine where lilies are not.

In North America about 20 native species of lily occur. In the eastern half of the continent the best-known are the wood lily (L. *philadelphicum*), the meadow lily (L. *canadense*), the Turk's-cap lily (*L. superbum*) and the bell lily (L. *grayi*). Noteworthy among the ten native lilies found in the Pacific states are the Washington lily (L. *washingtonianum*), the Columbia lily (L. *columbianum*) and the Humboldt lily (L. *humboldtii*). None of these American lilies compares with those from the Himalayas, Korea, China and Japan as garden plants. But many magnificent hybrid lilies were developed after 1930 on the Pacific coast. The North American Lily society at a meeting held at Cornell university awarded trophies for some of these outstanding hybrids to E. F. Palmer and Jan de Graaff. No true lily is found native in Great Britain.

The structure of the flower represents the simple type of monocotyledons, consisting of two whorls of petallike perianth lobes, of three free parts each: six free stamens: and a consolidated pistil of three carpels, ripening into a three-valved capsule containing many winged seeds. In form, the flower assumes three types: trumpet-shaped, with a more or less elongated tube (*e.g., L. longiflorum,* the white trumpet lily, and L. *candidum,* the Madonna lily); an open form with spreading perianth leaves (*e.g.,* L. *auratum*); or assuming a pendulous habit, with the tips strongly reflexed (*e.g.,* the martagon type). All have scaly bulbs which. in three western American species such as L. *humboldtii,* are remarkable for being somewhat intermediate between a bulb and a creeping rhizome. L. *bulbiferum* and its allies produce aerial reproductive bulbils in the axils of the leaves.

The bulbs of several species are eaten in some areas of the world. Medicinal uses were once ascribed to the species, but none appears to have any marked properties in this respect. From L. *longiflorum* was developed in Oregon the Croft lily, the commonest Easter lily in the United States.

The noble L. *auratum,* with its large white flowers, having a yellow band and numerous red or purple spots, is a magnificent plant when grown to perfection; and so are the varieties called *rubrovittatum* and Crimson Queen, which have the central band crimson instead of yellow, and the broad-petaled *platyphyllum* and its almost pure white subvariety called *virginale.* Of *L. speciosum,* the Japanese lily (well known to most gardeners as *lancifolium*), the true typical form and the red-spotted and white varieties are impressive plants for late summer blooming.

The tiger lily. L. *tigrinum,* and its varieties *fortunei, splendens* and *plenescens* are among the best species for the flower garden.

The pretty L. *leichtlinii* and *L. monadelphum,* with drooping yellow flowers, and the scarlet droop-flowered *L. tenuifolium* comprise, with those already mentioned, a series of the finest hardy flowers of the summer garden. The Indian L. *giganteum* is distinct in character, having broad heart-shaped leaves and a noble stem 10 to 14 ft. high and bearing a dozen or more large, deflexed, funnel-shaped, purple-stained white flowers; L. *cordatum* (China and Japan) is similar in character, but shorter stemmed.

The cultivation of lilies is not difficult if the gardener keeps in mind a few essentials. Nearly all of them tend to die out in a few years and should therefore be replaced by fresh plantings. They are rich feeders and should only be planted in rich garden loam, with a layer of well-rotted manure well below the bulb but never touching it. Many species, notably *L. hansonii* and *L. henryi,* prefer partial shade to full sun. Drainage must be perfect because they will not stand stagnant water over the winter. If rodents (which eat the bulbs) are a pest, bulbs should be planted in underground wire cages.

In planting (except for *L. candidum,* which should be planted shallowly) the bulbs should be planted at least three times their height below the surface, so that stem roots which develop above the bulb will be in the soil. If a bulb is 3 in. high, its base. when planted, should be 9 in. below the surface. All lilies respond to a winter mulch of manure about $1\frac{1}{2}$ in. thick. Tall sorts must be staked if the site is windy.

The word "lilv" is looselv used in connection with many plants which are not really members of the genus *Lilium,* but belong to genera which are quite distinct botanically.

Thus the Lent lily is a *Narcissus;* the African lily is *Agapanthus africanus;* the Belladonna lily is *Amaryllis belladonna (see* AMARYLLIS); the Jacobaea lily is *Sprekelia formosissima;* the Mariposa lily is *Calochortus;* the Peruvian lily is *Alstroemeria;* St. Bernard's lily is *Anthericum liliago;* St. Bruno's lily is *Pnradisea liliastrum;* the water lily is *Nymphaea;* the giant water lily of the Amazon is *Victoria regia* (*q.v.*); the arum lily is *Zantedeschia aethiopica;* and there are many others, among them the day lilies (*Hemerocallis*). *See* references under "Lily" in the Index volume.

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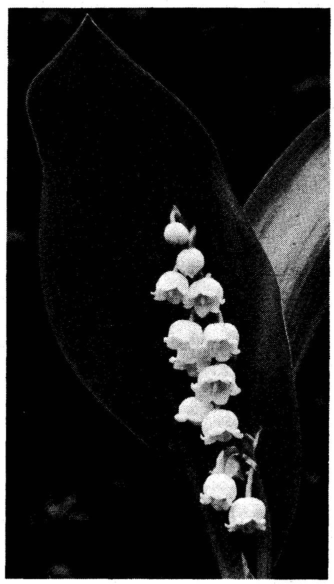
(N. TR.)



J. HORACE MCFARLAND CO.

LILY OF THE VALLEY (CONVALLARIA MAJALIS)

LILY OF THE VALLEY (*Convallaria majalis*), a beautiful plant of the lily family (Liliaceae), native to moods in some parts of England. Europe, northern Asia and possibly in the higher Allegheny mountains from Virginia to Tennessee, although the American plant is thought by some to be C. *montana,* an endemic species.

It is widely cultivated for its dainty, white, nodding, fragrant flowers. borne in spring on slender stalks, which, like the two oblong basal leaves, rise from an underground creeping stem, or rootstock. On these underground stems arise small detachable buds, commonly called pips. These. if planted about $1\frac{1}{2}$ in. deep preferably in the shade, represent the easiest way to start a planting. There are also doubleflonered and pink horticultural varieties. (N. TR.)

LIMA, a department in central Peru bounded on the southwest by the Pacific ocean, on the northwest by Ancash on the northeast by Huánuco. Pasco, Junin and Huancavelica and on the southeast by Ica. The northeastern border of the department is drawn along the westernmost range of the Andes, which forms the continental divide. Area 13,087 sq.mi. Pop. (1958 est.) 1,625,848. The capital is the city of Lima, pop. 1.186~212.

FOTO BOOZ FROM ANDEAN AIR MAIL AND PERUVIAN TIMES

MINISTRY OF EDUCATION BUILDING
One of the tallest structures in Lima

Along the coast there is seldom any rain at all. At Lima the average annual rainfall is 1.8 in., yet many years pass with no recorded rainfall. Temperatures along the coast are low, averaging between 61° F. in August and 74.3° in February. Only where rivers descend from the Andes can there be· irrigation. The five chief rivers—the Chancay. Huaura, Mala, Rimac and Cafiete—are all short and only the last two, which rise in snow fields among the highest peaks, have a vear-round flow of water to the ocean.

The coast is peculiar in that a thick cloud rests over it, especially from June to October. This cloud is in contact with the mountain slopes from about 2.500 ft. to 4,000 ft above sea level and there, in the fog zone, is a lush growth of herbaceous annuals known as *loma,* on which cattle can be fed. Above the zone of lomas there is a regular rainy season from October to April.

Outside the great urban concentration of Lima and Callao (*qq.v.*) most of the people work as farmers and herders. Cattle destined for the market in Lima are driven up and down the mountain slopes to feed on the vegetation as it turns green with the rainy season or the fog season. The lomas provide pasture from June to October and the high mountain grasslands are green irom October to April. From April to June cattle are fed on hay grown under irrigation. Other crops of the irrigated lowlands include sugar cane, cotton and a variety of vegetables.

There is some fishing off Callao and Huacho, but not nearly so much as the wealth of fish life would support. Salt is produced from the evaporation of sea water at Huacho and Chilca. In the mountains there are copper mines at Casapalca, and coal mines at Oyon. The department is crossed from northwest to southeast by the Inter-American highway and is connected with the highland centres by both rail and highway.

(P. E. J.)

LIMA (a corruption of Rimac), capital of Peru and of the department of Lima (12° 3′ 3″ S., 77° 2′ 14″ W.), on the Rimac. a river in summer, a rivulet in winter, is $8\frac{1}{2}$ mi, from its seaport, Callao (*q.v.*).

In the desert coast zone, nearly 500 ft. above sea level, the city is surrounded by an irrigated plain, out of which rise, here and there. rugged hills, among them San Cristobal (1,343 ft.) just north of the city. Pop (1958 est.) 1,186,212.

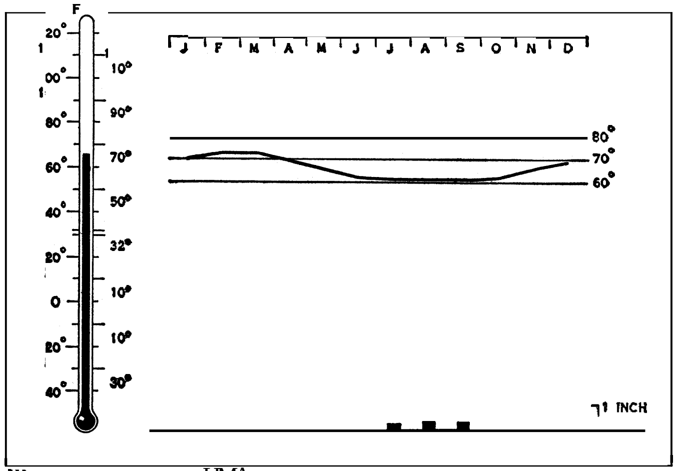
The climate is moderate, the mean annual temperature being 66° F.; it seldom drops below 54° or rises above 80°. Though there is almost no precipitation, the sky is overcast during the winter, when fogs and high relative humidity make it seem colder than it is.

History.—Lima was founded as the City of the Kings by Francisco Pizarro on Jan. 18, 1535, on the left bank of the Rimac. He traced the outlines of the chief plaza (Plaza de *Armas*) and the checkerboard of streets enclosing square areas (*manzanas*) with open plazas at intervals, a pattern which still survives. On the same day he laid the cornerstone of the cathedral, consecrated in 1625, where his remains are still preserved. Lima became the luxurious capital of the viceroys, the first of whom arrived in 1544. The obligatory centre of Spanish trade on the entire continent, it was the focus of Spanish colonization in South America. By a grant from Charles V, the Universidad Mayor de San Marcos was founded in 1551 under Dominican direction and secularized in 1571. The first archbishop was appointed in 1545. In 1570 the Inquisition was established. As vast wealth from the mines accumulated, the city was embellished with elaborate balconies and carved stone portals, while churches and monasteries glittered with gold and silver. Stone bridges were built across the Rimac; that of 1610 is still standing. Meanwhile, for protection against attacks of foreign pirates, the Duke of La Palata (viceroy 1681–89), built the city walls which stood until 1870, when they were razed and replaced by the present boulevards. This metropolis of a colonial empire was destroyed by earthquake on Oct. 28, 1746, and little in the present city antedates that catastrophe.

During Peru's struggle for independence Lima was the centre of Spanish resistance, and even after independence was declared (1821), it remained rigidly conservative. The era of reconstruction was followed by a vast influx of money from guano deposits, which resulted in some public improvements, such as the railway to Callao (1851), lighting and water systems. The city suffered from all the revolutions which convulsed Peru under the republic, but the greatest calamity was its occupation by a Chilean army from Jan. 17, 1881, to Oct. 22, 1883. During that time public buildings and scientific, literary and artistic collections were systematically pillaged. The spirit, as well as much of the history of Lima, is embodied in the six volumes of *Tradiciones* Peruanas by Ricardo Palma.

Streets, Buildings and Public Utilities.—The present city is a curious blend of old and new. The streets, about 30 ft. wide, are paved with stone or asphalt. Most of them have a different name on every block. The houses are usually one story in height, of adobe covered with plaster, built about a patio with plants and flowers, and barred outer windows. The better ones are two storys high, with balconies overlooking the street. The Torre Tagle mansion, now the foreign office, is the best remaining example of secular colonial architecture. The Plaza ***de Armas*** is still the centre of Lima, from which tram and omnibus lines radiate. It is surrounded by the cathedral on the east, the archbishop's palace, municipal building, government palace (Palace of the Viceroys), rebuilt and enlarged in 1938, and numerous shops and arcades. On the Plaza de la *Inquisición* is the ancient Inquisition building, now the senate house, with the chamber of deputies near by. In addition to the government palace, the National Palace of Justice (1939) and the Municipal palace (1944) are outstanding among later government edifices.

All the plazas have fountains, shrubs. and flowers. Some of them have statues of national heroes, such as Manco Capac, Bolívar, San Martin and Bolognesi. Many wide avenues, paved with concrete, are favourite promenades. The Paseo *Colón*, 1 mi. long, 150 ft. wide, with a statue of Columbus, is bordered by trees, flowers and beautiful residences. At one end is the Exposition park, 30 ac. of gardens, walks, artificial lakes, the national museum, mining and metallurgy exposition building and a zoological garden. A favourite promenade for the poorer classes is the Alameda de *los* Descalzos, north of the river, a shady avenue with statues and marble benches, leading to the monastery of the barefoot friars. Several concrete or asphalt highways have been built to neighbouring towns and suburbs. such as the Avenida *del* Progreso to Callao and Avenida *Leguía* to Miraflores, five miles to the south. Electric tramways and buses run to Miraflores, Barranco and Chorrillos, to Magdalena and through Callao to La Punta, all of which are bathing and yachting resorts. In and about Lima there are more than 90 mi. of street railways.



WEATHER GRAPH OF LIMA. THE THERMOMETER INDICATES THE ANNUAL MEAN TEMPERATURE. THE CURVE SHOWS THE NORMAL MONTHLY TEMPERATURE. AND THE COLUMNS, THE NORMAL MONTHLY PRECIPITATION. MONTHS NOT ACCOUNTED **FOR** IN COLUMN HAVE **A** "TRACE" OF PRECIPITATION. LESS THAN 0.1 INCH

During winter, the favourite resort is Chosica, 30 mi, east of Lima on the Central railway, with a sunny climate above the fogs. Chosica may also be reached by the Central highway. Peruvians are fond of sports, especially association football. There is a modern country club with tennis courts, golf links and polo field. The Jockey club has a racecourse with large grandstand, but the best races are held at the San Felipe hippodrome. The bull ring, the Plaza de Toros in Alameda de Acho, built in 1768, accommodates 8,000 spectators. There are several excellent theatres and numerous cinemas. Many parts of the ancient City of the Kings present a quite modern appearance, with tall office buildings, banks. schools, mid-20th century style homes. excellent hotels and a large two-story central market building which covers an entire block.

An enlarged water supply involved building two reservoirs of reinforced concrete. of 26,000,000 l. and 13,000,000 l. capacity, additional collecting galleries, a new aqueduct and renewing 62 mi. of pipe. A 16-in. main was also built to Miraflores.

Churches and Other **Institutions.**—In spite of these modern improvements, the past still presides over Lima. More than 50 Spanish colonial churches are scattered throughout the city, among which are Santo Domingo, San Francisco, La Merced, San Agustin and the Sanctuary of Santa Rosa de Lima, built on the site of the house where she was born in 1586, besides monasteries and convents of which that of San Francisco is the largest. Freedom of worship was granted to Protestants in 1915, and there are several Protestant churches. Among the clubs, some of which are located on the *Plaza de Armas*, should be mentioned the National, founded 1855, Union, 1868, and many foreign clubs such as the Phoenix (British) club. Learned societies include the Athenaeum, founded (1877) as a literary organization, the Historical institute (1905) and the Geographical society (1888), with a library of 10,000 volumes, 2,000 maps and a small museum as well as a seismological observatory. Its bulletins are a treasure house of information. The Corps of Mining and Hydraulic Engineers (1902) also issues bulletins indispensable to a student of the field. There is a national academy of medicine (1885), an outgrowth of that established by Dr. Unánue in 1787, engineers' and lawyers' clubs, a geological society and many more.

Education. — The University of San Marcos (1551) has faculties of theology, jurisprudence, medicine, political and economic science, philosophy, history and letters. mathematical, physical and natural sciences, and institutes of pharmacy and dentistry. It has a library, two museums, a department of physical education, a gymnasium and a meteorological observatory. The Catholic university has faculties of letters, jurisprudence and political science. A school of engineering was established in 1876 with departments of mines, civil engineering and architecture. There is a school of scientific agriculture, a military school in Chorrillos, a naval academy in La Punta, a school of arts and crafts, a popular university, established in 1921, a school of fine arts (1918), a teachers' college (1905), normal schools, a reform school for boys, the Jorge Chávez school of aviation, a national academy of music and conservatory, business and language schools, numerous secondary schools for boys, the largest of which is Guadalupe (1841), and some for girls, though the majority of schools for girls are convents or private schools. There are in all ten museums, which include collections of Peruvian antiquities, arts, costumes and paintings of scenes and characters in national history. The Lima charity organization maintains public hospitals, including the Arzobispo Loayza, modern in design and equipment. There are many private hospitals, eight volunteer fire companies, five large markets and a modern prison. The National library, founded in 1821 and destroyed by the Chileans in 1881, was razed by fire on May 10, 1943, destroying the library's valuable collection of some 120,000 volumes. A new building on the same site was completed in 1945. There is postal and telegraphic service with cable connection at Callao, and wireless communication from a high-power station near Lima. Lima's airport, 3 mi. from the city at Limatambo, is one of South America's best. There are many newspapers, chief among them *El Comercio* (1839), and periodicals devoted to various interests, some illustrated, some published in foreign languages.

Trade, Industry and Finance. — Hydroelectric power for city lighting and tramways, as well as for industrial purposes, is furnished by the Lima Light, Power and Tramways company, transferred by high-tension wires from Chosica and Yanacoto. Business is chiefly in the hands of wholesale houses, both native and foreign, which export raw products and import manufactured goods. They have chains of branch houses throughout the republic.

The most important manufacturing industry is textiles; eight cotton and two woollen mills have a total production of more than 30,000,000 yd. a year. Other industries are tanneries, factories for making shoes and leather articles, hats, furniture, chocolate and biscuits, tile, candles, soap and powder; also oil refineries, coke ovens, railway shops, flour mills, distilleries and breweries.

The *Estanco del Tabaco,* subsidiary of the National Tax Collecting company, has a factory in Lima which produces cigarettes and cigars. Other industries include factories for making glass, portland cement, aluminum articles for household use, rubber goods, hosiery and chemicals (caustic soda and chloride of lime).

The principal banks, with branches in other cities, are the Bank of London and South America; Italian bank (1889), now the Credit Bank of Peru; Popular bank (1899); Royal Bank of Canada (1916); National City bank (1920). The *Caja de Ahorros* (Savings bank) was established in 1868, the *Caja* de *Depdsitos y Consignaciones* (a depository for government trust funds such as customs receipts, internal taxes, tobacco revenues) in 1905 and the Reserve bank in 1922 (*see* also PERU).

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LIMA, a city of northwest Ohio, U.S., is located on the Ottawa river (Hog creek), 79 mi. S.S.W. of Toledo; the seat of Allen county. The site was designated by state law in 1831, and its name was chosen by lot, the last to be drawn from a hat. It was incorporated in 1832.

Lima became the centre of the northwest Ohio oil fields in the 1880s and 1890s, especially after scientists discovered a commercially profitable method of removing the oil's sulfur content. and peak annual output once surpassed 20.000.000 bbl. As production diminished in the 20th century. Lima became the centre of a pipeline system operated by six major oil companies from fields in Wyoming, Texas and Oklahoma and supplying the Great Lakes and east coast.

Lima's factories manufacture machine tools, automotive engines, aircraft parts, power shovels and cranes, quarry and road-building equipment, cigars. electric and neon signs, enamelware, steel castings, school and highway buses, hearses, electric motors, rubber, petroleum products and chemicals. It is also the centre of a diversified agricultural area producing grain. soybeans, sugar beets, potatoes, and dairy, poultry and meat products.

Nearby are Indian Lake, Lake St. Mary's and Ft. Amanda State parks.

The population in 1960 was 51,037; for comparative population figures see table in OHIO: *Population.* (R. C. Do.)

LIMAÇON: *see* CURVES, SPECIAL.

LIMAN VON SANDERS, OTTO (1855–1929), German soldier, was born in Stolp, Prussia, Feb. 18, 1855. Entering the German army in 1874 he held various posts in the cavalry, and in 1913 was sent to Turkey as leader of a German military mission. His appointment as commander of the 1st Turkish army was annulled because of Russian protests, but he remained inspector of the Turkish army. Made a Prussian general in Jan. 1914, in November he was given the chief command of the Turkish troops in the Caucasus. In March 1915, as commander of the 5th Turkish army, he successfully opposed the British and French attacks on the Dardanelles and Gallipoli. In 1918 Von Sanders succeeded Freiherr von der Goltz as leader of the Turkish forces in the middle east, and was in command in Syria and Palestine when Viscount Allenby was victorious there. Von Sanders escaped capture, but after the Armistice gave himself up to the Allies and was interned until Aug. 1919. He gave an account of his experience in Turkey in *Fünf Jahre Türkei* (1920; Eng. trans. 1928), which throws much light on the Dardanelles campaign and on Turkish politics. He died at Munich on Aug. 23, 1929.

LIMASOL (anc. LEMESSUS), a seaport on the south coast of Cyprus, in Akrotiri Bay with a considerable trade in wine and carobs. Pop. (1946) 22,799. Only a fort attributed to the 13th century has survived many earthquakes and much warfare. In the neighbourhood are the ancient sites of Amathus and Curium. Limasol was the scene of the marriage of Richard I, king of England, with Berengaria of Navarre, in 1191.

LIMB. (1) A word of Teutonic origin, meaning any member of the body, but now restricted to the legs and arms or the lower (pelvic) and the upper (thoracic) limbs. The word is also used of the main branches of a tree, of the projecting spurs of a range of mountains, of the arms of a cross, etc. "Limb" was used by ecclesiastical writers of the 16th and 17th centuries of a person as being a component part of the church or other corporate body; *cf.* such expressions as "limb of the law," etc.

It is also a term for an estate dependent on another, or for the subordinate members of the Cinque Ports, attached to one of the principal towns; Pevensey was thus a "limb" of Hastings. (2) An edge or border, frequently used in scientific language for the boundary of a surface; *e.g.,* the edge of the disk of the sun or moon, or of the expanded part of a petal or sepal in botany. This word is a shortened form of *limbo* or *limbus,* Lat. for "edge," for the theological use of which *see* LIMBUS.

LIMBA, a small group of intelligent, dark-skinned people of medium stature, living in the valleys of the upper Little Skarcies and Kakuna rivers in Sierra Leone, skilled traders, speaking an ancient language related to Landuman and Timne. They are grouped in confederated villages under a paramount chief. The paternal nephew marries the widow of his paternal uncle. The Limba are organized in clans and have secret societies and age classes. They are engaged in cultivation, arboriculture and cattle-raising. Their religion is animist in type, and there are traces of totemism.

See N. W. Thomas, *Anthropological Report on Sierra Leone* (1916).

LIMBACH, a town in the district of Karl-Marx-Stadt, Ger., in a manufacturing area 6 mi. W.N.W. from the city of Karl-Marx-Stadt. Combined with the town of Oberfrohna to form Limbach-Oberfrohna. Pop. (1950) 28,493. Its industries include the making of hosiery, gloves, cloth, silk and sewing machines, and dyeing and bleaching.

LIMBORCH, HENDRICK VAN (1680–1758), Dutch painter, was born at The Hague, Holland. He studied painting under Adriaan van der Werff, whose style he imitated rather successfully, although he never acquired the skill of his master. Limborch is known for landscapes, portraits and historical paintings. His extant works include "The Repose in Egypt" and "The Golden Age," both of which hang in the Louvre, "Venus and Cupid" and "Cupid and Psyche."

LIMBORCH, PHILIPP VAN (1633–1712), Dutch Remonstrant theologian, was born on June 19, 1633, at Amsterdam, where his father was a lawyer. He received his education at Utrecht, at Leyden, in his native city and finally at Utrecht university, which he entered in 1652. In 1657 he became a Remonstrant pastor at Gouda, and in 1667 he was transferred to Amsterdam, where, in the following year, the office of professor of theology in the Remonstrant seminary was added to his pastoral charge. He was a friend of John Locke. He died at Amsterdam, April 30, 1712.

His most important work, *Institutiones theologiae christianae, ad praxin pietatis et promotionem pacis christianae unice directae* (Amsterdam, 1686, 5th ed., 1735, Eng. trans. 1702), is a full and clear exposition of the system of Simon Episcopius and Stephan Curcellaeus. The fourth edition (1715) included a posthumous "Relatio historica de origine et progressu controversiarum in foederato Belgio de praedestinatione." Limborch also wrote *De veritate religionis Christianae amica collatio cum erudito Judaeo* (Gouda, 1687); *Historia Inquisitionis* (1692), in four books prefixed to the "Liber Sententiarum Inquisitionis Tolosanae" (1307–23) and *Commentarius* in *Acta Apostolorum et in Epistolas ad Romanos et ad Hebraeos* (Rotterdam, 1711). His editorial labours included the publication of various works of his predecessors and of *Epistolae ecclesiasticae praestantium ac eruditorum virorum* (Amsterdam, 1684), chiefly by Jakobus Arminius, Joannes Uytenbogardus, Konrad Vorstius (1569-1622), Gerhard Vossius (1577–1649), Hugo Grotius, Simon Episcopius (his granduncle) and Gaspar Barlaeus; they are of great value for the history of Arminianism. An English translation of the *Theologia* was published in 1702 by William Jones (*A Complete System or Body of Divinity, Both Speculative and Practical, Founded on Scripture and Reason,* London, 1702); and a translation of the *Historia Inquisitionis,* by Samuel Chandler, with "a large introduction concerning the rise and progress of persecution and the real and pretended causes of it" prefixed, appeared in 1731.

LIMBURG (LIMBOURG), **POL** (fl. *c.* 1400), Flemish miniature painter was the most famous of three brothers whose family name was Malouel, all of whom followed the same profession. At one time Pol traveled to Italy to study at first hand the works of contemporary Italian artists, whose influence is clearly evident in his later work, but little else is known of the details of his early life. Any records there may have been have disappeared, probably destroyed by the wars which ravaged the Netherlands during his lifetime.

For a time he and his two brothers, Hermann and Janneken, worked for Philip the Bold, duke of Burgundy, beginning for him the illustration of the *Bible historike.* This manuscript was later finished by other hands after Philip's death in 1404. Not long after, probably about 1411, the brothers entered the service of Philip's brother, John, duke of Berry, and it was under his patronage that Pol did his best work, the illuminating of the two prayer books *Les Très riches Heures du duc de Berry* and *Les Heures d'Ailly* (also known as the *Belles Heures).*

Although Pol did not finish the first manuscript in his lifetime, he and his brothers are thought to be responsible for nearly half of it, and it may have been partially completed after Pol's death by Hubert and Jan van Eyck, whose style Pol was one of the first of the Flemish painters to foreshadow.

See The Metropolitan Museum of Art, *The Belles Heures of Jean, Duke of Berry, Prince of France* (1958).

LIMBURG, one of the many small feudal states into which the duchy of Lower Lorraine was split up in the second half of the 11th century. The first count was Walram of Arlon, who married Judith, the daughter of Frederick of Luxembourg, duke of Lower Lorraine (d. 1065), who bestowed upon him a portion of his possessions lying upon both sides of the river Meuse. It received its name from the strong castle built by Count Walram on the river Vesdre, where the town of Limburg now stands. Henry, Walram's son (d. 1119), was turbulent and ambitious. On the death of Godfrey of Bouillon (1089) he forced the emperor Henry IV to recognize him as duke of Lower Lorraine. He was afterwards deposed and imprisoned by Count Godfrey of Louvain, on whom the ducal title had been bestowed by the emperor Henry V (1106). For three generations the possession of the ducal title was disputed between the rival houses of Limburg and Louvain. At length a reconciliation took place (1155). The name of duke of Lower Lorraine thenceforth disappeared, the rulers of the territory on the Meuse becoming dukes of Limburg, those of the larger territory to the west, dukes of Brabant. With the death of Duke Walram IV (1280) the succession passed to his daughter, Irmingardis, who was married to Reinald I, count of Guelders. Irmingardis died without issue (1282); and her cousin, Count Adolph of Berg, laid claim to the duchy. His rights were disputed by Reinald, who was in possession and was recognized by the emperor. Too weak to assert his claim by force of arms Adolph sold his rights to John I, duke of Brabant (*q.v.*) in 1283. This led to a long and desolating war which lasted until 1288. At the end of that time, finding the power of Brabant superior to his own, Reinald in his turn sold his rights to Count Henry III of Luxembourg.

Henry and Reinald, supported by the archbishop of Cologne and other allies, now raised a great army. The rival forces met at Woeringen and John of Brabant gained a complete victory, after which the duchies of Limburg and Brabant passed under the rule of a common sovereign. The duchy comprised during this period the bailiwicks of Hervé, Montzen, Baelen, Sprimont and Wallhorn and the counties of Rolduc, Daelhem and Falkenberg, to which was added in 1530 the town of Maastricht. The provisions and privileges of the famous Charter of Brabant, the *Joyeuse Entrke* (*q.v.*), were from the 15th century extended to Limburg and remained in force until the French Revolution.

By the Treaty of Westphalia (1648) the duchy was divided into two portions, the counties of Daelhem and Falkenberg with the town of Maastricht being ceded by Spain to the United Provinces, where they formed what was known as a "Generality-Land." At the peace of Rastatt (1714) the southern portion passed under the dominion of the Austrian Habsburgs and formed part of the Austrian Netherlands until the French conquest in 1794. During the period of French rule (1794–1814) Limburg was included in the two French departments of Ourthe and Meuse Inférieure. In 1814 the old name of Limburg was restored to one of the provinces of the newly created kingdom of the Netherlands, but the new Limburg comprised, besides the ancient duchy, a piece of Gelderland and the county of Looz. At the revolution of 1830 Limburg, with the exception of Maastricht, threw in its lot with the Belgians, and during the nine years that King William refused to recognize the existence of the kingdom of Belgium, the Limburgers sent representatives to the legislature at Brussels and were treated as Belgians. When in 1839 the Dutch king suddenly announced his intention of accepting the terms of the settlement proposed by the treaty of London, as drawn up by representatives of the great powers in 1831, Belgium found herself compelled to relinquish portions of Limburg and Luxembourg. The part of Limburg that lay on the right bank of the Meuse, together with the town of Maastricht and a number of communes on the left bank of the river, became a sovereign duchy under the rule of the king of Holland. In exchange for the cession of the rights of the Germanic confederation over the portion of Luxembourg which was annexed by the treaty to Belgium, the duchy of Limburg (excepting the communes of Maastricht and Venloo) was declared to belong to the Germanic confederation. This somewhat unsatisfactory condition of affairs continued until 1866, when at a conference of the great powers, held in London to consider the Luxembourg question *(see* LUXEMBOURG), it was agreed that Limburg should be freed from every political tie with Germany. Limburg became henceforth an integral part of Dutch territory.

In Dec. 1918 indignation was expressed by Belgium at the authorization by the Dutch government of the passage of the retreating German army through Limburg, which enabled the Germans to save 70,000 to 120.000 men and to carry away the proceeds of their exactions in Belgium and a large quantity of war material. Feeling in Belgium was the more inflamed because the Dutch government had refused to liberate the Belgians interned in Holland until the consent of Germany had been obtained, an attitude which should have had its logical counterpart in the internment of the retreating Germans. It was felt that Holland had created a precedent affecting the security of Belgium. In 1918–19 a proposal was brought before the peace conference in Paris for the revision of the treaty of 1839, in order to place Dutch Limburg under Belgian rule. This was not favourably received in Paris and was strenuously opposed in Holland. It was finally vetoed. Limburg was occupied by Germany in 1940.

See P. S. Ernst, *Histoire du Limbourg* (1837–52); M. J. de Poully, *Histoire de Maastricht et de ses environs* (1850); *Diplomaticke bescheiden betreffends de Limburg-Luxemburgsche aangelegenheden 1866–67* (1868); C. J. Luzac, *De Landen van Overmuze in Zonderheid 1662 (1888)*; R. Fruin, *Geschied. der Staats-Instellingen in Nederland* (1901).

LIMBURG, the N.E. province of Belgium. part of the ancient duchy of Limburg. The part of the duchy east of the Mèuse was transferred to Holland by the London conference and a part including the old capital, now called Dolhain, was put into the province of Liége.

The Kempen, a wild heath district, has coal under it, workings on which began in 1906 and production in 1917. Towns include Hasselt (the capital), St. Trond. Tongres, Maeseyck and Looz. from the last of which an ancient ducal family takes its title. There are 3 administrative *arrondissements,* 13 cantons and 206 communes. Area 930 sq.mi. Pop. (1955 est.) 528,123, or 567.9 per square mile.

LIMBURG, the southeasternmost and third smallest province of the Netherlands. bounded north by Gelderland, northwest by Korth Brabant. southwest by the Belgian province of Lirnburg, south by that of Liége and east by Germany. Its area is 857 sq.mi. and its population (est. 1957) was 849.870, the density per square mile being 991.7. In the extreme southeast there are Cretaceous hills rising to over 300 ft. (the highest land in the Netherlands), while the rest of the province is formed of more recent deposits. It is watered by the Meuse (Maas), which forms part of its southwestern boundary (with Belgium) and then flows through its northern portion, and by such tributaries as the Roer. Its capital is Maastricht, at the ancient river crossing, giving its name to one of the two administrative districts into which it is divided, the other being Roermond. Venlo is a station on the railway from Crefeld to Breda which crosses the province. while subsidiary lines link it with Maastricht to the south and Nijmwegen to the north.

The richest part of the province is the southeast: on the loess deposits here there is a rich cultivation of wheat, rye, sugar beet and fruit. There is a coal field near Heerlen and Kerkrade, and among the industries of Maastricht are glass, porcelain and leather. The province was speedily overrun by German troops during the invasion of May 1940.

LIMBURG, a town in the *Land* of Hesse, Ger., on the Lahn, there crossed by a bridge dating from 1315, and on the main railway line from Coblenz to Lollar and Cassel. Pop. (19jo) 15,419. It is the seat of a Roman Catholic bishop and the small seven-towered cathedral, dedicated to St. George the Martyr, was founded early in the 10th century and consecrated in 1235. It was restored in 1872–78.

Limburg, which has a castle, was a flourishing place during the middle ages and had its own line of counts until 1414, when it was purchased by the elector of Trier. It passed to Nassau in 1803. Its industries include the manufacture of tobacco, soap, machinery of various kinds, paints and leather.

LIMBURG CHRONICLE or FESTI LIMPURGENSES, a German chronicle probably written by Tileman Elhen von Wolfhagen after 1402. It is a source for the history of the Rhineland between 1336 and 1398 but is more valuable philologically and for the folklore and pictures of manners which it contains.

First published by Faust in 1617, it was edited by Wyss for *Monumenta Germaniae historica. Deutsche Chroniken,* Band iv (1883).

See A. Wyss, *Die Limburger Chroizik untersucht* (18; 5).

LIMBURGITE, a dark-coloured volcanic rock resembling basalt in appearance. but containing normally no feldspar. The name is taken from Limburg (Germany): where it occurs in the well-known rock of the Kaiserstuhl. It consists essentially of olivine and augite with a brownish glassy ground mass, in which a second generation of small augites frequently occurs; more rarely olivine is present also as an ingredient of the matrix.

The principal accessory minerals are titaniferous iron oxides and apatite, and in some limburgites large phenocrysts of hornblende and biotite are found; in others large crystals of soda-orthoclase or anorthoclase. Hauynite, a variety of sodalite (*q.v.*), is an ingredient of some of the limburgites of the Cape Verde Islands. Rocks of this group occur in considerable numbers in Germany (Rhine district) and in Bohemia. also in Scotland (Whitelaw hill, Haddington), Auvergne, Spain. Kilimanjaro, Brazil, etc. They are associated principally with basalts, nepheline- and leucite-basalts and monchiquites. From the last-named rocks the limburgites are not easily separated a; the two classes bear a very close resemblance in structure and in mineral composition. The ground mass of the monchiquites is not a glass. however. but crystalline analcite (see LAMPROPHYRE). Limburgites may occur as flows, as sills or dikes. and are sometimes highly vesicular.

LIMBUS, a theological term denoting the border of hell. where dwell those who, while not condemned to torture, are deprived of the joy of heaven. The more common form in English is "limbo," which is used both in the technical theological sense and derivatively in the sense of "prison," or for the condition of being lost, deserted. obsolete.

In medieval theology there are (1) the *Limbus Infantum* and (2) the *Limbus Patrum.*

1. The *Limbus Infantum* or *Puerorum* is the abode to which human beings dying without actual sin, but with their original sin unwashed away by baptism, were held to be consigned; the category included, not unbaptized infants merely, but also idiots, cretins and the like. The word "limbus," in the theological application, occurs first in the *Summa* of Thomas Xquinas; for its extensive currency it is perhaps most indebted to the *Commedia* of Dante (*Inf.* c. 4). The question as to the destiny of infants dying unbaptized presented itself to theologians at a comparatively early period. Generally speaking it may be said that the Greek fathers inclined to a cheerful and the Latin fathers to a gloomy view. Thus Gregory of Nazianzus (*Orat.* 40) says "that such children as die unbaptized without their own fault shall neither he glorified nor punished by the righteous Judge, as having done no wickedness, though they die unbaptized, and

as rather suffering loss than being the authors of it." Similar opinions were expressed by Gregory of Nyassa, Severus of Antioch and others — opinions which it is almost impossible to distinguish from the Pelagian view that children dying unbaptized might be admitted to eternal life, though not to the kingdom of God. In his recoil from Pelagian heresy, Augustine was compelled to sharpen the antithesis between the state of the saved and that of the lost and taught that there are only two alternatives — to be with Christ or with the devil, to be with Him or against Him. Following up, as he thought, his master's teaching, Fulgentius declared that it is to be believed as an indubitable truth that "not only men who have come to the use of reason, but infants dying, whether in their mother's womb or after birth, without baptism in the name of the Father, Son and Holy Ghost, are punished with everlasting punishment in eternal fire." Later theologians and schoolmen followed Augustine in rejecting the notion of any final position intermediate between heaven and hell but otherwise inclined to take the mildest possible view of the destiny of the irresponsible and unbaptized. Thus the proposition of Innocent III that "the punishment of original sin is deprivation of the vision of God" is practically repeated by Aquinas, Scotus and all the other great theologians of the scholastic period, the only outstanding exception being that of Gregory of Rimini, who on this account was afterward called "tortor infantum."

The first authoritative declaration of the Latin Church upon this subject was that made by the second council of Lyons (1274) and confirmed by the council of Florence (1439), with the concurrence of the representatives of the Greek Church, to the effect that "the souls of those who die in mortal sin or in original sin only forthwith descend into hell, but to be punished with unequal punishments." Perrone remarks *(Prael. Theol.* pt. iii, chap. 6, art. 4) that the damnation of infants and also the comparative lightness of the punishment involved in this are thus *de fide;* but nothing is determined as to the place which they occupy in hell, as to what constitutes the disparity of their punishment or as to their condition after the day of judgment. In the council of Trent there was considerable difference of opinion as to what was implied in deprivation of the vision of God, and no definition was attempted, the Dominicans maintaining the severer view that the *Limbus Infantum* was a dark subterranean fireless chamber, while the Franciscans placed it in a region of light above the earth. Some theologians continue to maintain with Bellarmine that the infants "in limbo" are affected with some degree of sadness on account of a felt privation; others, following the *Nodus praedestinationis* of Celestine Sfrondati (1649–96), hold that they enjoy every kind of natural felicity, as regards their souls now and as regards their bodies after the resurrection, just as if Adam had not sinned. In the condemnation (1794) of the synod of Pistoia (1786) the 26th article declares it to be false, rash and injurious to treat as Pelagian the doctrine that those dying in original sin are not punished with fire, as if that meant that there is an intermediate place, free from fault and punishment, between the kingdom of God and everlasting damnation.

2. The *Limbus Patrurn* or *Sinus Abrahae* ("Abraham's Bosom") is defined in mediaeval theology as the place in the underworld where the saints of the Old Testament were confined until liberated by Christ on his "descent into hell." Regarding the locality and its pleasantness or painfulness nothing has been taught as *de fide.* It is sometimes regarded as having been closed and empty since Christ's descent, but other authors do not think of it as separate in place from the *Limbus Infanturn.* The whole idea, in the Latin Church, has been described as the mere *caput mortuum* of the old doctrine of Hades, which was gradually superseded in the west by that of purgatory.

LIME. The tree and fruit of the species *Citrus aurantifolia,* widely grown for its fruits throughout the tropical and subtropical areas of the world. The native home of the tree is believed to be the East Indian archipelago and perhaps the nearby mainland of Asia. The Arabs are believed to have taken limes, as well as lemons, from India to the eastern Mediterranean countries and Africa around 1000 A.D. or possibly earlier. Limes were introduced to the western Mediterranean countries by returning crusaders in the 12th and 13th centuries A.D. Columbus took citrus fruit seed, probably including limes, to the West Indies on his second voyage in 1493 and the trees soon became widely distributed and partially naturalized in the West Indies, Mexico and Florida.

The tree seldom grows more than 8 to 15 ft. high and if not pruned becomes shrublike. Its branches spread and are irregular, with short stiff twigs, small leaves and an abundance of small, sharp thorns. The leaves are pale green; the small white flowers are usually borne in clusters. The fruit is $1\frac{1}{4}$ to $1\frac{3}{4}$ in. in diameter, oval to nearly globular, often with a small apical nipple; the peel is thin, and greenish-yellow when the fruit is ripe. The pulp is tender, juicy, yellowish-green in colour and decidedly acid. As a group, limes somewhat exceed lemons in both acid and sugar content. There are, however, some varieties so lacking in citric acid that they are known as sweet limes. These are grown to some extent in Egypt and other tropical countries.

The two general groups of acid limes are the Mexican and the Tahiti. The Mexican group is characteristic of the species C. *aurantifolia,* described above. Several varieties, including Everglade and Yung, have been named but in general differ but little from each other. Numerous thornless strains of Mexican limes have arisen from seedlings and from bud sports.

The trees of the Tahiti group resemble the lemon and are larger and more vigorous than those of the Mexican group, with leaves larger and darker coloured. The fruit is larger and more elongated than the Mexican lime; the peel is thicker and the fruit nearly seedless.

The flavour of the fruit of the two groups is similar, but the Tahiti lime lacks some of the bouquet which is typical of the Mexican. The Tahiti lime so closely resembles a lemon that the fruit could easily be confused except for the colour of the pulp and the distinctive taste. From the appearance of the Tahiti group there seems to be a possibility that this fruit may be a hybrid between the lemon and the typical Mexican lime. Leading varieties of the Tahiti group are Bearss, Pond and Tahiti, also called Persian.

Mexico is a leading country in lime production, producing around 2,000,000 boxes per year. Egypt produces about 1,000,000 boxes annually, but some estimates are much higher. From 300,000 to 400.000 boxes per year are produced in the United States, mainly in southern Florida. Limes are grown throughout the West Indies and to a limited extent in practically all citrus-growing areas. The trees are a little less cold resistant than most kinds of citrus, so production is largely restricted to relatively frost-free locations.

The lime hybridizes readily with other species of citrus and some closely related genera. Some of these hybrids are grown as novelties and, to a limited extent, commercially. The Perrine lemon, a cross of Mexican lime and Genoa lemon, is grown locally in Florida and warmer parts of Louisiana and Texas. The limequats, crosses of limes and kumquats, are hardier and more disease resistant than limes and are grown in areas slightly too cold for limes or lemons. Hybrids of limes and mandarin oranges are acid fruits grown locally and also used to some extent as rootstocks for the propagation of other kinds of citrus.

Limes are used mainly for flavouring drinks, food and confections, much as are lemons. Limeade and other lime-flavoured drinks have a flavour and bouquet quite distinct from those made from lemons. The juice may be concentrated, frozen or canned in a manner similar to lemon juice.

The yield of fresh juice depends upon the variety and the condition of the fruit and varies from 60 to go gal. per ton of fruit. The small Mexican lime is less readily handled by machinery in the reaming process than are the larger varieties. Limes contain vitamin C (ascorbic acid) and were formerly used in the British navy to prevent scurvy (hence the nickname "Limey"). Lime oil is a by-product of the fruit, the chief centre for its production being the West Indies. Citrate of lime and citric acid are also prepared from it.

Methods of culture, propagation and pest control for limes are comparable to those used in other citrus orchards. *See* LEMON and ORANGE.

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LIME. In the strict chemical sense lime refers only to calcium oxide (or quicklime) ; however, lime which is commercially manufactured from limestone is rarely produced in the pure state and the presence of other substances gives rise to different types of limes having commercial importance. High-calcium limes, chiefly used for various chemical and industrial purposes, are produced from calcareous materials (generally limestone but also chalk and oyster shells) containing 95% to 99% calcium carbonate. Limestones containing various proportions of magnesium carbonate are widely found and are also used to make lime. Magnesium limes are produced from stones containing magnesium carbonate in excess of 5%. One magnesium lime of special importance is dolomitic lime, produced from the mineral dolomite, a type of limestone containing from 30% to 45% magnesium carbonate (see CALCITE; DOLOMITE; LIMESTONE). In the U.S. only limes made from high calcium and dolomitic limestones have commercial significance.

In common usage the term lime includes the various chemical or physical forms of quicklime, hydrated lime and hydraulic lime. When limestone is heated under controlled calcination conditions, the carbonates decompose: producing quicklime. Commercially, quicklime is commonly produced by burning carefully graded limestone in rotary kilns, similar to those used in portland cement manufacture. and in large stationary vertical kilns. The by-product carbon-dioxide gas is generally permitted to escape from the kilns, though sometimes it is collected and used to manufacture precipitated calcium carbonate, dry ice, etc. Quicklime, as it is normally manufactured, is highly reactive; however, when calcined for a prolonged time at elevated kiln temperatures, the porous structure contracts. The material loses its chemical reactivity and the lime is said to be "dead burned." Some dolomitic limestone is commercially processed in this manner; it is known as dead-burned dolomite and is widely used as a lining for basic open-hearth steel furnaces.

When quicklime reacts with water the process is called slaking; the reaction is exothermic, and proceeds at times with almost explosive violence. Dry hydrated lime is produced when quicklime is reacted with just sufficient water to satisfy its chemical affinity for moisture under the conditions of hydration. High calcium quicklimes react readily with water; on the other hand, dolomitic quicklimes, due to the less reactive magnesium oxide component, do not hydrate completely in ordinary processing equipment.

Dolomitic limes hydrated in equipment operated at atmospheric pressures and low retention times are known as dolomitic normal hydrated limes and essentially consist of calcium hydroxide, magnesium oxide with a small quantity of magnesium hydroxide. The magnesium oxide portion of dolomitic lime along with the calcium oxide can be hydrated completely in special equipment using longer retention periods or elevated pressures and temperatures. These "pressure hydrated" or highly hydrated limes are commercially known as dolomitic special hydrated lime.

Hydraulic lime is a type of cementitious lime that will set and harden under water in a manner similar to portland cement. It is obtained by calcining an impure limestone containing large quantities of silica and alumina so that sufficient calcium silicates and aluminates are formed to give the lime its characteristic hydraulic properties. Hydraulic limes are widely used in Europe for mortars in masonry construction; use in the United States, however, is limited.

Limes vary considerably in chemical and physical properties. In part this is due to differences in geology and chemical analyses of the raw limestone. More markedly, however, the degree of overcalcination and other processing variables and conditions affect the rate of slaking, plasticity, density and chemical reactivity of the limes produced. Both quick and hydrated limes are usually white in colour, though some grayish impure limes are known. Calcium and magnesium hydroxides are only slightly soluble in water; nevertheless, the term lime water denotes a weak aqueous solution. Milk-of-lime is a suspension of lime solids in water.

Lime is widely used to neutralize acids; on the basis of neutralizing values, quick and hydrated limes are stronger bases than sodium hydroxide and sodium carbonate.

Uses.--Next to sulfuric acid, lime was the most widely used chemical in industry in the second half of the 20th century, and mas the leading alkali in tonnage consumed. Both quick and hydrated lime products find extensive application in the agricultural, building and chemical industries. Formerly lime was considered primarily a building and agricultural material, and in many undeveloped parts of the world applications for lime are still largely confined to these fields. However, lime is employed basically as a chemical in industry. In the U.S. alone three-fourths of the annual lime tonnage is consumed industrially. Chemical lime is consumed in large quantities by the metallurgical industry in the manufacture of open-hearth and electric-furnace steel, production of magnesium, treatment of aluminum, gold and silver ores, and the smelting and refining of copper, zinc and other metals. Dead-burned dolomite is extensively used as a refractory material to line high-temperature kilns and furnaces. Large quantities of lime are required in the manufacture of paper, calcium carbide and glass, as well as in the purification of water supplies and in the treatment of sewage and industrial wastes. Other chemical applications are in sugar and petroleum refining and in the manufacture of sand-lime brick and concrete products. insecticides, leather goods, bleaching powder, sodium hydroxide, varnish and paints, grease and other products. A market for lime was also developed as a soil-stabilizing agent in the construction of base courses for modern highways and airport runways.

In agriculture, lime—not to be confused with pulverized limestone—is one of several soil liming materials used for promoting crop production by correcting soil acidity and furnishing important plant nutrients.

History.—Lime is one of the oldest products known to man, dating possibly as far back as the cave-man era and the discovery of fire. Primitive kilns which are believed to have been used for preparing lime during the Stone Age have been excavated. It is certain that lime was the first manufactured chemical used by mankind, probably the first agricultural material employed for soil fertility, and certainly one of the oldest mortar and plastering building materials known. Virtually every civilization has utilized lime. Lime plaster, still in good condition, has been found in some pyramids built more than 4,500 years ago in Egypt. The Old and New Testaments of the Bible mention lime several times. Lime was extensively used in mortars and plasters by the Greeks, Romans, Arabians, Moors and other Mediterranean cultures. It was also used by the Incas and Aztecs in South and Central America and by the Chinese in constructing their Great Wall. The first mention of lime as a chemical reagent was by the Roman, Xenophon, who recorded that ships carrying a cargo of linen and lime (for its bleaching) were wrecked in 350 B.C. near Marseilles. And another Roman, Vitruvius, an architect under Augustus, wrote the first detailed lime specification. The Romans also used lime in building the road base of the famous Appian way. The Romans originated cement (hydraulic lime), which they prepared from mixtures of lime putty and volcanic ash. Old relics and records in England indicate that lime was used as a mortar material during the Roman occupation. Lime plastering and stuccoing reached their peak during the Italian Renaissance; and during the same period Michelangelo, Raphael and other famous artists created their mural and fresco masterpieces using lime putties extensively. (See also FRESCO PAINTING.)

In North America lime was probably first used by the Spaniards in Florida in the 16th century. "Tabby" construction consisting of oyster shell lime, sand and crushed shells was employed for building walls. Early Spanish missions in California and the southwest were invariably constructed of lime stucco. As early as 1635 in Rhode Island quicklime was produced from limestone; however, the Pilgrims probably burned lime from shells at an earlier date shortly after settling at Plymouth, Mass. Lime manufacturing first became a significant industry in commerce about 1733, when boats were used to ship lime from Rockland, Me., to Boston Mass.

Technical progress since the beginning of the 20th century markedly advanced lime manufacturing to its modern important industrial position.

See also LIMING; MORTAR IN BUILDING; PLASTERING.

(K. J)

LIME: *see* LINDEN.

LIME CEMENT: *see* CEMENT.

LIMEHOUSE, a parish in the metropolitan borough of Stepney on the north bank of the Thames and in the East End of London. Eng. It is said to take its name from the limekilns which were demolished in 1935. Running through Limehouse from the Lea to the Thames are (north to south) the Regent's canal and (northeast to southwest) the Limehouse Cut (built in 1769). Most of its associations are maritime and among the many buildings for seamen are the British Sailors' society, formerly the home of Nelson's family and dating from about 1650; the Empire Memorial hostel, a residential club opened in 1924; and the Ocean Library stores, the headquarters of more than 5,300 libraries for the merchant navy afloat. St. Anne's parish church (founded 1712. consecrated 1730) was designed by Nicholas Hawksmoor and is a landmark for ships coming up the river. The town hall dates from 1879 and the public library was opened in 1901 and enlarged in 1931.

LIMERICK, THOMAS DONGAN, SECOND EARL OF (1634–1715), governor of New York, was born in Castletown, Ire He began his career in the army, serving first in England and later under Louis XIV in France in an Irish regiment. He abandoned the army. however. to accept the position of lieutenant governor of Tangiers, an office he resigned in 1680. Two years later the duke of York named him governor of New York, which included, at that time, a portion of New England.

Dongan was responsible for a number of important developments in the history not only of New York but of the entire group of American colonies. The so-called "Charter of Liberties," drawn up by the New York assembly, nhich he convened shortly after he arrived in the colony, served as the basis of New York's later constitution and of the constitution of the entire Cnited States in many of its provisions. It was, however. never put into effect in New York, since the duke of York, although he signed it. failed to return the charter to the colony, probably because of its extreme liberalism. Dongan helped to fix the boundaries of New York by treaty with the Indians and by agreement with the surrounding colonies and Canada. His charters for the cities of New York and Albany both remained in effect for many years after they were drawn up, New York's for more than 100 years and Albany's for nearly 200. He was responsible for convincing the king of England that French power in America should not be allowed to increase if the English were to maintain their supremacy, especially with regard to the Indians of the Five Nations, and his Indian policy set the example for English colonial governors thereafter.

In 1638 Dongan was relieved of his governorship hut remained in New York until 1689. when he was forced to take refuge in New England because of the persecution of Roman Catholics which followed the fall from power of James II. He returned to England in 1691 and seven years later succeeded his brother as earl of Limerick. His family's lands had been seized even before he received the title, and he never recovered them. He died in London. a poor man. on Dec. 14, 171j.

LIMERICK, a western county of Ireland. province of Munster. bounded north by the Shannon estuary and the counties of Clare and Tipperary, east by Tipperary. south by Cork and west by Rerry. The land area is 1,036.9 sq.mi. Population (1961) 133,025.

Limerick is mainly a Carboniferous Limestone county! with fairly level land, broken by ridges of Old Red Sandstone. On the northeast, the latter rock rises on Slieve Felim, around a Silurian core, to 1,411 ft. In the south. Old Red Sandstone rises above an enclosed area of Silurian shales at Ballylanders, the opposite scarp of Old Red Sandstone forming the Ballyhoura hills on the Cork border. The Galtee mountains, which extend into Tipperary, attain in Galtymore a height of 3,018 ft. Volcanic ashes, andesites, basalts and intrusive sheets of basic rocks are well seen under Carrigogunnell castle and in a ring of hills around Ballybrood. The coals in the west are not of commercial value. Lead ore has been worked in places in the limestone.

The Shannon is navigable for large vessels to Limerick, above which are the rapids of Doonas and Castleroy and a canal. Castleconnell is a fishing centre. The Maigue, which rises in the Galtees and Aows into the Shannon, is navigable as far as Adare

Limerick was included in the kingdom of Thomond. Afterward it had a separate existence under the name of Aine-Cliach. From the 8th to the 11th century it was partly occupied by the Danes. (*See* LIMERICK. City.) Limerick is one of the 12 counties generally considered to owe their formation to Ring John who, at his accession installed Willam de Burgh as governor. About 100,000 ac. of the estates of the earl of Desmond, which were forfeited in 1j86. were situated in the county. and other extensive confiscations took place after the Cromtvellian wars. In 1709 a German colony from the Palatinate was settled by Lord Southwell near Bruff. Rathkeale and Adare.

There are remains of round towers at Ardpatrick and at Dysert, and of stone circles. pillar stones and altars at Loch Gur where important excavations have been made. Besides the monasteries in the city of Limerick, the most important monastic ruins are those of Adare abbey. Askeaton abbey, Galbally friary, Kilflin monastery. Kilmallock and Monaster-Kenagh abbey.

Limerick includes the greater part of the Golden vale, the most fertile district of Ireland. which stretches from Cashel in Tipperary nearly to the town of Limerick. Along the banks of the Shannon there are fertile tracts of meadowland formed of deposits of calcareous and peaty matter. The soil in the mountainous districts is mostly thin and poor and incapable of improvement The large farms nere chiefly devoted to grazing. until Limerick became one of the most active centres of the agricultural co-operative movement, organized by Sir Horace Plunkett. which produced a great advance in agricultural methods and organization. especially in co-operative creameries. The principal crops are oats, potatoes and wheat. The county benefited widely from the Shannon hydroelectric scheme, nith its main power station close to Limerick city, and also from the rapid development of the Shannon airport. close to the borders of Clare and Limerick, as an international centre of air traffic. Limerick junction, which lies on the main railway from Dublin to Cork and Rerry, is also close to the borders of the county. Its large racecourse is one of the principal attractions of the popular hunting country around Limerick. Important salmon fishing on the Shannon also has its headquarters at Limerick.

The western and eastern divisions of Limerick, which include the county borough, together return seven members to *dail* eirennn

LIMERICK, a county borough, port and the chief town of County Limerick, Ire.. occupying both banks and an island (King's Island) of the River Shannon, at the head of its estuary, 129 mi. W S.W. of Dublin by rail. Pop (1961) 50.497.

Lrmerick is said to have been the *Regia* of Ptolemy and the *Rosse-de-Nailleagh* of the Annals of Multifernan. There is a tradition that it was visited by St. Patrick in the jth century, but it is first authentically known as a settlement of the Danes, who sacked it in 812 and afterward made it the principal town of their krngdom of Limerick but were expelled from it toward the close of the 10th century by Brian Boroimhe. From 1106 till its conquest by the English in 1174 it was the seat of the kings of Thomond or North Munster. and, although in 1177 the kingdom of Limerick was given by Henry II to Philip de Braose. the city was frequently in the possession of the Irish chieftains till 1195 Richard I granted it a charter in 1197.

By King John it was committed to the care of William de Burgh, who founded English Town, and for its defense erected a strong castle. The city was frequently besieged in the 13th and 14th centuries. In the 15th century its fortifications were extended to include Irish Town, and until their demolition in 1760 it was one of the strongest fortresses of the kingdom. In 1651 it was taken by Gen. Henry Ireton, and after an unsuccessful siege by William III its resistance was terminated in 1691 by the treaty of Limerick. The dismantling of its fortifications began in 1760, but fragments of the old walls remain. In 1609 it received a charter constituting it a county of a city and also incorporating a society of merchants of the staple, with the same privileges as the merchants of the staple of Dublin and Waterford.

The prosperity of the city dates chiefly from the foundation of Newtown Pery in 1769 by Edmund Sexton Pery (d. 1806), speaker of the Irish house of commons. Under the Local Government act of 1898 Limerick became one of the six county boroughs having a separate county council. The city is divided into English Town (on King's Island), Irish Town and Newtown Pery, the first including the ancient nucleus of the city, and the last the principal modern streets. The main stream of the Shannon is crossed by Thomond bridge and Sarsfield or Wellesley bridge. The first is commanded by King John's castle, on King's Island, a Norman fortress fronting the river. At the west end of the bridge is preserved the Treaty stone, on which the treaty of Limerick was signed in 1691. The cathedral of St. Mary, also on King's Island, was originally built in 1142–80 and exhibits some Early English work. The modern Roman Catholic cathedral of St. John is in early pointed style. The churches of St. Munchin (to whom is attributed the foundation of the see in the 6th century) and St. John, Whitamore's castle and a Dominican priory, are of interest.

Communication with the Atlantic ocean is open. while inland navigation is facilitated by a canal which avoids the rapids above the city. Quays extend on each side of the river, and vessels of 600 tons can moor alongside at spring tides. There is a graving dock and a wet dock. The principal imports are grain, timber, oil and coal. The exports consist mainly of fish and agricultural produce. The principal industrial establishments include flour mills (Limerick supplying most of the west of Ireland with flour), factories for bacon curing and for condensed milk and creameries. Some brewing, distilling and tanning are carried on, and the manufacture of lace is maintained at the Convent of the Good Shepherd. The salmon fisheries of the Shannon, for which Limerick is the headquarters of a district, are the most valuable in Ireland. The city benefited greatly from the establishment of the Shannon hydroelectric power station close by (see SHANNON) and from the proximity of Shannon airport. about 20 mi. to the west.

LIMERICKS. The origin of this very popular type of nonsense verse is lost in obscurity, and recent research work has done little to pierce the gloom. Nor is it known for what reason the name "limerick" is attached to it. The theory that the title derives from the chorus "Will you come up to Limerick?" sung after impromptu verses composed at convivial parties, helps us not at all. since there is no record of this kind of verse being used at such parties. Rather is the limerick a kind of ribald epigram, passed on by word of mouth, and more often whispered than sung.

Langford Reed, the only collector of limericks who has toiled valiantly with their history, suggests that "this peculiar form of verse was brought direct to Limerick by the returned veterans of the Irish Brigade, who were attached to the French army for a period of nearly 100 years from 1691." The brigade was organized in Limerick, and when disbanded was no doubt responsible for giving currency to many rude barrack-room songs; but the evidence of a French origin for the five-lined metrical scheme of the limerick rests upon very feeble foundations. Langford Reed quotes from Boswell's Life of Johnson:

On s'étonne ici que Caliste
Ait pris l'habit de Moliniste;
Puisque cette jeune beaut6
Ote à chacun sa liberté
N'est-ce pas une Janseniste?

—an epigram in The Menagiana (1716) on a young lady who appeared at a masquerade dressed as a Jesuit during the fierce contentions of the followers of Molinos and Jansenius. But Reed also quotes:

Digerie, Digerie, Doge,
La souris ascend l'horloge;
L'horloge frappe
La souris s'échappe,
Digerie, Digerie, Doge,

and appears to consider this a true limerick form, thus permitting the verse form almost as wide a licence in metre as it has latterly attained in morals.

It may be sufficient to suppose that the limerick satisfies some natural instinct of the ear in rhymed verse, the prefatory couplet demanding a third line as complement, and staving this off, for the sake of surer effect, by the interposed short lines. But this would not account for the famous limericks of Edward Lear, in his Book of Nonsense (1846), where the last line is merely a choric repetition, employing one of the previous rhymes, and adding little or nothing to the sense. In spite of this defect, Lear certainly gave to what is now known as the limerick its modem popularity—some even assert that "learick" is the proper form of the word—and established at once its insistence on topography and its attention to varieties of personal behaviour.

There was a young girl of Majorca
Whose aunt was a very fast walker;
She walked sixty miles
And leaped fifteen stiles,
Which astonished that girl of Majorca.

Or again,

There was an old person of Anerly
Whose conduct was strange and unmannerly:
He rushed down the Strand
With a pig in each hand,
But returned in the evening to Anerly.

Lear, however, did previsage the now usually accepted formula:

There was an old man at the Cape
Who made himself garments of crape;
When asked "Will they tear?"
He replied "Here and there,
But they keep such a beautiful shape!"

Limericks have been composed upon every conceivable topic, not excluding philosophy and religion—

There was a young man who said "Damn!
It is borne upon me that I am
An engine which moves
In predestinate grooves,
I'm not even a bus: I'm a tram!"

but their usual themes became similar to those of the epigrams of Martial, and would doubtless so have remained, milder variants being substituted when blushes were to be spared, had it not been for their sudden vogue at the beginning of the present century as a subject for prize competitions in the newspapers, which gave large sums of money to readers for supplying the cleverest last line. The judges in these competitions must have had poor ears for scarcely any of the winning lines contained the correct number of feet. A good limerick should have the consecutive fluency of conversational prose, the metre remaining faultlessly dactylic throughout. No better example can be given than

There was an old man of Khartoum
Who kept two tame sheep in his room:
"For," he said, "they remind me
Of one left behind me,
But I cannot remember of whom!"

Fantastic rhyme schemes to the limerick are innumerable. As for instance,

The lifeboat that's kept at Torquay
Is intended to float in the suay:
The crew and the coxswain
Are sturdy as oxswain,
And as smart and as brave as can buay.

Limericks have been translated into all languages, and the globe has been ransacked for rhymable towns. The best verses contain the largest amount of improbable incident or of subtle innuendo that can be crowded into the available space, and they may be regarded as the fixed English form for light or indelicate epigrammatic satire, as opposed to the ordinary rhyming quatrains which are used on more dignified occasions. (E. V. K.)

LIMES GERMANICUS. The Latin limes denoted a path, a boundary path, or boundary; hence it was utilized to denote frontiers marked in some distinct fashion. In the sense of frontiers, the term has been extended by modern historians. Thus the Wall of Hadrian in North England (see BRITAIN: Roman) is now sometimes styled the Limes Britannicus, and so forth. In particular the frontier lines which bounded the Roman provinces of upper (southern) Germany and Rhaetia, stretching from near Bonn on the Rhine to near Regensburg on the Danube, are called the Limes Germanicus. The history of these lines is the subject of the following paragraphs. They have become much better known through systematic excavations and other researches, and though many details are still doubtful, their general development can be traced.

From the death of Augustus (A.D. 14) until after A.D. 70, Rome accepted as its German frontier the water boundary of the Rhine and upper Danube. Beyond these rivers Rome held only the fertile plain of Frankfiirt, opposite the Roman border fortress of Moguntiacum (Mainz), the southernmost slopes of the Black Forest and a few scattered têtes-du-pont. The northern section of this frontier, where the Rhine is deep and broad, remained the Roman boundary until the empire fell. The southern part was different. The upper Rhine and upper Danube are easily crossed. The frontier which they form is inconveniently long, enclosing an acute-angled wedge of foreign territory — the modem Baden and Wdrttemberg. Geographical convenience and movements of Roman subjects across the Rhine combined to urge a forward policy at Rome. and Vespasian began a series of advances which gradually closed up the acute angle, or at least rendered it obtuse.

The first advance came about A.D. 74, when what is now Baden was invaded and roads carried from the Roman bases on the upper Rhine, Strassburg (Argentoratum) and Windisch (Vindonissa) to Rottweil (Arae Fluviae). This road was subsequently extended to Cannstadt, meeting a road from Mainz, and was then probably extended to reach the Danube at Faimingen below Ulm. The point of the angle was broken off. The second advance was made by Domitian about A.D. 83. He pushed out from Moguntiacum, extended the Roman territory east of it, and enclosed the whole within a systematically defended frontier with numerous blockhouses along it and larger forts in the rear.

Among the blockhouses was one which by various enlargements grew into Saalburg fort, near Homburg. This advance necessitated a third movement, the construction of a frontier, connecting the annexations of A.D. 74 and 83. The line of this frontier ran from the Main to the upper waters of the Neckar, and was defended by a chain of forts. The whole was reorganized, probably by Hadrian, with a continuous wooden palisade reaching from the Rhine to the Danube. Either Hadrian or Pius marked out a new frontier roughly parallel to, but in advance of, these two lines.

This is the frontier which is now visible and visited by the curious. It consists of two distinct frontier works; one, known as the Pfahlgraben (or "Pale"), is an earthen mound and ditch, best seen in the neighbourhood of the Saalburg, but which once extended from the Rhine southward into southern Germany. The other, which begins where the earthwork stops, is a stone wall, though not very formidable, the Teufelsmauer ("Devil's Wall"); it runs roughly east and west parallel to the Danube, which it finally joins at Hienheim near Regensburg. The Pfahlgraben is extraordinarily direct in its southern part, which for more than 50 mi. runs mathematically straight and points almost absolutely true to the Polar star. It is an ancient frontier laid out in American fashion. This frontier remained for about 100 years, and no doubt in that long period much was done to it. The exact date even of the Pfahlgraben and Teufelsmauer is uncertain. But the pressure of the barbarians began to be felt seriously in the latter part of the 2nd century A.D., and the whole or almost the whole district east of the Rhine and north of the Danube was lost about A.D. 250.

BIBLIOGRAPHY.—The best English account is in H. F. Pelham's, essay in *Trans. of the Royal Hist. Soc.*, vol. XX, reprinted in his *Essays on Roman History*, p. 179–211 (1911), where the German authorities are fully cited. *Cf.* J. E. Sandys, *Companion to Latin Studies* (1921).

LIMESTONE, a rock containing at least 50% calcium carbonate, $CaCO_3$, but generally not including such rocks that have been recrystallized and chemically altered by metamorphism (see MARBLE). Limestones are typically soluble in cold dilute acids and have a specific gravity of 2.6 to 2.8. They are soft, for calcite, the most abundant mineral constituent, has a hardness of only 3, and are white to cream-coloured unless stained yellow or brown by iron oxides or rendered bluish to black by included organic matter and iron disulfide. Limestones are typically well cemented and without large amounts of intergranular porosity, although chalk and calcareous sinter are incoherent and earthy.

Limestone is appreciably soluble in water enriched in organic acids and carbonic acid. such as ground water which has passed through soil. Terrain which is underlain by limestone in humid regions develops underground drainage and the characteristic karst topography, and abounds in caves and sinkholes (see CAVE). Limestones are noteworthy in that extensive solution and reprecipitation may take place in them after formation, sufficient in some cases to obscure fossils and other evidence of their manner of formation.

Formation and Composition. — The carbonate portion of limestones consists of mixtures in yarious proportions of land-derived detrital particles, or debris, of older limestone, fecal pellets of invertebrates. fossils and fragments of partly consolidated limestone torn loose by waves in the depositional environment. These materials are cemented by microcrystalline carbonate ooze and coarser-grained pore-filling calcite cement. With increasing numbers of dolomite (*q.v.*) crystals replacing the calcium carbonate of the rock, limestones grade into dolomitic (*i.e.,* rich in magnesium carbonate) limestones and dolomites. The noncarbonate minerals include detrital quartz and feldspar and resistant minerals such as zircon, garnet, and tourmaline. Calcium phosphate and silica are contributed by the shells of some organisms. Well-formed crystals of albite and monoclinic potash feldspar, quartz, pyrite, and other minerals which grew in the rock during or after its formation are said to be authigenic. The nodules and bands of chert (flint) which replace limestones can be shown in some cases to have resulted from concentration of silica originally present in organic spicules and tests.

Most limestones are partly or entirely of organic origin. The soft, whitish limestones known as coquinas are composed almost entirely of shells and shell fragments, and were formed in warm shallow water like that around the Bahamas today, where organisms grew abundantly and the waves were able to wash away finer-grained material. Some chalks are largely composed of foraminifera such as Globigerina. Another foraminifera1 limestone, that made by the disc-shaped Nummulites, is famous as the rock from which the pyramids of Egypt were built. Crinoidal limestones are frequently found in older rocks such as the Carboniferous.

Reef limestones were formed by organisms that were able to erect rigid wave-resistant structures in relatively shallow water near upwelling currents rich in nutrients. Corals and calcareous algae are the principal frame builders today in places such as the Pacific atolls and the Great Barrier reef of Australia, but other organisms played this role in the past. Reef limestones are very pure carbonate rocks, and are often dolomitized.

The oolites in oolitic limestones are composed of $CaCO_3$ chemically deposited about nuclei of various kinds. The purer oolitic limestones contain very little fine-grained material and were formed in agitated water like that overlying the underwater oolite dunes near the edge of the Bahaman platform.

The origin of fine-grained limestones is frequently in doubt because of recrystallization of original features. Some probably were formed from the minute remains of primitive unicellular organisms (coccolithophores and rhabdoliths) others from tiny aragonite (*q.v.*) needles like those resulting from chemical precipitation and from the disarticulation of algal remains in the drewite muds of the Bahamas. Fine grained limestones containing appreciable amounts of clay minerals, pyrite and organic matter were formed below the level of wave action where tiny detrital particles could settle out, in a stagnant, oxygen-poor environment suitable for the preservation of organic matter and the formation of pyrite.

Limestones and dolomites associated with beds of anhydrite and salt, as in the rocks of Permian Age west of the great Capitan reef in west Texas and New Mexico, contain very few fossils and are believed to be chemical precipitates from saline waters concentrated by evaporation. The solubility of these carbonates is such that they should precipitate before anhydrite and salt. This sequence of precipitation is observed today in a long narrow inlet on the arid Peruvian coast.

Limestones formed from accumulations of carbonate rock particles carried by streams are found in the Arbuckle mountains of Oklahoma and in the region north of the Alps. Such rocks are uncommon and formed only in regions of high relief and abundant limestone outcrops, for limestone particles are quickly reduced in streams by abrasion and solution. Relatively common along tropical coasts, however, are limestones formed by the cementation of calcareous beach deposits and dunes.

Lakes in regions such as the north central part of the United States, where ground waters contain large amounts of calcium carbonate dissolved from glacial drift, contain fine-grained carbonate-rich deposits precipitated in large part by the activity of fresh-water algae. The deposits in Lake Zurich are made up of seasonal layers or varves which are alternately rich in carbonates and in organic matter. The dolomitic lake deposits of Eocene Age in Wyoming and Utah are also varved but the varied and unusual suite of authigenic minerals here indicates that the lake waters became highly concentrated.

Occurrences of limestone are discussed in articles on the various geologic systems and epochs, as CRETACEOUS SYSTEM; EOCENE AND PALEOCENE, etc., and on states and countries, as INDIANA; JAPAN. See also GEOLOGY; OCEAN AND OCEANOGRAPHY: Marine Sediments; SEDIMENTARY ROCKS.

Uses.—Limestone has a large variety of economic uses. High purity calcium carbonate rock is used in the production of sodium carbonate from sodium chloride (salt) by the Solvay process, the manufacture of aluminum oxide (alumina) by the Bayer process, production of synthetic phenol, calcium nitrate, dyestuffs and intermediates, and the refining of beet sugar by the carbonation process.

It is a food supplement for livestock and poultry and is used in whiting (see also CHALK) and as a reactant in the refining of salt brines and the manufacture of glass. The calcination of limestone at temperatures high enough to dissociate calcium carbonate yields both carbon dioxide and lime for commercial use. The latter is used in the construction industries and in manufacturing chemicals including calcium carbide, which is produced by fusing lime with coke in the electric-arc furnace.

Limestones containing impurities of the proper kind and amount are desired for some purposes, although other materials can be mixed with high purity limestone to achieve the same result. The manufacture of portland cement requires one part of shale or clay to three or four parts of limestone. Natural cement is made from rock containing 10% to 22% silica and 4% to 16% aluminum oxide and iron oxide. Rock wool manufacture requires 45% to 65% calcium carbonate (or magnesium carbonate), with the remainder of the rock principally silica.

Limestones may be phosphatic because of original concentrations of phosphatic shells or pellets. On some Pacific islands they become phosphatized from the replacement of carbonate by phosphates removed by ground water from guano. Such rock-phosphate is used for artificial fertilizers. Limestones, because of their susceptibility to attack by acid hydrothermal solutions, are also hosts for deposits of many valuable metals. Like other sedimentary rocks, they may contain accumulations of petroleum and natural gas.

Rocks high in dolomite are used for the manufacture of Epsom salts, of basic magnesium carbonate, which is mixed with asbestos for an insulating material, and of high-magnesium lime which is used in the building industry and in the production of certain chemicals such as magnesia. Dead-burned dolomite is used for patching and repair of basic open-hearth furnaces and for electric furnace bottoms.

There are many applications for which either limestone or dolomite may be used. These include monuments, exterior and interior facings and floors in buildings, flagstone for walks, and chips for roofing, stucco, etc. Crushed rock is used for railroad ballast, riprap fill around the base of dams, piers, etc., filter beds in sewage treatment and surfacing for airports, playground, tennis courts, etc. It is employed extensively in road construction, either alone or mixed with cement or bitumen, and as aggregate in making concrete for buildings and other structures. Agstone (crushed limestone for agricultural and other uses) is employed to regulate soil acidity, to improve soil structure, and to furnish nutrients. Used as fluxes in blast furnaces producing pig iron, during the manufacture of steel in basic open-hearths, and in nonferrous metal smelters, limestone and dolomite combine with impurities to form a slag which can be removed. More finely ground material is added as a filler and conditioner in fertilizers and is employed in the manufacture of paper by various processes.

The specifications for carbonate rock vary greatly with the particular application. Colour is particularly important for many uses of whiting substitutes. Poultry grit should contain less than 0.1% fluorine. A low iron oxide content is particularly important in glassmaking, and building stone used on exterior surfaces should not contain pyrite or marcasite which would yield iron oxide stains on weathering. The total carbonate content is of cardinal importance for agstone. Resistance to repeated freezing and thawing is important for flagstone, for concrete aggregate, and for crushed rock in riprap and railroad ballast. Resistance to abrasion is a required quality of limestone for floors and for road surfaces. Limestones are preferred to dolomite for use in the neutralization of acidic sewage and industrial wastes because of higher reaction rate.

See also QUARRYING; STONE. (D. L. G.)

LIMICOLAE, shore or wading birds, now known as suborder Charadrii, including jaçanas, snipes, oyster catchers, lapwings, plovers, woodcock, sandpipers, stilts, avocets, phalaropes, pratincoles and sheathbills (qq v.).

LIMINA APOSTOLORUM (literally, "The Thresholds of the Apostles"), an ecclesiastical term used to denote Rome and especially the church of St. Peter and St. Paul. A Visitatio *Liminum* might be undertaken ex voto (in accordance with a vow) or ex lege (in accordance with a law). In 743 a Roman synod decreed that all bishops subject to the metropolitan see of Rome should meet personally every year in that city to give an account of the state of their dioceses. Gregory VII and Sixtus V greatly enlarged the number of bishops subject to this law and Benedict XIV in 1740 extended the summons to all abbots, provosts and others who held territorial jurisdiction. Under the regulation of Pius X established in 1909, the Visitatio ad Limina Apostolorum must be made, either personally or by representative, by all ordinaries and vicars apostalic who have jurisdiction; the periods are five years for those whose dioceses are in Europe and ten for those outside Europe. During the middle ages ex voto pilgrimages ad Limina Apostolorum were popular among laymen.

LIMING is the applying of lime (calcium) materials to cropland soils to improve productivity. The principal effects are: (1) to supply needed calcium and (2) to reduce soil acidity. This practice was known long before the Christian era and has been used since the beginnings of agricultural history (see LIME: History). It was not, however, until the early years of the 20th century that the underlying chemical principles began to emerge. By mid-20th century, the liming of noncalcareous soils in the humid regions of the world had become a most important land-use practice.

Chemically, liming materials are chiefly carbonates of calcium. They are found abundantly in nature as limestone, dolomite, chalk, marl (*qq.v*) and shell, as well as in other forms. The soft forms, as chalk, can be prepared readily for applying and mixing with soils. The stone forms are of little use until reduced to suitable particle sizes. At one time this was done by burning and slaking. The development of rock crushing, screening and applying equipment in the first half of the 20th century quickly expanded the use of liming materials. With these developments, the amount applied to U.S. soils, to take one example, reached 25,000,000 tons annually.

Both crops and soils are involved in the need for and usefulness of liming materials. Crops require soil-derived calcium in various amounts and vary in their ability to obtain the supplies they need from different soils. For instance, buckwheat, a high-calcium requiring crop, can obtain its supplies from soils of low-supplying powers, while sweet clover, with a moderate requirement, does best on soils of high-supplying powers. Some reasons for such behaviour are: differences in feeding capacities; in ratio balances between basic and acidic soil components; and symbiotic effects which bring atmospheric nitrogen into the plant without accompanying basic components. Soils vary in their supply of calcium and in ability to release it, largely according to the variable amounts of clay-mineral complexes developed in the soil by soil-forming processes. These clays are characterized by various capacities for holding and exchanging basic chemical substances in which calcium and hydrogen are dominant. In productive soils a large proportion of calcium is released to crops and drainage waters.

Liming materials, if present, provide replacements; if not present, hydrogen is substituted and acidity begins to develop. As the acidity intensifies soils become less favourable for crop production: nutrient availabilities decline, soil micro-organisms are handicapped in their activities, substances toxic to plants may develop and physical conditions appear that lead to tillage, drainage and erosion difficulties. Well-planned liming practices will do much to correct these difficulties and to prevent their recurrence.

Liming practices are based chiefly on the principle of correcting acidity by supplying sufficient calcium to satisfy the base exchange requirements of soils for high productivity. Soil tests for acidity (pH) provide guiding information Where low-cost limestones are abundant. a product with particle sizes ranging downward from an eighth of an inch to dust may be applied in larger amounts for immediate and long-time efficiency. Subsequent applications may not be needed for periods ranging upward from 4 years to as much as 12 or more years. Used in this manner. liming practices will do much to keep soils physically fit. chemically balanced and biologically active for continuing high productivity. ***See*** also FERTILIZERS *AND* MANURES; SOIL; SOIL TESTING AND ANALYSIS (F. C. BR.)

LIMIT, a concept fundamental in mathematical analysis, occurs in so many contexts that its general definition can only be given in the setting of general topology. Here will be given a sketch of its origin and principal occurrences. Among the ancients the "method of exhaustion" (so-named in modern times) was the precursor of the theory of limits; it was employed by Euclid and Archimedes in proofs of theorems concerning figures with curved boundaries. A circle, for example, may be approximated by a sequence of inscribed regular polygons (fig. 1), beginning with the square ABCD and the octagon AEBFCGDH and so on, each figure having twice as many vertices as the preceding. If each polygon is regarded as having removed its area from that of the circle, it seems clear that the latter is progressively exhausted, in the sense that the remaining area becomes smaller than any previously assigned amount, however small. If p_1 is the perimeter of ABCD, then $\left(\frac{p_1}{2}\right)a_1$ is the area of ABCD;

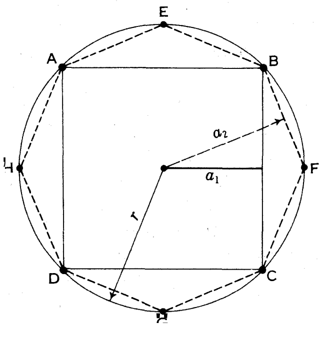

FIG. 1.— METHOD OF EXHAUSTION: POLYGONS APPROXIMATING THE CIRCLE

if p_2 is the perimeter of the octagon, then $\left(\frac{p_2}{2}\right)a_2$ is its area; and in general, $\left(\frac{p_n}{2}\right)a_n$ is the area of the nth approximating polygon. In modern language one would say that a_n becomes arbitrarily close to r, the radius of the circle, and p_n becomes arbitrarily close to $2\pi r$, the perimeter of the circle, as n increases. Thus $\left(\frac{p_n}{2}\right)a_n$ approaches $\left(\frac{2\pi r}{2}\right)r$ or πr^2, which must therefore be the area of the limiting configuration, the circle.

This sort of argument was characteristic of the 18th century; actually, the ancients argued more closely: To prove the area of the circle could not be ***less than*** πr^2 they would imagine by way of contradiction that it was, say, πs^2, with s less than r. Then an approximating polygon could be shown to exist whose area exceeded this amount. The part being less than the whole (for the polygon lay within the circle), this was impossible. That the area could not be ***greater than*** πr^2 could then be proved using circumscribed polygons, which exhausted the exterior of the circle. In the argument sketched here, there is not the slightest appeal made to notions of the infinite. The construction of polygons need not be pushed "to the limit"; some one finite polygon can be shown to produce the desired contradiction ***(see*** SCIENCE: *Alexandrian* **Science: First Period,** *300–30* B.C.).

Something, if not most, of the finite flavour of such rigorous argument was lost when, in the 17th century, the notion of limit appeared in the work of Newton, Leibniz and their successors in the development of the calculus. It seemed convenient, for example, sometimes to regard a curve (such as a circle) as a polygon of an infinite number of sides, each of infinitesimal length. Arguments based on such apparently nonsensical notions yielded results of such richness and scope that the ideas of the "infinitesimal calculus" survived the most devastating (and just) philosophical attacks. Yet errors and paradoxes occurred which were the work of a later era to resolve.

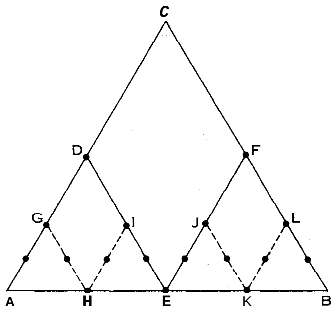

FIG. 2.— LIMIT PARADOX: THE POLYGONS APPROXIMATING STRAIGHT LINE AB ARE ALL TOO LONG

For example (fig. 2) the broken line ACB has twice the length of AB. So does ADEFB. So does AGHIEJKLB. If this process is continued, the area between the broken lines and AB diminishes to zero, and AB is clearly the limiting configuration. It might be argued that AB should therefore have twice its own length, because all the approximations do. This paradox is the result of the mistaken idea that the limiting configuration must have properties which are the limiting cases of the corresponding properties of the approximating configurations. By such reasoning, however, one would have also to claim that AB had an infinite number of corners, each a 60° angle.

Beginning with the work of Augustin Cauchy on the convergence of infinite series the 19th century carried to completion the work of arithmetizing analysis. The notion of limit, previously quasi-geometrical, was put into numerical language and divested of all trace of the language of "ultimate behaviour."

Arithmetical Theory of Limits.—If $a_1, a_2, a_3, \ldots, a_n, \ldots$ is a number sequence, we say it has the limit L if the following statement is true: For every positive number ϵ, however small, there corresponds an index p such that if $n > p$ (n greater than p), then $a_n - L$ is less than ϵ in absolute value. Thus, for example, if $a_n = \frac{n}{n+1}$, *i.e.*, if the sequence is $\frac{1}{2}, \frac{2}{3}, \frac{3}{4}, \ldots$, the limit L is clearly 1 because $a_n - L = \left(\frac{n}{n+1}\right) - 1 = \left(\frac{-1}{n+1}\right)$, whose absolute value is surely as small as any ϵ that might be named, once n is chosen answeringly large. In symbols, one writes

$$\lim_{n \to \infty} \left(\frac{n}{n+1}\right) = 1.$$

Other sequences do not have so obvious a limit; a famous example is where $a_n = \left(1 + \frac{1}{n}\right)^n$. Here the limit is conventionally named e, and is approximately 2.71828. The proof, in this case as in many others, that a limit does exist makes use of the criterion of Cauchy: A sequence a_n has a limit if and only if to each positive ϵ there corresponds an index p such that $a_m - a_n$ is less than ϵ in absolute value whenever m and n both exceed p. Georg Cantor (about 1880) made this criterion a part of the definition of real number. If f is a real function, that is. if for each real number x there corresponds a real value $f(x)$, we say

$$\lim_{x \to a} f(x) = L$$

if the following statement holds: for every positive number ϵ, there is an interval I surrounding a (say all real numbers between $a - \alpha$ and $a + \alpha$) such that if x is in I, but x is not a itself. then $f(x) - L$ has absolute value less than ϵ. This definition gives precision to the intuitive notion "$f(x)$ is near L when x is near a" and makes possible the rigorous proof of the theorems connecting the limit-taking operation with the more usual arithmetic procedures. These theorems are at the root of the utility of the calculus.

Generalizations.—The statements "$f(x)$ is near L when x is near a," and "a_n is near L when n is far out," whose precise definitions are given above, continue to have meaning even when the quantities involved are not real numbers or integers but instead are members of more general structures in which appropriate notions of nearness and far-outness have been defined. Nearness takes on meaning in all topological spaces, of which the real numbers, the complex numbers, and most geometric configurations are examples; and far-outness takes on a useful meaning in many ordered sets; of which the integers form an example.

See CALCULUS, DIFFERENTIAL AND INTEGRAL; INFINITE PRODUCTS; INFINITESIMAL; NUMBER; SERIES; TOPOLOGY. GENERAL. *See* also Index references under "Limit" in the Index volume.

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LIMITATION, STATUTES OF, the name given to Acts of parliament by which rights of action are limited in England, Wales and the north of Ireland to a fixed period after the occurrence of the events which give rise to the cause of action. This is one of the devices by which lapse of time is employed to settle disputed claims. The principle was first adopted in English law in connection with actions for the recovery of real property. At first a fixed date was taken, and no action could be brought of which the cause had arisen before that date. By the Statute of Westminster the First (3 Edward I. c 39), the beginning of the reign of Richard I. was fixed as the date of limitation for such actions. Possession of rights in *alieno solo* from time immemorial was held to be an indefeasible title, and the courts held time immemorial to begin with the first year of Richard I.

A large number of statutes since that time have established periods of limitation for different kinds of actions, Of those now in force the most important are the Limitation Act 1623 for personal actions in general, and the Real Property Limitation Act 1833 relating to actions for the recovery of land. The latter statute has been much amended by the Real Property Limitations Act 1874.

By s 14 of the Act of 1833, when any acknowledgment of the title of the person entitled has been given to him, the statute begins to run from that fact. By s. 15, persons under the disability of infancy, lunacy or coverture, or beyond seas, and their representatives, are to be allowed ten years from the termination of this disability, or death (which shall have first happened), notwithstanding that the ordinary period of limitation shall have expired.

By the Act of 1623 actions of trespass, detinue, trover, replevin or account, actions on the case (except for slander), actions of debt arising out of a simple contract and actions for arrears of rent not due upon specialty shall be limited to six years from the date of the cause of action. Actions for assault, menace, battery, wounds and imprisonment are limited to four years, and actions for slander to two years. Persons labouring under the disabilities of infancy, lunacy or unsoundness of mind are allowed the same time after the removal of the disability. When the defendant was "beyond seas" (*i.e.*, outside the United Kingdom and the adjacent islands) an extension of time was allowed, but by the Real Property Limitation Act of 1874 such an allowance is excluded as to real property, and as to other matters by the Mercantile Law Amendment Act 1856.

An acknowledgment, whether by payment on account or by mere spoken words, was formerly sufficient to take the case out of the statute. The Act 9 Geo. IV. c. 14 (Lord Tenterden's Act) requires any promise or admission of liability to be in writing and signed by the party to be charged, otherwise it will not bar the statute.

Contracts under seal are governed as to limitation by the Act of 1883, which provides that actions for rent upon any indenture of demise, or of covenant, or debt or any bond or other specialty, and on recognizances, must be brought within 20 years after cause of action. Actions of debt on an award (the submission being not under seal), or for a copyhold fine, or for money levied on a writ of *fieri facias,* must be brought within six years. With regard to the rights of the Crown, the principle obtains that *nullum tempus occurrit regi,* so that no statute of limitation affects the Crown without express mention. But by the Crown Suits Act 1769, as amended by the Crown Suits Act 1861, in suits relating to land, the claims of the Crown to recover are barred after the lapse of 60 years. For the prosecution of criminal offences generally there is no period of limitation, except where they are punishable on summary conviction. In such case the period is six months by the Summary Jurisdiction Act 1848. Suits and indictments under penal statutes are limited to two years if the forfeiture is to the Crown, to one year if the forfeiture is to the common informer. Penal actions by persons aggrieved are limited to two years by the Act of 1833. Prosecutions under the Riot Act can only be sued upon within 12 months after the offence, and offences against the Customs Acts within three years. By the Public Authorities Protection Act, 1893, a prosecution against any person acting in execution of statutory or other public duty must be commenced within six months

Trustees are expressly empowered to plead statutes of limitation by the Trustees Act 1888. For further information *see* the Crown Suits Acts 1769 and 1861, Summary Jurisdiction Acts 1848 and 1925, the Riot Act, the Customs Acts, the Public Authorities Protection Act 1893, the Criminal Law Amendment Acts 1885 and 1922, and the Trustees Act 1888. (*See* PRESCRIPTION, LACHES.)

As regards the application and adoption of the English statutes in the colonies, *see* W. Burge, *Commentaries on Colonial and Foreign Laws* (new ed., 1907–27), vol. iv., pt ii.

United States.—The various States possess their own statutes of limitation which are modelled in the main upon the English statutes but differ widely in their minor details. Real actions are usually not barred for twenty years, whereas personal actions survive only for six years. Numerous distinctions exist with reference to personal actions, a distinction generally being drawn between actions sounding in contract and those sounding in tort, the latter having a shorter period ranging from two to six years. About half the States have copied the provisions of the English statute of 1833 known as Lord Tenterden's Act requiring any promise or acknowledgment of liability to be in writing in order to revive a debt barred by the period of limitation. Separate statutes prescribe varying periods of limitation for the prosecution of criminal offenses. A difference of opinion exists in the State courts as to whether the statute of limitations must be specially pleaded in order to be available as a defense. A few States take judicial notice of the running of the period but most States insist that the defendant must expressly claim the benefit of the statute.

LIMOGES, a town of west-central France, capital of the *département* of Haute-Vienne, formerly capital of the old province of Limousin, 176 mi. S. by W. of Orléans on the railway to Toulouse and a junction for Poitiers, Angoulême, Périgueux and Clermont Ferrand. Pop. (1954) 98,405.

Limoges sent a large force to the defense of Alesia.. In 11 B.C.

it took the name of Augustus *(Augustoritum)*; but in the 4th century it was called anew by the name of the *Lentovices*, whose capital it was. It then contained palaces and baths, had its own senate and the right of coinage. Christianity was introduced by St. Martial. From the 5th century onwards Limoges suffered greatly through wars. Upder the Merovingians Limoges was celebrated for its mints and its goldsmiths' work. In the middle ages and until 1792 the town was divided into two distinct parts, each surrounded by walls. The chbteau, which grew up around the tomb of St. Martial in the 9th century, and was surrounded with walls in the 10th and again in the 12th, was under the jurisdiction of the viscounts of Limoges, and contained their castle and the monastery of St. Martial; the *cite'*, under the jurisdiction of the bishop, had but a sparse population, the habitable ground being practically covered by the cathedral, the episcopal palace and other churches and religious buildings. In the Hundred Years' War the bishops sided with the French, while the viscounts were unwilling vassals of the English. In 1370 the *cite'*, which had opened its gates to the French, was taken by the Black Prince and given over to fire and sword. The religious wars, pestilence and famine desolated Limoges in turn but Henri d'Aguesseau and Turgot helped it to recover. Limoges celebrates every seven years the Fête d'Ostension, during which the relics of St. Martial are exposed for seven weeks, attracting large numbers of visitors. It dates from the 10th century, and commemorates a pestilence believed to have been stayed by the saint.

The town, on a hill on the right bank of the Vienne, comprises two parts originally distinct, the *cite'* with narrow streets and old houses occupying the lower slope, and the town proper the summit. In the latter a street known as the Rue de la Boucherie is occupied by a powerful and ancient corporation of butchers. Boulevards have replaced the ramparts, outside which are suburbs with wide streets and spacious squares. The cathedral was begun in 1273, in 1327 the choir was completed, and before the middle of the 16th century the transept, with its fine north portal and the first two bays of the nave; from 1875 to 1890 the construction of the nave was continued, and it was united with the west tower (203 ft. high), the base of which belongs to a previous Romanesque church. In the interior there is a magnificent rood loft of the Renaissance. St. Michel des Lions (14th and 15th centuries) and St. Pierre des Queyroix (12th and 13th centuries) contain interesting stained glass. An old basilica of St. Martial was pulled down after 1794. The Vienne is crossed by a railway viaduct and four bridges, two of which, the Pont St. Étienne and the Pont St. Martial, date from the 13th century. The museum includes a rich ceramic collection.

Limoges is the headquarters of the 22nd army corps and the seat of a bishop, a prefect, a court of appeal and a court of assizes, and has tribunals of first instance and of commerce, a board of trade, arbitrators and a chamber of commerce. The educational institutions include a national school of decorative art. The chief industry is that of making and decorating porcelain; others are enamelling, a mediaeval industry revived at the end of the 19th century, the making of shoes and clogs and skin gloves, cloth weaving, straw papermaking and printing. The Vienne is navigable for rafts above Limoges, and the logs brought down by the current are stopped at the entrance of the town by the inhabitants of the Naveix quarter, who form a special guild for this purpose.

LIMÓN (PUERTO LIMÓN) principal Caribbean port of the republic of Costa Rica. Pop. (1950) 11,310. Located in the vicinity of the land seen by Columbus in 1503, Limón was used alternately with other small ports by Spanish colonial merchants as well as smugglers and was the occasional target of pirate and Mosquito Indian attacks. It began to grow in importance after the end of the William Walker filibustering era *(see* WALKER, WILLIAM) and about 1867 the port was opened to foreign commerce. Under the leadership of Minor Keith, an American, a railroad through very difficult terrain finally joined Limón and San José in 1890. Construction cost 4.000 lives and about $8,000,000. Much of the construction was done by West Indian Negroes who, until the 1940s, were prohibited by law from migrating to other Costa Rican provinces. The banana industry was developed along the tracks to provide a cash cargo, and by 1900 the United Fruit company had taken the lead in this business.

The chief business of Limón is exporting and importing and it yearly handles more freight than any other port in Costa Rica. Limón is the capital of Limón province, area 3,629 sq.mi., pop. (1950) 41,360. The province is an area of heavy rainfall (about 100 in. annually) that produces sugar cane and two corn crops a year. The region suffered from Panama disease in the 1930s, banana production fell drastically and about 100.000 ac. of banana land were abandoned as the companies moved to the Pacific coast of Costa Rica. (T. L. K.)

LIMONITE or BROWN IRON ORE, a natural hydrated ferric oxide, is one of the major iron-bearing minerals. The name is from the Greek word for meadow, in allusion to its occurrence as bog ore in meadows and marshes. Limonite was originally considered to be one of a series of hydrated ferric oxides, some with specific names, including turgite, limonite, xanthosiderite and limnite. Investigation showed, however, that there is only one hydrated form, $Fe_2O_3.H_2O$ This compound is dimorphous, and occurs in two crystalline forms which differ in the nature of the hydrogen-oxygen bonds, and whose formulas may be written as follows, goethite, $HFeO_2$ and lepidocrocite $FeO(OH)$. It was then assumed that limonite was this monohydrate in an amorphous condition, but X-ray studies clearly established the fact that most of the so-called limonite, especially the type with a radial fibrous structure, is distinctly crystalline, and is actually goethite.

The name limonite should properly be restricted to impure hydrated iron oxide, with variable water content, and colloidal or amorphous in character. It is sometimes pitchlike or has a vitreous lustre, with a black colour, occurring in stalactitic or botryoidal forms; or more commonly as earthy or porous masses, brown to yellow in colour (yellow ochre). The streak is yellow-brown. The hardness may be as high as 5.5, but usually is apparently less. It is commonly mixed with clay, sand and manganese oxide. It is formed as an alteration product of other iron minerals, such as the hydration of hematite or the oxidation and hydration of siderite and pyrite. *See* also GOETHITE; IRON AND STEEL: *Iron Ore.* (L. S. RL.)

LIMOSIN (LIMOUSIN), **LÉONARD** (*c.* 1505–*c.* 1577), French painter best known for his fine portraits in enamel, the most famous of a family of seven enamel painters of Limoges, was the son of an innkeeper in that city. He was influenced at the beginning of his career by the German school; indeed, his earliest authenticated work, signed "L. L." and dated 1532, is a series of 18 plaques of the "Passion of the Lord," after Albrecht Diirer. But this influence was counterbalanced by that of the Italian masters of the school of Fontainebleau, Primaticcio, Rosso, Giulio Romano and Solario, from whom he acquired his taste for arabesque ornament and mythological subjects Nevertheless, the French tradition was sufficiently ingrained to save him from becoming an imitator. In 1530 he entered the service of Francis I as painter and *varlet de chambre,* a position which he retained under Henry II. For both these monarchs he executed many portraits in enamel—among them plaques depicting Diane de Poitiers in various characters—plates, vases, ewers and cups, besides decorative works for the royal palaces, for, though he is best known as an enameler distinguished for rich colour, and for graceful designs in grisaille on black or bright-blue backgrounds, he also enjoyed a great reputation as an oil painter. His last signed works bear the date 1574, but the date of his death is uncertain, though it could not have been later than the beginning of 1577. He executed nearly 2,000 enamels. He is best represented at the Louvre, which has his two famous votive tablets for the Sainte Chapelle, each consisting of 23 plaques, signed "L.L." and dated 1553; and many portraits. *See* also ENAMEL: *Origin and European Development.*

LIMOUSIN, a geographical region and former province of France. For the geographer, Limousin is the western part of the Massif Central, *i.e.,* the wide zone of Archaean and primary rocks that spreads westward from the upper valleys of the Cher and the Dordogne, over the three *de'partements* of Haute-Vienne, Corrèze and Creuse and the *arrondissements* of Confolens in Charente and Nontron in Dordogne. Far from the Alps, it was little affected by the Tertiary earth movements and consists mostly of peneplains or rolling plateaus and falls slowly from 3,000 ft. in the Montagne Limousine to 1,000 ft. in the low plateaus of the west; still it is a hilly country with deep river valleys. where communications were difficult till the railway age. The rough climate and the low fertility of the acid topsoils gave Limousin a reputation for poverty.

Originally a political unit (first the Gallic and Roman civitas of the Lemovices, then the Merovingian and Carolingian *pagus* Lemovicinus) coincided with these geographical limits. But since the 10th century the historical Limousin has been much smaller than the geographical. The Romans subdued the country in 49 B.C. and included it (27 B.C.) in the province of Aquitania. It was the object of endless contests between the Jlerovingian kings and later. from 760 to 768. the theatre of a fierce war between the Frankish king Pippin and the duke of Aquitaine. Waifer. In the 10th century it was divided between a number of feudal principalities: the northern part was cut off to form the county of Marche (*q.v.*), which later came to be considered a different province; some border districts (Confolens, Chabanais, Combrailles and Rochechouart) fell to the neighbouring principalities of Poitou. Auvergne and Angoumois; and the remnant was soon shared out between the viscountcies of Limoges, Comborn, Turenne and Ventadour.

From 866 these viscountcies mere vassals of the dukes of Aquitaine (*q.v.*) who used to be crowned in the cathedral of Limoges. Therefore, when Eleanor of Aquitaine married Henry Plantagenet, Limousin became part of the Angevin empire and a battlefield in the long struggle between Capetians and Plantagenets. After many risings against the latter, it fell to the French in 1214, but Henry III recovered some rights over the diocese of Limoges by the treaty of Paris (1259). At the beginning of the Hundred Years' War Limousin became again a battlefield. Overrun by the English after the battle of Poitiers. it was given over to them by the treaty of Brétigny (1360) but was reconquered by the French from 1370 to 1374. During those centuries Limousin had, however. been the centre of an original culture. connected with the civilization of southern France. In the 11th century the monastery of Saint Martial at Limoges was a place of learning, famous for its illuminated manuscripts; but the two main contributions of Limousin to the Occitanian culture are its enamelling industry (see ENAMEL), whose products were exported all over Europe, and its literature. It was the cradle of the lyric poetry of the troubadours, who used the Limousin dialect in their poems.

From the end of the 14th century this cultural autonomy declined as the centralizing policy of the kings made the country look increasingly northward rather than southward. In 1607 the viscountcy of Limoges, which from the houses of Comborn, Brittany and Blois had passed to that of Albret, was united to the crown by Henry IV. The gouvernement of Limousin was co-extensive with the four great feudal viscountcies, but the *généralité* of Limoges was much larger, since it included Angoumois and Basse Marche. In the 18th century its intendants, particularly the marquis de Tourny and the famous Turgot (who had there his political apprenticeship), tried hard to promote welfare and prosperity. But Limousin was one of the poorest French provinces in 1789, with its agriculture backward and its population politically inert (for example, during the French Revolution), and remained so, far into the 19th century. After 1850. however. the country underwent an economic revolution, owing" to the building of the railways, which made possible the import of fertilizers, lime and marl. The modernization of agriculture was quick, with the disappearance of waste and fallow and the extension of cattle breeding. Furthermore, the Limoges district became the main French producer of china and footwear. Under the third republic the evolution of political opinion toward the left went farther in Haute-Vienne and Corrèze than in any other French region, despite the predominance of agriculture and peasant ownership. In World War II Limousin was one of the main theatres of guerrilla warfare in France; on June 10, 1944, the whole population of the small town of Oradour-sur-Glane was murdered in retaliation by German troops of the S.S. division.

(F. CT.)

LIMPKIN, a single species of big, brown, raillike bird of the Americas. constituting the family Aramidae, closely related to the crane (*q.v.*). This bird (Aramus *scolopaceus*), 28 in., called courlan or crying bird from its loud. prolonged, wailing cry, and limpkin from its peculiar halting gait as it hunts along the ground, ranges lowlands from eastern Argentina north to southern Mexico. Puerto Rico and Hispaniola. One race (A. *s. pictus*) is resident in the Florida peninsula and southern Georgia (Okefinokee swamp). It is found along borders of wooded streams, bayous, sloughs or in open marshes, sometimes uplands, where it runs raillike through brush with long strides or perches on a small tree. The limpkin flies with short concave wings slowly flapping, neck extended and legs dangling. It feeds on mollusks, crustaceans, aquatic insects, frogs and worms. In the Everglades it feeds chiefly on large, greenish fresh-water snails (Ampullaria). These carried to its nest or favourite feeding perch and held firmly in one foot are struck several powerful blows with the 4-in. bill. The bill is then forced into the spiral opening of the shell to pull out the animal. The bulky nest of leaves, twigs and Spanish moss, it found among grasses or shrubs, or in a low tree over or near water; the eggs. four to six, rarely eight are buff splashed with brown and drab. (G. F. Ss.)

LIMPOPO or CROCODILE, a river of southeast Africa more than 1,000 mi. in length. next to the Zambezi the largest river of Africa entering the Indian ocean. Its head streams rise on the northern slopes of the Witwatersrand less than 300 mi. due W. of the sea, but the river makes a great semicircular sweep across the high plateau. For a great part of its course the Limpopo forms the northwest and north frontiers of the Transvaal. Its banks are well wooded and present many picturesque views. In descending the escarpment of the plateau the river passes through rocky ravines, piercing the Zoutpansberg near the northeast corner of the Transvaal at the Toli Azimé falls. In the low country it receives on the right bank its chief affluent, the Olifants river (450 mi. long), which shares with the main river the distinction of having cut back across the eastern escarpment, and of draining parts of the interior plateau. The Limpopo enters the ocean in 25° 15′ S. The mouth, about 1,000 ft. wide, is obstructed by sand banks. In the rainy season the Limpopo loses a good deal of its water in the swampy region along its lower course. High-water level is 24 ft. above low-water level, when the depth in the shallowest part does not cxcccd 3 ft. The river is navigable all the year round by shallow-draught vessels from its mouth for about 100 mi. to a spot known as Gungunyana's ford. In flood time there is water communication south with the river Komati (*q.v.*). At this season stretches of the Limpopo above Gungunyana's ford are navigable. The river valley is generally unhealthful.

The basin of the Limpopo includes the northern part of the Transvaal, the eastern portion of Bechuanaland, southern Matabeleland and a large area of Portuguese territory north of Delagoa bay. Its chief tributary, the Olifants, has been mentioned. Of its many other affluents, the Macloutsie, the Shashi and the Tuli are the most distant northwest feeders. Among the streams which, flowing north through the Transvaal, join the Limpopo is the Nylstroom, so named by Boers trekking from the south in the belief that they had reached the river Nile. In the coast region the river has one considerable affluent from the north, the Chengane, which is navigable for some distance.

The Limpopo is a river of many names. In its upper course it is called the Crocodile, and that name is also applied to the whole river. Though claiming the territory through which it ran, the Portuguese made no attempt to trace the river. This was first done by Capt. J. F. Elton, who in 1870, travelling from the Tati gold fields, sought to open a road to the sea via the Limpopo. He voyaged down the river from the Shashi confluence to the Toli Azimé falls, which he discovered, following the stream thence on foot to the low country. The lower course of the river had been explored 1868–69 by another British traveller. St. Vincent Whitshed Erskine.

LINACEAE, the flax family, comprising 22 genera and 320 species. mostly herbs and shrubs. The only important genus of this family of dicotyledons is *Linum*. See FLAX; LINSEED.

LINACRE, THOMAS (c. 1460–1524), English humanist and physician, founder (1518) and first president of the Royal College of Physicians, was probably born *c.* 1460 at Canterbury, Kent. Educated at the universities of Oxford and Padua, he was fully imbued with the "new learning" and c. 1501 was called to court as tutor to Prince Arthur. On the accession of Henry VIII he was appointed the king's physician and he also treated most of the great statesmen and prelates. He made benefactions to medical teaching at Oxford and Cambridge, wrote a Latin grammar and a work on Latin composition and published Latin translations of several of the works of the Greek physician Galen. He died in London on Oct. 20, 1524. An intimate friend of Erasmus, Sir Thomas More, John Colet, William Grocyn and others, Linacre is the prototype of the great scholar physicians of the Renaissance.

See J. N. Johnson, *Life of Thomas Linacre*, ed. by R. Graves (1835). (W. J. Bp.)

LINARES, inland province of central Chile. The province was separated from Maule province in 1873, reabsorbed in 1927 and recreated in 1936. Area (altered slightly in 1943) 3,791 sq.mi. Pop. (1952) 146,2j7. The province consists of central valley and Andean cordillera terrain, all lying within the Maule drainage system. In the rolling central valley soils are not outstanding, but the province is of major agricultural significance because there is an abundance of water for irrigation. It ranked high in wheat and in wine and flax production, in *chacareria* area (beans, corn, chick-peas, potatoes, peas and lentils), and in rice and sunflower acreage. The San Javier-Villalegre district is noted for its vineyards. Livestock raising (cattle and sheep) is general. Crops are processed and shipped through the market and administrative centres of San Javier (pop. (1952) 7,006), Parral (10,-717) and Linares (19,624), the provincial capital. The towns are served by the state railway; at Parral the Cauquenes (Arauco Province) branch line begins. The longitudinal highway also traverses the province, and lesser lateral roads lead to spas at Longaví, Panamávida, Catillo and Quinamávida. Although the city of Linares was founded as San Javier de Bella Isla (1755) and renamed Villa de San Ambrosio de Linares (1794), its present name became official in 1875. (J. T.)

LINARES, a town of southern Spain, in the province of Jaén, among the southern foothills of the Sierra Morena, 1,375 ft. above sea level and 3 mi. N.W. of Guadalimar river. Pop. (1950) 52,819 (mun.). It is connected by four branch railways with the argentiferous lead mines on the northwest, and with the main railways from Madrid to Seville. Granada and the principal ports on the south coast. Its population is chiefly engaged in the lead mines, and in the manufacture of powder, dynamite, match for blasting purposes, rope and the like. The mining plant is entirely imported, and smelting, desilverizing and the manufacture of lead sheets, pipes, etc.. are carried on. Linares lead is unsurpassed in quality. About 2 mi. S. is the village of Cazlona, with remains of the ancient *Castulo*. Linares remained in government hands until shortly before the close of the civil war of 1936–39.

LINCOLN, EARLS OF. The first earl of Lincoln was William d'Aubigny, created earl about 1139. He soon lost the title, becoming earl of Sussex, though more generally known as earl of Arundel. About 1141 King Stephen created William de Roumare (*c.* 1096–before 1161) earl of Lincoln; but about 1147–48 he granted the earldom to Gilbert de Gant (*c.* 1120–56). After Gilbert's death the earldom was dormant for about 60 years and although in Richard I's time William's grandson and heir was styled Earl William de Roumare. he was not apparently styled earl of Lincoln. In 1216 Louis of France gave it to another Gilbert de Gant; but on May 23, 1217, it was transferred to Ranulf de Blundeville, earl of Chester (d. 1232). From Ranulf the title to the earldom passed through his sister Hawise to the family of Lacy, John de Lacy (d. 1240) being made earl of Lincoln in 1232. He was a son of Roger de Lacy (d. 1212), justiciar of England and constable of Chester. It was held by the Lacys until the death of Henry, the 3rd earl (1251–1311).

Henry served Edward I in Wales, France and Scotland, both as a soldier and a diplomatist. He succeeded (1296) Edmund, earl of Lancaster. as commander of the English forces in Gascony. He fought at Falkirk in July 1298. He was then employed by Edward to negotiate successively with popes Boniface VIII and Clement V. and also with Philip IV of France; and was present at the death of the English king in July 1307. Under Edward II he joined Thomas, earl of Lancaster, and the baronial party. was one of the "ordainers" appointed in 1310 and was regent of the kingdom during the king's absence in Scotland in the same year. He died in London on Feb. 5, 1311, and was buried in St. Paul's cathedral. He married Margaret (d. 1309), granddaughter and heiress of William Longsword, 2nd earl of Salisbury, and his only surviving child, Alice (1281–1348), became the wife of Thomas, earl of Lancaster. who thus inherited his father-in-law's earldoms of Lincoln and Salisbury.

In 1349 Henry Plantagenet, earl (afterward duke) of Lancaster, a nephew of Earl Thomas, was created earl of Lincoln; and when his grandson Henry became king of England as Henry IV in 1399 the title merged in the crown. In 1467 John de la Pole (c. 1462–87), a nephew of Edward IV, was made earl of Lincoln. He joined Lambert Simnel and was killed at the battle of Stoke, leaving no children. The dignity was conferred in 1525 upon Henry Brandon (1516–34), son of Charles Brandon, duke of Suffolk, on whose death the earldom again became extinct. In 1572 Edward Fiennes Clinton, 9th Lord Clinton (1512–85), lord high admiral and the husband of Henry VIII's mistress, Elizabeth Blount, was created earl of Lincoln. The title is still held by Clinton's descendants. In 1768 Henry Clinton, the 9th earl (1720–94), succeeded his uncle Thomas Pelham as 2nd duke of Newcastle-under-Lyne, and since this date the title of earl of Lincoln has been the courtesy title of the eldest son of the duke of Newcastle.

See G. E. C(okayne), *Complete Peerage*, vol. vii (London, 1929).

LINCOLN, ABRAHAM (1809–1865), 16th president of the United States, was born on Feb. 12, 1809, in a backwoods cabin three miles south of Hodgenville, Ky. When he was two years old he was taken to a farm in the neighbouring valley of Knob Creek. His earliest memories were of this home and, in particular, of a flash flood that once washed away the corn and pumpkin seeds he had helped his father plant. The father, Thomas Lincoln, was descended from a weaver's apprentice who had migrated from England to Massachusetts in 1637. Though much less prosperous than some of his Lincoln forebears, Thomas was a sturdy pioneer. On June 12, 1806, he married Nancy Hanks. The Hanks genealogy is difficult to trace, but Nancy appears to have been of illegitimate birth. She has been described as "stoop-shouldered, thin-breasted, sad," and fervently religious. Thomas and Nancy Lincoln had three children: Sarah, Abraham and Thomas (died in infancy).

In Dec. 1816, faced with a lawsuit challenging the title to his Kentucky farm, Thomas Lincoln moved with his family to southeastern Indiana. There, as a "squatter" on public land, he hastily put up a "half-faced camp"—a crude structure of logs and boughs, with one side open to the weather—in which the family took shelter behind a blazing fire. Soon he built a permanent cabin, and later he bought the land on which it stood. Abraham helped to clear the fields and take care of the crops but early acquired a dislike for hunting and fishing. In after years he recalled the "panther's scream," the bears that "preyed on the swine," and the poverty of Indiana frontier life, which was "pretty pinching at times." The unhappiest period of his boyhood followed the death of his mother in the autumn of 1818. As a ragged nine-year-old, he saw her buried in the forest, then faced a winter without the warmth of a mother's love. Fortunately, before the onset of a second winter, Thomas Lincoln brought home from Kentucky a new wife for himself, a new mother for the children. Sarah Bush Johnston Lincoln, a widow with two boys and a girl of her own, had energy and affection to spare. She ran the household with an even hand, treating both sets of children as if she had borne them all, but she became especially fond of Abraham: and he of her. He afterward referred to her as his "angel mother."

This stepmother doubtless encouraged Lincoln's taste for reading, yet the original source of his desire to learn remains something of a mystery. Both of his parents were almost completely illiterate, and he himself received very little formal education. He once said that, as a boy, he had gone to school "by littles"—a little now and a little then—and his entire schooling amounted to no more than one year's attendance. His neighbours later recalled how he used to trudge for miles to borrow a book. According to his own statement. however, his early surroundings provided "absolutely nothing to excite ambition for education. Of course when I came of age I did not know much. Still somehow, I could read, write, and cipher to the Rule of Three; but that was all." Apparently the young Lincoln did not read a large number of books but thoroughly absorbed the few that he did read. These included Parson Weems's *Life of Washington* (with its story of the little hatchet and the cherry tree), *Robinson Crusoe, Pilgrim's Progress* and Aesop's *Fables*. From his earliest days he must have had some familiarity with the Bible, for it doubtless was the only book his family owned.

In March 1830 the Lincoln family undertook a second migration, this one to Illinois, with Lincoln himself driving an ox team. Having just reached the age of 21, he mas about to begin life on his own. Six feet four inches tall, he was rawboned and lanky but muscular and physically powerful. He was especially noted for the skill and strength with which he could wield an ax. He spoke with a backwoods twang and walked in the long-striding. flat-footed, cautious manner of a plowman. Good-natured though somewhat moody, talented as a mimic and storyteller, he readily attracted friends. He was yet to demonstrate what other abilities he possessed.

Prairie Lawyer.—After his arrival in Illinois, having no desire to be a farmer, Lincoln tried his hand at a variety of occupations. As a "rail splitter," he helped to clear and fence his father's new farm. As a flatboatman, he made a voyage down the Mississippi river to New Orleans (this mas his second visit to that city, his first having been made in 1828, while he still lived in Indiana). On his return he settled in New Salem, a village of about 25 families on the Sangamon river. There he worked from time to time as storekeeper, postmaster and surveyor. With the coming of the Black Hawk War (1832), he enlisted as a volunteer and was elected captain of his company. Afterward he joked that he had seen no "live, fighting Indians" during the war but had had "a good many bloody struggles with the mosquitoes." Meanwhile, aspiring to be a legislator, he was defeated in his first try and then repeatedly re-elected to the state assembly. He considered blacksmithing as a trade but finally decided in favour of the law. Already he had taught himself grammar and mathematics, and now he began to study lawbooks. In 1836, having passed the bar examination, he began to practice law.

The next year he moved to Springfield, the new state capital, which offered much larger opportunities for a lawyer than New Salem did. At first he was a partner of John T. Stuart, then of Stephen T. Logan, and finally, from 1844 on, of William H. Herndon. Nearly ten years younger than Lincoln, Herndon was more widely read, more emotional at the bar, and generally more extreme in his views. Yet this partnership seems to have been as nearly perfect as such human arrangements ever are. Lincoln and Herndon kept few records of their law business: and they split the cash between them whenever either of them was paid. It seems they had no money quarrels.

Within a few years after his removal to Springfield, Lincoln was earning from $1,200 to $1,500 annually, at a time when the governor of the state received a salary of $1,200 and circuit judges only $750. He had to work hard. To keep himself busy he found it necessary not only to practise in the capital but also to follow the court as it made the rounds of its circuit. Each spring and fall he would set out by horseback or buggy to travel hundreds of miles over the thinly settled prairie, from one little county seat to another. Most of the cases were petty and the fees small.

The coming of the railroads, especially after 1850, made travel easier and practice more remunerative. Lincoln served as a lobbyist for the Illinois Central to assist in getting a charter from the state, and thereafter he was retained as a regular attorney for that railroad. After successfully defending the company against the efforts of McLean county to tax its property, he received the largest single fee of his legal career—$5,000. (He had to sue the Illinois Central in order to collect the fee.) He also handled cases for other railroads and for banks, insurance companies, mercantile and manufacturing firms. In one of his finest performances before the bar, he saved the Rock Island bridge, the first to span the Mississippi river, from the threat of the river transportation interests who demanded the bridge's removal. His business included a number of patent suits and criminal trials. One of his most effective and famous pleas had to do with a murder case. A witness claimed that, by the light of the moon, he had seen Duff Armstrong, an acquaintance of Lincoln's, take part in a killing. Referring to an almanac for proof, Lincoln argued that the night had been too dark for the witness to have seen anything clearly, and with a sincere and moving appeal he won an acquittal.

By the time he began to be prominent in national politics, about twenty years after launching upon his legal career, Lincoln had made himself one of the most distinguished and successful lawyers in Illinois. He was noted not only for his shrewdness and practical common sense, which enabled him always to see to the "nub" of any legal case, but also for his invariable fairness and utter honesty.

Private Life.—While residing in New Salem, Lincoln was acquainted with Ann Rutledge. Apparently he was fond of her, and certainly he grieved with the entire community at her untimely death. in 1835, at the age of 19. Afterward stories were told of a grand romance between Abraham and Ann, but these stories lack the support of sound historical evidence. A year after the death of Miss Rutledge. Lincoln was carrying on a half-hearted courtship mith Mary Owens. Miss Owens concluded that Lincoln was "deficient in those little links that make up the chain of woman's happiness." She turned down his proposal.

So far as can be known, the first and only real love of Lincoln's life was Mary Todd. High-spirited, quick-witted, and well-educated. Miss Todd came from a rather distinguished Kentucky family, and her Springfield relatives belonged to the social aristocracy of the town. Some of them frowned upon her association uith Lincoln, and from time to time he too had doubts whether he ever could make her happy. Nevertheless, they became engaged. Then, on a day in 1841 that Lincoln recalled as the "fatal first of January" they broke the engagement, apparently on his initiative. For some time after that, he was overwhelmed by a mood of terrible depression and despondency. Finally the two were reconciled and, on Nov. 4, 1842, were married.

Four children, all boys, were born to the Lincolns. Robert Todd, the eldest and the only one to survive to adulthood, was never very close to his father. Edward Baker died at the age of 4 and William Wallace at 12. Thomas. affectionately known as "Tad," outlived his father; Tad, who had a cleft palate and a lisp. was Lincoln's favourite. Lincoln left the upbringing of his sons largely to their mother, who was alternately strict and lenient in her treatment of them.

The Lincolns had a mutual affectionate interest in the doings and welfare of their boys, were fond of one another's company, and missed each other when apart, as existing letters show. Like most married couples, the Lincolns also had their domestic quarrels. which sometimes were hectic but nhich undoubtedly were exaggerated by contemporary gossips. Mrs. Lincoln suffered from recurring headaches, fits of temper, and a sense of insecurity and loneliness that was intensified by her husband's long absences on the lawyer's circuit. After his election to the presidency, she was afflicted in spirit by the death of her son Willie, by the ironies of war that made enemies of Kentucky relatives and friends, and by the unfair public criticisms of her as mistress of the White House. She lost all money sense and ran up embarrassing bills. She also put on some painful scenes of wifely jealousy. At last, in 1875, she was officially declared insane, but that mas after she had undergone the further shock of seeing her husband murdered at her side. During their earlier married life, Mrs. Lincoln unquestionably encouraged her husband and served as a prod to his own ambition. During their later years together she probably strengthened and tested his innate qualities of tolerance and patience.

With his wife, Lincoln attended Presbyterian services in Springfield and in Washington, but he never joined any church. He once explained "When any church will inscribe over its altar the Saviour's condensed statement of law and gospel 'Thou shalt love the Lord thy God with all thy heart and with all thy soul and with all thy mind, and love thy neighbor as thyself,' that church will I join mith all my heart." Early in life he had been something of a skeptic and free thinker. His reputation had been such that, as he once complained. the "church influence" was used against him in politics. When running for congress in 1846, he issued a handbill to deny that he ever had "spoken with intentional disrespect of religion." He went on to explain that he had believed in the doctrine of necessity—"that is, that the human mind is impelled to action, or held in rest, by some power over which the mind itself has no control." Throughout his life he also believed in dreams and other enigmatic signs and portents. As he grew older. and especially after he became president and faced the soul-troubling responsibilities of the Civil War, he developed a profound religious sense. and he increasingly personified Necessity as God. He came to look upon himself quite humbly, as an "instrument of Providence," and to view all history as God's enterprise. "In the present civil war," he wrote in 1862. "it is quite possible that God's purpose is something different from the purpose of either party — and yet the human instrumentalities, working just as they do, are of the best adaptation to effect His purpose."

Lincoln was fond of the Bible and knew it well. He also was fond of Shakespeare. In private conversation he used many Shakespearean allusions, discussed problems of dramatic interpretation with considerable insight, and from memory recited long passages with rare feeling and understanding. He liked the essays of John Stuart Mill, particularly the famous one on liberty, but disliked heavy or metaphysical works.

Though he enjoyed the poems of Lord Byron and Robert Burns, his favourite piece of verse was the work of an obscure Scottish poet, William Knox. Lincoln often quoted Knox's lines beginning: "Oh! why should the spirit of mortal be proud?" He liked to relax with the comic writings of Petroleum V. Nasby, Orpheus C. Kerr, and Artemus Ward, or with a visit to the popular theatre.

To the Presidency. — When Lincoln first entered politics, Andrew Jackson was president. Lincoln shared the sympathies which the Jacksonians professed for the common man, but he disagreed with the Jacksonian view that the government should be divorced from economic enterprise. "The legitimate object of government," he was later to say, "is to do for a community of people whatever they need to have done, but cannot do at all, or cannot do so well for themselves, in their separate and individual capacities." He most admired Henry Clay and Daniel Webster among the prominent politicians of the time. Clay and Webster advocated using the powers of the federal government to encourage business and develop the country's resources by means of a national bank, a protective tariff, and a program of internal improvements for facilitating transportation. In Lincoln's view, Illinois and the west as a whole desperately needed such aid to economic development. From the outset, he associated himself with the Clay and Webster party, the Whigs.

As a Whig member of the Illinois state legislature, to which he was elected four times from 1834 to 1840, he devoted himself to a grandiose project for constructing with state funds a network of railroads, highways and canals. Whigs and Democrats joined in passing an omnibus bill for these undertakings, but the panic of 1837 and the ensuing business depression brought about the abandonment of most of them. While in the legislature he demonstrated that, though opposed to slavery, he was no abolitionist. Resolutions were introduced, in 1837, in response to the mob murder of Elijah Lovejoy, an antislavery newspaperman of Alton. Instead of denouncing lynch law, these resolutions condemned abolitionist societies and upheld slavery within the southern states as "sacred" by virtue of the federal constitution. Lincoln refused to vote for the resolutions. Together with a fellow member he drew up a protest against them. This maintained, on the one hand, that slavery was "founded on both injustice and bad policy" and, on the other, that "the promulgation of abolition doctrines tends rather to increase than to abate its evils."

During his single term in congress (1847–49), Lincoln as the lone Whig from Illinois gave little attention to legislative matters as such. He proposed a bill for the gradual and compensated emancipation of slaves in the District of Columbia, but the bill was to take effect only with the approval of the "free white citizens" of the district. It displeased abolitionists as well as slaveholders, and never was seriously considered.

Much of his time Lincoln devoted to presidential politics. to unmaking one president, a Democrat, and making another, a Whig. He found an issue and a candidate in the Mexican War. With his "spot resolutions" he challenged the statement of Pres. James K. Polk that Mexico had started the war by shedding American blood upon American soil. Along with other members of his party. Lincoln voted to condemn Polk and the war while voting supplies for carrying it on. At the same time he laboured for the nomination and election of the war hero Zachary Taylor. After Taylor's success at the polls, Lincoln expected to be named commissioner of the general land office as a reward for his campaign services, and he was bitterly disappointed when he failed to get the job. His criticisms of the war, meanwhile, had not been popular among the voters in his own congressional district. At the age of 40, frustrated in politics, he seemed to be at the end of his public career.

For about five years he took little part in politics, and then a new sectional crisis gave him a chance to re-emerge and rise to statesmanship. In 1854 his political rival Stephen A. Douglas maneuvered through congress a bill for reopening the, entire Louisiana purchase to slavery and allowing the settlers of Kansas and Nebraska (with "popular sovereignty") to decide for themselves whether to permit slaveholding in those territories. The Kansas-Nebraska act provoked violent opposition in Illinois and the other states of the old northwest. It gave rise to the Republican party while speeding the Whig party on the way to disintegration. Along with many thousands of other homeless Whigs, Lincoln soon became a Republican (1856). Before long, some prominent Republicans in the east talked of attracting Douglas to the Republican fold, and with him his Democratic following in the west. Lincoln would have none of it. He was determined that he, not Douglas, should be the Republican leader of his state and section. In their basic views he and Douglas were not quite so far apart as they seemed in the heat of political argument. Neither was an abolitionist, neither a proslavery man. But Lincoln, unlike Douglas, insisted that congress must exclude slavery from the territories. He disagreed with Douglas's belief that the territories were by nature unsuited to the slave economy and that no congressional legislation was needed to prevent the spread of slavery into them. He declared (1858): "'A house divided against itself cannot stand.' I believe this government cannot endure permanently half slave and half free." He predicted that the country eventually would become "all one thing, or all the other." Again and again he insisted that the civil liberties of every U.S. citizen, white as well as black, were at stake. The territories must be kept free, he further said, because "new free states" were "places for poor people to go and better their condition." He agreed with Thomas Jefferson and other founding fathers, however, that slavery should be merely contained, not directly attacked. In the Lincoln-Douglas debates of 1858, while contesting for Douglas's seat in the United States senate, he drove home the inconsistency between Douglas's "popular sovereignty" principle and the Dred Scott decision (1857), in which the U.S. supreme court held that congress could not constitutionally exclude slavery from the territories. Though he failed to obtain the senate seat, Lincoln gained national recognition and soon began to be mentioned as a presidential prospect for 1860.

On May 18, 1860, after Lincoln and his friends had made skillful preparations, he was nominated on the third ballot at the Republican convention in Chicago. He then put aside his law practice and, though making no stump speeches, gave his full time to the direction of his campaign. His "main object," he had written, was to "hedge against divisions in the Republican ranks," and he counseled party workers to "say nothing on points where it is probable we shall disagree." With the Republicans united, the Democrats divided, and a total of four candidates in the field. he carried the election on Nov. 6. No one in the deep south voted for him, and fewer than 40 out of 100 in the country as a whole. Still, the popular votes were so distributed that he won a clear and decisive majority in the electoral college.

The War Comes. — After Lincoln's election and before his inauguration, the state of South Carolina proclaimed its withdrawal from the Union. To forestall similar action by other southern states, various compromises were proposed in congress. The most important, the Crittenden compromise, included constitutional amendments (1) guaranteeing slavery forever in the states where it already existed and (2) dividing the territories between slavery and freedom. Though Lincoln had no objection to the first of these amendments, he was unalterably opposed to the second, and indeed to any scheme infringing in the slightest upon the free-soil plank of his party's platform. "I am inflexible," he privately wrote. He feared that a territorial division, by sanctioning the principle of slavery extension, would only encourage planter imperialists to seek new slave territory south of the American border and thus would "put us again on the highroad to a slave empire." From his home in Springfield he advised Republicans in congress to vote against a division of the territories. The proposal was killed in committee. Six additional states then seceded and, with South Carolina, combined to form the Confederate States of America.

So, before Lincoln took office, a disunion crisis was upon the country. Attention North and South focused in particular upon Fort Sumter, in Charleston harbour. This fort, still under construction, was garrisoned by U.S. troops under Naj. Robert Anderson. The Confederacy claimed it and, from other harbour fortifications: threatened it. Foreseeing trouble, Lincoln while still in Springfield confidentially requested Winfield Scott, general in chief of the U.S. army, to be prepared "to either hold, or retake, the forts, as the case may require, at, and after the inauguration." In his inaugural address (March 4. 1861), beside upholding the Union's indestructibility and appealing for sectional harmony, Lincoln restated his Sumter policy as follows: "The power confided in me, will be used to hold, occupy, and possess the property, and places belonging to the government, and to collect the duties and imposts; but beyond what may be necessary for these objects, there will be no invasion—no using of force against, or among the people anywhere." Then, near the end, addressing the absent southerners: "You can have no conflict, without being yourselves the aggressors."

No sooner was he in office than Lincoln received word that the Sumter garrison, unless supplied or withdrawn, would shortly be starved out. Still, for about a month, Lincoln delayed to act. He was beset by contradictory advice. On the one hand, General Scott. Secretary of State William H. Seward, and others urged him to abandon the fort, and Seward through a go-between gave a group of Confederate commissioners to understand that the fort would in fact be abandoned. On the other hand, many Republicans insisted that any show of weakness would bring disaster to their party and to the Union. Finally Lincoln ordered the preparation of two relief expeditions, one for Fort Sumter and the other for Fort Pickens, in Florida. (He afterward said he would have been willing to withdraw from Sumter if he could have been sure of holding Pickens.) Before the Sumter expedition got under way, he sent a messenger to tell the South Carolina governor: "I am directed by the President of the United States to notify you to expect an attempt will be made to supply Fort-Sumpter with provisions only; and that, if such attempt be not resisted, no effort to throw in men, arms: or ammunition, will be made, without further notice, or in case of an attack upon the Fort." Without waiting for the arrival of Lincoln's expedition, the Confederate authorities presented to Major Anderson a demand for Sumter's prompt evacuation, which he refused. On April 12, 1861, at dawn, the Confederate batteries in the harbour opened fire.

"Then, and thereby," Lincoln informed congress when it met on July 4, "the assailants of the Government began the conflict of arms." The Confederates, however, accused him of being the real aggressor. They said he had cleverly maneuvered them into firing the first shot so as to put upon them the onus of war guilt. Though some historians have repeated this charge, it appears to be a gross distortion of the facts. The facts apparently are these: Lincoln was determined to preserve the Union; to do so, he thought he must take a stand sooner or later against the pretensions of the Confederacy, and he concluded he might as well take this stand at Sumter.

Lincoln's primary aim was neither to provoke war nor to maintain peace. In preserving the Union, he would have been glad to preserve the peace also, but he was ready to risk a war, which he thought would be short.

Commander in Chief.—After the firing on Fort Sumter. Lincoln called upon the state governors for troops (Virginia and three other states of the upper south responded by joining the Confederacy). He then proclaimed a blockade of the southern ports. These steps—the Sumter expedition, the call for volunteers, and the blockade—mere the first important decisions of Lincoln as commander in chief of the army and navy. He still needed a strategic plan and a command system for carrying it out.

General Scott advised him to avoid battle with the Confederate forces in Virginia, to get control of the Mississippi river, and by tightening the blockade to hold the South in a gigantic squeeze. Lincoln had little confidence in Scott's comparatively passive and bloodless "Anaconda" plan. He believed the war must be actively fought if it ever was to be won. Overruling Scott. he ordered a direct advance on the Virginia front. which resulted in defeat and rout for the Union forces at Bull Run (July 21, 1861). After a succession of more or less sleepless nights, Lincoln produced a set of memoranda on military policy. His basic thought was this: the armies should advance concurrently on several fronts and should move in such directions as to hold and use the support of Unionists in Missouri, Kentucky, western Virginia, and eastern Tennessee. "I state my general idea of this war to be," he later explained. "that we have the greater numbers. and the enemy has the greater facility of concentrating forces upon points of collision; that we must fail, unless me can find some way of making our advantage an overmatch for his; and that this can only be done by menacing him nith superior forces at different points, at the same time." This, with the naval blockade, comprised the essence of Lincoln's strategy.

From 1861 to 1864, while hesitating to impose his ideas upon his generals, Lincoln experimented with command personnel and organization. Accepting the resignation of Scott (Nov. 1861) he put George B. McClellan in charge of the armies as a whole. After a few months, disgusted by the slowness of McClellan, he demoted him to the command of the army of the Potomac alone. He questioned the soundness of McClellan's plans for the peninsular campaign, repeatedly compelled McClellan to alter them, and after the Seven Days' battle before Richmond (June–July 1862) ordered him to give them up. Then he tried a succession of commanders for the army in Virginia—John Pope, McClellan again. Ambrose E. Burnside. Joseph Hooker and George Gordon Meade—but was disappointed with each of them in turn. Meanwhile he had in Henry W. Halleck a general in chief who gave advice and served as a liaison with field officers but who shrank from making important decisions. For nearly two years the Union armies had no very effective unity of command. President Lincoln, General Halleck and War Secretary Edwin M. Stanton acted as an informal council of war. Lincoln, beside transmitting official orders through Halleck, also communicated directly with the generals, sending personal suggestions in his own name. To generals opposing Robert E. Lee, he suggested that the object was to destroy Lee's army, not to capture Richmond or to drive the invader from northern soil.

Finally Lincoln looked to the west for a top general. He admired the Vicksburg campaign of Clysses S. Grant. Nine days after the Vicksburg surrender (which occurred on July 4, 1863), he sent Grant a "grateful acknowledgment for the almost inestimable service" he had done the country. Lincoln sent also an admission of his own error. He said he had expected Grant to bypass Vicksburg and go on down the Mississippi, instead of crossing the river and turning back to approach Vicksburg from the rear. "I feared it was a mistake," he wrote in his letter of congratulations. "I nou wish to make the personal acknowledgment that you were right, and I was wrong."

In March 1864 Lincoln promoted Grant to lieutenant general and gave him command of all the Union armies. At last Lincoln had found a man who, nith such able subordinates as William T. Sherman, Philip Sheridan, and George H. Thomas, could put into effect those parts of Lincoln's concept of a large-scale co-ordinated offensive that still remained to be carried out. Grant was only a member. though an important one, of a top-command arrangement that Lincoln eventually had devised. Overseeing everything was Lincoln himself, the commander in chief. Taking the responsibility for men and supplies was Stanton, the secretary of war. Serving as a presidential adviser and as a liaison with military men was Halleck, the chief of staff. And directing all the armies, while accompanying the army of the Potomac, was Grant, the general in chief. Thus Lincoln pioneered in the creation of a high command, an organization for amassing all the energies and resources of a people in the grand strategy of total uar. He combined statecraft and the over-all direction of armies. with an effectiveness that year by year increased His achievement is all the more remarkable in view of his lack of training and experience in the art of warfare. This lack may have been an advantage as well as a handicap. Unhampered by outworn military dogma, Lincoln could all the better apply his practical insight and common sense—some would say his military genius—to the winning of the Civil War.

Emancipation.— There can be no doubt of Lincoln's deep and sincere devotion to the cause of personal freedom. Before his election to the presidency he had spoken often and eloquently on the subject. In 1854, for example, he said he hated the Douglas attitude of indifference toward the possible spread of slavery to new areas. "I hate it because of the monstrous injustice of slavery itself." he declared. "I hate it because it deprives our republican example of its just influence in the world—enables the enemies of free institutions, with plausibility, to taunt us as hypocrites. . . ." In 18 j5, writing to his friend Joshua Speed, he recalled a steamboat trip the two had taken on the Ohio river 14 years earlier. "You may remember, as I well do," he said. "that from Louisville to the mouth of the Ohio there were on board. ten or a dozen slaves, shackled together with irons. That sight was a continual torment to me; and I see something like it every time I touch the Ohio. or any other slave-border."

Yet, as president, Lincoln was at first reluctant to adopt an abolitionist policy There were several reasons for his hesitancy. He had been elected on a platform pledging no interference with slavery within the states, and in any case he doubted the constitutionality of federal action in the premises. He was concerned about the possible difficulties of incorporating nearly 4,000,000 Negroes, once they had been freed, into the nation's social and political life. Above all, he felt that he must hold the border slave states in the Union, and he feared that an abolitionist program might impel them, in particular his native Kentucky, toward the Confederacy. So he held back while others went ahead. When Gen. John C. Frémont and Gen. David Hunter. within their respective military departments, proclaimed freedom for the slaves of disloyal masters, Lincoln revoked the proclamations. When congress passed confiscation acts (in 1861 and 1862), he refrained from a full enforcement of the provisions authorizing him to seize slave property. And when Horace Greeley in the New *York Tribune* appealed to him to enforce these laws, Lincoln patiently replied (Aug. 22, 1862): "My paramount object in this struggle is to save the Union, and is not either to save or to destroy slavery. If I could save the Union without freeing any slave I would do it, and if I could save it by freeing all tht slaves I would do it; and if I could do it by freeing some and leaving others alone I would also do that."

Meanwhile, in response to the rising antislavery sentiment, Lincoln came forth with an emancipation plan of his own. According to his proposal, the slaves were to be freed by state action, the slaveowners were to be compensated, the federal government was to share the financial burden, the emancipation process was to be gradual. and the freedmen were to be colonized abroad. Congress indicated its millingness to vote the necessary funds for the Lincoln plan, but none of the border slave states nas willing to launch it, and in any case few Negro leaders desired to see their people sent abroad.

While still hoping for the eventual success of his gradual plan, Lincoln took a quite different step by issuing his preliminary (Sept. 22, 1862) and his final (Jan. 1, 1863) emancipation proclamation. This famous decree, which he justified as an exercise of the president's war powers, applied only to those parts of the country actually under Confederate control. not to the loyal slave states nor to the Union-occupied areas of the Confederacy. Directly or indirectly the proclamation brought freedom during the war to fewer than 200,000 slaves. Yet it had great significance as a symbol It indicated that the Lincoln government had added freedom to reunion as a war aim. and it attracted liberal opinion in England and Europe to increased support of the Union cause.

Lincoln himself doubted the constitutionality of his step, except as a temporary mar measure After the war the slaves freed by the proclamation would have risked re-enslavement, had nothing else been done to confirm their liberty. Something else was done: the 13th amendment was added to the constitution, and Lincoln played a large part in bringing about this change in the fundamental law. Through the chairman of the Republican national committee he urged the party to include a plank for such an amendment in its platform of 1864. The plank, as adopted, stated that slavery was the cause of the rebellion, that the president's proclamation had aimed "a death blow at this gigantic evil." and that a constitutional amendment was necessary to "terminate and forever prohibit" it. When Lincoln was re-elected on this platform, and the Republican majority in congress mas increased, he was justified in feeling as he apparently did, that he had a mandate from the people for the 13th amendment. The newly chosen congress. with its overwhelming Republican majority, was not to meet until after the lame-duck session of the old congress during the minter of 1864–6j. Lincoln did not wait Using his resources of patronage and persuasion upon certain of the Democrats. he managed to get the necessary two-thirds vote before the session's end. He rejoiced as the amendment went out to the states for ratification, and he rejoiced again and again as his own Illinois led off and other states followed one by one in acting favourably upon it. (He did not live to rejoice in its ultimate adoption)

Lincoln deserves his reputation as the Great Emancipator His claim to that honour, if it rests uncertainly upon his famous proclamation, has a sound basis in the support he gave to the antislavery amendment It is well founded also in his greatness as the war leader who carried the nation safely through the four-year struggle that brought freedom in its train. And. finally, it is strengthened by the practical demonstrations he gave of respect for human north and dignity. regardless of colour. During the last two years of his life he nelcomed Negroes as visitors and friends in a nay no president had done before. One of his friends was the distinguished former slave Frederick Douglass. Afterward Douglass wrote: "In all my interviews nith Mr. Lincoln I nas impressed with his entire freedom from prejudice against the colored race."

Wartime Politics.—To win the war. President Lincoln had to have popular support. The reunion of North and South required. first of all, a certain degree of unity in the North. But the North contained various groups nith special interests of their own. Lincoln faced the task of attracting to his administration the support of as many divergent groups and individuals as possible. So he gave much of his time and attention to politics, which in one of its aspects is the art of attracting such support. Fortunately for the Union cause, he was a president with rare political skill. He had the knack of appealing to fellow politicians and talking to them in their own language. He had a talent for smoothing over personal differences and holding the loyalty of men antagonistic to one another. Inheriting the spoils system, he made good use of it, disposing of government jobs in such a nay as to strengthen his administration and further its official aims.

The opposition party remained alive and strong. Its membership included mar Democrats and peace Democrats, often called "copperheads," a few of whom collaborated with the enemy. Lincoln did what he could to cultivate the assistance of the war Democrats as in securing from congress the timely approval of the 13th amendment. So far as feasible, he conciliated the peace Democrats. He gave heed to the complaints of one of them, Gov. Horatio Seymour of New York, in regard to the draft quota for that state. He commuted the prison sentence of another, Congressman Clement L Vallandigham of Ohio. to banishment within the Confederate lines. In dealing with persons suspected of treasonable intent, Lincoln at times authorized his generals to make arbitrary arrests He justified this action on the ground that he had to allow some temporary sacrifice of parts of the constitution in order to maintain the Union and thus preserve the constitution as a whole. He let his generals suspend several newspapers, but only for short periods, and he promptly revoked a military order suppressing the hostile *Chicago Times* In a letter to one of his generals he expressed his policy thus. "You mill only arrest individuals and suppress assemblies or newspapers when they may be working palpable injury to the military in your charge, and in no other case will you interfere with the expression of opinion in any form or allow it to be interfered with violently by others. In this you have a discretion to exercise with great caution, calmness, and forbearance." Considering the dangers and provocations of the time, Lincoln was quite liberal in his treatment of political opponents and the opposition press. He was by no means the dictator critics often accused him of being.

Within his own party he confronted factional divisions and personal rivalries that caused him as much trouble as did the activities of the Democrats. True, he and most of his fellow partisans agreed fairly well upon their principal economic aims. With his approval the Republicans enacted into law the essentials of the program he had advocated from his early Whig days—a protective tariff; a national banking system, and federal aid for internal improvements, in particular for the construction of a railroad to the Pacific coast. The Republicans disagreed among themselves, however, on many matters regarding the conduct and purposes of the war. Two main factions arose: the "radicals" and the "conservatives." Lincoln himself inclined in spirit toward the conservatives, but he had friends among the radicals as well, and he strove to maintain his leadership over both. In appointing his cabinet, he chose his several rivals for the 1860 nomination and, all together, gave representation to every important party group. Wisely he included the outstanding conservative, Seward, and the outstanding radical. Salmon P. Chase. Cleverly he overcame cabinet crises and kept these two opposites among his official advisers, until Chase's resignation in 1864.

He had to deal with even more serious factional uprisings in congress. The big issue was the "reconstruction" of the South. The seceded states of Louisiana, Arkansas, and Tennessee having been largely recovered by the Union armies, Lincoln late in 1863 proposed his "ten per cent plan," according to which new state governments might be formed when 10% of the qualified voters had taken an oath of future loyalty to the United States. The radicals rejected Lincoln's proposal as too lenient. and they carried. through congress the Wade-Davis bill, which would have permitted the remaking and readmission of states only after a majority, not a tenth, had sworn to past, rather than prospective loyalty. When Lincoln pocket vetoed that bill, its authors published a "manifesto" denouncing him.

Already he was the candidate of the "Union" (that is, the Republican) party for re-election to the presidency, and the Wade-Davis manifesto signalized a movement within the party to displace him as the party's nominee. He waited quietly and patiently for the movement to collapse, but even after it had done so, the party remained badly divided. A rival Republican candidate, John C. Frémont, nominated much earlier by a splinter group, was still in the field. Leading radicals promised to procure Frémont's withdrawal if Lincoln would obtain the resignation of his conservative postmaster general, Montgomery Blair. Eventually Frémont withdrew and Blair resigned. The party was reunited in time for the election of 1864.

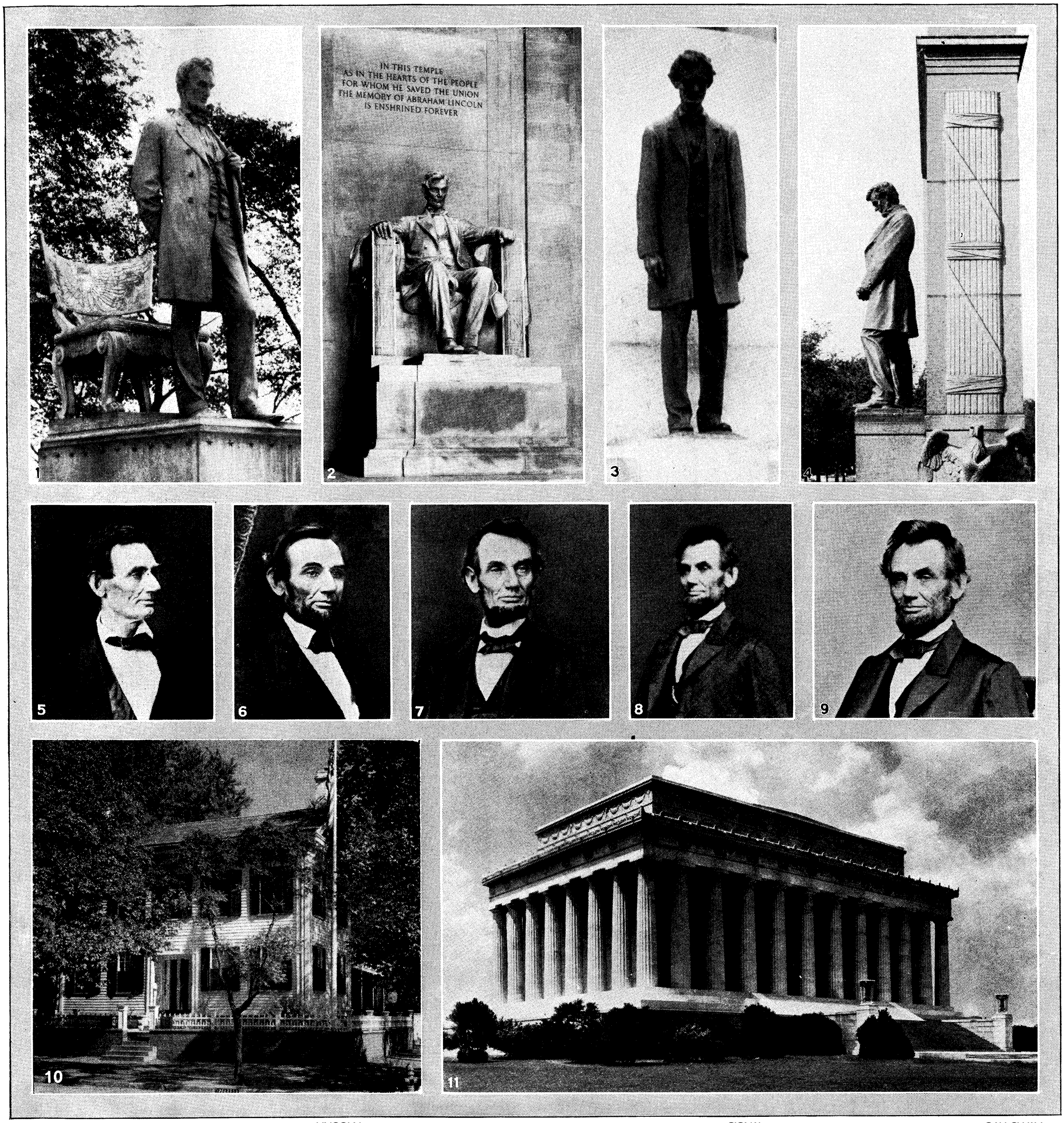
In 1864, as in 1860, Lincoln was the chief strategist of his own electoral campaign. He took a hand in the management of the Republican speakers' bureau, advised state committees on campaign tactics, hired and fired government employees to strengthen party support, and did his best to enable as many soldiers and sailors as possible to vote. Most of the citizens in uniform voted Republican, and their ballots were a great help to Lincoln. He was re-elected with a large popular majority (55%) over his Democratic opponent, George B. McClellan.

Peace Planning.— In 1864 the Democratic platform called for an armistice and a peace conference, and prominent Republicans as well as Democrats demanded that Lincoln give heed to Confederate peace offers, irregular and illusory though they were. So, in a public letter (July 18, 1864), he stated his own conditions: "Any proposition which embraces the restoration of peace, the integrity of the whole Union, and the abandonment of slavery, and which comes by and with an authority that can control the armies now at war against the United States, will be received and considered by the Executive government of the United States, and will be met by liberal terms on other substantial and collateral points." When conservatives protested to him against the implication that the war must go on to free the slaves, even after reunion had been won, he explained: "To me it seems plain that saying reunion and abandonment of slavery would be considered, if offered, is not saying that nothing else or less would be considered, if offered." After his re-election, in his annual message to Congress, he said: "In stating a single condition of peace, I mean simply to say that the war will cease on the part of the government, nhenever it shall have ceased on the part of those who began it." On Feb. 3, 1865, he met personally with Confederate commissioners on a steamer in Hampton Roads. He promised to be liberal with pardons if the south would quit the war, but he insisted on reunion as a precondition for any peace arrangement. In his second inaugural address he embodied the spirit of his policy in the famous words "with malice toward none, with charity for all." His terms satisfied neither the Confederate leaders nor the radical Republicans, and so no peace was possible until the final defeat of the Confederacy.

At the end of the war Lincoln's policy for the defeated South was not clear in all its details, though he continued to believe that the main object should be to restore the "seceded states, so-called," to their "proper practical relation" with the Union as soon as possible. He possessed no fixed and uniform program for the region as a whole. As he said in the last public speech of his life (April 11, 1865), "so great peculiarities" pertained to each of the states, and "such important and sudden changes" occurred from time to time, and "so new and unprecedented" was the whole problem that "no exclusive and inflexible plan" could "safely be prescribed." With respect to states like Louisiana and Tennessee, he continued to urge acceptance of new governments set up under his ten per cent plan during the war. With respect to states like Virginia and North Carolina, he seemed willing to use the old rebel governments temporarily as a means of transition from war to peace. He was on record as opposing the appointment of "strangers" (carpetbaggers) to govern the South. He hoped that the southerners themselves, in forming new state governments. would find some way by which whites and blacks "could gradually live themselves out of their old relations to each other, and both come out better prepared for the new." A program of education for the freedmen, he thought, was essential for preparing them for their new status. He also suggested that the vote be given immediately to some Negroes—"as, for instance, the very intelligent, and especially those who have fought gallantly in our ranks."

On the question of reconstruction, however, Lincoln and the extremists of his own party stood even farther apart in early 1865 than a year before. Some of the radicals were beginning to demand a period of military occupation for the South, the confiscation of planter estates and their division among the freedmen, and the transfer of political power from the planters to their former slaves. In April 1865 Lincoln began to modify his own stand in some respects and thus to narrow the gap between himself and the radicals. He recalled the permission he had given for the assembling of the rebel legislature of Virginia, and he approved in principle—or at least did not disapprove—Stanton's scheme for the military occupation of southern states. After the cabinet meeting of April 14, Attorney General James Speed inferred that Lincoln was moving toward the radical position. "He never seemed so near our views," Speed believed. What Lincoln's reconstruction policy would have been, if he had lived to complete his second term, can only be guessed at. On the evening of April 14, 1865, John Wilkes Booth shot Lincoln as he sat in Ford's theatre in Washington, and early the next morning he died.

The Living **Lincoln.**—"Now he belongs to the ages," Stanton is supposed to have said as Lincoln breathed his last. Many thought of him as a martyr. The assassination had occurred on Good Friday. and on the following Sunday, memorable as "Black Easter," hundreds of speakers found a sermon in the event. Some of them saw more than mere chance in the fact that assassination day was also crucifixion day. One declared: "Jesus Christ died for the world; Abraham Lincoln died for his country." Thus the post-



BY COURTESY OF (4) THE CHAMBER OF COMMERCE. LINCOLN, NEB., (5) THE F. H. MESERVE COLLECTION, (7, 8, 9) THE U.S. SIGNAL CORPS; PHOTOGRAPHS, (1, 10) EWING GALLOWAY, (2) ERNEST L. CRANDALL, (3) RAYMOND H. GEORG, (11) THE C. O. BUCKINGHAM COMPANY

LINCOLN MONUMENTS AND PHOTOGRAPHS

1. Statue of Abraham Lincoln, Lincoln Park, Chicago, Ill. (1887), by Augustus St. Gaudens (1848–1907)
2. Statue of Abraham Lincoln, Lincoln Memorial, Washington, D.C. (1920), by Daniel Chester French (1850–1931)
3. Statue of Abraham Lincoln, State House Grounds, Springfield, Ill., by Andrew O'Connor (1874–1941)
4. Lincoln Monument, State Capitol Grounds, Lincoln, Neb. (1912). Bronze statue by Daniel Chester French. Architect, Henry Bacon. The vertical sides of the bronze slab which has the Gettysburg Address on its face have the Roman fasces carved in low relief
5. Abraham Lincoln, June 1860, at the age of 51, during his first presidential campaign, from a photograph, Springfield, Ill., by Alexander Hesler. It is one of the last to show him without a beard
6. Abraham Lincoln, Jan. 3, 1861. Springfield, Ill., from the C. S. German-Butler-F. M. McNulty photograph. The original negative is owned by H. W. Fay, custodian of the Lincoln Tomb, 1928
7. Photograph of Abraham Lincoln, 1864, at the age of *55*, by M. B Brady, Washington, D.C.
8. Photograph of Abraham Lincoln, probably 1864, by M. B. Brady. Washington, D.C.
9. Photograph of Abraham Lincoln, one of the later ones, by M. B. Brady, Washington, D.C.
10. Lincoln's house. Springfield, Ill., where he lived from 1844–61. It now belongs to the State of Illinois and is open to the public
11. Lincoln Memorial, Potomac Park, Washington, D.C., erected by the United States and dedicated May 30, 1922. Architect, Henry Bacon. The colonnade, 188 ft. long and 118 ft. wide. of 36 columns, represents the 36 States existing at the time of Lincoln's death

LINCOLN'S GETTYSBURG ADDRESS

THE Battle of Gettysburg was fought on the first, second and third clays of July 1863. On November 19 of the same year a portion of the battlefield was dedicated as a final resting place for those who died there. The main address on that occasion was one of two hours in length, delivered by Edward Everett, the best-known orator of the time. After his address, Lincoln delivered the short speech now so famous. Lincoln had begun the preparation of this address the day before the dedication while still in Washington. After reaching Gettysburg he spent a portion of the evening and of the next morning in finishing the address, writing it out, partly in ink and partly in pencil.

.It the time almost no attention was paid to this address, it being relegated to the inner pages of the newspapers, while Edward Everett's elaborate oration received unqualified praise. It was not until many years later that the address became recognized as one of the classic utterances of all time.

It is interesting, however, to know that Edward Everett wrote to Mr. Lincoln on the day following the address, saying: "I wish that I could flatter myself that I had come as near to the central idea of the occasion in two hours as 1-ou did in two minutes."

The following is the text of the Gettysburg Address from the final manuscript copy which Lincoln prepared for publication. It is also the text inscribed in granite at the Lincoln Memorial, Washington, D.C.

"FOURSCORE and seven years ago our fathers brought forth on this continent a new nation conceived in liberty and dedicated to the proposition that all men are created equal. S o w we are engaged in a great civil war testing whether that nation, or any nation so conceived and so dedicateti, can long endure. We are met on a great battlefield of that war. We have come to dedicate a portion of that field as a final resting-place for those who here gave their lives that that nation might live. It is altogether fitting and proper that we should do this. Hut, in a larger sense, we cannot dedicate, we cannot consecrate, we cannot hallow this ground. The brave men, living and dead, who struggled here have consecrated it far above our poor power to add or detract. The world will little note nor long remember what we say here, but it can never forget what they did here. It is for us the living rather to be dedicated here to the unfinished work which they who fought here have thus far so nobly advanced. It is rather for us to be here dedicated to the great task remaining before us— that from these honoured dead we take increased devotion to that cause for which they gave the last full measure of devotion—that we here highly resolve that these dead shall not have died in vain, tliat this nation under God shall have a new birth of freedom, and that government of the people, by the people, for the people, shall not perish from the earth."

humous growth of his reputation was influenced by the timing and circumstances of his death, which won for him a kind of sainthood.

Among the many who remembered Lincoln from personal acquaintance, one was sure he had known him more intimately than any of the rest. and influenced the world's conception of him more than all the others put together. That one was his former law partner. Herndon. When Lincoln died. Herndon began a new career as Lincoln authority, collecting reminiscences wherever he could find them and adding his own store of memories. Though admiring Lincoln, he objected to the trend toward sanctifying the man. He saw. as the main feature of Lincoln's life, the far more than ordinary rise of a self-made man. a rise from the lowest depths to the greatest heights — "from a stagnant, putrid pool. like the gas which, set on fire by its own energy and self-combustible nature, rises in jets, blazing, clear, and bright." To emphasize this point. Herndon gave his most eager attention to evidences of the dismal and sordid in Lincoln's background. An extremely significant event in Lincoln's development. as Herndon viewed it. was a "romance of much reality" with Ann Rutledge. Lincoln loved no one but Ann and, after her death. never ceased to grieve for her. His memory of her both saddened and inspired him. As for his wife, Mary Todd, she married him out of spite. then devoted herself to making him miserable. So Herndon would have it. and after him countless biographers and novelists and playwrights elaborated upon his views, which persist as accepted knowledge about Lincoln despite their refutation by historical scholarship.

Lincoln has become a myth as well as a man. The legendary is to be sought in imaginative literature and in folklore: in poems. plays, novels, anecdotes and the like. It is also to be found in ostensibly factual productions. including footnoted biographies and histories. The Lincoln of legend has grown into a protean god who can assume a shape to please almost any worshiper. He is Old Abe and at the same time a natural gentleman. He is Honest Abe and yet a being of superhuman shrewdness and cunning. He is also Father Abraham. the wielder of authority, the support of the weak, and he is an equal, a neighbour and a friend.

Lincoln the man has a reputation which may be considered apart from that of Lincoln the myth. While he was yet alive, this reputation began to grow. and before his death his qualities of greatness already were widely recognized. In the midst of the Civil War, for instance, the *Washington Chronicle* found a resemblance between him and George Washington in their "sure judgment," "perfect balance of thoroughly sound faculties," and "great calmness of temper, great firmness of purpose, supreme moral principle. and intense patriotism." The *Buffalo Express* referred to his "remarkable moderation and freedom from passionate bitterness." then added: "We do not believe that Washington himself was less indifferent to the exercise of power for power's sake." An English newspaper, the *Liverpool Post,* suggested that "no leader in a great contest ever stood so little chance of being the subject of hero worship as Abraham Lincoln." if one were to judge only by the way he looked. His long arms and legs. his grotesque figure, made him too easy to caricature and ridicule. "Yet," this newspaper concluded, "a worshiper of human heroes might possibly travel a great deal farther and fare much worse for an idol than selecting this same lanky American." His inner qualities — his faithfulness, honesty, resolution. insight, humour and courage — would "go a long way to make up a hero," whatever the man's personal appearance.

A ong American heroes. Lincoln continues to have a unique appeal for his fellow countrymen and also for people of other lands. This charm derives from his remarkable life story — the rise from humble origins. the dramatic death — and from his distinctively human and humane personality as well as from his historical role as saviour of the Union and emancipator of the slaves. His relevance endures and grows especially because of his eloquence as a spokesman for democracy. In his view. the Union was worth saving not only for its own sake but also because it embodied an ideal, the ideal of self-government. which was of interest to the people of the entire world. Hence the universality of his continuing appeal.

His best ideas and finest phrases did not occur in impromptu speeches. Rather, his long-remembered sayings were written and rewritten with meticulous revisions ahead of time. Some resulted from a slow gestation of thought and phrase through many years. One of his recurring themes — his central theme — was the promise and the problem of self-government. As early as 1838, speaking to the Young Men's Lyceum of Springfield on "The Perpetuation of Our Political Institutions," he recalled the devotion of his Revolutionary forefathers to the cause, and went on to say: "Their ambition aspired to display before an admiring world a practical demonstration of the truth of the proposition. which had hitherto been considered at best no better than problematical; namely. the capacity of a people to govern themselves." Again and again he returned to this idea, especially after the coming of the Civil War, and he steadily improved his phrasing. In his first message to congress after the fall of Fort Sumter he declared that the issue between North and South involved more than the future of the United States. "It presents to the whole family of man, the question whether a constitutional republic, or a democracy — a government of the people. by the same people — can, or cannot. maintain its territorial integrity, against its own domestic foes." And finally at Gettysburg he made the culminating. the supreme statement, concluding with the words: "that from these honored dead we take increased devotion to that cause for which they gave the last full measure of devotion — that we here highly resolve that these dead shall not have died in vain — that this nation, under God, shall have a new birth of freedom — and that government of the people. by the people, for the people, shall not perish from the earth."

See also Index references under "Lincoln, Abraham" in the Index volume.

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(R. N. Ct.)

LINCOLN, a city and county of a city, municipal. county and parliamentary borough, and the county town of Lincolnshire. Eng. Pop. (1951) 69.401. Area 9.6 sq.mi. Lincoln is built on the north side of a gap occupied by the river Witham in the limestone ridge known as the Lincoln edge or cliff. The town spreads from the summit (200 ft.) down the hill and over the flat plain. The cathedral stands on the hill, and is a landmark for miles. Lincoln is 130 mi. N. by W. from London by road. There are two railway stations. Fosse way starts at Lincoln, and Ermine street (*q.v.*) runs through it.

The Cathedral. — Lincoln cathedral contains some of the earliest purely Gothic work extant. as well as every style from the simple massive Norman of the central west front and the later Norman of the nest doorways and towers onward through all the Gothic styles, of each of which both early and late examples appear.

The building material is the oolite and calcareous stone of Lincoln Heath and Haydor. which has the peculiarity of becoming hardened on the surface when tooled. Formerly the cathedral had three spires, all of wood or leaded timber. The spire on the central tower, which would appear to have been the highest in the world, was blown down in 1547. Those on the two western towers were removed in 1808. In 1921 the north and southwest and centre towers were found to be in imminent danger of collapse. To save them they, with the west transept, Galilee porch and nave, were treated by grouting. the work being completed in 1932. The peal of 12 bells in the southwest tower, of which four were a World War I memorial to ringers, were lowered 30 ft. and the upper part of the tower was reconstructed with a lantern roof and the lower louvers were closed.

The ground plan of the first church, adapted from that of Rouen, was laid by Bishop Remigius in 1086, and the church was consecrated three days after his death, on May 6, 1092. The west front consists of an Early English screen (*c.* 1225) thrown over the Norman front, the west towers rising behind it. The earliest Norman work is part of that of Remigius; the great portals and the west towers up to the third story are Norman (c. 1148). The upper parts of them date from 1365. Perpendicular windows (*c.* 1450) are inserted. The nave and aisles were completed about 1220. The transepts mainly built between 1186 and 1235 have two rose windows; that in the north Early English, that in the south Decorated. The first has contemporary stained glass. These are called respectively the Dean's Eye and Bishop's Eye. A Galilee of Early English work forms the entrance of the south transept. Of the choir the western portion known as St. Hugh's (1186–1200) is the famous first example of pointed work; the eastern, called the Angel choir, is ornate work completed in 1280. Perpendicular canopied stalls fill the western part. The great east window, 57 ft. high, is an example of transition from Early English to Decorated (*c.* 1288). Other features of the interior are the Easter sepulchre (c. 1300), and the organ screen of a somewhat earlier date. The great central tower is Early English as far as the first story. the continuation dates from 1307. The total height is 271 ft.; and the tower contains the bell, Great Tom of Lincoln, weighing more than 5 tons. The dimensions of the cathedral internally are: nave, 252×79.6×80 ft.; choir, 158×82×72 ft.; angel choir, which includes presbytery and lady chapel, 166×44×72 ft.; main transept, 220×63×74 ft.; choir transept, 166×44×72 ft. The west towers are 206 ft. high.

The buildings of the close that call for notice are the chapter house of ten sides. 60 ft. diameter, 42 ft. high, with a vestibule of the same height, built about 1225, and therefore the earliest of English polygonal chapter houses, and the library, built by Sir Christopher Wren. The episcopal palace contains work of the date of St. Hugh, and the ruined great hall is mainly Early English. There is some Decorated work. and much Perpendicular.

The see covers almost the whole of the county, with very small portions of Kottinghamshire. At its earliest formation, when Remigius, almoner of the abbey of Fécamp, removed the seat of the bishopric here from Dorchester in Oxfordshire shortly after the Conquest, it extended from the Humber to the Thames. eastward beyond Cambridge and westward beyond Leicester. It was reduced, however. by the formation of the sees of Ely, Peterborough and Oxford, and by rearrangement of diocesan boundaries in 1837. Lincoln cathedral possesses the finest copy extant of Magna Carta (1215). It was exhibited at the New York world's fair, 1939–40, and was afterward sent to the Library of Congress, Washington, D.C., where it remained during World War II.

Other Buildings. — The Newport arch or northern gate of *Lindum* is one of the most perfect specimens of Roman architecture in England. It consists of a great arch flanked by two smaller arches, of which one remains. The Roman Ermine street runs through it, leading northward almost in a straight line to the Humber. Fragments of the town wall remain at various points. There is an extensive collection of Roman antiquities from the *colonia* in the City and County museum. Several Roman cemeteries have been discovered; pottery kilns have been excavated and buildings unearthed. Of these last the most important is the series of column bases, perhaps belonging to a basilica, beneath a house in the street called Bailgate, adjacent to the Newport arch. There is a fine Roman altar in the modern St. Swithin's church found during the building of the church. An extensive Roman villa at Greetwell is now within the city boundary.

Among churches. apart from the minster. two of outstanding interest are those of St. Mary-le-Wigford and St. Peter-at-Gowts (*i.e.*, sluice gates), both in the lower part of High street. Their towers are in the Saxo-Norman style and probably of mid-11th-century date. Bracebridge church shows similar early work; but as a whole the churches of Lincoln show plainly the results of the siege of 1644.

There were formerly three small priories, five friaries and four hospitals in or near Lincoln. The preponderance of friaries over priories of monks is explained by the fact that the cathedral was served by secular canons. Bishop Grosseteste was the devoted patron of the friars, particularly the Franciscans, who were always in their day the town missionaries. The Grey friary, near St. Swithin's church, is a picturesque two-storied building of the 13th century, now housing a museum. The building known as John of Gaunt's stables, actually St. Mary's guildhall, is of two stories: with Norman doorway and moulding. The Jew's house is another 12th-century building; and Norman remains appear in several other houses, such as Deloraine court and the house attributed to Aaron the Jew. Lincoln castle, lying west of the cathedral, was newly founded by William the Conqueror when Remigius decided to found his minster under its protection. There are Norman remains in the Gateway tower; parts of the walls are of this period, and the keep dates from the middle of the 12th century. Among mediaeval gateways, the Exchequer gate. serving as the county record office, is a fine specimen of 14th-century work. Pottergate is of the 14th century, and Stonebow in High street of the 15th, with the guildhall above it. In the Strait lived the Christian boy afterward known as "little St. Hugh," who was asserted to have been crucified by the Jews in 1255 His shrine remains in the S. choir aisle of the minster. Other antiquities are the Perpendicular conduit of St. Mary in High street and the High bridge, carrying High street over the Witham and retaining some old houses upon it.

HISTORY

The British *Lindon,* a town in the northeast of the territory of the Coritani, was probably the nucleus of the Roman town of *Lindum.* In A.D. 47–48 the 9th legion of the Romans here established their legionary fortress. The military phase was followed by a civil settlement toward the end of the 1st century A.D. when Lindum became a *colonia* or settlement for time-expired legionary soldiers. The walls of the latter enclosed a rectangular area of 41 ac., the limits of which are marked on the north by Newport arch, on the west by the west wall of the castle, on the south by the edge of the plateau, and on the east by a line running through the cathedral choir. The town increased in size and importance and early in the 3rd century the western and eastern walls were extended to the south down the hillside almost as far as the River Witham to enclose a second rectangular area of some 46 ac. There was some extramural settlement on the low ground to the south across the river, where the railway stations now lie. The Roman enclosures formed the nucleus of mediaeval Lincoln to which additions were made outside the walls as the population grew. The bishop of Lincoln is believed to have attended the council of Arles in 314. Lincoln *(Lindocolina, Lincolle, Nicole)* is mentioned in the *Antonini Itinerarium,* written in the and century. Although said to have been captured by Hengest in 475 and recovered by Ambrosius in the following year, the next authentic mention of the city is Bede's record that Paulinus preached in Lindsey in 628 and built a stone church at Lincoln in which he consecrated Honorius archbishop of Canterbury.

The Danes, about 877, established themselves at Lincoln, which was one of the five boroughs recovered by King Edmund in 940. Coins were struck here by the Danes in imitation of Alfred pennies and there was a mint from the reign of Edgar to that of Edward I. At the time of Domesday, Lincoln was governed by 12 lawmen, relics of Danish rule, each with hereditable franchises of sac and soc. The strength of the position of the castle built by William I in 1068 brought much fighting on Lincoln.

In 1141 King Stephen was imprisoned for a short time in the castle by Ranulf, earl of Chester, fighting for the empress Maud. In 1149 Stephen bought the friendship of Ranulf by conceding him, among other territories, the castle and city of Lincoln. King John. in 1200, went to Lincoln to attend the obsequies of St. Hugh and while there he received the homage of the king of Scotland. In 1216 the castle stood a siege by the partisans of the French Prince Louis, who were defeated at the battle called Lincoln Fair on May 20. 1217. John de Lacy, nephew by marriage of Ranulf, became the first earl of Lincoln of the Lacy family in 1232, on the death of Ranulf. By the marriage of his descendant, Alice, to Thomas Plantagenet, the castle became part of the future duchy of Lancaster, which, on the accession of Henry IV, was united with the crown.

In 1157 Henry II gave the citizens their first charter, granting them the city at a fee-farm rent and all the liberties which they had had under William II. In 1200 the citizens obtained release from all but pleas of the crown without the walls, and pleas of external tenure. and were given the pleas of the crown within the city according to the customs of the City of London. on which those of Lincoln were modelled. The charter also gave them quittance of toll and lastage throughout the kingdom, and of certain other dues. The office of mayor is first mentioned in 1206. In 127j the citizens claimed the return of writs, assize of bread and ale and other royal rights. and in 1301 Edward I, when confirming the previous charters, gave them quittance of murage, pannage, pontage and other dues. The mayor and citizens mere given criminal jurisdiction in 1327, when the burghmanmot held weekly in the guildhall since 1272 by the mayor and bailiffs was ordered to hear all local pleas, which led to friction with the judges of assize. The city became a separate county by charter of 1409, when it was decreed that the bailiffs should henceforth be sheriffs and the mayor the king's escheator, and the mayor with four others, justices of the peace. with defined jurisdiction. As the result of numerous complaints of inability to pay the fee-farm rent of £180 Edward IV enlarged the bounds of the county of the city in 1466, while Henry VIII in 1j46 gave the citizens four advowsons, and possibly also in consequence of declining trade the city markets were made free of tolls in 1554. A charter was granted by Charles I in 1628 after quo warranto proceedings. It provided for 13 aldermen, 4 coroners and other officers. Lincoln surrendered its charters in 1684, but the first charter was resumed after the Revolution, and was in force till 1835.

Parliaments were held at Lincoln in 1301, 1316 and 1328, and the city returned two burgesses from 1295 to 1885, when it lost one member. After the 13th century the chief interests of Lincoln were ecclesiastical and commercial. As early as 1103 Ordericus declared that a rich citizen of Lincoln kept the treasure of King Magnus of Norway, supplying him with all he required, and there is other evidence of intercourse with Scandinavia. There was an important Jewish colony, Aaron of Lincoln being one of the most influential financiers in the kingdom between 1166 and 1186. Made a staple of wool, leather and skins in 1291, famous for its scarlet cloth in the 13th century, Lincoln had a few years of great prosperity. but with the transference of the staple to Boston early in the reign of Edward III, its trade began to decrease. The craft guilds remained important until after the Reformation. a pageant still being held in 1566.

The fair now held during the last whole week of April seems to be identical with that granted by Charles II in 1684. Edward III authorized a fair from St. Botolph's day to the feast of SS. Peter and Paul in 1327. Henry IV granted one in 1409 for 15 days before the feast of the Burial of St. Hugh, and William III gave one for the first Wednesday in Septemher.

The principal industry is heavy engineering. Lincoln produces oil engines. excavators, pumps. castings and motorcar components. The market has a large trade in corn and agricultural produce. The race course. famous for the Lincolnshire handicap, is owned by the corporation. The county borough of Lincoln returns one member to parliament.

See also Index references under "Lincoln" in the Index volume.

See J. W. F. Hill, *Mediaeval Lincoln* (1948). (J. W. F. H.)

LINCOLN, city and seat of Logan county, Ill., U.S., is located 29 mi. N. of Springfield. Founded in 1853 and incorporated in 1857, it was named after Abraham Lincoln, then a Springfield attorney, who performed the legal work of the incorporators. Lincoln had tried cases in Postville (the 1835 settlement now part of Lincoln city), and was legislative sponsor of Logan county. Through his influence Lincoln became the county seat.

Situated in an area rich in tillable lands, coal and building materials, it is a shipping point for grains, poultry and dairy products, manufactures. sand and gravel. Manufactures include chinaware. glass containers. cosmetics, store fixtures, metal castings, electrical goods, women's garments and corrugated boxes.

It is the seat of Lincoln college (Presbyterian) chartered in 1865 as Lincoln university, the Lincoln State school for feeble-minded children. the Lincoln Bible institute for theological training. and the Illinois Odd Fellows' Orphans' home.

For comparative population figures see table in ILLINOIS: *Population.* (S. *R. K.)*

LINCOLN, the capital city of Nebraska, U.S., and seat of Lancaster county, is located 55 mi. S.W. of Omaha in a grain and livestock raising region.

Lincoln came into existence in 1867 as a compromise site for a state capital between two conflicting factions, the h'orth Platters who favoured Omaha and the South Platters who favoured a location south of Salt creek. A commission selected the village of Lancaster in Lancaster county, and renamed it Lincoln after Pres. Abraham Lincoln. This location was also chosen because of the salt basin along Salt creek, but industrial development of the saline deposits never materialized.

The admittance of Nebraska to the union as a state in March 1867, the establishment of Lincoln and the beginning of railroad building in the region were almost simultaneous.

Lincoln was incorporated in 1869 and succeeded in getting its first rail connection, the Burlington and Missouri River line from Plattsmouth, in 1870. It was made a city of the first class in 1887 and became a junction of the Burlington railroad system for the major routes from Chicago to Denver, and from Kansas City to Billings, Mont. Lincoln attracted other railroad connections and by the late 19th century there were 19 different rail routes leading from the city.

A communication hub: Lincoln also developed as a distribution and wholesale centre. Railroads furnished Lincoln with its most important continuing industry through the establishment of major repair and locomotive shops in suburban Havelock. Havelock, University Place, College View and Bethany, previously separate towns, were annexed by Lincoln during 1926–30.

In the early 20th century the political life of Lincoln was dominated by William Jennings Bryan (*q.v.*) who lived there from 1887 to 1921 and published the *Commoner*. A long period of prosperity, growth and civic improvement followed World War I until the area was hit by the economic depression of the 1930s, aggravated by drought. By the 1940s the agricultural market was again stable, and Lincoln's economy was given an industrial and commercial boost during the World War II period when a number of large business enterprises were established there.

Lincoln also has a large milling and grain storage business and manufactures industrial rubber V-belting, agricultural machinery, light self-propelled vehicles, telephone equipment, valves and plumbing supplies, office equipment, dairy and meat products, bricks and pharmaceuticals. The wholesale and jobbing business remained important and the city also became a focus for retail trade. Of added commercial significance was Lincoln's growth as a major insurance centre. A number of federal activities including an air force base and a veterans hospital added to the city's development.

Lincoln early acquired and maintained a position as an educational, cultural and religious centre in the state. The University of Nebraska (founded 1869, state supported), Nebraska Wesleyan university (1887, Methodist), Union college (1891, Seventh-day Adventist) and Cotner School of Religion (1889, Christian Church) are schools of collegiate rank. There is a concentration of state and regional church offices, religious organizations and schools.

The Nebraska Art association. the Lincoln Symphony orchestra and the Lincoln Community playhouse are representative of the cultural groups active in the city.

Outstanding on the prairie is the Nebraska state capitol, completed in 1932. A central tower of 400 ft. rises from a massive two-story base. Designed by Bertram Grosvenor Goodhue, it was a pioneer in changing the architectural concepts of the nation in regard to the design of public buildings, holding a place as one of the nation's architectural showpieces. The Nebraska State Historical society building houses an outstanding museum with collections of Indian and pioneer relics.

The population in 1950 was 98.884; in 1960 it was 128,521 The population of the Lincoln standard metropolitan statistical area comprising Lancaster county in 1960 was 155,272.

(W. D A.)

LINCOLN HIGHWAY, an American highway 3 384 mi. in length, connecting New York with San Francisco, Calif. It was organized in 1913 as a memorial to Abraham Lincoln. Its development has helped advance the state and federal highway systems of the United States. It is improved, hard or paved throughout and traverses impressive mountain, desert and prairie territories.

The highway serves Philadelphia and Pittsburgh, Pa.; Akron O.; South Bend. Ind.; Chicago, Ill.; Cedar Rapids and Council Bluffs, Ia.; North Platte, Neb.; Cheyenne and Rock Springs. Wyo ; Salt Lake City, Utah; Ely, Reno and Carson City, Nev.; and Sacramento. Calif.

LINCOLN JUDGMENT, THE. In this celebrated English ecclesiastical contest, the bishop of Lincoln (Edward King) was cited before his metropolitan, the archbishop of Canterbury (Dr. Benson), to answer charges of various ritual offenses committed at the administration of Holy Communion in the diocese of Lincoln in Dec. 1887.

The question at issue related to certain details in the celebration of Holy Communion: especially whether it was lawful for the celebrant (as the bishop had done) to mix water with the wine in the chalice during the service; to take the eastward position (facing the altar); and to make the sign of the cross in the air.

The validity of the archbishop's jurisdiction was upheld by the judicial committee of the privy council, and Dr. Benson heard the case, and in the end pronounced no admonition or condemnation on the bishop. His action was confirmed by the judicial committee.

The case is now mainly of historical interest, questions. of a more fundamental character having arisen in the interval.

LINCOLN PARK, a city of Wayne county, Mich., U.S., is one of Detroit's many residential suburbs. It is grouped with several other communities along the west side of the Detroit river, which are referred to as the "down river communities." The building of the nearby Ford River Rouge plant at Dearborn (*q.v.*) during World War I created a need for many workers' residences.

The alkali industries of Wyandotte (*q.v.*) are nearby and many people from Lincoln Park are also employed there. Lincoln Park was incorporated as a village in 1921 and became a city in 1925. Ecorse and Wyandotte lie between Lincoln Park and the Detroit river.

The population in 1960 was 53,933; for comparative population figures see table in MICHIGAN : Population. (F. E. LE.)

LINCOLNSHIRE, an eastern county of England, bounded north by the Humber, east by the Korth sea and the Wash. southeast for 3 mi. by Norfolk, south by Cambridge and Northamptonshire, southwest by Rutland. west by Leicestershire and Nottinghamshire and northwest by Yorkshire. The area is 2,663.9 sq.mi. and it is the second largest county in England. Pop. (1961) 743,383. The main structural features lie across the county from north to south, the two chief being the limestone escarpment of oolitic rocks in the west, extending from the boundary of Rutland, due north past Lincoln to the Humber, and forming the sharp westward-facing scarp of the Lincoln edge or heights; and the chalk escarpment of the Wolds in the northeast. East of Lincoln edge, for 4 or 5 mi., is the Heath, a dip-slope that is almost treeless and waterless and where there are a few scattered villages and the fields are divided by dry-stone walls. Between the Heath and the Wolds is a wide clay vale, and between the Wolds and the sea are great flat marshes above which rise here and there islands of boulder clay. On the chalk, especially that of the Wolds, boulder clay is plentiful and there is much glacial sand. Beyond the Lincoln heights to the west stretches a plain consisting of (1) Triassic Keuper with gypsum in the Isle of Axholme and the valley of the Trent, with red clay and with Rhaetic beds at the junction of the Trias and Lias; (2) a broad stretch of Lias rocks, with valuable ironstone deposits. Around the Wash in the southeast are fens formed of silt near the sea and peat farther inland, and an extension of the fens runs up the Witham valley to Lincoln. In the silt area are many more trees and farms than in the peaty district. Sandy shores on the North sea have given rise to holiday resorts but, while land is being reclaimed from the shores of the Wash, sea walls and other defenses are necessary north of Gibraltar point. The drainage pattern of the county is simple on the whole. being mostly longitudinal. The chief rivers are the Trent (only partly in Lincolnshire), the Ancholme, the Witham and the Bain. a tributary of the Witham. Some streams draining from the chalk are consequent in their lower courses. A striking feature is the gap in the Lincoln heights at Lincoln, through which the Trent waters formerly flowed out until captured at Newark (Notts.) by a subsequent stream working back from the Humber. The Witham is now the only river flowing through the gap.

History. — A few Palaeolithic implements mark the beginning of human settlement in Lincolnshire, continued through Mesolithic to Neolithic times when long barrows were built on the Wolds. There was a fairly heavy occupation in the Bronze Age by invaders entering through the Humber and Wash estuaries: some notable Iron Age antiquities from the River Witham at Lincoln attest the importance of this junction of river and oolitic ridge and there was a little coastal settlement in the same period. Lincolnshire was important in Roman times as a corn-producing area and, as well as the main urban centre at Lincoln, contained small towns at Ancaster, Caistor and Horncastle, each with walled enclosures. Anglo-Saxon cemeteries suggest by their distribution that these invaders entered mainly by the Humber and Wash and settled in the north and south of the county.

The origin of the three main divisions of Lincolnshire is prior to that of the county itself and largely the outcome of natural conditions. Lindsey was practically an island in early times. being bounded by the swamps of the Trent and the Witham on the west and south, and on the east by the Korth sea. Kesteven and Holland were respectively the regions of forest and of fen.

In the 7th century the supremacy over the kingdom of Lindsey alternated between Mercia and Northumbria. but few historical references to the district are extant until the time of Alfred. Kesteven and Holland belonged to Middle Anglia. At this period the Danish inroads upon the coast of Lindsey had already begun, and in 873 the army wintered at Torksey, while in 878 Lincoln and Stamford were included among the five Danish boroughs.

The shire court for Lincolnshire was held at Lincoln every 40 days, the lords of the manor attending with their stewards, or in their absence the reeve and four men of the vill. The ridings were each presided over by a riding-reeve, and wapentake courts were held in the reign of Henry I twelve times a year, and in the reign of Henry III every three weeks, while twice a year all the freemen of the wapentake were summoned to the view of frankpledge or tourn held by the sheriff. The boundaries between Kesteven and Holland were a matter of dispute as early as 1389 and were not finally settled until 1816.

Lindsey was originally included in the Mercian diocese of Lichfield, but when it was conquered by Ecgfrith of Northumbria about 671 it came under the bishop of York. On the subdivision of the Northumbrian see by Theodore in 677. it was made into a separate diocese. The Danish invasions of the 9th century put an end to the bishopric and to the organized ecclesiastical life; Benedictine foundations, which existed at Ikanho, Barrow, Bardney and Partney as early as the 7th century, were destroyed and only Bardney was ever rebuilt. The Middle Anglian diocese had had its sent at Leicester but in 877, during the Danish occupation, it was transferred to Dorchester. Oxon., which became the episcopal centre for the whole region and remained so until Bishop Remigius transferred it to Lincoln in 1072.

In the struggles of the reign of Stephen. castles at Newark and Sleaford were raised by Alexander, bishop of Lincoln. against the king. In the baronial outbreak of 1173 Roger Mowbray, who had inherited the Isle of Axholme from his father. Nigel d'Albini. garrisoned Kinnardferry, in Axholme, against Henry II but had to surrender after a few days. The castle was destroyed, as were Mowbray's more northern fortresses: and Epworth in Axholme became the principal seat of the Mowbrays. In the struggles between John and his barons in 1216 Lincoln remained loyal to the king. but after the landing of Prince Louis the city was captured by Gilbert de Gant, created earl of Lincoln by Louis. The castle held out successfully against the invaders. After his disastrous march to Swineshead abbey, John journeyed through Sleaford to Newark, where he died, and in the battle called Lincoln Fair in 1217 Gilbert de Gant was captured by the royalists and the city sacked. At the time of the Wars of the Roses the county, owing to territorial influence. was mainly Lancastrian, and in 1461 the Yorkist strongholds of Grantham and Stamford were sacked to such effect that the latter never recovered. In the Civil War of the 17th century, Lindsey for the most part declared for the king. Lord Willoughby of Parham was a prominent parliamentary leader. and the Isle of Axholme and the Puritan yeomanry of Holland declared for parliament.

At the time of the Domesday survey there were between 400 and 500 mills in Lincolnshire; 2.1 11 fisheries producing large quantities of eels; 361 saltworks; and iron forges at Stow, St. Mary and Bytham. Lincoln and Stamford were flourishing centres of industry, and markets existed at Kirton-in-Lindsey. Louth. Old Bolingbroke. Spalding, Barton and Partney. The early manufactures of the county are all connected with the woollen trade, Lincoln being noted for its scarlet cloth in the 13th century, while an important export trade in the raw material sprang up at Boston. The deforestation of Kesteven in 1230 brought large areas under cultivation. and the same period is marked by the growth of the maritime and fishing towns, especially Boston (which had a famous fish market). Grimsby. Barton, Saltfleet, Wainfleet and Wrangle. The Lincolnshire towns suffered from the general decay of trade in the eastern counties which marked the 15th century, but agriculture was steadily improving, and with the gradual drainage of the fen districts culminating in the vast operations of the 17th century. more than 330,000 ac. in the county were brought under cultivation, including more than two-thirds of Holland. The fen drainage resulted in the extinction of many local industries, such as the trade in goose feathers and the export of wild fowl to the London markets. Other historic industries of Lincolnshire are the breeding of horses and dogs and rabbit snaring.

As early as 1295 two knights were returned to parliament for the shire of Lincoln, and two burgesses each for Lincoln. Grimsby and Stamford. In the 14th century Lincoln and Stamford were several times the meeting places of parliament or important councils, the most notable being the Lincoln parliament of 1301, while at Stamford in 1309 a truce was concluded between the barons, Piers Gaveston and the king. Stamford discontinued representation for about 150 years after the reign of Edward II; Grantham was enfranchised in 1463 and Boston in 1552. Under the act of 1832 the county was divided into a northern and southern division each returning two members, and Great Grimsby lost one member. Cnder the act of 1868 the county returned six members in three divisions and Stamford lost one member. Under the act of 1885 the county returned seven members in seven divisions; Lincoln, Boston and Grantham lost one member each and Stamford was disfranchised. In 1935 Lincolnshire and Rutland were together divided into seven: Brigg, Gainsborough, Grantham. Holland with Boston, Horncastle, Louth, and Rutland and Stamford.

Administration.—Lincolnshire is divided into three administrative counties called the Parts of Holland, the Parts of Kesteven and the Parts of Lindsey, each with a county council. Holland, the smallest. covers 418.j sq.mi. and contains one municipal borough (Boston), one urban and three rural districts. Its population in 1951 was 101,55j. Kesteven. in the southwest, covers 724.2 sq.mi. and within it are two municipal boroughs (Grantham and Stamford), two urban districts and four rural districts. Its population in 1951 was 130,717. Lindsey: covering 1j20.4 sq.mi. including the county boroughs of Lincoln and Grimsby, contains three municipal boroughs (Cleethorpes, Louth and Scunthorpe), nine urban and nine rural districts. Its population in 1951 was 473,550.

There are 605 rural parishes, the majority with fewer than 300 inhabitants, and the small rural community is typical of Lincolnshire. Apart from the industrial areas in the north and northwest, the seaside resorts and a number of market towns. Lindsey is mainly a county of small villages, 258 of its 404 parishes having fewer than 300 inhabitants. The provision of adequate schools, village halls, public transport and other amenities is therefore a special problem. Holland has fewer and larger parishes. only three of its 43 having less than 300 inhabitants: although some of the larger parishes contain more than one village. Kesteven with 154 parishes (just under half of them having fewer than 300 inhabitants) stands intermediate. By arrangement between the three administrative counties there is a single police force outside Lincoln and Grimsby.

For judicial purposes the county is variously divided. It lies in the midland circuit of the high court and the assize town is Lincoln. Separate commissions of the peace are issued for Holland, for Kesteven, for Lindsey (divided into 3, 6 and 17 petty sessional divisions respectively), for Grantham, for Grimsby and for Lincoln, and separate quarter sessions are held for each of these areas. Lincoln has its own assizes, being a county of a city.

The crown is represented by a lord lieutenant appointed for the entire geographical county and by a high sheriff for the entire county except Lincoln, which elects its own.

Architecture.—At the time of the suppression of the monasteries in the reign of Henry VIII there were upward of 100 religious houses; and among the fens rose some of the finest abbeys held by the Benedictines. The Gilbertines were a purely English order which took its rise in Lincolnshire. Sempringham, the chief house of the order, was founded by St. Gilbert of Gaunt in 1139. Barlings (Premonstratensian), northeast of Lincoln, was founded in 1154. The Benedictine Mitred abbey of Crowland (*q.v.*) existed in 1051. Thornton abbey (Black Canons) in the north near the Humber and Kirkstead abbey (Cistercian) were founded in 1139.

In the Parts of Lindsey fine examples of various styles are the churches of St. Peter, Barton-on-Humber, for Saxon work; Stow, for Norman of various dates; Bottesford and St. James. Grimsby, for Early English; Tattershall and Theddlethorpe for Perpendicular. In the Parts of Kesteven the churches are built of excellent local stone. The Decorated style is particularly well displayed in the churches of Heckington. Grantham, Caythorpe, Claypole, Navenby and Ewerby. Some of the finest churches are in the Parts of Holland although the district is composed wholly of marshland and is without stone of any kind: the churches of the south part of this district probably owe their origin to the munificence of the abbeys of Crowland and Spalding. The church of St. Botolph, Boston (*q.v.*), is famous for its magnificent lantern-crowned tower or "stump."

There are few remains of mediaeval castles. those of Lincoln and Tattershall being the most noteworthy. The city of Lincoln is remarkably rich in remains of domestic architecture from the Norman period onward and Stamford's lovely Georgian houses are built of local ironstone.

Agriculture.—Lincolnshire is one of the principal arable counties of England, 86% of the total area of nearly 1,700,000 ac. being cultivated. In 1951 wheat was the largest grain crop, covering 261,000 ac.; barley and oats together occupied 241,000 ac. Cattle and pigs are raised in large numbers (280,000 and 145,000 respectively in 1951). The Lincoln Red shorthorn has been bred in the county since the middle of the 19th century and a breed of pig favoured by farmers there is the Lincolnshire Curly Coat. On the wolds and heaths are flocks of the largest British sheep—the Lincoln Longwool—whose popularity outside the county has increased since World War II. It has been of great value for crossing with Merino in New Zealand. Australia and the Argentine. Lincolnshire agriculture is highly mechanized.

One-fifth of the vegetable acreage of England and Wales is in Lincolnshire and a sixth of the sugar beet. Horticultural crops are predominant in the south of the county round the Wash, where 145,000 ac. of potatoes are grown. The Spalding area is notable for its bulb-fields, and there 3,000 ac. are devoted to daffodil and tulip bulbs.

Industries.—In a county of such varied geological structure the surface extraction of minerals is a considerable industry. Ironstone is won from rich beds at several places. The Frodingham ironstone (Lower Lias) is quarried along 7 mi, of its outcrop near Scunthorpe, the Marlstone ironstone (Middle Lias) near Grantham, and the Northampton ironstone (Inferior Oolite) at Colsterworth; and there is mining of the Claxby ironstone (Lower Cretaceous) south of Caistor. Due to the dip of the strata, an increasing depth of overburden is having to be removed in opencast working! and underground mining must eventually supersede quarrying near Scunthorpe. The reserves of ore there are amply sufficient for more than 200 years. There are large cement works near Barton upon Humber (using chalk) and at Kirton-Lindsey (using the Lincolnshire limestone). Building stone from the Lincolnshire limestone has long been famous, the finest quarries being at Ancaster. Clay, sand and gravel are also worked.

At Scunthorpe are some of the largest and most up-to-date iron foundries and rolling mills in Europe, and between 1901 and 1952 the population of the town grew from 9,000 to 55,000 on account of its steel industry. Lincoln, Grantham and Gainsborough long enjoyed an international reputation for the manufacture of agricultural machinery; but the scope of their engineering and other industries has greatly extended and includes (at Lincoln) oil engines, pumps, winding gear, excavators, forged castings, steam boilers and heavy platework; (at Grantham) oil engines, cranes, boilers and road rollers; (at Gainsborough) tractors, automatic packing machinery, road rollers and flour milling. There are smaller but established industries such as milling, brewing, beet-sugar extraction, ropemaking. canning (especially at Boston) and oil-cake manufacture at Barton upon Humber, Brigg. Boston, Louth. Sleaford and elsewhere. At Immingham (*q.v.*) on the Humber a deep water dock was constructed in 1912 and has been extensively used for trading. chiefly in coal, iron, grain, timber and motor vehicles. With the development close by, since 1945, of large chemical and fertilizer factories and an oil refinery, the village is expanding into a small but prosperous town. At Keadby on the Trent a new electric power station was put into operation in 1952. Grimsby is the greatest deep-sea fishing port in England and has a numerous fleet (about 300) of steam trawlers. Boston is a port whose shipping trade with the European continent consists largely of the importation of timber and agricultural produce.

At Cranwell. 12 mi. N.E. of Grantham. is the Royal Air Force college originally set up in 1920 and officially opened in 1934. It is the training place for permanent commissioned officers. There is also a training station for short-service officers.

The Lincolnshire coast is a very popular holiday area for the industrial Midlands. The principal resorts (from north to south) are Cleethorpes. Mablethorpe and Sutton. Chapel St. Leonards, Ingoldmells (where there is a big holiday camp) and Skegness. Large sums were spent to restore the sea defenses after the storms of Jan. 1953. The Skegness and Gibraltar Point nature reserve has a very fine bird observatory.

Communications.—Lincoln was an important meeting place of Roman roads. and today it is a great railway centre. Canals are now little used, but the rivers Trent, Witham, Ancholme and the Roman Fossdyke are navigable by barge. A ferry crosses the Humber from New Holland to Kingston upon Hull in Yorkshire, but the county's ambition is the erection of a Humber bridge, 2 mi. long, between Barton in Lincolnshire and Hessle in Yorkshire.

See A. Mee (ed.), *Lincolnshire* (London, 1949).

LINCOLN TUNNEL: *see* HOLLAND AND LINCOLN VEHICULAR TUNNELS.

LIND, JAMES (1716–1794), Scottish physician, who has been called the "founder of naval hygiene in England," took his M.D. at Edinburgh in 1748. He was physician to the Royal Naval hospital at Haslar (1758–83), and then physician to the royal household at Windsor. When Lind went to Haslar, scurvy was rife in the navy, and he had as many as 350 cases in a ten weeks' voyage. As early as 1593 Sir Richard Hawkins had discovered the utility of orange and lemon juice in the sailors' diet. Lind revived it; an admiralty order prescribed the use of lemon juice (179j), and scurvy disappeared from the navy. He also studied typhus (then known as jail fever), recommending disinfection by the smoke of wood; suggested the use of hospital ships for sick sailors in tropical ports; arranged (1761–62) for the distillation of sea water for drinking purposes; and secured many important and beneficial changes in life on board ship. Lind died on July 13, 1794. His three classical works are: *A Treatise* on *the Scurvy* (1754); *On the Most Effectual Means of Preserving the Health of Seamen* (1757); and *Essay on Diseases of Europeans in Hot Climates* (1768).

LIND, JENNY (1820–1887), the famous Swedish singer, was born at Stockholm, Swed., on Oct. 6, 1820, the daughter of a lace manufacturer. Mlle. Lundberg, an opera dancer, first discovered her musical gift, and induced the child's mother to have her educated for the stage; during the six or seven years in which she was what was called an "actress pupil," she occasionally appeared on the stage, but in plays, not operas, until 1836, when she made a first attempt in an opera by A. F. Lindblad. She was regularly engaged at the opera house in 1837. Her first great success was as Agathe, in Carl Maria von Weber's *Der Freischütz,* in 1838, and by 1841, when she started for Paris, she had already become identified with nearly all the parts in which she afterward became famous. But her celebrity in Sweden was due in great part to her histrionic ability, and her wonderful vocal art was attained only after a year's hard study under Manoel Garcia.

Her first appearance in England was as Alice in Giacomo Meyerbeer's *Robert le Diable* at Her Majesty's theatre (May 4, 1847). The furore she created was prodigious. She sang in several of her favourite characters, and in that of Susanna in Wolfgang Amadeus Mozart's *Figaro,* besides creating the part of Amalia in Giuseppe Verdi's I *Masnadieri,* written for England and performed on July 22. In the autumn she appeared in operas in Manchester and Liverpool and in concerts at many provincial centres. At Norwich began her acquaintance with the bishop, Edward Stanley (1779–1849), which was said to have led to her final determination to give up the stage as a career.

After four more appearances in Berlin, and a short visit to Stockholm, she appeared in London in the season of 1848, when she sang in Gaetano Donizetti's *L'Elisire d'amore* and Vincenzo Bellini's *I Puritani,* in addition to her older parts. At the beginning of the season of 1849 she intended to give up operatic singing, but a compromise was effected by which she was to sing the music of six operas, performed without action, at Her Majesty's theatre; but the first, a concert performance of Mozart's *Il Flauto magico,* was so coldly received that she felt bound, for the sake of the manager and the public, to give five more regular representations, and her last performance on the stage was on May 10, 1849, in *Robert le Diable.* In 1850, just before leaving for the U.S., she sang the soprano music in *The Messiah* at Liverpool with superb art. She remained in the U.S. for nearly two years, being for a great part of the time engaged by P. T. Barnum. In Boston, she married (1852) Otto Goldschmidt (1829–1907), whom she had met at Liibeck in 1850.

For some years after her return to England, her home for the rest of her life, she appeared in oratorios and concerts, and her dramatic instincts were as strongly and perhaps as advantageously displayed in these surroundings as they had been on the stage, for the grandeur of her conceptions in such things as the scene of the widow in *Elijah* and the religious fervour of "I know that my Redeemer liveth," could not have found a place in opera. In her later years she took an active interest in the Bach choir, conducted by her husband, and not only sang in the chorus, but gave the benefit of her training to the ladies of the society. For some years she was professor of singing at the Royal College of Music. Her last public appearance was at Düsseldorf on Jan. 20, 1870, when she sang in *Ruth*, an oratorio composed by her husband.

She died at Malvern on Nov. 2, 1887. The supreme position which she held so long in the operatic world was due not only to the glory of her voice and the complete musicianship which distinguished her above all her contemporaries, but also the naïve simplicity of her acting in her favourite parts, such as Amina, Alice or Agathe. In these and others she had the precious quality of conviction, and identified herself with the characters she represented with a thoroughness rare in her day. Unharmed by the perils of a stage career, she was a model of rectitude, generosity and straightforwardness, carrying the last quality into a certain blunt directness of manner that was sometimes rather startling.

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LIND-AF-HAGEBY, EMELIE AUGUSTA LOUISE (1878–), British writer, born in Sweden on Sept. 20, 1878, was educated in Stockholm and at Cheltenham college, England. From 1896 onward she lived in England and in 1912 became a naturalized British subject. She worked actively for the movement toward the emancipation of women. She was a strong opponent of vivisection, and founded several societies, including the international federation of antivivisection and animal protection societies (1909). At the outbreak of World War I her three hospitals for wounded horses were authorized by the French government (the Purple Cross), and two years later she opened a sanatorium at Carqueiranne for French and Serbian soldiers, and children who had suffered through the war. She became a well-known public speaker, and wrote numerous books and pamphlets on humanitarian subjects. Her works include *August Strindberg* (1913), *Mountain Meditations* (1917), *Marriage and the New Woman* (1920), *Women's Right to Work* (1920), *Be Peacemakers* (1924), *The Great Fox-Trot* (1938).

LINDAU, PAUL (1839–1919), German dramatist and novelist, the son of a Protestant pastor, was born at Magdeburg, in the Prussian province of Saxony, on June 3, 1839. He was educated at the *Gymnasium* in Halle and then studied in Leipzig, Berlin and Paris, where he spent five years.

Lindau was one of the most brilliant journalists of his day, beginning as a foreign correspondent for the German press while he was a student in Paris and continuing after his return to Germany in 1863. In 1870 he founded *Das neue Blatt* at Leipzig, and from 1872 to 1881 he edited the Berlin weekly, *Die Gegenzvart.* Meanwhile, in 1878, he founded *Nord und Siid,* a famous monthly, which he continued to edit until 1904. Many of his contributions to the press were collected in a series of entertaining volumes.

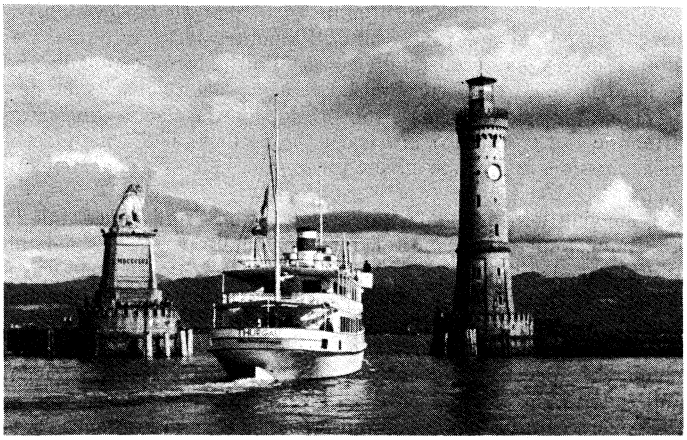
Two books of travel, *Aus Venetien* (1864) and *Aus Paris* (1865), were followed by some volumes of critical studies written in a light satirical vein, which at once made him famous. These works include *Harmlose Briefe eines deutschen Kleinstädters,* in two volumes (1870), *Moderne Märchen für grosse Kinder* (1870) and *Literarische Rücksichtslosigkeiten* (1871).

In 1895 he was appointed intendant of the court theatre at Meiningen, but in 1899 he moved to Berlin, where he became manager of the Berliner Theater and subsequently, until 1905, of the Deutsches Theater. *Marion* (1868) was the first of a long series of plays in which Lindau showed a mastery of stage effects and a command of witty and lively dialogue. Among the more famous of his works for the stage were *Maria und Magdalena* (1872), *Tante Therese* (1876), *Gräfin Lea* (1879), *Die Erste* (1895), *Der Abend* (1896), *Der Herr im Hause* (1899) and *So ich dir* (1903). Five volumes of his plays were published (1873–88).

His work also includes some volumes of short stories, which acquired great popularity, especially *Herr und Frau Bewer* (1882) and *Toggenhurg und andere Geschichten* (1883). A novel sequence with the general title *Berlin* included *Der Zug nach dem Westen* (1886), *Arme Mädchen* (1887) and *Spitzen* (1888). Among his later novels were *Die Gehilfin* (1894), *Die Brüder* (1895) and *Der König von Sidon* (1898). Earlier books on Molière (1871) and Alfred de Musset (1877) were followed by some volumes of dramatic and literary criticism.

Lindau died in Berlin on Jan. 31, 1919.

LINDAU, a town and pleasure resort in the *Land* of Bavaria, Ger., central point of the transit trade between Bavaria and Switzerland, situated on two islands off the northeastern shore of Lake Constance. Pop. (1959 est.) 23,334. On the site now



AUTHENTICATED NEWS

HARBOUR ENTRANCE, LAKE OF CONSTANCE, LINDAU, GERMANY

occupied by the town there was a Roman camp, the castrum Tiberii, and the authentic records of Lindau date back to the end of the 9th century. In 1274, or earlier, it became a free imperial town. In 1804 it lost its imperial privileges and passed to Austria, being transferred to Bavaria in 1805.

LINDBERGH, CHARLES AUGUSTUS (1902–), U.S. aviator, probably the best-known but least understood figure in aeronautical history, the man whose dramatic solo flight across the Atlantic in May 1927 accelerated world-wide interest in aviation. That flight brought him fame, wealth and a great personal tragedy, but in retrospect it stands only as one episode in a career that greatly influenced the development of commercial and military flying.

Lindbergh was born in Detroit, Mich., on Feb. 4, 1902. His early years were spent mostly in Little Falls, Minn., and in Washington, D.C. (His father represented the 6th district of Minnesota in congress for ten years.) His formal education terminated during his second year at the University of Wisconsin, Madison, when his growing interest in aviation led to enrollment in a flying school in Lincoln, Neb., and the purchase of a World War I Curtiss "Jenny," which he flew on barnstorming tours through southern and midwestern states. After a year at the army flying schools in Texas (1924–25), he became an airmail pilot (1926), flying the route from St. Louis, Mo., to Chicago, Ill. During this period he obtained financial backing from a group of St. Louis businessmen to compete for the $25,000 prize offered by Raymond Orteig for the first nonstop flight between New York and Paris. In the Ryan monoplane "Spirit of St. Louis" he made the flight in 33½ hours on May 20–21, 1927. There followed a series of flights in Europe and America.

In Mexico, Lindbergh met Anne Morrow, daughter of the United States ambassador, Dwight Morrow. They were married on May 27, 1929, at the Morrow home in Englewood, N.J. Together they made fights that took them into many countries of the world. During this period Lindbergh acted as technical adviser to Transcontinental Air Transport and to Pan American Airways, personally pioneering many of their routes.

In March 1932 Lindbergh's two-year-old son, Charles Augustus, Jr., was kidnaped from their home near Hopewell, N.J., and murdered. Partly because of Lindbergh's world-wide popularity, this became the most celebrated crime of the 1930s, and it was a major subject of newspaper attention until April 1936, when Bruno Richard Hauptmann was executed after being convicted of the kidnap-murder. The publicity was so distasteful to the Lindberghs that they took refuge in Europe. After 1936, when he visited German centres of aviation, Lindbergh repeatedly warned against the growing air power of Germany. His decoration by the German government in 1938 led to considerable criticism, as did the neutrality speeches he made in 1940–41 after his return to the United States. Criticism of his public statements by Pres. Franklin D. Roosevelt led Lindbergh to resign his air corps reserve commission in April 1941.

When the United States entered World War II. however. Lindbergh, as a civilian, threw himself unobtrusively into the war effort. serving as a consultant to the Ford Motor company and to the United Aircraft corporation. In the latter capacity he flew 50 combat missions during a tour of duty in the Pacific. and later, after the end of the war in Europe, he accompanied a navy technical mission in Europe investigating German aviation developments.

Following World War II Lindbergh and his family lived quietly in Connecticut. He continued as consultant to Pan American World Airways and to the U.S. department of defense. He was a member of the National Advisory Committee for Aeronautics and served on a number of other aeronautical boards and committees. He received many honours and awards, including the medal of honor (by special act of congress, 1927), the Guggenheim medal and the Wright Brothers Memorial trophy. For his services to the government he was appointed brigadier general in the air force reserve by Pres. Dwight D. Eisenhower in 1954. His book *The Spirit of St. Louis,* describing the flight to Paris, was published in 1953 and gained him a Pulitzer prize. He was also the author of *We* (1929), *Of Flight and Life* (1948) and, with Alexis Carrel, *The Culture of Organs* (1938), concerning researches on which he and Carrel had collaborated.

ANNE MORROW LINDBERGH (1906–) wrote essays and poetry, in addition to accounts of her trips. Her books include *North to the Orient* (1935), *Listen! The Wind* (1938), *Gift From the Sea* (1955) and *Unicorn and Other Poems, 1935–1955* (1956).

(S. P. J.; X)

LINDE, CARL VON (1842–1934). German engineer. inventor of a process of liquefying gas that is basic to the science of refrigeration, was born at Berndorf, in Bavaria. on June 11, 1842. He attended the Polytechnikum at Zurich. Switz., during 1861–64 and then obtained employment at locomotive works. first in Berlin, then in Munich. In 1868 Linde became assistant professor of machine design at the newly established Technische Hochschule in Munich. A scientific paper published in 1870 dealing with the withdrawal of heat at low temperature by mechanical means decided his life work. Another paper relating to refrigeration followed: and brewers, taking note of the practical value of his studies, financed his development of a methyl-ether refrigerator in 1874. In 1876 he took out his first patent for an ammonia refrigerator. Other refrigeration machines had been in use, but Linde's was the first one based upon precise calculations of efficiency. In 1891 he established an experimental laboratory to study refrigeration and related matters more strictly scientifically. Utilizing the Joule-Thomson effect, he succeeded in producing liquid air in 1895. A rectifying column devised by Linde produced either fairly pure oxygen or fairly pure nitrogen in a single rectification. Many later developments in this field have used essentially Linde's methods, and modern research in the physics of low temperatures and also of very high vacuum have been made possible by his work. He was raised to the nobility in 1897 and died at Munich on Nov. 16, 1934.

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(W. E. HD.)

LINDEMANN, (CARL LOUIS) FERDINAND VON (1852–1939), German mathematician. known particularly for his proof that the number π is transcendental. that is, does not satisfy any equation nith rational coefficients, was born at Hanover on April 12, 1852. Educated at the universities of Göttingen, Erlangen, Munich, Paris and London. he served as professor of mathematics at the universities at Freiburg im Breisgau, Königsberg and Munich. His mathematical papers were mainly on geometric topics. His famous proof establishes that the classical Greek construction problem of squaring the circle by compass and ruler is insoluble. He died in Munich, March 7, 1939. (O. OE.)

LINDEN, a city in Union county, N.J.. U.S.. 18 mi. S.W. of New York city. Because of its metropolitan location, many major companies operate plants there, and manufactures include chemicals, oil, metal products, cars and trucks, aircraft parts, furniture, clothing, and foods and beverages. The town was settled early in the 18th century on four village sites, which combined in 1861 to form the township of Linden, a name chosen to reflect the existence of many linden trees in the area. Incorporated as a city in 1924, it was largely a farming centre until local industrialization began around 1900.

For comparative population figures *see* table in NEW JERSEY: *Population.* (W. L. CA.)

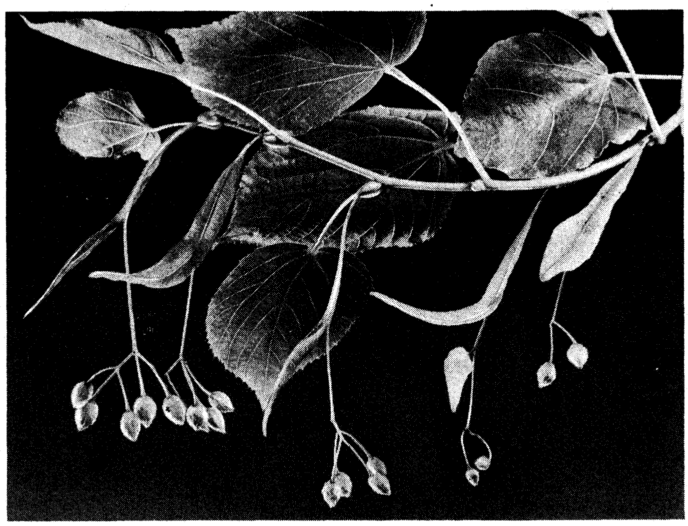
LINDEN (LIME, BASSWOOD) is a member of the genus *Tilia* of the family Tiliaceae. Lime and Linden both have their origin in the word *lind,* Old English for lime tree.

The genus *Tilia* includes about 30 species of deciduous trees widely distributed through the northern hemisphere. It also includes a number of natural and well-established hybrids. The lindens are readily recognized by their coarsely toothed, irregularly heart-shaped leaves and their flowers and fruits, borne in clusters at the termination of long stalks suspended from large, foliaceous, straplike bracts. Few trees exhale greater fragrance when in blossom and the cream and gold flowers, rich in nectar, attract the honeybee. Linden honey, light in colour, is highly regarded for its food value.

Linden wood, soft yet firm, has been a prime favourite with continental wood carvers for centuries. Many of the best expressions of their art are the exquisite frets and carvings of religious motifs to be found in churches of both the old and new worlds. The inner bark of the lindens is rich in fiber, and several species are still cultivated by the Russians for paper, cloth, and cordage fibers. The soft inner tissues were used by ancients as an antiseptic for binding and healing wounds.

Several of the lindens acquire great size; one is recorded in Norfolk. Eng.. as being 16 yd. in circumference. The famous linden tree which gave the town of Neuenstadt in Wurttemberg the name of Neuenstadt an der grossen Linden was nine feet in diameter. Among the many famous avenues of limes are the Unter den Linden, of Berlin, and the avenue at Trinity College, Cambridge.

The large-leaved lime, T. *platyphyllos,* a large tree often 100 ft. tall, is found over much of Europe, including France, Germany, Belgium. Poland, Spain and Italy, and extends eastward into Greece and the Crimea. The small-leaved linden, T. *cordata,*



JOHN MARKHAM

FRUIT AND FOLIAGE OF LINDEN OR EUROPEAN LIME (TILIA EUROPAEA) another tree of commercial proportions, occurs naturally in the Scandinavian countries thence south to Spain, the Balkans and east to the Crimea and Siberia.

The common and widespread European lime, *T. europaea*, is generally regarded by most taxonomists as being a natural hybrid between the two foregoing species. The Crimean lime. T. *ezrchlora*, is a well-established hybrid between *T. cordata* and *T. dasystyla*, the latter species a tree of southeastern Europe, the Caucasus and northern Iran. Two Asiatic species, the Japanese lime *(T. japonica)* and mongolian linden (T. *mongolica*), are locally important timber trees.

Most important of the four American species is American basswood (T. *americana*), a tree of modest proportions that occurs in mixed hardwood forests from New Brunswick to southern Manitoba, thence south to North Carolina and Missouri. Its moderately soft, straight-grained wood of light colour is used in manufacturing venetian blinds, piano keys, luggage, millwork and, especially, cabinets and excelsior. (E. S. Hr.)

LINDENTHAL, GUSTAV (1850–1935), U.S. engineer. was born at Brünn. Aus., May *21. 1850,* and was educated there and at Vienna. After some experience in railway and bridge work in Austria and Switzerland, he moved to the United States in 1871. He was engineer at the Centennial exposition, Philadelphia. Pa.. 1874–77, and then practised in Pittsburgh as consulting engineer in railway and bridge construction till 1890. when he moved to New York city. In *1902–03* he was commissioner of bridges for the city of New Tork.

Lindenthal designed and acted as consulting engineer for the steel-arch railway bridge spanning the East river at Hell Gate, which was opened for traffic in March *1917.* With its approaches. it is about 3½ mi. in length and at the date of completion contained the longest steel arch in the world (977 ft.). It remains one of the greatest arches of all time: its outline, framed between great masonry towers, produces a monumental composition. Lindenthal died July *31. 1935.*

LINDESAY, ROBERT, of Pitscottie *(c.* 1530–*c.* 1590), Scottish historian: of the family of the Lindesays of the Byres, was born at Pitscottie, in the parish of Ceres, Fifeshire, which he held in lease at a later period. His *Historie and Cronicles of Scotland,* covering the period from 1437 to 1456, the only work by which he is remembered, is described as a continuation of that of Hector Boece, translated by John Bellenden. Sir Walter Scott made use of it in *Marmion.*

The *Historie and Cronicles* was first published in *1728. A* complete edition of the text *(2* vol.). based on the Laing manuscript No. 218 in the University of Edinburgh. was published by the Scottish Text society in *18'39* under the editorship of Aeneas J. G. Mackay. The manuscript formerly in the possession of John Scott of Halkshill is fuller. and, though in a later hand, is, on the whole. a better representative of Lindesay's text.

LINDET, JEAN BAPTISTE ROBERT *(1749–1825),* French revolutionary. was born at Bernay (Eure), and was an *avocat* at Bernay. Appointed deputy to the legislative assembly and then to the Convention. he furnished a *Rapport sur les crimes imputés à Louis Capet* (Dec. 10, 1792), and voted for the death of Louis without appeal or respite. As member of the Committee of Public Safety he successfully organized the food supply of the army in the face of great difficulties. Without being formally opposed to Robespierre, he did not support him, and he was the only member of the Committee of Public Safety who did not sign the order for the execution of Danton and his friends. He opposed the Thermidorian reaction and defended Barère, Billaud-Varenne the Collot d'Herbois on March *22,* 1795. Himself denounced on May 20, 1795, he was defended by his brother Thomas (Constitutional bishop and member of the Convention) but escaped condemnation by the vote of amnesty of the 4th Brumaire, pear IV (Oct. *26.* 1795). He was minister of finance from June *18* to Nov. 9, 1799, but refused office under the consulate and the empire. In 1816 he was proscribed by the Restoration government as a regicide and left France until just before his death on Feb. *17, 1825.*

LINDGREN, WALDEMAR (1860–1939), U.S. economic geologist, was born near Kalmar, Sweden, on Feb. *14, 1860.* His father was a district judge and a member of the Swedish parliament. Lindgren was educated at Kalmar and at the Royal Academy of Mines at Freiberg, Ger., then Europe's foremost school of mining and geology, from which he graduated in *1883.* He went to the United States in the same pear and, in *1884,* began 28 years of continuous service with the United States geological survey (USGS), during which he acquired the varied firsthand familiarity with the ore deposits of the western states that became the cornerstone of his career. His acute observations during those years, interpreted with rare judgment and presented with clarity, made it possibie to diagnose from the mineralogy and textures of ores, with an accuracy not before attained, the physical and chemical conditions under which they formed. They established more firmly than before the igneous sources of many of the mineralizing solutions and clarified the methods by which ores were deposited, notably the method of replacement, the importance of which was not appreciated at the time.

Lindgren became chief geologist of the USGS in 1911, but a year later he resigned to become professor of economic geology and chairman of the department of geology at the Massachusetts Institute of Technology. There, during *27* years, he shared with his students his exceptional knowledge of the work of other geologists and the results of his own rich experience. During his last years in the USGS. he wrote *Mineral Deposits (4th* ed.. 1933) which became generally recognized as the leading advanced text in its field. Lindgren was the recipient of many honours, including membership in the National Academy of Sciences, the presidency (1924) and the Penrose gold medal of the Geological Society of America (1933), and the presidency of the International Geologic congress (1933), and many others. He died at Brighton. Mass.. on Nov. *3.* 1939. For further discussion of Lindgren's theories of mineralization and additional information about his classification of mineral deposits *see* ORE DEPOSITS: *Classification and Genesis.* (E. S. BA.)

LINDLEY, JOHN (1799–1865), English botanist, known for his attempts to formulate a natural system of plant classification and for his services to horticulture, was born Feb. 5. 1799, at Catton, near Korwich, where he was educated. On Lindley's going to London in *1819.* Sir William Jackson Hooker gave him an introduction to Sir Joseph Banks, who employed him as assistant librarian. In *1820* he published an original *Rosarum Monographia,* with descriptions of new species and drawings executed by himself, and in *1821 Digitalium Monographia.*

Shortly afterward, while writing the descriptive portion of the *Encyclopaedia of Plants,* he became convinced of the superiority of the "natural" system of plant classification of A. L. de Jussieu, as distinguished from the "artificial" system of Linnaeus followed in that encyclopaedia. This conviction found expression in Lindley's *A Synopsis of the British Flora; Arranged According to the Natural Orders (1829)* and *An Introduction to the Natural System of Botany (1830).*

In *1829* Lindley accepted the chair of botany in University college. London, which he retained till *1860.* He was also assistant secretary of the Royal Horticultural society in *1830* and secretary in *1858* and served on many government committees and commissions. He died at Acton, Middlesex, on Nov. *1, 1865.*

Lindley's works also include *The Fossil Flora of Great Britain* (with W. Hutton, 1831–37); *Flora Medica (1838)*; *Theory of Horticulture (1840); The Vegetable Kingdom (1846); Folia Orchidacea* (1852–59); and *Descriptive Botany (1858).* He was editor of the *Botanical Register* and *Gardeners' Chronicle.*

LINDLEY, NATHANIEL LINDLEY, BARON (1828–1921), English judge, son of John Lindley (*q.v.*), was born at Xcton. Middlesex. on Nov. *29, 1828,* and was educated at University college school and University college, London. Called to the bar at the Middle Temple in *1850,* he began practice in the court of chancery and became a Q.C. in *1872.* In *1875* he was appointed a justice of common pleas and, in pursuance of the changes made by the judicature acts. became a justice of the common pleas division of the high court of justice and, in *1880.* of the queen's bench division. In *1881* he was raised to the

Court of Appeal and made a privy councillor; in 1897 he succeeded Lord Esher as master of the rolls, and in 1900 was made a lord of appeal in ordinary, with a life peerage and the title of Baron Lindley. He resigned the judicial post in 1905, and died at East Carlton, near Norwich, on Dec 9, 1921. Lord Lindley was the last serjeant-at-law appointed. His reputation is mostly a professional one. He was at home throughout the law; a brilliant example of his judgments will be found in *Colls* v. *Home and Colonial Stores* (1904, AC. 179). He published *An Introduction to the Study of Jurisprudence* (1855), a translation of Thibaut's *System des Pandekten-Reckts: Treatise on the Law of Partnership* (2 vols., 1860). with a supplement in 1862. This work has since been developed into two text-books, *Lindley on Companies* and *Lindley on Partnership.*

See *The* Times (Dec. 12, 1921) ; *Law Journal* (Dec. *17,* 1921) ; *Dict. Nat. Biog.* (Supp: 1912–21).

LINDLEY, WILLIAM (1508- goo), English engineer, was born in London on Sept. 7, 1808. He was engaged for a time in railway work in various parts of Europe, and then settled in Hamburg, as engineer-in-chief to the Hamburg-Bergedorf railway. His first achievement was to drain the Hammerbrook marshes, and so add some 1,400 ac. to the available area of the city. His real opportunity, however, came with the great fire which broke out on May 5, 1842, and burned for three days. The strong measures he adopted to prevent the spread of the fire, including the blowing-up of the town hall, brought his life into danger with the mob, who professed to see in him an English agent charged with the destruction of the port of Hamburg. Lindley was then appointed consulting engineer to the senate and town council, to the Water Board and to the Board of Works. He constructed a complete sewerage system, and designed, between 1844 and 1848 the water-works of the city, the intake from the Elbe being at Rothenburgsort. In 1846 he erected the Hamburg gasworks; public baths; wash-houses were built, and large extensions to the port executed according to his plans in 1854; and he supervised the construction of the Altona gas and water-works in 1855. Among other services he rendered to the city were the trigonometrical survey executed between 1848 and 1860, and the conduct of the negotiations which in 1852 resulted in the sale of the "Steelyard" on the banks of the Thames belonging to Hamburg jointly with the two other Hanseatic towns, Bremen and Liibeck.

In 1860 he left Hamburg, and during the remaining 19 years of his professional practice he was responsible for many engineering works in various European cities, among them Frankfort-on-the-Main, Warsaw, Pesth, Diisseldorf, Galatz and Basel. In Frankfort he constructed sewerage works on the same principles as those he followed in Hainburg, and the system was widely imitated in Europe and America. He advised the New River Company of London on the adoption of the constant supply system in 1851; and he was commissioned by the British Government to carry out various works in Heligoland, including the big retaining wall "Am Falm." He died at Blackheath, London, on May 22, 1900.

LINDQ, MARK PRAGER (1819–1879), Dutch prose writer, of English-Jewish descent, was born in London on Sept. 18, 1819. He settled in Holland, taught English, studied at Utrecht, and made translations from the works of the classic English novelists. He also wrote humorous original sketches and novelettes in Dutch, which he published under the pseudonym of De Oude Herr Smits ("Old Mr. Smits"). Lindo's serious original Dutch writings he published under his own name, the principal one being *De Opkomst en Ontwikkeling van het Engelsche Volk* ("The Rise and Development of the British People," 2 vols, 1868–1874)—a valuable history. Lindo was appointed an inspector of primary schools in the province of South Holland in 1865, a post he held until his death at The Hague on March 9, 1879.

LINDSAY, the family name of the earls of Crawford. The family is one of great antiquity in Scotland, the earliest to settle in that country being Sir Walter de Lindesia, who attended David, earl of Huntingdon, afterwards King David I., in his colonization of the Lowlands early in the 12th century. His descendants divided into three branches, whose heads sat as barons in the Scottish parliament for more than 200 years before the elevation of the chief of the house to an earldom in 1398. The Lindsays held the great mountain district of Crawford in Clydesdale, from which the title of the earldom is derived, from the 12th century till the close of the 1 jth, when it passed to the Douglas earls of Angus. *See* CRAWFORD, EARLS OF.

See A. W. C. Lindsay, afterwards earl of Crawford, Lives *of* the *Lindsays, or a Memoir* of the *Houses of Crawford and Belcarres* (3 vols., 1843 and 1858).

LINDSAY, SIR COUTTS, 2ND BART. (1824–1913), English artist, was born on Feb. 2, 1824 and died at Kingston on May 7, 1913. He entered the army, where he commanded the 1st Regt. of the Italian Legion during the Crimean War. Between 1862 and 1874 he exhibited many pictures, and in 1877 founded the Grosvenor Gallery, London, which exhibited the works of the pre-Raphaelite group and other artists outside the academic circle.

LINDSAY, NORMAN ALFRED WILLIAM (1879–), Australian artist and novelist, was born at Creswick, Victoria, on Feb. 23, 1879. He began to draw for a Melbourne newspaper at 16, and in 1901 moved to New South Wales. He was for many years the chief cartoonist of the *Sydney Bulletin.* His chief characteristics of imaginative power. grim strength and a certain coarseness of style are apparent in his illustrations to Theocritus. Boccaccio, Casanova and Petronius, the best of which were collected in *The Pen Drawings of Norman Lindsay* (1918). Among his other published works are *Redheap* (1931), *Saturdee* (1933), *Pan in the Parlour* (1934), *Age of Consent* (1938) and *The Cousin from Fiji* (1945). He illustrated many books, including his own novel *The Cautious Amorist,* and was joint founder of the Endeavour press. (D. L. FR.)

LINDSAY, (NICHOLAS) VACHEL (1879–1931), U.S. writer, was born at Springfield, Ill., Nov. 10, 1879. In 1897 he entered Hiram college, in Ohio, but left after three years to study art in Chicago and New York city. He supported himself, in part, by lecturing for the Y.M.C.A. and the Anti-Saloon league. Meanwhile he had turned to the writing of poetry, and for several summers he wandered through the states, reciting his poems in return for food and shelter. His ambition was to convert America to his vision of beauty. "If I put my soul and body without reserve into the hands of the Lord," he wrote in his diary, "my part will be done. Then let them lead or kill or cure me as they will." (Quoted by Edgar Lee Masters in *Vachel Lindsay: A Poet of America,* Charles Scribner's Sons.)

Lindsay's fame began when *Poetry* published his "General Booth Enters Into Heaven" in its fourth issue (1913). His poems of this kind, based on the American rhythms of the crowd and the camp meeting, are his best. Audiences for years delighted to hear him perform them as a kind of "higher vaudeville." Much of Lindsay's poetry is visionary and "hieroglyphic," but he understood the leaders of American cults and causes, men like Alexander Campbell (founder of the Disciples of Christ), Johnny Appleseed, John Peter Altgeld and William Jennings Bryan. The 20 or so poems which audiences demanded so often that Lindsay grew weary of reciting them ("General William Booth," "The Congo," "Bryan, Bryan, Bryan, Bryan" and "The Santa Fe Trail," for example) became a part of the United States poetic heritage. His "Moon-Poems" and others of this phantasmic kind have been forgotten. Lindsay's best work was done by 1920. Of his later volumes of verse, only *The Candle in the Cabin* (1926) contains poems of distinction.

Lindsay's principal works are: *General William Booth Enters Into Heaven and Other Poems* (1913); *Adventures While Preaching the Gospel of Beauty* (1914), prose; *The Congo and Other Poems* (1914); *A Handy Guide for Beggars* (1916), prose; *The Chinese Nightingale and Other Poems* (1917); *The Golden Whales of California, end Other Rhymes in the American Language* (1920); *The Golden Book of Springfield* (1920), prose; *Going-to-the-Sun* (1923); *Going-to-the-Stars* (1926); *The Candle in the Cabin: A Weaving Together of Script and Singing* (1926). Lindsay took his life on Dec. 5, 1931.

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LINDSEY, BENJAMIN BARR (1869–1943), U.S. judge, a pioneer in juvenile court work and first judge of the conciliation court at Los Angeles, Calif., was born in Jackson, Tenn., on Nov. 25, 1869. At the age of 16 he moved to Denver, Colo., and in 1894 was admitted to the Colorado bar. He sponsored legislation establishing the juvenile court at Denver, served as its presiding judge from 1900 to 1927 and made it the model for similar courts throughout the country. His philosophy, now widely accepted, was that the juvenile offender should be under the protection of the state and a ward of the court, that equity rather than criminal procedure should be employed and that treatment of the juvenile's problem rather than punishment should be the objective. From 1939 until his death he served as judge of the conciliation court at Los Angeles, a special court he helped establish to deal with divorce cases where there was some chance to reconcile the parties. He was one of the first to propose a "family court" with integrated jurisdiction over delinquency and divorce. His ardent championship of "companionate marriage," by which he meant practising birth control to prevent parenthood until a marriage was solidly established, divorce by mutual consent where the marriage had failed and there were no children but no divorce as of right if children were involved, created great controversy and was confused by his critics with the "trial marriage" proposal of Bertrand Russell. Outspoken, at times contentious, he was an implacable foe of political machines and a leading reformer of archaic legal procedures concerning family social problems. He wrote *Problems of the Children* (1903); *The Beast and the Jungle* (with Harvey O'Higgins) (1910); *Children in Bondage* (with George Creel) (1914) ; *Pan-Germanisnz in America* (1919) ; *The Doughboy's Religion* (with Harvey O'Higgins) (1919); *The Revolt of Modern Youth* (with Wainwright Evans) (1925); *Childhood, Crime, and the Movies* (1926) ; *The Companionate Marriage* (with Wainwright Evans) (1927) ; *The Dangerous Life* (with Rube Borough) (1931), an autobiography; and many brochures on juvenile delinquency, domestic relations and crime. He died in Los Angeles. March 26, 1913. (H. H. F.)

LINDSEY, an Anglo-Saxon kingdom probably conterminous with the modern district of Lindsey, Lincolnshire, mas an area of early Anglian settlement. A genealogical list of its royal house, extending to Aldfrith, who can be identified with a king of this name who attests a charter of Offa of Mercia between 787 and 796, shows that it had kings of its own. One name in the list, Caedbaed, has a British first element, which may suggest some intermarriage with the Britons. About 631 it mas subject to Edwin of Northumbria, and Oswald of Northumbria also obtained control there, which was resented by the inhabitants. Before 674 Lindsey had become subject to Wulfhere of Mercia, who lost it to Ecgfrith of Northumbria in that year; but Wulfhere's brother: Aethelred of Mercia, recovered it after his victory at the Trent in 678, and it probably remained subject to Mercia until the Danish settlement.

The Danes raided Lindsey in 841 and wintered at Torksey in 873. When they settled in northeast Mercia in 877. Lincoln became one of the Five Boroughs *(see* DANELAW), and Lindsey was probably divided at that time into its three ridings. It seems to have submitted to Edward the Elder in 918. It was raided by the Danes in 993, accepted Sweyn I as king in 1013 and supported Canute when Sweyn died in 1014, thus calling down the vengeance of King Aethelred II. Place names show an intensive Danish settlement, which explains this incident.

After the conversion by Paulinus in about 631. nothing is heard of the church in Lindsey until 677, when Archbishop Theodore created a diocese, with its see at an unidentified Sidnaceaster. This ceased at the Danish settlement. and the religious history of Lindsey becomes obscure. A bishop Leofwine, first recorded in 953, is said by Florence of Worcester to have united the sees of Lindsey and Dorchester-on-Thames in Edgar's reign, and Lindsey remained part of the latter diocese except that it had a bishop of its own, Sigeferth, from about 997 to 1004. After the Norman conquest, the see was moved from Dorchester to Lincoln. Lindsey was claimed unsuccessfully by 11th-century archbishops of York as part of their diocese.

See F. M. Stenton, "Lindsey and Its Kings," in H. W. C. Davis (ed.), *Essays in History Presented to Reginald Lane Poole* (1927) and *Anglo-Saxon England,* 2nd ed. (1947). (D. WK.)

LINDSTROM, GUSTAF (1829–1901), Swedish paleontologist, was born at Visby in Gotland on Aug. 27, 1829. In 1848 he entered the university at Uppsala, and in 1854 he became interested in the zoology of the Baltic and published several papers on the invertebrate fauna and on the fishes. He described the fossils of the Silurian rocks in Gotland; also remains of the fish *Cyathaspis* from Wenlock beds, and (with T. Thorellj a scorpion *Palaeophonus* from Ludlow beds at Visby. He determined the true nature of the operculated coral *Calceola;* and while he described organic remains from other parts of northern Europe, he worked especially at the Paleozoic fossils of Sweden. In 1876 he was appointed keeper of the fossil Invertebrata in the State museum at Stockholm, where he died on May 16, 1901.

See obituary (with portrait) by F. A. Bather, *Geol. Mag.* (1901).

LINDUS, one of the three cities of Rhodes before their synoecism, was situated at Vroulia on the east coast, with a finely placed acropolis and good natural harbour. Danish excavators have discovered the early temple of Athena Lindia on the acropolis, splendid propylaea resembling those at Athens, other early temples, rock inscriptions, a theatre and rock tombs. The sculptors of Laocoon are among the priests of Athena Lindia. On the acropolis is a castle, built. like many houses in the town, by the Knights of St. John in the 14th century.

See Chr. Blinkenberg and K. F. Kinch, *Exploration archéologique de Rhodes* (1904–07); *Fouilles de Vroulia Lindiaca* (several memoirs).

LINE, in mathematics, is an abstraction to which the stroke of a pen only approximates. Euclid defines it as length without thickness and specifies that the boundaries of a line are points and that lines define the boundaries of a surface. Another classical definition (not in Euclid) regards the line as generated by the motion of a point and, similarly, a surface by the motion of a line. Starting from the other end, a surface can be defined as the boundary of a space *(see* SOLUTIONS: *Definitions*), a line as the intersection of two surfaces, and a point as the intersection of a line and a surface or of two lines on one surface.

In modern geometry (at least in English) the term line generally means a straight line (the more general curved line being called a curve) thought of as extended indefinitely both ways; if bounded at one end it is called a half line, if at both ends a segment. Some old-established phrases survive, such as line of force and line of striction, which do not imply straightness. Euclid defines a straight line as one that lies evenly with respect to the points on itself, a phrase that has called for a good deal of exegesis; for Archimedes it is the shortest distance between two points; and another definition, essentially due to Hero of Alexandria, is that a straight line does not change its position when rotated about its two ends. The properties of straight lines that are most fundamental for modern geometers are those that belong to the aggregate of straight lines, rather than to each one, and include the notions that any two points can be joined by a straight line, that no two straight lines can have more than one common point and that two straight lines in one plane either meet in a point or are parallel; all of which are among Euclid's axioms and postulates.

In analytic or algebraic geometry the straight line is represented by one or more equations uf the first degree. in plane geometry by a single equation and in solid geometry by two independent equations.

The special study of line geometry deals with the properties of families of straight lines in space that satisfy one or more conditions, such as passing through a given point, meeting or touching a given curve or touching a given surface. *See* ANALYTIC GEOMETRY; LIKE GEOMETRY; CURVES; CURVES, SPECIAL; *see* also references under "Line" in the Index volume. (P. DU V.)

LINEAR PROGRAMING: see MANAGEMENT SCIENCES.

LINE ENGRAVING: *see* ENGRAVING, LINE.

LINE GEOMETRY. In geometry, curves and other loci are frequently regarded as generated by a point, the position of which is defined by certain conditions. A straight line however may be thought of as the generating element, such as a tangent to a curve, or as a generator of a cone. That branch of geometry in which the line is regarded as the generating element is called line geometry.

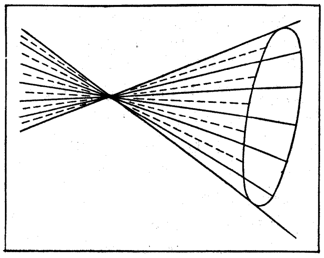

FIG. I

A point in space is determined by its distances from three planes which intersect in one point (*i.e.,* by its *co-ordinates),* and a plane is defined by the totality of the points the co-ordinates of which satisfy a linear equation. The coefficients of the co-ordinates in the equation are called *plane co-ordinates.* A point and a plane are in united position when their co-ordinates satisfy a certain bi-linear equation (*i.e.,* linear in the co-ordinates of the point, and also linear in the co-ordinates of the plane). The principle of duality (*q.v.*) asserts that for every theorem involving points, obtained from properties of point co-ordinates, there is another involving planes, and conversely. These properties remain true if each point co-ordinate is replaced by any linear fractional homogeneous expression in four numbers x_1, x_2, x_3, x_4 with common denominator and non-vanishing determinant. The numbers x_i are called *projective point co-ordinates.* Similarly, u_1, u_2, u_3, u_4 may be taken as *projective plane co-ordinates,* and the condition for united position may be expressed by the equation $\Sigma\ u_i x_i = o$.

In the plane, the projective co-ordinates, x_1, x_2, x_3, may be defined either as point co-ordinates or as line co-ordinates, thus giving rise to point-line duality in the plane. In space a straight line is self dual; it is uniquely determined by any two distinct points on it, or by any two distinct planes through it. The line itself may be regarded as an element; for many purposes in kinematics, in dynamics, and in optics this is more advantageous than to have it defined indirectly in terms of points or planes.

Line **Co-ordinates.**—Given two points $(x_1, x_2, x_3, x_4) = (x)$, $(y_1, y_2, y_3, y_4) = (y)$ on a line, the six expressions of the form $x_i y_k - x_k y_i$ are called its *homogeneous line co-ordinates* p_{ik}. Apart from a constant factor common to all, they are independent of what two distinct points are chosen. Among them there is a quadratic relation which is identically satisfied $P \equiv 0$. All the relations between two lines, such as distance, angle or condition for intersection, or any other relation, can be expressed in terms of their co-ordinates. A line meets two distinct planes each in one point, finite or infinite, and a point in each is determined when its two co-ordinates are fixed. Thus it follows that a line is determined by four independent co-ordinates, or there exist ∞^4 lines in space.

When the co-ordinates p_{ik} satisfy one equation, there are ∞^3 lines singled out, which constitute a *complex;* if they satisfy two such equations, the ∞^2 lines constitute a *congruence;* if they satisfy three, the ∞^3 lines belong to a *ruled surface;* if they satisfy four, there will be only a finite number of lines. The linear complex $\Sigma a_{ik} p_{ik} = 0$ can, by a proper choice of a system of co-ordinates, be reduced to the form $xy' - x'y + k(z - z') = 0$, in which x, y, z and x', y', z' are the cartesian co-ordinates of any two points on a line. If $k = 0$, the complex is special; it now consists of all the lines which meet the fixed line $x = 0$, $y = \sim$ the *axis.* If k is not zero, the line $x = 0$, $y = 0$ is still called the axis but not all the lines of the complex meet it. The complex can be visualized in various ways. It is identical with the null system of mechanics, *i.e.,* the totality of those axes of rotation with regard to which a system of forces in space have a moment of rotation zero. In a linear complex there is, associated with every point P (pole) (*see* POLE AND POLAR) a plane π (polar) passing through it which contains a pencil of lines with vertex at P. Dually, the lines of a linear complex lying in a plane pass through a point called the pole of the plane. As P describes a line 1, its polar plane as to a linear complex $A = 0$ describes a pencil with axis a line $1'$. Dually, every plane π' through 1 has a pole P' on $1'$. Two such lines l, l' are called *conjugate polars* as to $A = 0$. When 1 is a line of $A = o$, $1 = l'$. Any line of $A = 0$ which meets l will also meet $1'$ and every line which meets both l and l' is a line of $A = 0$. By this transformation a linear complex $B = 0$ is changed into a linear complex $B' = 0$. If A and B are in involution, $B = B'$. The six co-ordinate complexes $x_i = 0$ in the Klein system are mutually in involution.

A geometric picture can be obtained as follows: let a be the axis, and π any plane perpendicular to a. If the plane be moved parallel to itself, and rotated into itself about a, the translation and the tangent of the angle of rotation being in proportion, then every point P of a will describe a right circular helix. The lines of the complex are the normals to these ∞^2 helices.

The lines which belong to two linear complexes $A = 0$, $B = 0$ belong to every complex of the system $\lambda A + \mu B = 0$ for every value of λ and μ. Within this system are two special complexes $A' = 0$, $B' = 0$, and the linear congruence may be defined as the ∞^2 lines which meet two given lines, called the directrices of the congruence. They may be distinct, coincident or imaginary. When they are coincident, the congruence consists of ∞^1 pencils of lines with vertices P on the directrix d, and lying in planes a through d, such that P, π are projectively related.

Two complexes $A = o$, $B = o$ are in involution when on every line p of the complex, the poles of an arbitrary plane through p in $A = 0$, $B = 0$ are harmonic (*i.e.,* with cross ratio $= -1$; *see* PROJECTIVE GEOMETRY: *Cross-Ratio)* as to the intersections of p with the axes of the two special complexes $A' = 0$, $B' = 0$ in the system.

The lines which belong to three linear complexes $A = 0$, $B = 0$, $C = 0$ constitute the ∞^1 lines of a regulus, *i.e.,* one system of generators of a quadratic surface; if they are real, they form a hyperboloid of one sheet, or a hyperbolic paraboloid. These lines also belong to every linear complex of the form $\lambda A + \mu B + \nu C = 0$. The other system of generators belongs to three independent linear complexes, each of which is in involution with $A = 0$, $B = 0$, $C = 0$.

The lines belonging to four linear complexes are the two transversals of the axes of the four independent special linear complexes contained in the system. They may be distinct, co-incident or imaginary. These ideas had been recognized in part by various writers, but they were first put into systematic form in terms of co-ordinates by Arthur Cayley in 1860. The results attracted the attention of several mathematicians, in particular of Julius Plucker, who soon contributed a number of notes leading to their further development. Eight years later appeared the first part of Plucker's book on line geometry.

By means of a simple transformation of the line co-ordinates p_{ik}, the quadratic identity $P \equiv 0$ can be reduced to the sum of six squares, $\Sigma x_i^2 = 0$. These x_i are called *Klein co-ordinates;* they furnish one of the most striking examples in mathematics of the power and the ease of obtaining results in consequence of a proper notation.

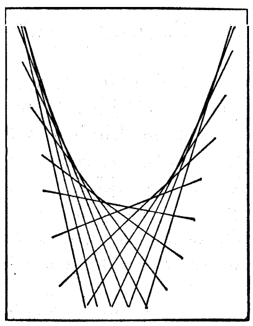

FIG. 2

The Line-sphere Transformation.—The p_{ik} or the x_i can also be interpreted as the co-ordinates of a sphere, since the co-ordinates of the centre and the length of the radius furnish four independent quantities which determine a sphere. By making the co-ordinates homogeneous, and by expressing the length of the radius in terms of the coefficients in the equation of the sphere, the quadratic identity appears. Two lines which intersect are thus transformed into two spheres which touch each other. The points of space (spheres of zero radius) are the images of the lines of a certain complex; the planes of space (spheres whose radii become infinite) are the images of the lines of a certain special linear complex. A linear equation in sphere co-ordinates (linear complex of spheres) defines the ∞^3 spheres which cut a fixed sphere at a constant angle.

The line-sphere transformation together with its projective generalizations, is a ponerful weapon in the study of certain curves and ruled surfaces. Thus, all the sextic ruled surfaces (120 types) and those of order seven having a straight line directrix (about 300 types) have been determined by this method.

Mapping on Hyperspace.—If the p_{ik} (or the x_i) are thought of as homogeneous point co-ordinates in space of five dimensions, the quadratic identity $P=0$ becomes the equation of a quadric variety, hence line geometry may be interpreted as the geometry on a quadric variety in five-way space. A linear complex is then the section of the quadric by a linear four-nay space, and hence it defines a three-dimensional quadratic variety in space of four dimensions. By stereographic projection this can be mapped on the points of three-nay space, hence there is a one-to-one correspondence betneen the points of ordinary space and the lines of any linear complex.

The **Cylindroid.**—The axes of the complexes of a pencil describe a ruled cubic surface. the cylindroid, which is of value in the application of line geometry to dynamics, as is shown in the treatise of Ball. It may be generated as follows: Given a line d, and on it two points P, P'. Through P draw any line p perpendicular to d, and through P' draw a line p' perpendicular to d and to p. Now as a variable point G moves along d from P to P', associate with it a line g always passing through G, perpendicular to d, and such that the distance from P is proportional to the cosine of double the angle that g makes mith the plane d, p. At P, g coinrides with p, at P', g coincicles nith p' and nhen G is in the middle of the segment PP', g makes an angle of 45° with rhe plane d, p. Then think of a second line g' doing the same thing, but winding in the other direction. The line d is a double line on the resulting surface. The planes containing the pairs of intersecting lines g, g' are all parallel to a fixed plane; they intersect in an ideal line d' which also lies on the surface.

By taking d for the z axis, $x-y=0$, $z=h$ for p, $x+y=0$, $z=-h$ for p', the equation has the form

$$z(x^2+y^2)=2hxy.$$

Every ruled cubic mith two distinct directrix lines can be projected into this form.

The General Complex.—An algebraic equation homogeneous and of order n in p_{ik}, together with the identity $P=0$ defines a complex of order n. By holding one point (y) fixed, the points (x) which satisfy the equation all lie on a cone of order n, having (y) as vertex. Similarly, the lines of the complex which lie in a fixed plane all touch a curve of class n. For an arbitrary point, the complex cone has no multiple or cuspidal generators, and in an arbitrary plane the complex curve has no double or inflexional tangents. A point (y) nhich is the vertex of a cone having a double generator is called a *singular point*. The locus of the singular points is a surface. Similarly, the plane (u) mhich contains a complex curve with a double or inflexional tangent is called a *singular plane*. The envelope of the singular planes is identical mith the locus of the singular points. It is called the *surface of singularities;* in particular cases it may be simply a curve.

A congruence may be the complete or partial intersection of two complexes. If it is algebraic the number of its lines passing through an arbitrary point is called its *order,* the number in an arbitrary plane is called its *class*. Let p be any line of a congruence, the distance from p to consecutive lines of the congruence is a certain differential expression of the first order. mhich vanishes to the third order for two points P, P' on p. These are called *foci,* and their locus, as p describes the given congruence, is the *focal surface,* to which p is a bitangent. P and P' may describe the same surface. or different surfaces, or either or both may describe a curve. In the last case the congruence consists of the lines which intersect both curves Congruences of lines are of particular importance in differential geometry (*q.v.*), both metric and projective, *e.g.,* that formed as lines of curvature, asymptotic lines, etc., and that formed by the tangents to one parameter systems of curves on a surface, as by the normals to a surface. They are also of importance in optics.

The complete or partial intersection of three complexes is a *ruled surface*. The number of its lines which meet a given line is its *order*, which is also its *class*. For every order greater than two, a con-conical ruled surface must have one or more double curves. Every plane section is either proper or, if composite, must consist of one proper curve and of straight lines, counted simply or multiply. All the plane section?, apart from straight-line components, are birationally equivalent (their points are in one-to-one correspondence), hence if the surface is algebraic all have the same genus, which may be called the genus of the ruled surface. These ruled surfaces of maximum genus for a given order are those contained in a linear congruence. If all the generators of a ruled surface are tangents to a curve C, the surface is called a *developable surface*. Then C appears on the surface as a cuspidal curve. The surface also contains double curves, if the order of the curve C is greater than 3.

Every generator of a non-developable ruled surface of order n meets $n-2$ other generators.

The Quadratic Complex.—If $\phi=0$ is the equation of the complex of order 2, then the lines belonging to it satisfy the equation $\phi+\lambda P=0$ for every value of λ. When the discriminant of this form has six distinct roots Xi, the equation can be reduced to $\phi=\Sigma\lambda_i x_i^2=0$ when $P=\Sigma x_i^2=0$. The surface of singularities is in this case the most general Kummer surface of order and class 4, with 16 double points and 16 singular planes, *i.e.,* planes which touch the surface at every point of a conic. Each conic passes through six double points, and each double point lies on six such conics. The same surface is also a complete focal surface for six congruences of order and class 2, namely those defined by $\phi=0$, $x_i=0$ $(i=1, 2, \ldots, 6)$.

The surface is invariant under the operation of interchanging the points of contact of the lines of each congruence; these generate a finite group of order 32, of which 16 are harmonic homologies, and 16 are involutorial correlations. For particular forms of ϕ, corresponding particularities exist in the Kummer surface. Thus, if $\phi=\Sigma a_{ik}p^2_{ik}=0$, the complex consists of lines mhich intersect two given quadrics harmonically. The surface of singularities is now the tetrahedroid. The six nodes on each conic are in involution. It is a projective generalization of the wave surface of Fresnel. This complex is known as Battaglini's complex. Another particularization is that in which the λ-discriminant is a square and each λ_i makes every first minor vanish. The complex consists of the lines which meet the faces of a fixed tetrahedron in projective tetrads. The surface of singularities consists of the faces of the tetrahedron. This complex is called the *tetrahedral complex.* The first systematic study of the quadratic complex was made by Battaglini, who assumed, erroneously, that the most general one could be expressed as a linear function of the squares of the p_{ik}.

The correction of this error led to the complete classification according to the form of the X-discriminant, thus affording one of the early applications to the theory of elementary divisors. The Kummer surface also furnished one of the first illustrations of a surface nhich remains invariant under an infinite number of distinct birational transformations, but this property is shared by the focal surface of many other congruences. Line geometry shows close connection among various branches of mathematics.

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LINEN AND LINEN MANUFACTURES. Under the name of linen are included all the yarns spun and fabrics woven from flax fibre. (*See* FLAX.)

From the earliest periods of human history till almost the close of the 18th century linen manufacture was one of the most extensive and widely disseminated of the domestic industries of European countries. The industry was most largely developed in Russia, Austria, Germany, Holland, Belgium, the northern provinces of France, and certain parts of England, in the north of Ireland. and throughout Scotland; and in these countries its importance was generally recognized by the enactment of special laws, having for their object the protection and extension of the trade. The inventions of Arkwright, Hargreaves and Crompton in the later part of the 18th century, benefiting almost exclusively the art of cotton-spinning, and the unparalleled development of that branch of textile manufactures, largely due to the ingenuity of these inventors, gave the linen trade as it then existed a fatal blow. Domestic spinning, and with it hand-loom weaving, immediately began to shrink; the trade which had supported whole villages and provinces entirely disappeared, and the linen manufacture, in attenuated dimensions and changed conditions, took refuge in special localities, where it resisted, not unsuccessfully, the further assaults of cotton, and, with varying fortunes, rearranged its relations in the community of textile industries. The linen industries of the United Kingdom were the first to suffer from the aggression of cotton; more slowly the influence of the rival textile reached other countries.

In 1810 Napoleon I. offered a reward of 1,000,000 francs to any inventor who should devise the best machinery for the spinning of flax yarn. Within a few weeks thereafter Philippe de Girard patented in France important inventions for flax spinning by both dry and wet methods. His inventions, however, did not receive the promised reward and were neglected in his native country. In 181j he was invited by the Austrian Government to establish a spinning mill at Hirtenberg, near Vienna, which was run with his machinery for a number of years, but it failed to prove a commercial success. In the meantime English inventors had applied themselves to the task of adapting machines to the preparation and spinning of flax. The foundation of machine spinning of flax was laid by John Kendrew and Thomas Porthouse, of Darlington, who, in 1787, secured a patent for "a mill or machine upon new principles for spinning yarn from hemp, tow, flax or wool." By innumerable successive improvements and modifications, the invention of Kendrew and Porthouse developed into the perfect system of machinery with which, at the present day, spinning-mills are furnished; but progress in adapting flax fibres for mechanical spinning, and linen yarn for weaving cloth by power-loom was much slower than in the corresponding case of cotton.

Modern Methods of Manufacture.— The modern manufacture of linen divides itself into two branches, spinning and weaving, to which may be added the bleaching and various finishing processes, which, in the case of many linen textures, are laborious undertakings and important branches of industry. The flax fibre is received in bundles from the scutch mill, and, after having been classed into various grades according to the quality of the material, is labelled and placed in the store ready for the flax mill. The whole operations in yarn manufacture comprise (1) hackling, (2) preparing, and (3) spinning. For cominoner types of yarn, a process known as carding replaces that of hackling.

Hackling.— This first preparatory process consists not only in combing out, disentangling and laying smooth and parallel the separate fibres, but also serves to split up and separate the strands of fibre which, up to this point, have been agglutinated together. The hackling process was originally performed by hand. and it was one of fundamental importance, requiring the exercise of much dexterity and judgment. The broken, ravelled and short fibres, which separate out in the hackling process, form tow, an article of inferior value to the spinner. A good deal of hand-hackling is still practised, especially in Irish and continental mills; and it has not been found practicable, in any case, to dispense entirely with a rough preparation of the fibre by hand labour. In hackling by hand, the hackler takes a handful or "strick" of rough flax, winds the top end around his hands, and then, spreading out the root end as broad and flat as possible, by a swinging motion dashes the fibre into the hackle teeth or needles of the rougher or "ruffer." The rougher is a board plated with tin and studded with spikes or teeth of steel about jin. in length, which taper to a fine sharp point. The hackler draws his strick several times through this tool, working gradually up from the roots to near his hand, till in his judgment the fibres at the root end are sufficiently combed out and smoothed. He then seizes the root end and similarly treats the top end of the strick. The same process is again repeated on a similar tool, the teeth of which are jin. long and much more closely studded together, and for the finer counts of yarn a third and a fourth tool may be used, of still increasing fineness and closeness of teeth. In dealing uith certain varieties of the fibre, for fine spinning especially, the flax is, after roughing, broken or cut into three lengths—the top, middle and root ends. Of these the middle cut is most valuable, being uniform in length, strength and quality. The root end is more woody and harsh, while the top, though fine in quality, is uneven and variable in strength. From some flax of extra length it is possible to take two short middle cuts; and, again, the fibre is occasionally only broken into two cuts Flax so prepared is known as "cut line," in contradistinction to "long line" flax which is the fibre unbroken. The subsequent treatment of line, whether long or cut, does not present sufficient variation to require further reference to these distinctions.

In the case of hackling by machinery, the flax is first roughed and arranged in stricks, as above described under hand hackling. In the construction of hackling machines, the general principles of those now most commonly adopted are identical. The machines are known as vertical sheet hackling machines, their essential features being a set of endless leather bands or sheets revolving over a pair of rollers in a vertical direction. These sheets are crossed by iron bars, to which hackle stocks, furnished with teeth, are screwed. The hackle stocks on each separate sheet are of one size and gauge, but each successive sheet in the length of the machine is furnished with stocks of increasing fineness, so that the hackling tool at the end where the flax is entered is the coarsest, say about four pins per inch, whereas that to which the fibre is last submitted has the smallest and most closely set teeth. The finest tools may contain from 45 to 60 pins per inch. Thus the whole of the endless vertical revolving sheet presents continuous series of hackle teeth, and the machines are furnished with a double set of such sheets revolving face to face, so close together that the pins of one set of sheets intersect those on the opposite stocks. Overhead, and exactly centred between these revolving sheets, is the head or holder channel, from which the flax hangs down while it is undergoing the hackling process on both sides. The flax is fastened in a holder consisting of two heavy flat plates of iron, between which it is spread and tightly screwed up. The holder is 11in. in length, and the holder channel is fitted to contain a line of six, eight or 12 such holders, according to the number of separate bands of hackling stocks in the machine. Tbe head or holder channel has a falling and rising motion by which it first presents the ends and gradually more and more of the length of the fibre to the hackle teeth, and, after dipping down the full length of the fibre exposed, it slowly rises and lifts the flax clear of the hackle stocks. By a reciprocal motion all the holders are then moved forward one length; that at the last and finest srt of stocks is thrown out, and place is made for filling in an additional holder at the beginning of the series. Thus with a six-tool hackle, or set of stocks, each holder full of flax from beginning to end descends into, and rises from, the hackle teeth six times in travelling from end to end of the machine. The root ends being thus first hackled, the holders are shot back along an inclined plane, the iron plates unclamped, the flax reversed, and the top ends are then submitted to the same hackling operation The tow made during the hackling process is carried down by the pins of the sheet, and is stripped from them by means of a circular brush placed immediately under the bottom roller. The brush revolves in the same direction as, but quicker than the sheet, consequently the tow is withdrawn from the pins. The tow is then removed from the brush by a doffer roller, from which it is finally removed by a doffing knife. This material is then carded by a machine similar to, but finer than, the one described under **JUTE** (*q.v.*). The hackled flax, however, is taken direct to the preparing department. In the machine just described the work is usually performed by four operatives, who feed in the holders, remove them at the opposite end, and change the stricks of flax—end for end—in the holders. The automatic hackling machine does all this work except that of the first feed. The holders are removed, the nuts unscrewed, the flax turned, the nuts screwed tight and the furnished folder replaced in the machine by ingenious mechanism. Further, in some machines, the hackled stricks are mechanically fed into the spread-board—a type of drawing frame.

Preparing.—The various operations in this stage have for their object the proper assortment of dressed line into qualities fit for spinning, and the drawing out of the fibres to a perfectly level and uniform continuous ribbon or sliver, containing throughout an equal quantity of fibre in any given length. From the hackling the now smooth, glossy and clean stricks are taken to the sorting room, where they are assorted into different qualities by the "line sorter," who judges by both eye and touch the quality and capabilities of the fibre. So sorted, the material is passed to the spreading and drawing frames, a series or system of machines all similar in construction and effect. The essential features of the spreading frame are: (1) the feeding cloth or creeping sheet, which delivers the flax to (2) a pair of "feed and jockey" rollers, which pass it on to (3) the gill frame or fallers. The gill frame consists of a series of narrow hackle bars, with short closely studded teeth, which travel between the feed or retaining rollers and the drawing or "boss and pressing" rollers to be immediately attended to. The fallers are moved forward, at a slightly greater speed than that of the retaining rollers, by means of spiral screws, and the flax fibres are drawn out or attenuated by the drawing rollers; meanwhile the fibres are straightened between the gill pins of the fallers. When the fallers successively approach within a short distance of the drawing rollers, they are pushed downwards into a lower plane to be carried backwards by a similar but coarser spiral screw to a point near the retaining roller, when they are pushed upwards to repeat the cycle. They thus form a field of pins or an endless moving level toothed platform for carrying away the flax from the feed rollers. This is the machine in which the fibres are, for the first time, formed into a continuous length termed a sliver. In order to form this continuous sliver, it is necessary that the short lengths of flax should overlap each other on the spread sheet or creeping sheet. This sheet contains four or six divisions, so that four or six lots of overlapped flax are moving at the same time towards the first pair of rollers—the boss rollers or retaining rollers. The fibre passes between these rollers and is immediately caught by the rising gill pins which carry the fibre towards the drawing rollers. The pins of the gills should pass through the fibre so that they may have complete control over it. The fibre is thus carried forward to the drawing rollers, which have a surface speed of from ten to 30 times that of the retaining rollers. The great difference between the speeds of the retaining and drawing rollers results in each sliver being drawn out to a corresponding degree. Finally all the slivers are run into one and in this state are passed between the delivery rollers into the sliver cans. Each can should contain the same length of sliver, a common length being 1,000yd. A bell is automatically rung by the machine to warn the attendant that the desired length has been deposited into the can. From the spreading frame the cans of sliver pass to the drawing frames, where from four to 12 slivers combined are passed through feed rollers over gills, and drawn out by drawing rollers to the thickness of one. A third and fourth similar doubling and drawing may be embraced in a preparing system, so that the number of doublings the flax undergoes, before it arrives at the roving frame, may amount to from 1,000 to 100,000, according to the quality of yarn in progress. Thus, for example, the doublings on one preparing system may be $6 \times 12 \times 12 \times 12 \times 8 = 82,944$. The slivers delivered by the last drawing frame are taken to the roving frame, where they are passed singly through feed rollers and over gills, and, after drafting to sufficient tenuity, they are slightly twisted by flyers and wound on bobbins, in which condition the material—termed "rove" or "rovings"—is ready for the spinning frame.

The preparation of tow for spinning differs in essential features from the processes above described. Tow from different sources, such as scutching tow, hackle tow, etc., differs considerably in quality and value, some being very impure, filled with woody shives, etc., whereas other kinds are comparatively open and clean. A preliminary opening and cleaning is necessary for the dirty, much-matted tows, and in general thereafter they are passed through two carding engines called respectively the breaker and the finisher cards till the slivers from their processes are ready for the drawing and roving frames. In the case of fine clean tows, on the other hand, passing through a single carding engine may be sufficient. The processes which follow the carding do not differ materially from those followed in the preparation of rove from line flax.

Spinning.—The spinning operation, which follows the roving, is done in two principal ways, called respectively dry spinning and wet spinning; the first being used for the lower counts or heavier yarns, while the second is exclusively adopted in the preparation of fine yarns. There is also a demi-sec method of spinning employed in some mills. The spinning frame does not differ in principle from the throstle spinning machine used in cotton manufacture. The bobbins of flax rove are arranged in rows on each side of the frame (the spinning frames being all double) on pins in an inclined plane. The rove passes downwards through an eyelet or guide to a pair of nipping or retaining rollers between which and the final drawing rollers, placed in the case of dry spinning from 18in. to 22in. lower down, the fibre receives its final draft while passing over and under cylinders and guide-plate, and attains that degree of tenuity which the finished yarn must possess. From the last rollers the now attenuated material, in passing to the flyers, receives the degree of twist which compacts the fibres into the round hard cord which constitutes spun yarn; and from the flyers it is wound on the more slowly rotating spool within the flyer arms, centred on the top of the spindle. The amount of twist given to the thread at the spinning frame varies from 1·5 to 2 times the square root of the count. In wet spinning the general sequence of operations is the same, but the rove, as unwound from its bobbin, first passes through a trough of water heated to about 150° F.; and the interval between the two pairs of rollers in which the drawing out of the rove is accomplished is very much shorter. The influence of the hot water on the flax fibre appears to be that it softens the gummy substance which binds the ultimate fibres together, and thereby allows these fibres to a certain extent to be drawn out without breaking the continuity of the fibre; and further it makes a finer, smoother and more uniform strand than can be obtained by dry spinning. The extent to which the original strick of flax as laid on the feeding roller for (say) the production of a 50 lea yarn is by doublings and drawings extended, when it reaches the spinning spindle, may be stated thus: 35 times on spreading frame, 15 times on first drawing frame, 15 times on second drawing frame, 14 times on third drawing frame, 15 times on roving frame and 10 times on spinning frame, in all 16,537,500 times its original length, with $8 \times 12 \times 16 = 1,536$ doublings on the three drawing frames. That is to say, 1yd. of hackled line fed into the spreading frame is spread out, mixed with other fibres, to a length of about 9,400m. of yarn, when the above drafts obtain. The drafts are much shorter for the majority of yarns.

The next operation is reeling from the bobbins into hanks. By act of parliament, throughout the United Kingdom the standard measure of flax yard is the "lea," called also in Scotland the "cut" of 300 yards. The flax is wound or reeled on a reel having a circumference of 90in. ($2\frac{1}{2}$yd.) making "a thread," and 120 such threads form a lea. The grist or count of all fine yarns is estimated by the number of leas in 1lb.; thus "50 lea" indicates that there are 50 leas or cuts of 300yd. each in 1 lb. of the yarn so denominated. With the heavier yarns in Scotland the quality is indicated by their weight per "spyndle" of 48 cuts or leas; thus "3 lb. tow yarn" is such as weighs 3 lb. per spyndle, equivalent to "16 lea," because jute count $\times$ lea count $= 48 \therefore \frac{48}{16}$ lea $= 3$ lb. per spyndle.

The hanks of yarn from wet spinning are either dried in a loft with artificial heat in one of the many modern hank-drying machines or exposed over ropes in the open air. When dry they are twisted back and forward to take the wiry feeling out of the yarn, and made up in bundles for the market as "grey yarn." English spinners make up their yarns into "bundles" of 20 hanks, each hank containing 10 leas; Irish spinners make hanks of 12 leas, $16\frac{2}{3}$ of which form a bundle; Scottish manufacturers adhere to the spyndle containing 4 hanks of 12 cuts or leas.

Commercial qualities of yarn range from about 6 lb. tow yarns (8 lea) up to 160 lea line yarn. Very much finer yarn up even to 400 lea may be spun from the system of machines found in many mills; but these higher counts are only used for fine thread for sewing and for the making of lace. The highest counts of cut line flax are spun in Irish mills for the manufacture of fine cambrics and lawns which are characteristic features of the Ulster trade. Exceedingly high counts have sometimes been spun by hand, and for the preparation of the finest lace threads it is said the Belgian hand spinners must work in damp cellars, where the spinner is guided by the sense of touch alone, the filament being too fine to be seen by the eye. Such lace yarn is said to have been sold for as much as £240 per pound. In the Great Exhibition of 1851, yarn of 760 lea, equal to about 130m. per lb. was shown which had been spun by an Irish woman 84 years of age. In the same exhibition there was shown by a Cambray manufacturing firm hand-spun yarn equal to 1,200 warp and 1,600 weft or to more than 204 and 272m. per lb. respectively.

Bleaching. — A large proportion of the linen yarn of commerce undergoes a more or less thorough bleaching before it is handed over to the weaver. Linen yarns in the green condition contain such a large proportion of gummy and resinous matter, removable by bleaching, or by benzine previous to bleaching, that cloths which might present a firm close texture in their natural unbleached state would become thin and impoverished in a perfectly bleached condition. Nevertheless, in many cases it is much more satisfactory to weave the yarns in the green or natural colour, and to perform all bleaching operations in the piece. Many manufacturers allow about 20 to 25% of loss in weight of yarn in bleaching from the green to the fully bleached stage, but some bleachers can obtain the desired degree of whiteness with a much lower percentage of loss; and the intermediate stages of boiled, improved, duck, cream, half bleach and three-quarters bleach, all indicating a certain degree of bleaching, have corresponding degrees of loss in weight. The differences in colour resulting from different degrees of bleaching are taken advantage of for producing patterns in certain classes of linen fabrics.

Linen thread is prepared from the various counts of fine bleached line yarn by winding the hanks on large spools, and twisting the various strands, two, three, four or six cord, as the case may be, on a doubling spindle similar in principle to the yarn spinning frame, excepting, of course, the drawing rollers. A large trade in linen thread has been created by its use in the machine manufacture of boots and shoes, saddlery and other leather goods, and in heavy sewing-machine work generally. The thread industry is largely developed at Lisburn, near Belfast, at Johnstone, near Glasgow, Bridport, Dorsetshire, and at Paterson, N.J., United States. Fine cords, net twine and ropes are also twisted from flax.

Weaving. — The difficulties in the way of power-loom linen weaving, combined with the obstinate competition of hand-loom weavers, delayed the introduction of factory weaving of linen fabrics for many years after the system was fully applied to other textiles. The principal difficulty arose through the hardness and inelasticity of the linen yarns, owing to which the yarn frequently broke under the tension to which it was subjected. Competition with the hand-loom against the power-loom in certain classes of work is conceivable, although it is absolutely impossible for the work of the spinning wheel to stand against the rivalry of drawing, roving and spinning frames. To the present day, in Ireland especially, a great deal of fine weaving is done by hand-loom. Warden states that power was applied on a small scale to the weaving of canvas in London about 1812; that in 1821 power-looms were started for weaving linen at Kirkcaldy, Scotland; and that in 1824 Maberly and Company, of Aberdeen, had two hundred power-looms erected for linen manufacture. The power-loom has been in uninterrupted use in the Broadford factory, Aberdeen, which then belonged to Maberly and Company, down to the present day, and that firm may be credited with being the effective introducers of power-loom weaving in the linen trade.

The various operations connected with linen weaving, such as winding, warping, dressing, beaming and drawing-in, do not differ in essential features from the like processes in the case of cotton weaving, etc., neither is there any significant modification in the looms employed. (See WEAVING.) Dressing is a matter of importance in the preparation of linen warps for beaming. It consists in treating the spread yarn with flour or farina paste, applied to it by flannel-covered rollers, the lowermost of which revolves in a trough of paste. The paste is equalized on the yarn by brushes, and dried by passing the web over steam-heated cylinders before it is finally wound on the beam for weaving.

Fabrics. — Linen fabrics are numerous in variety and widely different in their qualities, appearance and applications, ranging from heavy sail-cloth and rough sacking to the most delicate cambrics, lawns and scrims. The heavier manufactures include as a principal item sail-cloth, with canvas, tarpaulin, sacking and carpeting. The principal seats of the manufacture of these linens are Dundee, Arbroath, Forfar, Kirkcaldy, Aberdeen and Barnsley. The medium weight linens, which are used for a great variety of purposes, such as tent-making, towelling, covers, outer garments for men, linings, upholstery work, etc., include duck, huckaback, crash, tick, dowlas, osnaburg, low sheetings and low brown linens. Plain bleached linens form a class by themselves, and include principally the materials for shirts and collars and for bed sheets. Under the head of twilled linens are included drills, diapers and dimity for household use; and damasks for table linen, of which two kinds are distinguished — so-called single or five-leaf damask, and double or eight-leaf damask, the pattern being formed by the intersection of warp and weft yarns at intervals of five and eight threads of yarn respectively. The fine linens are cambrics, lawns and handkerchiefs; and lastly, printed and dyed linen fabrics may be assigned to a special though not important class. In a general way it may be said regarding the British industry that the heavy linen trade centres in Dundee and the adjoining counties; medium goods are made in most linen manufacturing districts; damasks are chiefly produced in Belfast. Dunfermline and Perth; and the fine linen manufactures have their seat in Belfast and the north of Ireland Leeds and Barnsley are the centres of the linen trade in England.

Linen fabrics have several advantages over cotton, resulting principally from the microscopic structure and length of the flax fibre. The cloth is much smoother and more lustrous than cotton cloth; and, presenting a less "woolly" surface, it does not soil so readily, nor absorb and retain moisture so freely, as the more spongy cotton; and it is at once a cool, clean and healthful material for bed-sheeting and clothing. Bleached linen, starched and dressed, possesses that unequalled purity, gloss and smoothness which make it alone the material suitable for shirt-fronts, collars and wristbands; and the gossamer delicacy, yet strength, of the thread it may be spun into fits it for the fine lace-making to which it is devoted. Flax is a slightly heavier material than cotton, while its strength is about double. (T. W.)

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LINEN FOLD, a panel decoration of the late Gothic period common in north Europe and England, especially used in woodwork, for wainscots, screens, chests. etc., and consisting of a representation of folded or pleated cloth or parchment, with the folds vertical. Certain 14th century French woodwork already shows panels thickened at the centre, with concave surfaces at each side; this thickness is terminated at top and bottom by curved lines. An additional scrolling or pleating of the surface developed this simple type into the elaborate linen fold decoration of the following century. Linen fold panels are especially common in the flamboyant work of France and in late Gothic in Flanders; it is probably through Flemish influence that they were introduced into England.

LINEN-PRESS, a contrivance, usually of oak, for pressing sheets, table napkins and other linen articles! resembling a modern office copying-press. Linen-presses were made chiefly in the 17th and 18th centuries, and are now chiefly interesting as curiosities of antique furniture.

LINER, a colloquial term used to describe large ocean-going passenger ships. *(See* SHIP.)

LINE SPECTRA: *see* SPECTROSCOPY.

LING, PER HENRIK (1776–1839), Swedish medical-gymnastic practitioner, was born at Ljuna. After taking his degree in divinity in 1797 he travelled abroad, earning a precarious living by teaching. In 1804 he returned to Sweden and became teacher of fencing at the University of Lund. He then took the medical course and elaborated a system of gymnastics, divided into four branches: (1) pedagogical, (2) medical. (3) military, (4) aesthetic. In 1813 Ling became principal of the Royal Gymnastic Central institute opened in Stockholm for the training of gymnastic instructors. In recognition of his introduction of gymnastics for therapeutic purposes, popularly known as the "movement cure" or Swedish massage, the Swedish General Medical association elected him a member in 1831.

Ling's collected works *(Samlade Arbeten)* were published in three volumes (1859–65).

LING (*Molva molva*), a food fish of the cod family, elongate in form: with terminal mouth. strong canines in the lower jaw, a short first dorsal fin, a long second dorsal and anal, and a rounded caudal.

It is a deep-water fish, ranging from Iceland and northern Europe to the Bay of Biscay; it is piscivorous, and reaches a length of 7 feet.

LING: *see* ERICACEAE; HEATH.

LINGARD, JOHN (1771–1851), English historian, mas born on Feb. 5. 1771, at Winchester. Educated at the English college at Douai, where he spent some time as tutor in the family of Ldrd Stourton, in Oct. 1794 he settled along with seven other former members of the old Douai college at Crook hall near Durham, where on the completion of his theological course he became vice-president of the reorganized seminary. In 1795 he was ordained priest, and soon afterward undertook the charge of, the chairs of natural and moral philosophy. In 1808 he accompanied the community of Crook hall to the new college at Ushaw. Durham, but in 1811, after declining the presidency of the college at Maynooth, he withdrew to the secluded mission at Hornby in Lancashire, where for the rest of his life he devoted himself to literary pursuits.

In 1817 he visited Rome, where he made researches in the Vatican library. In 1821 Pope Pius VII created him doctor of divinity and of canon and civil law; and in 1825 Leo XII is said to have made him cardinal *in petto*. He died at Hornby on July 17, 1851.

Lingard wrote *The Antiquities of the Anglo-Saxon Church* (1806), of which a third and greatly enlarged edition appeared in 1845 under the title *The History and Antiquities of the Anglo-Saxon Church; containing an account of its origin, government, doctrines, worship, revenues, and clerical and nzonastic institutions;* but the work with which his name is chiefly associated is *A History of England, from the first invasion by the Romans to the Commencement of the reign of William 111* (8 vols., 1819–30).

See the notice by Tierney prefixed to vol. x of the 6th ed. of the *History* (1854–55); and M. Haile and E. Bonney, *Life and Letters of John Lingard* (London. 1911).

LINGAYATS. An independent Saiva sect, or, indeed. the only strictly Saiva sect, are the *Vīra Saivas,* more commonly called *Lingayats* (popularly Lingaits) or *Lingavats*, from their practice of wearing on their person a phallic emblem of Siva, made of copper or silver, and usually enclosed in a case suspended from the neck by a string. Apparently from the movable nature of their badge, their *Gurus* are called *Jangamas* ("movable"). This sect counts numerous adherents in southern India. The reputed founder, or rather reformer, of the sect was Basava (or Basaba), a Brahmin of the Belgaum district who seems to have lived in the 11th or 12th century. According to the Basava-purana he early in life renounced his caste and went to reside at Kalyana, then the capital of the Chalukya kingdom, and later on at Sangamesvara near Ratnagiri, where he was initiated into the Vira Saiva faith which he subsequently made it his life's work to propagate.

Basava's doctrine, a kind of reaction against the severe sacerdotalism of Sankara, has spread over all classes of the southern community, most of the priests of Saiva temples there being adherents of it; while in northern India its votaries are only occasionally met with. and then mostly as mendicants, leading about a neatly caparisoned bull as representing Siva's sacred bull *Nandi.*

LINGAYEN, a municipality (with administrative centre and 23 *barrios* or districts) and capital of the province of Pangasinan, Luzon, Philippine Islands, about 110 mi. N. by W. of Manila, on the south shore of the Gulf of Lingayen, and on a low and fertile island in the delta of the Agno river. Pop. (1960) 45,039. Palay (rice) is the principal crop. Fishing is also a leading industry, and wine is made from the nipa palm.

The Pangasinan language is the vernacular. Lingayen was a principal landing point for Japanese troops in their drive southward to Manila in Dec. 1941.

LINGEH, a port town of Iran on the shores of the Persian gulf in 26" 33' N., 54° 53' E., about 300 mi. S.E. of Bushire in Fars *(ostan* 7).

The old port was at Kung, 7 mi. E. where the Portuguese had a "factory" and exercised political and commercial influence long after the loss of Hormuz (*q.v.*) until 1711. During the reign of the Zand dynasty, Lingeh was seized by Arabs from Ras-al-Khaimah who retained possession till 1887 when the Persian government re-established its authority. The population in 1956 was 4,920.

The town, comparatively well built and of pleasing appearance from the sea, extends for about a mile along the shore but, with the exception of an extensive belt of date palms, the surroundings are extraordinarily arid and the hills at the back of the town, which rise to 3,937 ft., render communications with Lar and the hinterland difficult. There is no harbour for larger vessels and the anchorage is about three-quarters of a mile offshore in 5 fathoms. Lingeh has a good reputation for boatbuilding and repairing. At one time it rivalled Bahrein as a centre for the collection and export of pearls; but the headquarters of the trade is on the Arabian coast.

Exports were fresh and dried fruits, carpets, skins, flax, tobacco, gum and assafoetida, chiefly to India. Steamers of the British India Steam Navigation company call fortnightly in each direction. There is a wireless station which communicates with the rest of the world through Henjam.

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LINGEN, town of Lower Saxony, Federal Republic of Germany. on the Ems canal; 43 mi. N.N.W. of Münster. Pop. (1959 est.) 24,636. It has manufactures of paper, sausages and trade in cattle. Among other industries are weaving and ore mining. Lingen was the seat of a university from 1685 to 1819. The county of Lingen in 1508 was divided into an upper and a lower county, but the two were united in 1541. A little later Lingen was sold to the emperor Charles V, and passed in 1597 to Maurice. prince of Orange. After the death of the English king, William III. in 1702, it passed to the king of Prussia, and in 1815 the lower county was transferred to Hanover, only to be united again with

Prussia in 1866.

LINGUA FRANCA is an auxiliary or compromise language used between peoples speaking mutually incomprehensible vernaculars. It may be one of a number of native languages like Swahili in east Africa, Hausa in nest Africa. and Hindustani in India; or it may be a mixed jargon like the pidgin English of the western Pacific or the Sabir (a mixture of French, Italian. Spanish, Greek and Arabic) of the Mediterranean ports.

The term lingua franca was perhaps first applied to a jargon based on southern French and Italian which crusaders and traders developed in the eastern Mediterranean during the middle ages Extension of trade routes, overseas colonization and slavery during and after the Renaissance, gave rise to a number of mixed contact jargons like Indo-Portuguese (Ceylon), Annamito-French (Cochin China), Spanish Papiamento (Curaçāo) and several varieties of pidginized English—all based on the languages of the colonizing nations.

Origin.—Such jargons generally begin as a compromise between two groups, each desiring to communicate, but unwilling or unable to learn the language of the other. The European may try to make himself understood by imitating the native's effort to speak the European language. The native, taking this imperfect imitation as a model, tries to reproduce it as best he can with the pronunciation and some of the grammatical structure of his own language. thus giving the European further distortions to imitate—and so on until a new compromise language is developed. In plantations. slaves from mutually unintelligible tribes got their model from infrequent contacts with European masters and used their vague impressions of their masters' language as a basis of a lingua franca for communication among themselves.

Spread.—The more polyglot an area, the better the chance for a lingua franca to spread. Thus Beach-la-mar or Sandalwood English became an important language in Melanesia where neighbouring villages might speak distinctly different languages: but not so in Polynesia where many dialects are mutually intelligible. Linguistic diversity in the American northwest was largely responsible for the spread of the Chinook jargon, a lingua franca based on Chinook and other American Indian languages, with English admixture. It became the trade language used not only between white traders and Indians. but also between different Indian tribes; and for a time it was the native language of the offspring of Oregon squaws and French-Canadian *voyageurs.*

When such jargons supplant the mother tongue they become known as Creole languages. Examples of these are Haitian French Creole. Cape Verde Portuguese, and Taki-Taki, a language developed out of a jargonized English used by the African slaves of English and Portuguese landholders who settled in Dutch Guiana in the middle of the 17th century.

Some contact vernaculars may thus develop into written and standardized national languages. Malay. a compromise of various Malayo-Polynesian languages, was used as a lingua franca in Bntish Malaya and the Dutch East Indies and later became the national language of the Republic of Indonesia.

See also BILINGUALISM; PIDGIN. (W. F. MY.)

LINGUET, SIMON NICOLAS HENRI (1736-1794), French journalist and advocate, was born on July 14, 1736, at Rheims. He was admitted to the bar in 1764, where he became one of the most famous pleaders of his century. but was dismissed in 1775 on account of his bitter attacks against his fellow advocates, especially against Gerbier (1725–88). He then founded the *Journal de politique et de littérature,* but was compelled to resign and leave the country after the publication of a sarcastic article on the French academy. After some years as a free-lance abroad, publishing the *Annales politiques, civiles et littéraires* in London and Brussels, he attempted to return to France in 1780, and was imprisoned for two years for an attack on the duc de Duras (1715–89). After a further period abroad he returned to France in 1786 as an Austrian councillor of state, and obtained 24,000 livres from the duc d'Aiguillon for legal services rendered some 1j years earlier His fame at the time surpassed that of his rival Pierre Beaumarchais He then visited the emperor at Vienna to plead the case of Van der Noot and the rebels of Brabant. On his return to Paris in 1791 he defended the rights of San Domingo before the national assembly; his last work was written in defense of Louis XVI. He retired to Marnes, near Ville d'Avray to escape the Terror. but was captured and guillotined at Paris on June 27, 1794, on the charge of "having flattered the despots of Vienna and London."

Linguet's writings include *Histoire du siècle d'Alexandre le Grand* (1762); *Histoire impartiale des Jésuites* (1 768, condemned to be burned); *Fanatisme des philosophes* (1 764); *Histoire des révolutions de l'empire romain* (1766–68); *Théorie des lois civiles* (an attack on the politics of Montesquieu. 1767); *Mémoires sur la Bastille* (1789). His best legal treatise is *Mémoire pour le comte de Morangies* (1; 72).

LINGUISTICS is the science devoted to the study of language and languages in all their aspects—their structure, their interrelationship with the rest of human activity, their history and mutual relations. It is an analytical science, resembling mathematics in many of its procedures. and can be called a "natural science" because it deals with the observation of discreet behaviour events. It is a social science. a branch of anthropology, in that it examines a part of human behaviour and the relation of language to the totality of human culture. It also deals with and impinges upon the humanities, taking its source materials partly from literary and other artistic creations, and studying history as well as contemporary activity.

Linguistics as a scientific discipline can be treated in terms of the following topics: history and development of the subject from antiquity to modern times in various parts of the world; analytical methods and procedures for the study of the sounds and forms of language; relationships of languages; application to problems of pedagogy and education in general; model and example for the study of human behaviour as a whole, including human history.

For other aspects of linguistics, *see* the articles PHILOLOGY; PHONETICS; GRAMMAR; LAKGUAGE; TEXTUAL CRITICISM; FOLKLORE; ETYMOLOGY; SEMANTICS IK LINGUISTICS. Some of these subjects are independent disciplines, others part of the integrated science of linguistics. Linguistics also has a relation to communication as a whole, the use of mass communication media, the psychology of learning, and certain aspects of psychotherapy and mental health.

HISTORY OF LINGUISTICS

Like many sciences. linguistics developed from procedures and observational techniques which were begun in prescientific times and which often produced results that are still valid. Among many peoples there have been sacred texts and other materials which were supposed to be preserved unaltered. This seems to have led to an attitude of observation of the details of linguistic usage which could serve as the basis for the kind of generalizations that are called grammatical statements. One place where this happened was ancient India. Their sacred texts, the Vedas, were studied and learned with the greatest care, and a tradition of grammatical examination of them arose. This tradition has come down to modern times in the compilation attributed to one Pāṇini, and in the restatements of and commentaries on his work. Pāṇini was the first precursor of modern linguistics. He based his statements on the direct observation of the actual language material in the texts he analyzed. and he expressed them in quasi-mathematical symbols. In many aspects his methods have not been improved upon since.

In another time and place, ancient Greece, there was also extant a large literature which was constantly being studied and transmitted. There, however, the attitude was a general one of interest in the phenomena of the universe, and of trying to interpret them philosophically. The Greeks developed a grammatical tradition which described their language with reasonable accuracy, but couched the description in philosophical rather than scientific terms. This philosophical grammar was passed on to the Latins, who followed it with some uneasiness. as their language was sufficiently different from Greek to require differences in analysis. This classical Graeco-Roman tradition lingered on in mediaeval

Europe. and with the coming of the Renaissance this grammatical philosophy began to be applied to the modern languages of Europe. As they were quite diiferent in structure, the classical analysis did not fit. However. couched as it was in philosophical terms, it could be stretched to cover up almost any real structural difference. This happened. and a linguistic science became almost impossible because the traditional philosophical grammar became hallowed with approved authority of all kinds.

With the discovery of the new world the linguistic experience of the western peoples widened, but the grammatical tradition made it difficult to record and describe the newly found languages accurately. They were forced into Latin moulds almost everywhere. In the 18th century, however, Europeans became acquainted with the traditions of India, and began to learn Sanskrit. In doing so. they learned about the Indic grammatical school of Piinini and his followers. Immediately, a new view of languages and of grammatical description became possible. As the principles of Piinini's descriptive techniques became known, and more new languages were found in the world. the foundations of modern linguistic analysis became firmer. However. they did not come to full fruition until the end of the 19th century in the Americanist linguistic school (*see* below). The first direct result of the discovery of Sanskrit was to bring about the development of the comparative linguistics of the 19th century: the techniques thus developed were the first scientific linguistics in the western world.

COMPARATIVE LINGUISTICS

Among the 18th century Englishmen in India who learned Sanskrit and began to study Indic literature was Sir William Jones. In 1786 he stated, in an address to a learned society, that the resemblance of Sanskrit to Greek and Latin is too close to be due to chance, and shows that all three "have sprung from some common source which. perhaps, no longer exists," and that Germanic and Celtic probably had the same origin. This is the first recorded recognition of what constitutes language relationship as recognized by modern linguistics. and may thus be counted as the beginning of comparative linguistics.

Before this time, there had been many instances of recognition that certain languages resembled each other, but very little had been done to state the resemblances systematically. In fact, it was simply not realized that the resemblances had to be systematic. Where it was apparent that a language like Italian was somehow a later form of Latin, the attitude was that it was a corruption of a perfect original, and as such hardly to be expected to show regularity and system. The thinking started by Jones led to the giving up of this sort of attitude by all serious scholars in the field. It was recognized that languages change constantly, that the changes are systematic and regular. and that only by careful examination of the changes within a language and comparison of the differences between languages could origins and relationships be established.

For the Indo-European languages, the beginning of systematic comparison was a treatise on verb inflection in Sanskrit. Greek, Latin. Persian and Germanic, published in *1816* by Franz Bopp. In 1818 Rasumus Rask, and in 1819 Jacob Grimm examined the relationships of the Germanic languages to each other. In 1833–36 August Friedrich Pott published his etymological studies of Indo-European. August Schleicher. in 1861, published a comparative grammar of the Indo-European languages, and in *1886* Karl Brugmann and Berthold Delbrück began to publish their *Outline of the Comparative Grammar of the Indo-European Languages*, which remained the standard work of reference in the field. Friedrich Diez studied the Romanic languages in a comparative grammar (1836–44), Johann Kaspar Zeuss began the study of Celtic (1853), and Franz von Miklosich wrote a comparative grammar of the Slavic languages (1852–74).

The interest in comparative linguistics led to the investigation of other language families (Finno-Ugric and Semitic at first), and also to the beginning of the descriptive treatment of contemporary languages without regard to history. That is. 19th century comparative linguistics was actually the beginning of all modern linguistic science, and from it grew what we now call linguistics, so that comparative and historical studies are based on the results of the descriptive method.

It is of interest to show how linguistic comparison of this kind is done and what its results are. If we look at French. Spanish and Italian we see immediately that they show great resemblances to each other. Suppose that these were the only languages of this kind in existence, and that they were known only in their modern forms. with no old texts. We might begin their comparison by making a list of several hundred words in each — numerals, kinship terms, words for parts of the body and for common artifacts, words for people, and so on. For the present purpose Table I gives a short list of this kind. In the listing of words in Table I

TABLE I.—*Examples of Linguistic Comparison*

Meaning	French		Spanish		Italian	
	Word	Pronunciation	Word	Pronunciation	Word	Pronunciation
one	un	øn	un(o)	ún[o]	un(o)	ún[o]
two	deux	dø[z]	dos	dós	due	dúe
three	trois	trua[z]	tres	trés	tre	tré
four	quatre	hatra	cuatro	kwátro	quattro	kwáttro
five	cinq	senk	cinco	θínko	cinque	čínkwe
six	six	sis	seis	séys	sei	séi
seven	sept	set	siete	syéte	sette	sέtte
eight	huit	üit	ocho	óčo	otto	ɔ́tta
nine	neuf	nof	nueve	nwébe	nove	nɔ́ve
ten	dix	dis	diez	dyéθ	dieci	dyέči
father	père	pe·r	padre	pádre	padre	pádre
mother	mère	me·r	madre	mádre	madre	mádre
brother	frère	fre·r	hermano	ermáno	fratello	fratέllo
sister	soeur	sdr	hermana	ermána	sorella	sorέlla
man	homme	oma	hombre	ómbre	uomo	wɔ́mo
woman	femme	fama	mujer	musér	donna	dónna
hand	main	men	mano	máno	mano	máno
foot	pied	pie	pie	pyé	piede	py Ede
head	tête	te·ta	cabeza	kabéθa	testa	tέsta
heart	coeur	kør	corazón	koraθón	cuore	kwɔ́re

a phonemic transcription is given, since it is the sounds that are being compared.

In the pronunciation, [*z*] means that the item appears with a *z* sound if a vowel follows. but otherwise does not have it; ϕ is a symbol for the front-rounded vowel usually spelled eu in French (*ö* in German); a indicates the release of the final consonant, varying from a full vowel of the character of the *a* in *sofa* to a mere audible ending of the consonant sound; n after a vowel in French means nasalization of the vowel; e· means a long vowel, something like the English sound in *pair;* ˈ indicates primary stress; [ ] means that the vowel is not always present; *θ* is a symbol representing the Castillian sound, like English *th* in *think*, but in Latin America pronounced like *s;* č is like *ch* in *church;* ε in Italian is the open vowel (more like English e in *set*), while e is a closer vowel (something like *a* in *rate*); ɔ is open, something like *o* in *or*, while o is close, like *o* in *note*.

When these lists are compared and we speculate. from a knowledge of phonetics (*see* below), on what original sounds might have given rise to the present sounds. the original forms can be reconstructed hypothetically. To exemplify the process, each form will be taken up separately.

The word for 'one' shows /ún[o]/ in two languages, /ϕn/ in the third; original /u/ could become/ϕ/—and other material in French confirms this; the final vowel is sometimes not present in Spanish and Italian; it was lost in French, and the /n/ then nasalized the vowel. We reconstruct */úno/ (the asterisk means the form is hypothetical). It will be seen later what this means in the light of the known Latin form *ūnum*.

For 'two' we have /dϕ[z]/ and /dós/ reconstructible to */dós/, but /dúe/ is clearly from some other form.

'Three' reconstructs to */trés/.

'Four' reconstructs to */kwátro/ or */kwáttro/—there is no way to know from this small amount of evidence which one it was.

For 'five' we must postulate an initial sound that could give rise to /č/, /s/, and /θ/—say /č/; the final /we/ in Italian and /o/ in Spanish might go back to an original /o/; we reconstruct */čínko/.

For 'six' we reconstruct */séys/, reserving judgment about the vowel because it has become /i/ in French.

For 'seven' we postulate */sétte/.

Were it not for the Spanish /č/, 'eight' might be */ótto/; but the /č/ suggests */ótyo/ or */óyto/.

For 'nine' we have */nóve/.

'Ten' shows a vowel like 'six' in French. like 'seven' in Spanish and the last consonant is like the initial one in 'five'. We reconstruct */déči/.

The words for 'father' and 'mother' seem to reconstruct to */pádre/ and */mádre/. The French form for 'brother' ought then to go back to */frádre/; but Spanish bas an entirely different form, and Italian shows /frat-/. with what n-e can later establish as a diminutive ending. This suggests that we reconstruct */frátre/ rather than */frádre/; then we extrapolate this result to the two preceding cases. and get */pátre/ and */mátre/. Then. if we say that an original single /t/ became /d/ in Spanish and Italian in this position (after /a/ and before /r/), and disappeared in French with preceding vowel change. we can go back to 'four' and decide that its original form had a double /t/, which remained in Italian, and became single in French and Spanish—*/kwáttro/.

The word for 'sister' can give us only */sor-/ at this stage, since Spanish does not help to establish the form.

'Man' is difficult to reconstruct. When we consider the Italian plural /wómini/ (*uomini*), it becomes possible to set up an original */ómini/ or */ómine/ for the singular, and a plural */ómines/. The Italian singular must be from a form */ómo/.

The words for 'woman' are all different, and cannot be reconstructed.

'Hand' goes hack easily to /máno/, while 'foot' seems to call for an original */pyéde/ or */pede/.

'Head' in French and Italian comes from */tésta/, but Spanish has a different word.

'Heart' must he from */kóre/. Spanish having an added suffix.

As was the case with the */tt/ of 'four' and the */t/ of 'father,' the addition of further material can refine and correct the reconstructions. The final reconstructions. based on all the available linguistic material. look thus: */úno/. */dós/ alternating with */due/. */trés/, */kwáttro/, */čínko/ alternating with /čínkwe/ (*i.e.*, here /o/ and /we/ cannot be from the same source), */séys/, */sέtte/, */óyto/, */nɔ́ve/, */dέči/, */pátre/, */mátre/, */frátre/ for *frère* (*/germáno/ for *hermano*, */fratéllo/ for the Italian form), */sór/ (*/germána/, */sorélla/), */ɔ́mine/ (*/ɔ́mo/), */fémma/ (*molyér/—the Italian has a form *moglie* /mólʸe/ 'wife'), */máno/, */pέde/, *tέsta/ (*/kapétya/), */kɔ́re/ (*/koratyóne/).

When knowledge of Latin is brought in. it is found that the forms differ in some respects from those that gave rise to the modern ones. The classical Latin forms are: *ūnum* (this is the masculine accusative form, which is at the base of the Romanic masculine forms). *duōs* (also acc.), *trēs, quattuor, quīnque, sex, septem, octō, novem decem, patrem* (acc.), *mātrem, frātrem, sorōrem, hominem, fēminam, manum, pedem, caput, cor*. This means that in the spoken Latin that is at the base of the Romanic forms certain words were changed or replaced. or were used differently from classical usage: *duae,* originally the feminine nominative of the numeral 'two,' came to be the only form used in central Italy, and became *due,* while *duōs,* the masculine acc., became */dóos/ and gave rise to *deux, dos; quattuor* was everywhere made more "regular" by becoming */kwáttrum/, *quīnque* became */kínkwe/ in Italy, but */kinko/ in Spain (the French *cinq* could be from either form); in Spain *fratrem* went out of use, to be replaced by *germanus,* originally meaning 'cousin, kinsman,' and the feminine *germana* replaced sorōrem. while in Italy diminutive forms *fratel-121s* and *sorella* came into being; *sorōrem* became */sórem/ and gave rise to *soeur* and *sor(ella); homō,* the nominative. persisted in Italy. becoming *uomo* (it also remained in France, but there came to he the indefinite pronoun *on*), while *hominem* became *homme* and *hombre; fēmina* continued in use in France, but was replaced in Spain by *mulierem* 'wife' (though Spanish also has *hembra* 'female.' from *fēmina*); *caput* was extended to */kapétya/ in Spanish. but replaced by *testu,* originally meaning 'beanpot,' in France and Italy.

From this demonstration the following results of the comparative method in linguistics can he seen. The changes in form in a language must be regular and consistent; where there are inconsistencies they must be explained by postulating replacement forms for those otherwise known. or by postulating more than one original form. The more that" is knon-n about a modern language or about an older one. the better and more complete can be the statements of relationship and of development. Whether we have written records of an ancestral language or not. we can reconstruct from modern languages with successively greater accuracy as we learn more about them and as we have more languages to compare. All kinds of detailed phonological information can be gleaned from the method: in the examples above, we see Latin *h* disappearing, /k/ becoming /č/ or /s/ in certain positions, vowels changing their quality, final consonants being lost. Grammatical changes can be seen in the loss of case distinctions in the modern Romanic languages. Meaning changes are seen in the word replacements.

But from the comparative method only what is still left in the languages can be reconstructed to an original form. Some things get lost irretrievably. So the Latin final *m* of *septem* and *decem* has left no traces and if we didn't have the classical forms we could not even guess at its presence. Similarly, the *p* of *septem* cannot be reconstructed as anything but a *t;* and while the *c* of *octō* has left traces leading to a reconstructed /y/, its original nature is unrecognizable.

On the basis of such reconstructions, language families have been arrived at. The members of such a family, the related languages, are the end products of change from a single original language. (*See* also LANGUAGE.)

DESCRIPTIVE LINGUISTICS

American Anthropological **Linguistics.**—While in Europe during the 19th century there was being elaborated the coniparative method in linguistics. and the interest was largely in historical matters. in America there developed a tradition of studying. in and of themselves. languages whose history and relationships were unknown. Traditional grammatical categories were inapplicable, there were no n-ritten records. apd even in cases of clear relationship. too little n-as known about the related languages to make reconstruction possible.

As early as the 17th century Roger Williams in Rhode Island was describing an Algonkian language under the title of "the language of America." When the American Philosophical society mas founded under the leadership of Benjamin Franklin, a number of its members, including Thomas Jefferson, showed a real interest in American Indian languages and their description.

With the westward expansion of the United States, many American Indian tribes became known to white settlers. and their movements and habits became matters of concern to the United States government. Various government agencies were established to deal with these matters, and some of the persons engaged in the work became interested in the languages of the Indians. Thus began the anthropological tradition in Americanist linguistics.

In 1842 the American Ethnological society n-as founded; one of its principal aims n-as the study of American Indian languages. Some 30 years later the Bureau of American Ethnology was started, as a part of the Smithsonian institution. The first director of the bureau. J. W. Powell. made it his principal interest to describe or at least identify the various languages of the Indians of the country. In 1891 there was published, in the 7th annual report of the bureau for 1885–86. Powell's "Linguistic Families of North America" (pp. 1–142). This work used the already established principles of comparative linguistics to make preliminary classifications of the languages of the Indians of the United States and Canada. Some 55 families were established. so soundly that not one error has been found since. though some of the families have been subsequently combined into larger groups with others. The result of this work was, however, not to lead to immediate further comparative work, but to spur on the study of the individual languages.

In the 1880s Franz Boas began to teach anthropology at Columbia university. Boas was originally trained as a natural scientist. This gave him an attitude that led to his approaching linguistic study as a matter of description and not history. Boas accompanied all his anthropological researches by extensive study of the languages of the people observed. He made all his students do the same. Anthropological linguistics. examining languages in terms of their own structure and regardless of historical considerations, thus became the principal kind of scientific language study in the United States.

While Boas was founding and fostering American anthropology and anthropological linguistics, work was also being done in the United States in the more traditional fields of Indo-European comparative linguistics. Even here, however, an insistence on full and exact description regardless of history was to be found. William Dwight Whitney, professor of Sanskrit at Yale in the 1880s, wrote a Sanskrit grammar that was, in effect, a modern version of Pāṇini's, without the esoteric symbolism. Whitney also wrote hooks on general linguistics.

The students of Whitney and Boas and their associates were thus all imbued with an interest in language description and language structure. The most noted of these were Edward Sapir (1884–1939) and Leonard Bloomfield (1887–1949). Sapir studied under Boas, and was his most brilliant student. He became the leading theoretical linguist in the field of American Indian languages, producing many important studies. In 1916 he published a paper showing the relationship of historical linguistic information to anthropological time perspective. In 1921 he published his *Language*, a general work in linguistic science that is still valued and usable. Sapir also produced, in 1925, a study that was the forerunner of modern phonemics (*see* below), and in the last years of his life, as professor of linguistics and anthropology at Yale, contributed much of great importance to the development of Indo-European comparative studies.

Bloomfield began his career as a traditional comparativist linguist in Indo-European and Germanic studies. He soon began to take an interest in American Indian languages, and in the whole Americanist descriptive tradition. In 1914 he published a general work on linguistics, and in 1933 rewrote it into a new work, entitled *Language*. Bloomfield's *Language* remained the best general introduction to linguistic science and the methods of analysis. Both Bloomfield and Sapir in their years at Yale produced a number of students who became leaders in their field.

The kind of linguistic work done by the Americanists was comparatively rare in other parts of the world. In African languages, there were linguistic studies with theoretical approaches that were similar in many respects to those used in America, and some work of the same kind was done in India, the far east, and with the languages of the Pacific area.

European Structuralist Linguistics.— The great interest in comparative linguistic studies in Europe did not exclude much descriptive work also. In fact, as soon as comparative interests were extended to the lesser known languages, it became clear that extensive descriptive studies would he needed to provide a base for reconstruction. In the fields of the languages of Asia, and for the dialects of the standard languages of Europe, it was necessary to work along many of the same lines as the Americanists employed.

In various countries there were started dialect studies which resulted in dialect atlases. Questionnaires and word lists were compiled, and the ways in which the items were said in different regions were recorded. Dialect atlas work also began in the United States about 1925.

As both descriptive and comparative studies of the kinds mentioned developed, an interest in a number of theoretical problems arose. There was the question of the relation of the language to the things talked about. This was approached in terms of the meaning or content of linguistic forms. The attempt to investigate these matters necessarily required increasing attention to language as a systematic structure, rather than as an aggregate of isolated forms. Ferdinand de Saussure, in his teaching at Geneva, developed a theory of linguistic structure that dealt with these problems. De Saussure as a young man had already exercised his structural bent by suggesting (in 1875) a theoretical approach to the phonological structure of Indo-European that differed markedly from the accepted doctrine as found in the work of Karl Brugmann and his predecessors. De Saussure postulated a relationship between the apparent short and long vowels of proto-Indo-European in which the short vowels were basic, and the long vowels were reconstructed as original sequences of a short vowel and a lengthening element which was described as some kind of h-like consonant. When Hittite was discovered in 1907 and later analyzed it was found that several such consonants had actually existed, and that De Saussure's structural extrapolation had actually been a correct picture of the situation. The theoretical basis of Indo-European studies was greatly reoriented by the developments after this confirmation.

In Russia, working with the structure of the Slavic languages, Jan Baudouin de Courtenay in 1894 produced a study of the phonological structure of these languages in which the modern concepts of phonemes and morphophonemic relationships (*see* below) were set forth for the first time. Various Russian and other European scholars were influenced by Baudouin de Courtenay's ideas, and this resulted in the development, under the leadership of Nicholas Trubetskoy (of Vienna) of the so-called Prague school of phonology. Trubetskoy and his colleagues formulated their principles at a congress of Slavic scholars in Prague in *1929*. The results were published in the first volume of the series known as *Travaux du Cercle Linguistique de Prague*. Modern phonemic analysis as a widespread activity took its start from this set of principles. But, as was noted, Sapir had already, in 1925, put forth ideas that anticipated these principles, and others of the Americanist group of linguists had worked along the same lines.

De Saussure's and Baudouin de Courtenay's theoretical approaches have also guided the work of linguists in Norway and Denmark: and to a lesser degree in France. These came to be known as structuralist studies, though much of the comparative work of the 19th century and most of the anthropological linguistic work has also explicitly dealt with systematic structure.

Fields of Linguistic **Analysis.**—After the end of World War II, with the resumption of international scholarly intercourse and activity, the various groups of linguists were able to exchange ideas and examine each other's theories and practices. It became clear that in general there was much fundamental agreement. A statement of what linguistic analysis is concerned with and how it operates is thus possible.

Difierences in terminology and in the philosophical bases of linguistics exist, but the actual work is seen to be along much the same lines everywhere.

As has been said, linguistics is a science; it involves the making of preliminary observations about a set of occurrences; the formulation of a working hypothesis about the events — their cause, relation, effects, and so on; further and detailed observations in terms of the frame of reference provided by the hypothesis; making statements about the events and their interrelation and function as parts of a system; testing the validity of the statements, with reformulation if necessary. As a social science, linguistics must observe events in statistically or otherwise valid samples, and must test its statements by comparing the events in different observational sets: that is, in different languages.

The field of linguistics in its largest aspects — those including all the studies associated with language—may be called macrolinguistics. This total field may be divided into three parts: prelinguistics, microlinguistics and metalinguistics (*see* Table II).

Prelinguistics is concerned with the study of the physical and biological events which enter into the act of speech (and hearing), and with the organization of the statements about these events in a form usable by the linguist. The linguist must have a body of knowledge about that part of the physical and physiological activity of speakers and hearers that produces language. He must know something about acoustics, and about the movements of the speech-articulating organs. This involves also some knowledge of the neural activity in the brain of the user of language. This information must be classified and arranged for the linguist by the physiologists and psychologists working with the material, and it must be classified in terms of the linguistic goal sought. That is, in physiology as such there are no organs of speech. But certain organs of the body are concerned with speech, and the linguist wants to know what these organs do and how they function. This aspect of prelinguistics calls for a description of the organs concerned, first in terms of their size, shape, and relation to each other, and then by the kinds of movements they are capable of and the sounds that are thus produced. Further, there is then needed a description of the ear and its sound-receiving mechanism, and of how this mechanism works. The linguist also asks the physiological psychologist to tell him about the parts of the brain that seem to be concerned with speech production and reception, and to indicate their function. This latter information was still largely unavailable in the later 1950s.

With a knowledge of prelinguistics, the linguist then begins microlinguistics, or linguistics proper. When the term linguistics is used generally, it refers to microlinguistic analysis unless specifically extended. In microlinguistics there are three main fields of interest: the analysis of the sounds of language, the analysis of the grammatical forms, and the analysis of the reference of these forms (their meaning). The analysis of sounds has several aspects: it deals first with the articulation and perception of sounds (based directly on the prelinguistic data alluded to above), then with their classification as speech sounds; this makes up the broad field of phonetics — subdivided into articulatory phonetics, acoustic phonetics and phonetics proper. Phonetics is then used to determine the varieties of sounds occurring in a language, and to classify them into significant contrasting units, called phonemes; below under *Phonology* details of phonetic classification and the principles of phonemics will be presented.

The analysis of sounds is involved in one further step, the study of the functioning of phonemes in the actual grammatical forms; the usual term for this aspect of the analysis is morphophonemics, which will be discussed below, under *Morphology*. The analysis of the forms of language begins with consideration of the morphophonemics, which is based directly on the phonemic analysis. It goes on to establish the units of form, the morphemes, in morphemics; this constitutes the morphology. A further and partially overlapping aspect of form analysis is the examination of the mords of a language as such; this starts from the morphemes composing the words and ends with the description of the kinds of words and their structure.

This leads then into the study of syntax (see below), where words as parts of constructions are examined: and the kinds of constructions they enter into are determined. There are several levels of syntactic analysis, involving successively larger combinations — words into phrases, phrases into clauses, clauses into sentences. At this point the microlinguist reaches his final and highest analytical level, the one where he begins to examine the references of linguistic forms. As microlinguist, however, he still limits himself to the linguistic system: he studies the restrictions on the distributions of words and constructions in terms of what precedes and follows them. This level of analysis has been investigated only slightly, and the necessary techniques can only be guessed at.

After the microlinguist has taken his analysis as far as he can, the metalinguistic examination of language is ready to be begun. At this level the distributional facts of the linguistic forms are taken as known, though in actual fact no such completeness of data has yet been achieved for any language. The known forms are now examined in relation to other cultural systems. The accompanying vocalizations and gestures (see LANGUAGE) may be studied in terms of the words and constructions they go with. Then the relationship of language usage to all other cultural systems — society, economic practices, the relations of men and women, the material resources of a people, and so on, may be examined systematically. This will be further discussed below.

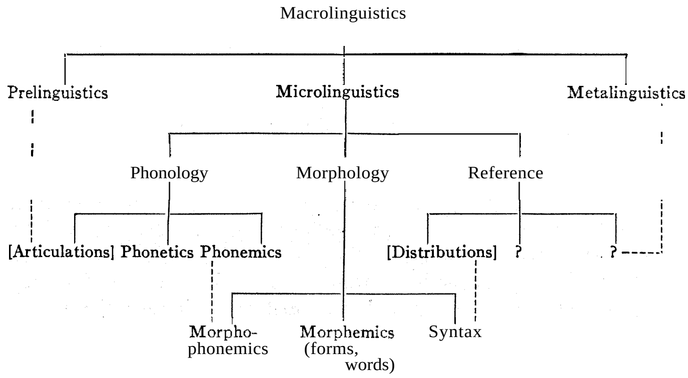
PHONOLOGY

The linguistic analysis of the sounds of language as a whole and of specific languages can be considered under three headings: (1) the study of the articulation of speech sounds; (2) the classification and description of speech sounds (phonetics); and (3) the functioning of speech sounds in the language structure (phonemics).

Articulation of Speech Sounds.—From the very beginning of the study of language there has existed a series of observations of the articulatory movements that produce speech sounds. Certain sounds have been described as produced by movements of the lips, others by the tongue, some as coming through the nasal passage, others as purely oral, and so on. These descriptions were the basis of the classification of sounds arrived at in phonetics.

Before modern times, the descriptions were at times fanciful or incorrect, and in any case were often incomplete because of the impossibility of observing internal activity in the mouth or elsewhere. During the 19th century there were developed various kinds of apparatus which enabled more accurate descriptions to be made of the movements of the articulatory organs. In the first half of the 20th century there were developed techniques for takin X-ray pictures of speech in action, and for analyzing the acoustic components of sounds. Thus arose the special fields of articulatory and acoustic phonetics (often referred to together as instrumental or experimental phonetics). In these fields much of the actual work is prelinguistic, being concerned with physics and physiology, but it goes over into the microlinguistic field of phonology as soon as it restricts itself to the actual descriptive bases for the classification of speech sounds as such. The descriptions of articulations on which most phonetic classification is based are found to be confirmed by modern acoustic analyses. The latter have been made principally with the help of such machines as the sound spectrograph.

TABLE *11.—Summary of Divisions of the Total Field of Linguistics**



*The terms in brackets above are the words for the subject matter of fields for which no common appellation exists. The question marks indicate lack of agreement as to what might be placed at those points. Dotted lines show interconnections other than those of direct subdivision.

Phonetics. — On the basis of observation of what happens when speech is produced, students of language, whether prescientific or scientific observers, have classified the resulting noises into various kinds of sounds. Phonetic description and classification, as has been said, have existed for a long time. In modern times there have been many studies of speech sounds in general and of the sounds of specific languages, and overall and basic classifications exist that are generally acceptable to workers in the field.

Speech sounds can be classified first into vowels and consonants. Vowels may be described as sounds produced in a resonance chamber (the oral passage, with or without the addition of the nasal passage) such that there is a minimum of interference with the freely and regularly vibrating air as it passes out from the throat passage Consonants, on the other hand, are produced so that there are various obstacles to the freely vibrating or moving air, with resultant noise or irregular vibrations introduced into the total sound. The position of the tongue in relation to the roof of the mouth and to the teeth, and the degree of spreading or rounding of the lips affect the kind of sound produced. Vowels are generally produced with the accompanying vibration of the vocal chords which is called voice, though voiceless vowels also occur. Consonants may be voiced or voiceless.

In articulatory phonetics vowels are classified by three criteria: tongue height, tongue advancement or retraction, and lip spreading or rounding. The usual practice is to show the classification as in Table III.

After the sounds have been classified, it is convenient to have symbols to represent them; such symbols are the letters of the alphabet, with additions and modifications as needed. A set of such symbols is called a phonetic alphabet. All phonetic alphabets are more or less alike, though differing in detail. It is not important what symbols are used, as long as they are carefully defined in terms of a table like that below. Such a table has predictive value also; until about 1950 the vowel sounds in the higher low and low front rounded positions had never been reported in any language: though any phonetician could make them; then a Mongolian dialect was found in which they were present, and it was perfectly easy to identify the sounds when they were heard. Using the initials F, C, B, U, R, H, Lh, Hm, M, Lm, Hl, L, we can exemplify some of the sounds in the table: HFU like French i in

TABLE III.—Table Used in Classifying Vowels

	Front		Central		Back	
	Unrounded	Rounded	Unrounded	Rounded	Unrounded	Rounded
High						
Lower high						
Higher mid						
Mid						
Lover mid						
Higher low						
Low						

si, LhFU like English *i* in *hit*, HmFU like French *é* in *café*, MFU like English *e* in *met*, LmFU like French e in *nette*, HlFU like English a in *hat*, LFU like French *a* in *patte*, HFR like French *u* in *tu*, MCU like English a in *sofa*, LBU like American English o in *hot*, HlBR like Southern British *o* in *hot*, etc. Sounds that are slightly different from the standard as defined by the table can be described by modifying terms and denoted by symbols with added diacritics; thus Spanish *i* in *si* is lower and less tense than French *i* in *si*; if the symbol [i] is used for the French sound, the Spanish one can be denoted by [i̫ˇ], where ˇ means lower, and ˬ means relaxed. It is customary to put phonetic symbols in brackets.

Consonants are classified in a table showing place of articulation and manner of articulation as in Table IV.

Bilabials are made with the two lips, as *p* in *pit*, *b* in *hid* (voiceless and voiced bilabial stops respectively), *m* in *mid* (voiced nasal). Labiodentals are the *f* and *v* sounds (voiceless and voiced spirants). Apical sounds are made by the tip of the tongue against the teeth (dental—as *th* in *thin*, a voiceless spirant). the upper gums back of the teeth (alveolar—as English *t* in ***tin***, a voiceless stop), or slightly raised or curled back of the gums (cacuminal—as American English *t* after *r* as in *hurt*, a voiceless stopj. Frontals or palatals are made by the middle portion of the tongue (the "front" technically) against the roof of the mouth; English *sh* in *shoe* is for most speakers a midpalatal voiceless spirant. Dorsals are made by the back of the tongue against the roof of the mouth: English *c* in *car* represents the midvelar voiceless stop. A glottal spirant is English *h* in *hot*. Stops are made by closing the passage and then releasing it. Nasals are stops with accompanying opening of the nasal passage. Spirants are sounds made by approaching the articulating organs but leaving part of the passage open. Laterals are made by leaving a passage open at one or both sides of the articulator (as 1 in English *low*). Vibrants are made by rapidly striking the articulating organs together; the sound represented by *brrr*, indicative of cold. is usually a bilabial voiced vibrant; the heavily trilled *r* of Spanish *rcy* is an alveolar voiced vibrant; some speakers of Parisian French use a postvelar voiced vibrant for *r* in *rouge*. As in the case of vowels, symbols can be devised for all the sounds in the table. and various other symbols and modifiers added for sounds not shown in the table as here given.

In addition to vowels and consonants. various other sound phenomena can be recorded, such as pitch (high, mid, low, falling, rising. etc.), stress (loud. medial, soft, etc.), quantity (short, long, extra-long, etc.), and various kinds of voice qualities and other modifications (nasal twang, whisper, etc.) There is less agreement on these phonetic phenomena than on vowel and consonant analysis.

Phonemics. — In every language the number of different sounds is often quite large, but the number of significant differences is smaller. For instance; in English the word *pit* begins with a voiceless bilabial fortis (tense) stop, with aspirated release; in *spit* the *p* represents a voiceless bilabial lenis (lax) stop, with smooth release into the vowel; in *upper* the internal consonant sound is a voiceless bilabial fortis stop with smooth release; in *up* the final consonant is usually a voiceless bilabial fortis stop without release. The phonetically untrained speaker of the language is unaware of these details, and to him these are all the "same" sound. On the other hand, the difference between the voiceless bilabial sounds in *pit, ripping, rip* and the voiced bilabial lenis stop in *bit, ribbing, rib* is heard and noted by the speaker of English. In the latter case he does not note, however, that *b* in *bit* begins without voice, *b* in *ribbing* is fully voiced, and *b* in *rib* ends voiceless.

The various *p* sounds discussed are said to be the members of a class of sounds which, as a whole, makes a significant difference from (is in contrast with) other such classes. Such a class of sounds is called a phoneme. It is customary to represent phonemes by symbols chosen from among the symbols used for the various members of the class. and to enclose them in slant lines; *i.e.*, the phoneme /p/, the phoneme /b/, etc. The members of a phoneme are called its allophones. The allophones of a phoneme are said to be in complementary distribution: that is, each occurs in statable positions in relation to the beginning or end of the item examined, or to other sounds, and no two allophones occur in the same positions: thus aspirated *p* is an initial allophone of /p/, lenis *p* is the allophone after *s*, fortis with smooth release is the allophone between vowels if the following vowel is weak. unreleased is the allophone in final position. Another criterion for phoneme membership is phonetic similarity: all the allophones of English /p/ are voiceless bilabial stops, but the /b/ allophones are also bilabial stops, so that mere phonetic similarity is not enough to decide whether one has only one phoneme or more than one. The criterion of complementary versus contrasting distribution is first. then that of phonetic similarity.

By the methods sketched. with additional refinements of detail, all the sounds of a language are grouped into a limited number of phonemes. Some languages have relatively few phonemes—say about 1 j, others have as many as jo or even more. The phonemes are of several classes: some vowels, a number of consonants, possibly several stresses and/or pitches. and some juncture (or transition) phonemes. One analysis of English establishes an overall pattern for the language as a whole of 45 phonemes: nine vowels, three semivowels, 21 consonants, four stresses, four pitches and four junctures. The vowels are as in *pit, pet, pat;* the adverb *just* as pronounced in most American English—often jokingly spelled *jist; cut;* American English *cot; put;* eastern New England *coat;* British or New England *cot.* The semivowels are: the y-like off-glide in the so-called long vowels and diphthongs in *see, say, sigh, soy* (and others, as any of the nine vowels can be followed by this off-glide); the *w*-like off-glide in *do, go, now* (and others), the centring off-glide in the usual eastern and southern American and British *dear, dare, cur, car, poor, core, war* (whether the *r* is fully heard or not) The

TABLE IV.—Consonant Table Showing Place and Manner of Articulation

	Labial		Apical			Frontal			Dorsal			Faucal	
	Bi-labial	Lahio-dental	Dental	Alve-olar	Cacu-minal	Pre-	Mid-palatal	Post-	Pre-	Mid-	Post-	Pharyn-gal	Glottal
Stop.													
Nasals													
Spirants													
Lateral,													
Vibrants													

consonants are as in the initials of *pit, tip, kick, bid, dig, go, chap, jet, fit, thin, sin, shin, vat, then, zone,* the internal consonant in *azure,* the initials of me, *now,* the final in *sing, low, row;* the consonants *w, y,* and *h* in *wet, yet, hot* are prevocalic allophones of the three semivowels mentioned before. The stresses are as in *elevator-operator* where *el-* has primary, *op-* has secondary, *-va-* and *-ra-* have tertiary, and the other syllables have weak stresses. The pitches are as in ^{2}*I* ^{3}*saw him*^{1}—beginning with middle pitch, rising to high on *saw,* and falling to low at the end; if *saw* is emphasized it has pitch 4, extra high. The junctures are: internal open, as in *night rate* contrasted nith *nitrate;* clause-terminal sustained as after the first *him* in *The first time I saw him I didn't like him;* rising as at the end of the sentence *Do you mean it?;* fading as at the end of the usual declarative sentence in English.

The phonemes constitute the basic structure of the material of the language, and it is out of them that the grammatical forms, to be considered next, are formed.

MORPHOLOGY

The material of a language alluded to above is generally taken to be its words. This layman's approach is confirmed by linguistic analysis. When a child learns its native language, or anyone learns a foreign language, it is the words that are first apprehended as more or less indivisible units. Of course, as accuracy increases, one specifically learns the sounds as recurring units, and in this sense phonology is basic to the further analysis of a language. However, morphological study is possible even when the phonology of a language is imperfectly known.

As was the case for phonology, the overall term morphology can be considered under three headings: (1) the study of the phonemic structure of grammatical forms and words (morphophonemics) ; (2) the analysis of the forms themselves and of how they enter into words (morphemics and the lexicon) ; and (3) the arrangement of the words in larger units such as phrases, clauses and sentences (syntax).

Morphophonemics.—This part of morphology can be done only for languages whose phonology is rather well known. If the records of an extinct language are in a writing system that uses unit symbols for whole words—as was the case for ancient Egyptian and for Sumerian—then it is obviously not possible to know much about the phonemes of which the words were composed. In the case of existing languages, if only some conventional written form of the language is known, there are likely to be parts of the phonology that are not represented in the writing, and thus the phonemic make-up of some of the morphemes may be in doubt or unknown. Even for those languages that have been most studied and analyzed. linguists still have doubts about some aspects of the phonology, so that morphophonemic statements cannot be complete.

For English the kinds of morphophonemic statements that can be made may be illustrated. It is observed that English words may begin with a vowel; of the nine simple vowels indicated above, five are common as initials—those in *it, elder, at, up, otter;* in weak-stressed syllables, a sixth vowel occurs frequently, that used in *exception, event,* and other words by people who use the *cut* vowel in *above, allow,* but the *"jist"* vowel in *exception,* etc. The vowel of *put* occurs initially for some speakers only in the exclamation *oops* (others use the vowel-plus-semivowel of *food* in this word) ; in *obey* and other words spelled with *o* there may be instances of the short vowel also found in New England *coat;* in *already* as pronounced by some the ninth vowel is found. English words may also begin with one of the vowel-plus-semivowel combinations; the actual occurrences vary in different parts of the English-speaking world. An English word may begin with any of the single consonants except the *ng* of *sing.* Also found initially are groups of two or three consonants; the two-consonant clusters are numerous but of certain kinds only—tr- exists but not *tl-,* while both *pr-* and *pl-* are found; there are only a few three-consonant clusters—spl-, *spr-, str-,* /skl/ spelled *scl-,* /skr/ spelled *scr-,* /skw/ spelled *squ-,* /spy/ in words spelled *sp* before *u* or *eu* or *ew,* /sty/ in words spelled *st* before *u* or *eu* or *ew* (but many speakers of English do not use the /y/ in these words). English words may end in a weak-stressed short vowel, or in a vowel-semivowel combination with any stress, or in any single consonant, and in clusters of two, three, or four consonants—the last two kinds being few in number. Every English word has at least one vowel, and when said by itself has one (and only one) primary stress. English words may be of one syllable (*i.e.,* with one vowel). or of many syllables, though most are of one, two or three syllables. Various stress patterns are noted in English words: *upper, above, animal, allowing, entertain,* etc. All English utterances, whether long or short, are said with a sequence of pitches of some kind, the most usual (declarative sentence) being 2-3-1, the 3 falling on the syllable with the primary stress.

In addition to the kinds of statements just made, it can also be said about English that there are many instances of addition of one or two (or occasionally more), sounds to a word to form related words: *cat, cats; bed, beds; rose, roses; go, going; nice, niceness; starve, starvation.* In some cases there are noted changes in the original form: *knife, knives; tuke, took; vain, vanity.*

A complete morphophonemic analysis has not been made for English or any other language. But Pāṇini for Sanskrit made a very extensive analysis of the morphophonemic relations.

Morphemics.—The examination of the kinds of phenomena discussed under morphophonemics makes possible the segmentation of the material of a language into various kinds of structural grammatical units. This is done by noting what may be called recurrent partials. Thus in observing the English forms *boy, boys, girl, girls,* one sees immediately the recurrent partials *boy, girl* and *-s.* In comparing *boy, boiling* to *prince, princeling* one might be tempted to set up the partials *boy (boi-), prince, -ling,* but a further look at the situations in which the forms are found shows that *boiling* does not relate to *boy,* but is rather connected with *boil* as *doing* is with *do,* giving the segmentation *boil* and *-ing.* The recurrent partials that are established are then grouped together by the principle of complementary distribution (parallel to the grouping of allophones into phonemes); they are allomorphs of morphemes. In most morpheme analysis the short cut is taken of grouping allomorphs by finding their meaning; similar meaning is taken to mean that the forms belong to the same morphemes. But this can lead to all kinds of structural misapprehensions; if *subscript* and *underwritten* have similar meanings when the parts are separated, does this mean that *sub-* and *under-* are the same morpheme, and that *-script* belongs with *written (write)?* The answer is clear: criteria of distributional position must be used in morphemics as in phonemics, and meaning can at best be a guide to what to look for.

The morpheme structures of languages are extremely varied. In English it is possible to distinguish inflectional morphemes, derivational morphemes and base morphemes. Inflectional and derivational morphemes in English are suffixes—they come after the base, inflectional suffixes being last. In addition to bases and suffixes, it is found that we must recognize superfix morphemes in English: these are the patterns of stress (with or without one or more internal junctures), that close, as it were, the formational process of a word. Thus *boy, boys, boyish, boyishness, boyishnesses* are analyzed morphemically as follows: base *boy-;* inflectional suffix *-s* (pronounced /z/); derivational suffixes *-ish* and *-ness;* inflectional suffix *-es* (pronounced /ïz/ —ï being the high mid vowel of the first syllable of *event, see* above) ; superfixes "primary stress" on *boy* and *boys,* "primary-weak" on *boyish,* "primary-weak-weak" on *boyishness,* "primary-weak-weak-weak" on *boyishnesses.* English also has some morphemes like *pre-, in-,* a-, *be-, re-,* that precede the base; these function like special kinds of bases, and are best labelled pre-bases.

In some languages there are real prefixes that function like suffixes in inflection or derivation. Classical Arabic has forms like *katabat* "she wrote," with *-t* for feminine third person subject, but *taktubu* "she is writing," where the prefix *t-* is the sign of the feminine. In the language of Taos Pueblo, New Mexico, most subject and object relations of verbs, and the indications of possession for nouns are shown by prefixes: *tik'ôlą* "I ate it." where *ti-* means first person subject and third person singular object of one of five classes; *kikána* "our mother." where *ki-* means "our" (we being more than two). Some languages also have infix morphemes: Latin *relinquō* as compared with *relictus* shows an old *-n-* infix that originally functioned freely in proto-Indo-Hittite. Another kind of morpheme may be called pattern morphemes: in Arabic *kataba* the base (or "root") is *k-t-b* "to write" and the pattern *-a-a-a* indicates suffix tense (perfect); in *taktuba* we have the same base, but the pattern is *a--u-a* indicating the prefix tense (imperfect).

The inflectional morphemes of a language occur in sets that are labelled paradigmatic, and form paradigms of inflection. The paradigms are the basis for determining the kinds of words ("parts of speech") a language has. English has paradigms like the following: *boy, boy's, boys,' boys'; man, man's, men, men's;* these establish the class of words that may be labelled nouns; nouns are then defined as words that have inflection for plural and for possessive (or for one of these). The paradigms *go, goes, going, went, gone; talk, talks, talking, talked, talked,* etc., establish the word class of verbs, defined as words inflected for past and, in most cases, also for gender-indicated subject in the nonpast (*he, she,* it *talks),* present participle, and past participle. English also has the personal pronouns **I,** *you, we, he, she, it, they, who* (and *thou*), with an irregular inflectional pattern (**I,** *me, my, mine,* etc.). All other English words are uninflected (including adjectives with derived comparative and superlative), and their further classification as adverbs, prepositions and so on is made by syntactic criteria *(see* below).

Each language has its own patterns of inflection and its own set of parts of speech, with definitions specific to the language. In French, adjectives are defined as words inflected for gender (feminine *bonne,* masculine *bon)* as well as for plural (*bonnes, bons*), while nouns have only plural inflection (*homme, hommes*). Latin nouns are defined by inflection for five cases (a few have six) in the singular and four in the plural. The Nootka language of the Indians of Vancouver Island has only noninflected words (a few) and inflected words. All the inflected words have a complex inflectional system. some of the forms being translatable as nouns, some as adjectives, and so on; thus the base meaning "human" can have a nounlike form meaning "a man" and a verblike form meaning "he is a man." If a language has no inflection, and also no derivation by suffixes. as is the case in modern Chinese, then its words can be classified only by syntactic means, and not by morphemic ones.

Syntax. — The words of a language having been analyzed and their constituent morphemes determined, the next step in analysis is to find out the kinds of constructions in which they occur. In most, if not all, languages it appears that there exist morphemes of a special type which determine some of the constructions. In addition to these there are also factors of order and arrangement which constitute a higher analytical level than that of morphemes. In syntax, as in the other subdivisions of morphology, it has been traditional to establish the limits of constructions and to designate their functions in terms of meaning. But it is possible to make the analysis entirely in terms of the special morphemes mentioned and the higher-order arrangements; when this is done, it is seen that the linguistic material. here as elsewhere, furnishes its own analysis, and that this analysis can then serve as the basis for beginning the study of meanings and other metalinguistic matters.

In English the first level of syntax involves combining words into phrases. This is accomplished by morphemes of a special type, the phrase superfixes. Phrase superfixes consist of arrangements of stresses such that there are one primary stress and one or more other stresses, and there may be one or more internal junctures. This description sounds like that of word superfixes (above), but while there are as many word superfixes as there are different stress patterns in English words, there are only relatively few phrase superfixes. Moreover, the stresses of the phrase superfixes are dependent on and supersede the word stresses in stated ways. The word *writing* has the word superfix primary-weak, as does the word *paper;* there is a phrase superfix primary-internal juncture-tertiary, which, when applied to these two words in sequence, results in the phrase *writing paper* with stress pattern primary-weak-internal juncture-tertiary-weak; that is, the primary of the phrase superfix replaces the primary of the first word, while its tertiary replaces the primary of the second. To illustrate other phrase superfixes we shall use the marks ′ for primary, ^ for secondary, ˋ for tertiary, ◡ for weak, + for internal juncture. Examples are ˋ+′ *get up* (verbal) — but cf. ′+ˋ*get-zip* (a nominal phrase); ′+^ on *white house* in the sentence "I mean the *white* house, not the brown one"—*cf.* ′+ˋ in *White House;* ^+′ on *white house* in "We live in the white house you see down the street"; ′◡ (without juncture) in "Do it"; ◡(+)′ (with or without juncture) in "the man"; etc.

Larger units than the phrases illustrated are clauses. A clause is determined by an intonation pattern, which is a morpheme consisting of three or four pitch phonemes, and a terminal juncture. In the sentence "He said he'd like to see you before you leave," there are two clauses in this sense "^{2}He said he'd like to ^{3}see you^{2}" with sustained terminal pitch. and "^{2}before you ^{3}leave^{1}" with fading terminal pitch. The intonation patterns are *2–3–2-* sustained and 2–3–1-fading.

In syntactic analysis in a language like English, the first task is to determine the clauses and their intonation patterns. Then the clause is separated into its phrases, which often overlap; in the sentence illustrated just above the first clause has the phrases "he said" with ˋ+′, "he'd like" with ˋ+′, "to see" with ◡+′, "see you" with ′+ˋ; these combine so that only one primary (′) remains (on "see"). and the others are reduced to secondaries (^), giving ˋ+^+ˋ+^+◡+′+ˋ; in the second clause we have "before" as a separate construction, with primary here reduced to secondary, and "you leave" with ˋ+′. The various phrases can be given labels in terms of the kinds of functions they have: "he said" is a pronoun-plus-verb phrase and has a subject "he" and a predicate "said"; "he'd like to see you" is a complement of the verb "said" and as such is like a simple noun; we use the term nominal for it; it is divided into a subject-predicate part "he'd like" and complement "to see you" (a nominal, usually called the infinitive), and this latter has the verbal "to see" and the pronoun complement "you." Further statements can be made about the order of the items; what precedes a verb or verbal phrase is the subject; the complement follows.

Other constructions also have their rules of order—as the adjective preceding the noun in *good book,* the auxiliary preceding the participle in *is going,* the negative following the inflected verb in *do not.* Associated with rules of order are common superfix and intonation structures: the complement, whether nominal or adverbial has primary stress, unless it is a pronoun object, in which case it is weak or tertiary; prepositions have weak or tertiary stress before a noun *(in bed* ◡+′, *over water* ˋ◡+′◡), and tertiary stress when clause-final ("that rug is pleasant to walk on" ^+^+◡+^◡+◡+′+ˋ).

The syntax of any language can be arrived at in analogous ways. The phonologically determined parts of a discourse are found, and their constituent phrases separated out; then the make-up of the phrases in terms of inflected words is discovered and equivalents of inflected-word functions are determined. Then other words can be labeled with appropriate terms. Similar terms may be used in many languages, but the definitions and rules are determined by the actual usage and structure, not by philosophical speculation on meaning.

ANALYSIS OF MEANING; APPLICATIONS

Distributional Meaning. — When the syntactic analysis of a language is well advanced, it is then possible to begin determinations of the distribution of classes of words and of individual words and also morphemes, to find the limitations on their use which will indicate the metalinguistic structure (referential meaning—see below). Thus we find in English that we use *beautiful* with such words as *house, grass, woman* but more rarely and for special effect with *shack, weeds, man;* we find that *handsome* before *man* is apparently equivalent to *beautiful* before *woman,* but with *shack* and *weeds* no equivalent seems to occur. When the verb *massacre* is used, the object must be plural or collective;

when *mill around* occurs, the subject is plural or collective. By such observations, it is possible to establish all kinds of subdivisions of the different parts of speech and of constructions on the basis of what other kinds of words they go with, thus determining their distributional limitations. This sort of examination of distribution has not been done for any language except occasionally in studies of special literary works and of small sections of the total vocabulary.

Another aspect of distributional studies is one illustrated by the phrases *awe-struck* and *grief-stricken*. Both *struck* and *stricken* are morphemically past participles of the verb *strike*, and each has the syntactic function of an adjectival word in the two expressions. But one never says *awe-stricken* or *grief-struck*, nor does one say He *was stricken by a car*, though one can be *stricken by affliction*.

Distributional studies can be extended from individual words and constructions to whole discourses. That is, examining a speech, for instance, one can observe how one part of it follows another and establish relationships and predictable sequences. This leads directly to the analysis of what may be called congruence. In a legal text one must necessarily use words different from those in a popular lecture; a professor speaking to his class uses different words than when he speaks to his family; or if he does not, he becomes an object of ridicule. This brings us finally to the whole matter of the analysis of style, and of the criteria that constitute different styles. Discourse analysis, congruence analysis, and studies of style are microlinguistic disciplines that have been hinted at by linguists but only barely begun.

Referential Meaning.—All users of language since the dawn of mankind have of course been concerned with the reference of the linguistic forms they use to the rest of their behaviour and to the universe about them. In a practical way all speakers know the "real" meaning of what they say. But this "real" or referential meaning can be scientifically studied only by having extensive analyses of the linguistic structure and of the rest of the behaviour. That is, the child, in learning his language, points to objects and asks questions; when he encounters abstractions, he learns their meaning by observing the accompanying behaviour. He learns his total culture as he grows up and learns the accompanying language behaviour. The macrolinguist, in extending his interest from the highest levels of microlinguistics—those just discussed under the heading of distributional meaning—to referential meaning, extends his activity to what we are calling metalinguistics. He seeks to analyze or have analyzed for him all other cultural systems along lines analogous to those used in linguistic analysis. He suggests that analysts of culture should determine for their various fields units comparable to the phonemes, morphemes and distribution patterns of language. When such studies are available, then he believes it will be possible to establish point-by-point relations between language, as linguistically analyzed, and the other analyses.

In the meantime, meanings continue to be established by description, discursive speculations, and exposition of concrete objects and behaviour.

Translation.—In the light of what linguistic analysis holds theoretically desirable for ascertaining meaning, it is seen that translation can at best be approximate until more extensive metalinguistic studies have been made. When translation is between two languages that are structurally similar and whose speakers are culturally related as a whole, as between English and French, it is possible for the skilful translator to convey real equivalences of meaning in all or nearly all cases. Furthermore, if the material being translated is technical in nature, and speakers of both languages practise the particular technology, direct and exact translation is often possible. But if the languages in question are dissimilar structurally, as are English and Vietnamese, and the cultures as a whole are different, as are those of America and of Vietnam, then the problem of translation becomes very great; one really has to have full microlinguistic analyses of both languages and extensive general cultural knowledge and analysis.

A problem that has interested some researchers, especially since the development of electronic calculators, is that of a machine to do translation. That such a machine is theoretically possible is beyond doubt. and in 1953 a mechanical translator was actually demonstrated for a short and specialized text translated from English to Russian. The further development of such machines will call for the most extensive kind of microlinguistic studies, especially of morphemics and syntax, and very searching investigations into at least the general outlines of other cultural systems. The number of relationships that will have to be coded into a mechanical translator may be very large, but it will be finite and thus subject to such treatment.

Linguistics and **Education.**—A large aspect of education in all countries is the teaching of the use of the native language and, at higher age levels, the teaching of foreign languages. Both of these activities can increase their effectiveness by use of the results of linguistic knowledge. The native language is usually taught as an accumulation of traditional lore about sounds and their representation in spelling, "correct" and "incorrect" grammar, style, and so on. These are all matters to which the science of linguistics, as described above, can bring useful and usable findings. When the phonology of a language has been properly analyzed, the teaching of the writing system, no matter how complex it may be, is facilitated and regularized. The teaching of the use of a standard or literary language is maximally effective when the structures of that language and of all other languages or dialects involved are well known. The teaching of effective writing and good style depends on having objective criteria for measuring the goals.

In addition to these direct kinds of assistance, linguistics can also help in the total process of education. Most teaching, and especially most schooling, is in terms of linguistic interaction. Knowledge of the structure of the language material, of the prelinguistic facts about it, and of the metalinguistic relations of the language to the rest of the culture (which is the content of the school curriculum) can obviously help in imparting the desired material to the learner.

As a social science, then, linguistics is based on the physical and biological sciences, its analytic procedures may serve as a model for the other social sciences, and its results can be embodied in practical applications to education and the various humanities.

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LINKAGES, in mechanics, are combinations of links or bars, in general connected by pins, slides, rollers or screws. If the combination is such that no relative motion can exist between the parts a structure results. If the links can move relative to each other the linkage becomes a kinematic chain. Specific forms of kinematic chains are useful when the motions of the links are controlled so that constrained relative motion results. Such linkages are commonly referred to as mechanisms when the transmission of energy is not important.

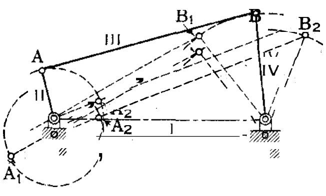


FIG. 1.—FOUR-BAR LINKAGE

Many linkages, or mechanisms, are used to obtain specific motions with little regard to the performance of work. Such devices as watches, typewriters, record changers, mechanical computers and working models are of interest for the relative movements of the parts, not the energy involved. Machines, however, commonly involve the performance of work or the transmission of power to some useful end.

Thus, practically all machines may be thought of as being mechanisms or linkages in various combinations in which work or energy is significant. The automobile, for example, is made up of many linkages, some of which—parts of the engine and transmission—function as machines, while others—steering and throttle linkages—are present primarily to provide certain desired motions of the parts.

Historical Background. — Many linkages in common usage, have had their origin in centuries past. From the time of the great early Egyptian civilizations, the minds of men have sought means to produce motions not obtainable with the human hand alone. Multiplication of effort, faster speeds, more complex motions over greater distances or in smaller spaces have been the goals of such men as Archimedes, Hero of Alexandria. Leonardo da Vinci, James Watt and others.

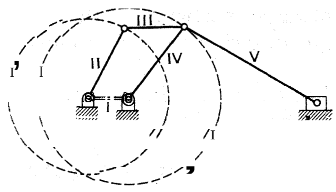


FIG. 2. — DRAGLINK MECHANISM

Hinged tongs were in use as early as the 6th century B.C. The screw of the Archimedean screw was invented. according to some authorities. around 400 B.C., and was in use in Egypt before Archimedes' time. By the 1st century A.D. the lever and the screw press were in use for crushing grapes. The ratchet and pawl (see RATCHET AND PAWL) were shown in types of crossbows described by Hero and Philo in the same century. A linkage for operating a fascinating hydraulic organ also was described by Hero. But for nearly 1.000 years, from about A.D. 400 to 1400, little advance was made in the use of mechanisms and linkages.

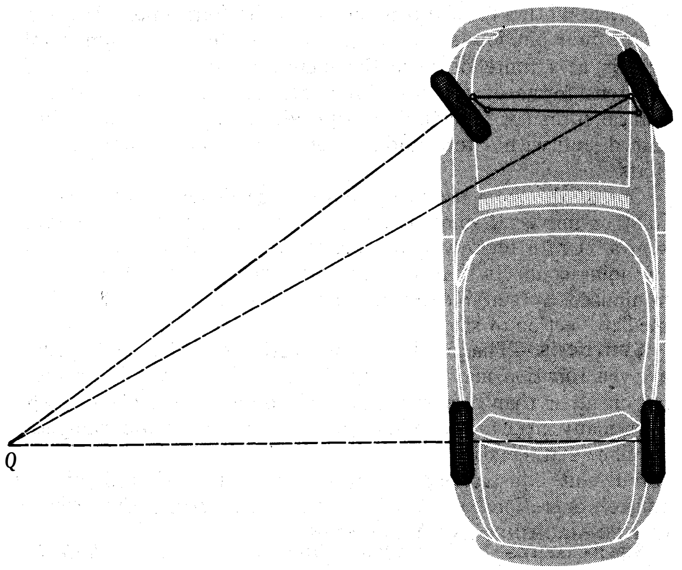


FIG. 3. — IDEAL RELATION OF AUTOMOBILE WHEELS WHEN TURNING A CORNER

Then the gradual awakening of western civilization and development of the industrial age stimulated many new and improved devices. Weaving and spinning machines and machines of war occupied Da Vinci's thoughts with ingenious and far-reaching results. Stamp mills and water-driven bellows used crude linkwork in the 16th century, the joints being constructed of interlocking eyes, as are the links of a chain. The Industrial Revolution saw the rise of many new linkages and led into the development of complex devices such as the Stephenson, Walschaert and Joy locomotive valve arrangements. Better methods of analysis and precision of manufacture in the 20th century gave rise to increasingly precise and complex linkages in typewriters, computing devices. packaging equipment and manipulating mechanisms used to position, hold and transfer products of industry.

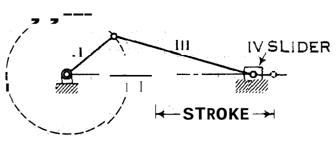
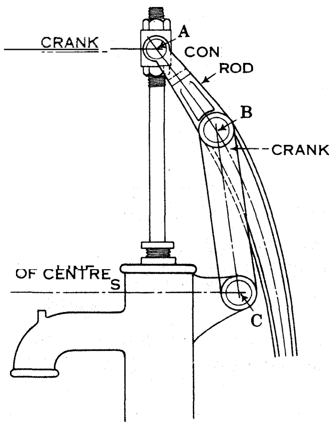


FIG. 4. — SLIDER-CRANKLINKAGE

Some giant linkages have been created, such as in some of the mining equipment of the 19th century. A mine pump in Germany is said to have had a connecting rod over 7,200 ft. long. In 1682 a French fountain display incorporated a linkage 2,000 ft. long, In existence in the mid-20th century was a water wheel 72 ft. in diameter that drove a mine pump on the Isle of Man. The 600-ft. long connecting rod was disconnected during the 1930s, but the wheel remained in operating condition. Some of the largest linkages continue to be employed in mining, as in the giant shovels used for removing overburden in strip mines.



FROM V. L. DOUGHTIE AND W. H. JAMES, "ELEMENTS OF MECHANISM": REPRODUCED BY PERMISSION OF JOHN WILEY & SONS, INC.

FIG. 5.—HAND PUMP LINK MECHANISM

Classification. — Attempts have been made at classification of linkages using rules such as the number of degrees of freedom of the chain. A link with unrestricted motion is said to have six degrees of freedom since it can move in any one of three mutually perpendicular directions in space and can rotate in any one of three mutually perpendicular planes. Such criteria, however, can distinguish between structures and mechanisms in general but may fail for special cases where a point-by-point analysis will be required.

Basic to all linkages are the types of joints or pairs employed. Such pairs may be classified as higher pairs when line or point contact between the members is indicated. Examples of such pairs are ball bearings, cams and flatface followers. pins in slots and gear teeth. Lower pairs are pairs with geometrically similar areas in contact, such as plain bearings, a piston in a cylinder, and ball and socket joints.

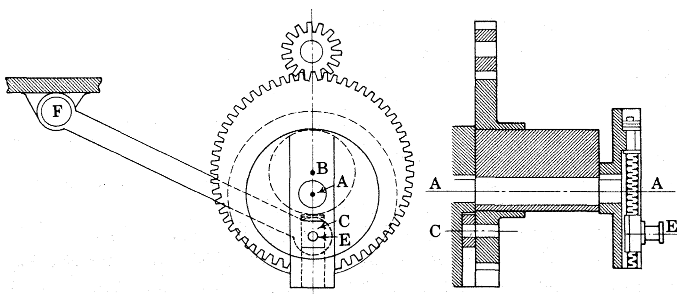


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FIG. 6. — WHITWORTHQUICK-RETURN MECHANISM

A further description is provided by the terms turning pairs (pin joints, sleeve bearings); sliding pairs (piston in cylinder, gears); and rolling pairs (balls and races in ball bearings, railroad car wheel on rail). A special pair having relative helical motion is known as a screw pair, as exemplified by the common bolt and nut.

Common Linkages. — The study of linkages generally begins with the analysis of some of the more common types and progresses to the more difficult problems of synthesis. One basic linkage is the four-bar linkage or quadric-crank mechanism (see fig. 1). This consists of four links connected by pin joints with one link (I) generally stationary. Link II is usually called a crank. link IV a lever, and link III a coupler. By varying the proportions of the links. various motions are transmitted to link IV as well as to points on link III. Thus, in fig. 1 the crank can make a complete revolution while the lever oscillates as shown by the dotted lines. This linkage can be used as a simple device to translate rotation into oscillation which. with a ratchet linkage. will produce an intermittent motion.

By altering the proportions the drag link mechanism, fig. 2, may be created. Here links II and IV both rotate completely, II at constant speed and IV with varying speed. This mechanism. when coupled with an additional link V, creates a type of quick-return mechanism commonly used in a Dill slotter, a machine for cutting keyways in shafts. If the links are paired with opposite links of equal length, a parallel linkage is formed such as is used in the cranks and parallel rod of a locomotive or in the Universal drafting machine, which is widely used in place of T squares and triangles. The automobile steering mechanism has generally employed a four-bar linkage to obtain the necessary differential motion of the two front wheels. Ideal performance dictates that the two wheels should operate as in fig. 3 in making a turn. Practically, a compromise usually is reached that provides for turning the wheels through unequal angles but does not attain a common centre of curvature at Q for the paths of all four wheels.

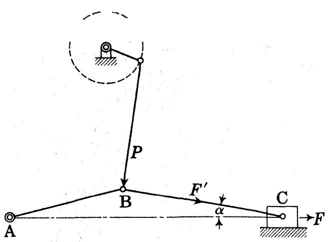

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FIG. 7.—TOGGLE LINKAGE

The idea of inversion is very important in the study of linkages. A mechanism or linkage is said to be inverted when the originally fixed or reference link is permitted to move and a different link is held fast, without changing the basic proportions of the linkage. Such inversion changes the motions of all links relative to a fixed reference system but does not change the motions of the links relative to each other.

A quadric-crank linkage in which the lever, link IV, is permitted to become infinitely long is represented by the slider-crank mechanism, fig. 4. One of the pin joints has thus been replaced by the rectilinear sliding pair. In this form it is the familiar crankshaft, connecting rod, piston and cylinder of the internal combustion engine, air compressor or refrigerator compressor. Mathematical and graphical techniques have been developed to analyze the motions of this mechanism quickly and accurately.

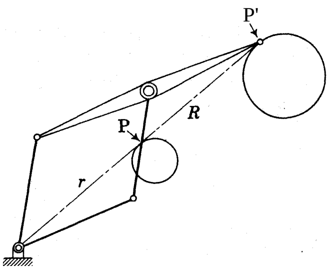

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FIG. 8.— PANTOGRAPH

Several inversions of this interesting and versatile linkage have been put to use. With link IV fixed, the common hand pump, fig. 5, results. By holding stationary the connecting rod, an oscillating piston and cylinder mechanism may be obtained, such as has been used in marine engines. Radial aircraft engines in which the cylinders rotated about a fixed crank were obtained from a fourth inversion of the basic slider-crank linkage at the time of World War I.

Inversiohs of the slider crank are frequently combined with additional linkage in modem machinery. The crank shaper, and the Whitworth quick-return mechanism, fig. 6, are devices used in machine tools where a reciprocating motion with controllable unequal times for advance and return strokes of the slider C are desired.

One quite useful variation is the toggle linkage, fig. 7. As the slider C approaches the end of its stroke it is capable of exerting a very large force F with a relatively low force P. By making AB = BC and having F act perpendicular to F, then

$$\frac{F}{P} = \frac{1}{2 \tan \alpha}$$

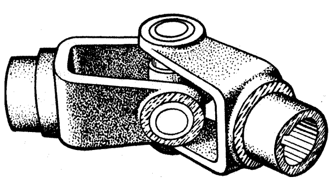

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FIG. 9.— UNIVERSAL (HOOKE'S) JOINT

Stone crushers, presses, clutches, pneumatic riveters use forms of this device.

Straight-Line Linkages.—The production of a straight-line motion in a plane has intrigued the minds of many scientists and engineers in times past. Exact straight-line motions may be obtained by the Scott Russel linkage, Hart's straight-line motion, Peaucellier's movement and the pantograph, fig. 8. However, these devices are not widely used since straight-line motions are generally obtained with slides. In special cases where the slide cannot be mounted at the point that is to move in a straight line, these linkages, particularly the Scott Russel, or some type of approximate straight-line motion linkage, are used.

The classical approximate straight-line motion linkages are generally special cases of the four-bar linkage. The best known of these are Watt's, Roberts' and Chebichev's mechanisms. Some giant dock cranes employed for loading ships are examples of the use of the Roberts approximate straight-line motion.

The pantograph is useful in the redrawing of maps or other figures to a different scale, several arrangements of this linkage being possible. In fig. 8 point P′ will trace the same figure traced by P, but R/r times as large. By joining several such linkages together the common lazy tongs is achieved, a device much used as a telephone support, in toys and in a railroad freight car unloader.

Steam engine valve gears, rather complex linkages involving straight-line motions, were developed as the reciprocating steam engine came into use during the 19th century. The Baker valve gear became one of the most popular of these linkages for the steam locomotive.

Space Linkages.—The conic four-bar linkage enables relative spherical motion to take place between the four links. If the axes of the four pin joints are not parallel but have a common intersection at a finite distance the members remain movable. The different forms of the plane linkages can be reproduced in the conical form (or space linkage) provided the above rule is maintained, and with a few modifications to eliminate interference of parts.

One of the most useful of these space linkages is the Hooke's joint or universal joint, fig. 9, used for joining two intersecting shafts. Unfortunately, a varying angular speed ratio results when the joint connects shafts at an angle, though this defect can be minimized by suitable arrangement of two joints and an intermediate section of shafting.

Synthesis.—The problem of proportioning a linkage to perform a given function may be relatively difficult when using a combination other than a simple cam and follower (see CAM). However, many mechanical computing devices have been developed for specific mathematical operations and are in widespread use throughout industry, performing a great variety of production and control operations. See COMPUTING MACHINES, ELECTRONIC; OFFICE MACHINES AND APPLIANCES.

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LINKÖPING, a city of Sweden, the chief town of the *län* (county) of Östergötland, situated on the Stang river near its outflow into Lake Rox, 100 mi. S.W. of Stockholm. Pop. (1960) 65,082.

A bishop's see was established about 1100. At a synod held in 1153 payment of Peter's pence (expenses toward the Holy See) was agreed upon at the instigation of the English legate Nicholas Breakspear, afterward Pope Adrian IV. The coronation of Valdemar, the son of Birger Jarl, took place in the cathedral in 1251. In the reign of Gustavus I Vasa several important diets were held in the town. In 1598 it was the scene of the battle against the Catholic king Sigismund III of Poland, which guarded the Evangelic Lutheran Church in Sweden and secured the Swedish throne for the Vasa dynasty.

The cathedral (c. 1100–1499 and restored in the late 19th century) is a great romanesque and Swedish Gothic building with a magnificent south portal and late Gothic choir; it has an altarpiece by Maerten van Heemskerck (1543) and a modern one by the Norwegian artist Henrik Sorensen (1931). In the church of St. Lars are some paintings by Pehr Hoerberg (1746–1816), the Swedish peasant artist; the remains of an older Roman church are preserved under the church floor.

Other buildings of note are the 13th-century castle (once the episcopal palace, afterward a royal palace rebuilt in the 16th century but now the residence of the governor of the county) and the old gymnasium founded by Gustavus II Adolphus in 1627 The Lutheran bishop's palace was erected in 1734 on the old site of a Franciscan monastery. There are also noted diocesan and city libraries and a modern museum (1939) with a picture gallery and collections of prehistoric art. Other museums are the Krogsfallsgården with two peasant houses, "Uncle Adam's House" with late 19th-century interiors and the Valla open-air museum with houses from the old city. The Fountain of the Folkungs by Carl Milles (1927), with an equestrian statue of Folke Filbyter, the mythical ancestor of the famous family, is in the Stora Torget (the principal square).

Industrial development came with the building of the Gota and Kinda canals and the Stockholm-Malmo railway. The town is a rail junction nith aircraft, freight car and automobile industries. Rope, textiles, tobacco and beer are produced. (B. J. C.)

LINLEY, THOMAS (1733–1795), English musician and father of a large family of musicians, was born at Badminton on Jan. 17, 1733. He studied music at Bath, and afterwards settled there as a singing-master and conductor. From 1774 he was engaged in the management of the oratorios performed at Drury Lane theatre, London. He composed or compiled the music for many of the dramatic pieces played there, including *The Duenna,* by his son-in-law Richard Brinsley Sheridan. In 1777 he was elected a member of the Royal Society of Musicians. He died in London on Nov. 19, 1795.

LINLITHGOW, a royal burgh and the county town of West Lothian, Scot. It lies on the south side of a loch. 18 mi. W. of Edinburgh by road. Pop. (1961) 4,327. In the 19th century its old-world appearance was much changed by rebuilding, and thereafter by the demolition of other buildings of local architectural merit. The outstanding feature of Linlithgow is the roofless royal palace (the birthplace of Mary, queen of Scots) and the parish kirk of St. Michael, standing together on the rising ground of the promontory which divides the loch into two nearly equal parts. The palace, a favourite abode of the kings of Scotland, is square in plan, enclosing an inner close in the centre of which stand the remains of the King's fountain erected by James V. At each corner is a tower provided with a turnpike turret. The north-western tower is crowned by a little octagonal cap-house known as Queen Margaret's bower from the tradition that it was from there that the consort of James IV watched for his return from Flodden. The original entrance, an imposing architectural feature, is in the eastern quarter, built in the first half of the 15th century; James V closed this entry and provided one in the south quarter. The north quarter, which contained the queen's suite, having become ruinous, was rebuilt for the "homecoming" of James VI in 1617. The royal apartments, the chapel and the Great hall, otherwise known as the Lyon chamber, were situated on the first floor. By the burning of the palace in 1746 by Gen. Henry Hawley's dragoons, Scotland lost a very historic and interesting architectural crown building.

Standing on the high ground southward of the palace is the mediaeval kirk of St. Michael the Archangel. In the early part of the 19th century the open crown spire was removed from the head of the tower, and thus the building was robbed of a typical Scottish feature. In front of the town hall (1662) is the Cross well, erected in 1807 by a one-handed mason. It is a copy of one made at the Restoration by Robert Myme, the king's master mason, who based his design on the King's fountain within the palace.

About 4 mi. S. by W. lies Torpichen, where the knights of St. John of Jerusalem had the chief Scottish preceptory. (J. S. Rn.)

LINNAEUS, CAROLUS (Carl Von Linné) (1707–1778), Swedish botanist after whom the world's system of classification of plants and animals is named. He was born on May 23 (N.S.) at South Rashult, where his father was a curate. His love of flowers developed at an early age. and it is recorded that when only eight years old he was nicknamed "the little botanist." He was educated at Wexio and at the universities of Lund and Uppsala, at which latter he qualified in medicine. It was when he visited Uppsala that he met the veteran botanist Olaf Celsius, an event that had a profound influence on his subsequent career. He was appointed lecturer in botany in 1730 and two years later explored in Lapland for the Academy of Sciences, the results of his journeyings being published in Amsterdam in 1737 as the *Flora Lapponica* and in English by Sir J. E. Smith as *Lachesis Lapponica* (1811). His reputation was established by this and, even more, by the appearance in 1735 of his *Systema naturae* and of the *Genera Plantarum* two years later. while the *Species Plantarum* did not appear till 1753. For purposes of nomenclature of flowering plants and ferns the first edition of the *Species Plantarum* has been internationally agreed as the starting point together with the fifth edition of the *Genera Plantarum* published in 1754. The *Systema naturae,* which Linnaeus had shown to Jan Fredrik Gronovius in manuscript, so impressed the latter that he published it at his own expense. This system was based mainly on the number of stamens and the number of pistils in the flower and the manner in which, if not free, they were joined together. Although artificial, as Linnaeus himself recognized, such a system had the supreme merit of enabling students rapidly to place a plant in a named category, and that at a period when the richness of the world's flora was being discovered at a rate which outstripped more leisurely methods of investigation. So successful was it in practice that its facile application was the greatest obstacle to its replacement by the so-called natural systems that superseded it. Linnaeus visited England in 1736 where he met Sir Hans Sloane in London, Phillip Miller at Chelsea Physic garden and Dillenius (Johann Jakob Dillen; *q.v.*) at Oxford. He returned to Holland to complete his work on the famous *Hortus Cliffortianus* and visited the Jussieu (*q.v.*) family in Paris with whom he became a close friend. A month later he was once again in Sweden and in 1738 settled in Stockholm as a practising physician, in which he attained considerable success. In 1739 he married the daughter of a physician, Sara Moraea, to whom he had been betrothed four years earlier. Two years after his marriage Linnaeus was appointed to the chair of medicine at Uppsala but a year later exchanged this for the chair of botany.

Henceforward his time was taken up by teaching and the preparation of other works. He issued his *Flora Suecica* in 1745 and *Fauna Suecica* in 1746; his two volumes of observations made during journeys in Sweden, *Wastgota resa* (1747) and *Skanska resa* (1751); his *Hortus Upsaliensis* (1748); his *Philosophia Botanica* (1751) and his important *Species Plantarum* (1753), in which the specific names are fully set forth. In 1755 he declined an invitation from the king of Spain to settle in that country with a liberal salary and full liberty of conscience. In 1761 he was granted a patent of nobility, antedated to 1757, from which time he was styled Carl von Linné. To his delight the tea plant was introduced alive into Europe in 1763. An apoplectic attack in 1774 greatly weakened him, and he died on Jan. 10, 1778, at Uppsala, in the cathedral in which he was buried.

Linnaeus delighted in devising classifications, and not only systematized the two kingdoms of living things, but even classified the mineral kingdom and drew up a treatise on the kinds of diseases. He was the first to enunciate the principles for defining genera and species and to adhere to a uniform use of specific names.

Of his 180-odd works those published during his lifetime were enumerated in R. Pulteney's *General View of the Writings of Linnaeus* (1781). His *epistolae ineditae* appeared at Groningen in 1830. His widow sold his collections and books to Sir J. E. Smith. the first president of the Linnean society of London. When Smith died in 1828 a subscription was raised to purchase the herbarium and library for the society, whose property they remain.

See also Index references under "Linnaeus, Carolus" in the Index volume.

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LINNET, *Carduelis cannabina,* a common songbird, frequenting almost the whole of Europe south of lat. 64°, and in Asia extending to Turkestan. It is a winter migrant to Egypt and Ethiopia, and is abundant at all seasons in Barbary, as well as in the Canaries and Madeira. Though the fondness of this species for the seeds of flax (*Linum*) has given it its common name in many European languages, it feeds chiefly on the seeds of Compositae (ragweed, sunflower, etc.). The males in spring have a handsome crimson-red breast and crown. The song is pleasant but apt to be monotonous. The linnet begins to breed in April, the nest being generally placed in a low bush. It is a neat structure of fine twigs. roots or bents. lined with wool or hair. The eggs, four to seven in number, are of a very pale blue marked with reddish or purplish brown. Two broods are raised in a season.

JOHN MARKHAM

LINNET (CARDUELIS CANNABINA) AT NEST WITH YOUNG

The plumage of this small finch varies much with age, sex and season; each phase may have a different common name, such as red linnet. gray linnet. The name mountain linnet is applied to the yellow-billed C. *flavirostris,* which never has crimson on crown or breast. Green linnet is a common name for the greenfinch (*q.v.*).

In the southwestern United States linnet is a name for the house finch (*Carpodacus mexicanus* frontalis), familiar, nesting about houses and a good singer; and to the desert house finch (C. *m. solitudinis*), British Columbia to Nevada and eastern California.

(G. F. Ss.)

LINOLEUM: see FLOOR COVERINGS.

LINOTYPE, U.S. trade name for a hot-metal composition typesetting machine that casts printing type in lines (slugs). Basic operations of the machine are the assembly of matrices from a multichanneled magazine in which they are stored; justification of the assembled line of matrices by spacebands (adjustable spacing devices); forcing of quick-cooling molten type metal against the assembled and justified matrices; trimming and delivery of the cooling slug of type; and distribution of each matrix to its proper channel in the magazine, ready for re-use. Invented by Ottmar Mergenthaler (*q.v.*) in the 1880s, the Linotype revolutionized the printing industry, making possible more rapid typesetting, with one Linotype operator being able to set the same amount of type as several hand compositors. *See* also PRINTING TYPE; TYPESETTING.

LINSANG, a civetlike carnivorous mammal (Prionodon *linsang*), found from upper Burma through the Malay peninsula to Borneo and Java. Linsangs are slender in build, with short legs and long, banded tail. Their general colour is pale buff, the forehead and muzzle are brown and five broad black or brown transverse bands cross the back. Other longitudinal markings occur on neck and sides. This species is about 30 in. long. See CARNIVORE.

(J. E. HL.)

LINSEED AND LINSEED OIL. Linseed, an oilseed known also as flaxseed, is the seed of a variety of the common flax. *Linum usitatissimum*, which is cultivated principally in the United States. Canada. the U.S.S.R., India and Argentina for its yield of linseed oil and linseed oil meal. This variety of flax has shorter straw, more branches and more seeds than other varieties that are grown primarily for fibre to be woven into linen. World production of linseed is about 140,000,000 bu. per year; the United States, the Soviet Union and Argentina rank among the leading producers. (*See* also FLAX.)

Linseed is borne in globular capsules, each containing ten long, flat elliptical seeds with slight projections at one end. Sizes vary considerably; typical seeds are about 3–4 mm. long, 2–3 mm. wide and 0.5 mm. thick. Average weights range from 3 to 9 mg. The seeds, usually brown, are smooth and shiny and contain a mucilaginous substance in their outer layer that makes them sticky when wet. Beneath the seed coat is a thick layer of endosperm, inside which the main volume of the seed is occupied by the two cotyledons. Unlike most grasses, mature linseed is devoid of starch granules.

The oil content of the whole seed depends upon several factors, including the type of the linseed: maturity of the seed, locality. soil, temperature, rainfall and other conditions of climate and weather under which the seed is grown. The oil content usually ranges from 33% to 43% in air-dried seed having a moisture content of about 6%.

Linseed oil has a high iodine number (value), which reflects the high degree of unsaturation of its fatty acid radical. The oil is a mixture of the glycerides of linolenic. linoleic. oleic, stearic and palmitic acids. Its high iodine number (usually between 175 and 205, depending on the grade) is due mainly to the linolenic and linoleic acid components. Linseed oil is a golden-yellow, amber or brown liquid that is classified as a drying oil because it thickens and hardens on exposure to air (see also OILS. FATS AND WAXES). It has a low melting point (about −20° C.) and is a little more viscous than most vegetable oils. It is used in the manufacture of paints, printing inks, linoleum, varnish and oilcloth.

Linseed oil is prepared commercially in several grades, including raw, refined, boiled and blown. Raw oil is the slowest drying of all the grades. The refined grade is raw oil from which solid fats, fragments of seeds and other undesirable materials have been removed. Boiled linseed oil dries in less time than either raw or refined oil and exhibits improved drying qualities (*i.e.*, it becomes thicker, denser and darker when dry) as a result of having materials called driers, such as manganese oxide, added while the oil is hot; the name is inaccurate, since the oil is not boiled. The blown grade dries to an even harder film as a result of having air blown through the oil while it is heated to about 125° C.; this grade is used in enamels and interior paints.

Although exposure to air causes the flavour of the seed to deteriorate rapidly, especially if it has been refined and deodorized, linseed was used as food by the ancient Greeks and Romans, and it continues to be used as such in parts of central Europe. In modern times, however, its main food use is as a livestock feed. After the oil is removed from linseed by compression, the remaining meal is heated and pressed into cakes for livestock. Linseed meal contains about 33% protein and is high in minerals. especially calcium and phosphorus. See FEEDS, ANIMAL: *Important* Concentrate Feeds; see also references under "Linseed and Linseed Oil" in the Index volume.

See U.S. Tariff Commission, *Flaxseed and Linseed Oil,* "Industrial Material Series," Report no. M-7 (Nov. 1952); E. W. Eckey, *Vegetable Fats and Oils* (1954).

(P HE.)

LINSINGEN, ALEXANDER VON (1850–1935), Prussian general, who commanded large German forces on the eastern front during World War I and who was responsible for the disposition of troops in and around Berlin at the time of the revolution in Nov. 1918. Born on Feb. 10, 1850. at Hildesheim. Hanover, Linsingen entered the Prussian army in 1868. He was commissioned a lieutenant in the infantry a year later, and in the Franco-German War he was awarded the Iron Cross. From 1909 to 1914 he was in command of the army II corps at Stettin (now

Szczecin), holding the rank of lieutenant general. During World War I he served first on the western front. holding commands at the early battles of Mons. the Marne and Ypres. He was later transferred to the eastern front, and in Jan. 1915 he was given command of the German southern army. which he exchanged in July for the command of the army of the Bug.

In September. after his army had taken Brest-Litovsk (now Brest), the German-Austrian southeastern group (army group L) was placed under his command. With these troops he pursued the retreating Russians, established a defensive line near Pinsk and foiled all Russian attempts to break through from 1915 to 1918. In March 1918 Linsingen led the advance into the Ckraine. and in June he mas appointed chief in command in the hlark (the province of Brandenburg, including Berlin!. In this capacity he was responsible for placing the troops who had been left in Berlin and neighbouring garrisons for the purpose of preserving order. On the eve of the revolution he and his officers in command under him failed to maintain their authority. and on Nov. 9. 1918. the troops made common cause with the revolutionaries who overthrew the imperial and royal regime and secured the proclamation of the German republic. A plan by Linsingen to put down the revolution with bombing planes was rejected by the war ministry, whereupon he retired to Stettin. He later moved to Hanover, where he died on June 5, 1935.

LINTH, a river of Switzerland. is one of the tributaries of the Aare (*q.v.*). It rises in the glaciers of the Tödi range and has eroded a deep bed that forms the Linthtal, which comprises the greater part of the canton of Glarus. A little below the town of Glarus the river, keeping its northerly direction, flows across the alluvial plain that it has formed toward the lake of Zurich. In order to regulate the flow of the river over this plain it has been canalized. and dikes protect the riparian lands. These works were begun in 1807, and the first portion of the undertaking was completed in 1811. when it received the name of the Escher canal. the river being thus diverted into the Walensee or lake of Walenstadt. The Walensee is 9 mi. long with an area of 9 sq.mi., an altitude of 1.375 ft. and a maximum depth of 492 ft. The Churfirsten range dominates the northern shore, which is less populated than the southern. The Seez river enters the lake from the east. Walenstadt is the main town on the lake. The second portion of the Linth. known as the Linth canal, regulated the course of the river between the Walensee and the lake of Ziirich and was completed in 1816. Many improvements and extra protective works were carried out after 1816, the date of the completion of the work being 1911. The Linth emerges from the lake of Ziirich as the Limmat and, keeping the northwesterly direction, joins the Aare a little way below Brugg and just below the junction of the Reuss with the Aare. The combined length of the Linth-Limmat is 87 mi. (A. F. A. M.)

LINTON, RALPH (1893–1953), U.S. anthropologist, an influential contributor to the development of cultural anthropology, was born into a Quaker family in Philadelphia. Pa.. on Feb. 27, 1893. While a student at Swarthmore college (B.A., 1915). he participated in archaeological expeditions to New Mexico, Colorado and Guatemala. Thereafter, he studied at the University of Pennsylvania (M.A., 1916). After serving in the American expeditionary forces as a corporal during World War I. Linton studied briefly at Columbia university and then at Harvard university (Ph.D., 1925). During these student years he continued to engage in archaeological research in New hlexico. Colorado. Ohio and the Marquesas Islands. Linton's experience in the Marquesas Islands turned his attention to ethnology and, during his association with the Field Museum of Natural History (later the Chicago Natural History museum) from 1922 to 1928. he led an expedition to Madagascar (1926) that resulted in his major ethnographic work, The *Tanala,* a Hill Tribe of *Madagascar* (1933).

Linton was professor at the University of Wisconsin (1928–37), Columbia (1937–46) and Yale (1946–53). His most important theoretical work, *The* Study of *Man* (1936). was a widely influential synthesis of theories from anthropology, psychology and sociology concerning the nature of human culture. Other major works were *The Cultural* Background *of* Personality (1945); and *The Tree of Culture* (1955), the fruition of his stimulating lectures on world ethnology at Yale university. His professional honours included the presidency of the American Anthropological association (1946), membership in the National Academy of Sciences Viking fund medallist (1951) and winning the Huxley memorial medal of the Royal Anthropological institute (1954). He died on Dec. 24, 1953, in New Haven, Conn. (D B St)

LINTON, WILLIAM JAMES (1812–1898), English wood engraver, author and active Chartist, was born in London on Dec. 7, 1812. He was apprenticed to the engraver. G. W. Bonner, and from an early age contributed engravings to the R. A. summer exhibitions and to books and periodicals. working both from his own designs and from those of other artists. He was noted for his skillful exploitation of the "white line." An ardent republican, Linton was politically active in the 1840s and early 1850s, founding a political party and editing a number of radical papers. His second wife. whom he married in 1858, was Eliza Lynn, the novelist, but the marriage was not a success. In 1866 Linton emigrated with his family to the United States. He set up a printing press at New Haven. Conn., where he died on Jan. 1, 1898. Linton wrote poetry, an autobiography (*Memories,* 1895) and books on his craft, among them The *Masters* of *Wood-Engraving* (1890). (A. Bs.)

LINTOT, BARNABY BERNARD (1675–1736), English publisher. was born at Southwater. Sussex, on Dec. 1. 1675, and started business as a publisher in London about 1698. He published for many of the leading writers of the day, notably Vanbrugh Steele. Gay and Pope. The latter's Rape of *the* Lock in its original form was first published in Lintot's *Miscellanies,* and Lintot subsequently issued Pope's translation of the *Iliad* and the joint translation of the Odysrey by Pope. Fenton and Broome. Pope, having quarreled with Lintot with regard to the supply of free copies of the Odyssey to the author's subscribers, in 1728 satirized the publisher in the *Dunciad* and in 1735 in the Prologue to the Satires.

Lintot died on Feb. 3. 1736.

LINUM is a genus of the family Linaceae. There are about 200 species of plants found in temperate and subtropical regions, especially the Mediterranean. About 30 species are native to North America. Among these are *Linum virginianum* (slender yellow flax'), of the eastern states; L. *floridanum* (Florida yellow flax). of the southeastern states; L. *rigidum* (large-flowered yellow flax), of the interior prairie region; L. *lewisii* (wild blue flax). widely distributed from Wisconsin to Alaska and southward to California and Texas; and L. *californicum* (white-flowered flax), of the coast ranges.

L. *grandiflorum* (flowering flax), a native of North Africa, with large red flowers, and L. *flavum,* with golden-yellow flowers native to Europe, are grown as ornamental plants. There are four species in the British flora: L. *catharticum* (purging flax), with white flowers. which is common; L. perenne (perennial flax); L. *angustifolium* (narrow-leaved flax); and L. *usitatissimum* (flax or linseed), which has been introduced and is cultivated especially in Ireland. Flax. the fibre of the last-named species, is obtained by the removal of the softer tissues by retting; the shorter fibres form tow. The seeds (linseed) yield an oil by pressure, and the cake left is a cattle food. See FLAX.

LINUS, SAINT was, according to Irenaeus, the immediate successor of St. Peter as bishop of Rome. Irenaeus says (in Against Heresies) "the blessed Apostles passed on the sacred ministry of the episcopacy to Linus." Linus was in all probability also attested by Hegesippus' list and is mentioned by Eusebius of Caesarea (*Church* History). In the Book of Popes (Liber *Pontificalis,* Duchesne edition) Linus comes immediately after St. Peter. This list dates back to primitive Christianity. His feast day is Sept. 23.

See L. R. Loomis and J. T. Shotwell, *Book of the Popes,* Eng. trans. based on Duchesne's work, in "Record of Civilization Series" (1916). (J. M. F. M.)

LINUS. A name abstracted from the ancient ritual cry ailinos, the refrain of a dirge, supposed Phrygian by Euripides[1]

[1]Eurip., *Orest.*, 1395.

but probably of Semitic origin (ai *lanu,* "woe to us"). It is as old as Homer,[2] and how much older is not known. To account for this lament for Linus (Gr. Linos), as it was supposed to be, two principal stories were told: (1) *Argive.*—Linus, child of Apollo and Psamathe, was exposed at birth and was torn in pieces by dogs. In revenge, Apollo sent a *Poine* or avenging spirit. which destroyed the Argive children. The hero Coroebus killed her. and a festival, Arnis, otherwise called Dog-killing day (*kunophontis*), was instituted, in which stray dogs were killed, sacrifice made, and Linus and Psamathe mourned for.[3] (2) *Theban.*—Linus was the son of Crania and Amphimarus, and a great musician. He invented the Linus song but was put to death by Apollo for setting up as his rival.[4] A later, half-burlesque story says that he was Hercules' music master and was killed by his pupil, whom he tried to correct.[5] He had a cult on Mt. Helicon. Later tradition rationalized him into an ancient poet, prophet or the like.

This and similar figures (Adonis, Maneros, Narcissus) are plausibly explained as originating ultimately in the ceremonial laments for the dead corn spirit.

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LINZ, the provincial capital of Upper Austria (Oberösterreich), lies on the Danube 100 mi. W. of Vienna. Pop. (1961) 197,121. The see of a bishop since 1785, it is a cultural centre with schools of art and music, a technical college, a religious seminary, scientific institutes, museums and art galleries, libraries, archives, an opera and theatres. Historic buildings include the castle; the Romanesque church of St. Martin (first mentioned 799); the early baroque town hall; the rectangular architecturally homogeneous main square (13th century) with a monument to the Holy Trinity; the City Parish church (built in the 13th century, remodeled baroque in the 17th century); the old cathedral (late 17th century); and the church of the Minorites (Franciscans) (13th century, remodeled 18th century). Other notable buildings are the 16th-century Landhaus (building of the provincial diet) and monastic churches (Capuchin, Ursuline, Carmelite). In the 19th century Archduke Maximilian d'Este fortified the town with a belt of towers, and the main fort on the Postlingberg (1,765 ft.) can be reached by mountain railway (the steepest without rack and pinion in Europe).

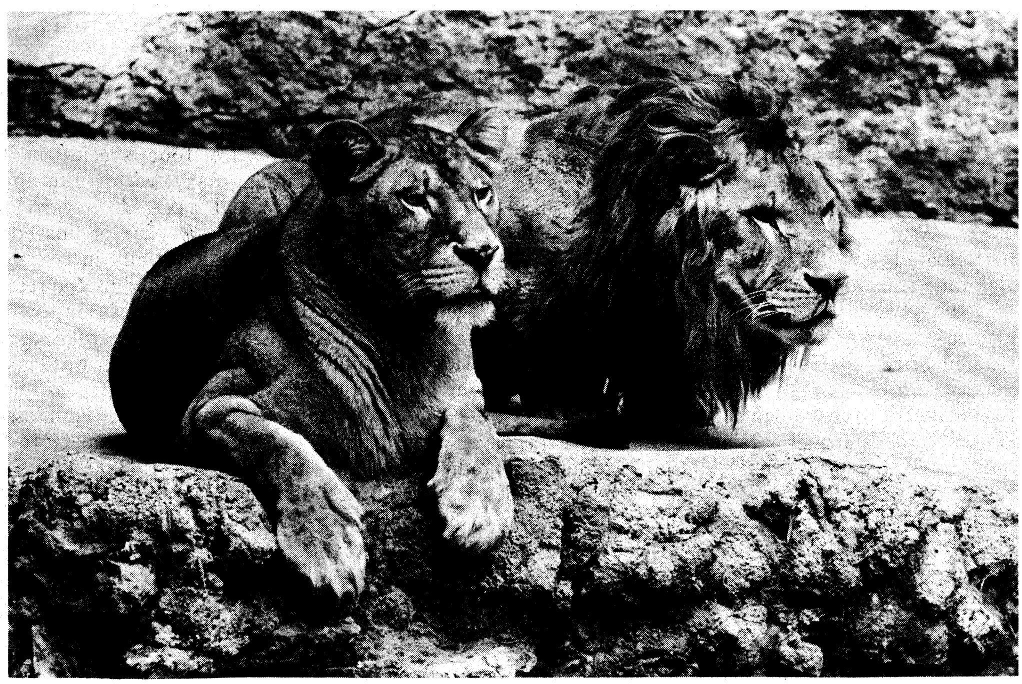
The most direct rail route between the Baltic sea and the Adriatic runs through Linz. and the town's position on the Danube makes possible a flourishing river transit trade. Urfahr, a large suburb on the left bank. is connected with the city by two bridges. After 1938 Linz developed into an important industrial centre with blast furnaces, smelting works, steel factories and a nitrogen fixation plant. War damage necessitated their reconstruction after 1945. The Linz-Donawitz (LD) oxygen-injection steel process is well knoan. The manufacture of machinery, electrical equipment, textiles and tobacco is also considerable.

Linz grew out of the Roman castle of Lentia (1st century A.D.) and it became an important medieval trading centre. By the 13th century it had all the outward characteristics of a regular city, but no civic rights. It achieved the status of provincial capital during the residence of the emperor Frederick III and was noted for its fairs. By the 18th century it was a city of the nobility, but it temporarily declined in the 19th century. The astronomer Johannes Kepler, the poet Adalbert Stifter and the composer Anton Bruckner all spent part of their working lives in Linz. (If'. F. RA.)

LION, since the earliest times one of the best-known wild animals. During the Pleistocene period the lion (*Panthera* leo) was distributed over the greater part of Europe, and within the historical period it inhabited north Africa, western Asia and probably Greece. It is now found in most parts of Africa south of the Sahara desert and in Kathiawar in Gujarat state, northwestern India, but is now extinct in Iran and Iraq. The lion. tiger, leopard, jaguar, and snow and clouded leopards, generally known as the big cats, make up the genus *Panthera* of the family Felidae, order Carnivora (see CARNIVORE).

The lion is a powerfully built beast of prey with long body, short legs and large, well-developed muscles. It varies considerably in size but averages about 9 ft. 6 in. (including the tail), stands about 3 ft. at the shoulder and weighs 400 to 500 lb. The hair is short and varies greatly in colour from pale sandy to dark tawny; the tuft at the end of the tail is usually darker. The outstanding characteristic of the male, the mane, varies greatly in its development from the entirely maneless condition through a mere fringe of longer hair round the face to the splendid full mane. At its most luxuriant it covers the back of the head, neck and shoulders and is continued on to the throat and chest, where it joins a fringe along the underside of the belly. In some lions the whole of the mane and fringe are very dark, almost black, so that the animal has a majestic and impressive appearance; in others it is lighter, often no darker than the rest of the coat. The reasons for the variation in mane development are unknown; they may be heritable, like the differences in hairiness among human beings. But it has also been suggested that lions living in dense bush country have their manes so thoroughly combed while penetrating among thick thorn scrub that most of the long hair is pulled out. The fact that lions in captivity generally grow much longer and fuller manes than wild lions is quoted in support of this supposition. A newborn lion cub is covered with dark spots on a pale ground colour, but these markings are generally lost with approaching maturity; in some lions, however, the spots are retained on the limbs, under parts and flanks throughout life.

The lion has no definite breeding season, and cubs may be born at any time of the year; the litter varies from two to four, rarely six (in captivity). In captivity lions often breed every year,



H. ARMSTRONG ROBERTS

FEMALE AND MALE LIONS (PANTHERA LEO)

[2]Hom., *Il.*, xviii, 570.
[3]Pausanias, i, 43, 7; Conon, narrat., 19.
[4]Paus., ix, 20, 6.
[5]Apollodorus, ii, 63.

but in the wild it is probable that they do not breed more frequently than once in two years. The young are born blind, the eyes opening at the age of about a week; they do not become adult until the permanent canines replace the .milk teeth, at the ape of about one year. In the wild the lion reaches its prime at about five or six years of age. The life span is not known for lions in the wild, but in captivity they may live 25 years or more.

The well-known roar of the lion is generally given forth when the animals arouse themselves in the evening before a night's hunting and again before lying up at dawn. The old story that the lion lashes himself into fury with the "claw" on his tail before making an attack is only a legend; the claw is usually no more than a small horny scale or spur attached to the skin at the tip of the last vertebra. In addition to the roar, the lion utters many other sounds: coughs. grunts, growls and deep purring noises.

Lions tend to be sociable animals and often live together in parties of a dozen or more, generally comprising several lionesses with their partly grown cubs. A lioness with cubs is often accompanied by a cubless one. The lion hunts by night and spends the day lying up in cover or under the shade of trees or rocks. After patiently stalking its prep. the lion makes a lightning-fast charge for the kill. Lions have frequently been seen hunting in company. and it is stated that some mill lie in ambush while others of the party drive prey toward them. In Africa lions feed on any animals they can pull down. from the smaller antelopes to the giraffe, although it takes several working together to overcome the larger animals. In the neighbourhood of human settlements lions are sometimes very destructive to stock, showing great cunning in breaking into enclosures and enormous strength in jumping over thick fences with their prey in their jaws.

Lions, like most other potentially dangerous animals, generally avoid man. but they sometimes take to man eating and may kill large numbers of natives if they are not promptly sought out and killed before man eating becomes a habit. When brought to bay a lion will often charge his attacker, rushing upon him with great speed. The lion can inhabit open country with only sparse cover. See also TIGER.

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(L. H. M.)

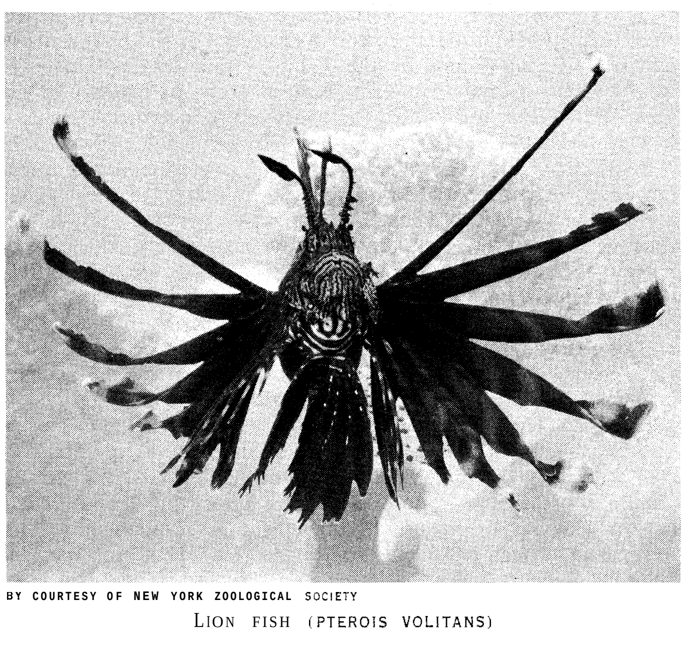
LION FISH (TURKEY FISH), a tropical marine fish (*Pterois volitans*), somewhat poisonous. of very striking appearance: its very high dorsal and large pectoral fins are more or less divided into long, wide-spreading strands that stand out from the body. In each strand is a spine and an associated venom gland. Its body, up to one foot long, and its fins are patterned with light and dark stripes.

Like the rest of the scorpion fish or rockfish family (Scorpaenidae), the lion fish is sluggish. spending most of its time on the bottom. It is found in the Indian ocean and in the Pacific from the East Indies eastward to Polynesia. Contact with the spines results in a painful wound in man; however, the toxin is not so virulent as that of the related stonefish or poison fish (*q.v.*). See also SCORPION FISH; FISHES. (J. T. N.; X.)

LIONNE, HUGUES DE (1611–1671), French statesman, was born at Grenoble on Oct. 11, 1611, of an old family of Dauphini.. Early trained for diplomacy, his abilities attracted the notice of Cardinal Mazarin, who sent him as secretary of the French embassy to the congress of Münster and, in 1642, on a mission to the pope. From that time he filled high offices. He helped to negotiate the peace of the Pyrenees (1659), which secured the marriage of Louis XIV to the infanta Maria Theresa. At Mazarin's dying request he was appointed his successor in foreign affairs and, for the next ten years, continued to direct French foreign policy. Among his most important diplomatic successes were the treaty of Breda (1667), the treaty of Aix-la-Chapelle (1668) and the sale of Dunkirk. He died in Paris on Sept. 1. 1671. leaving memoirs.

See U. Chevalier, *Lettres inédites* de *Hugues de Lionne,* (1879); J. Valfrey, *La diplomatie française au XVIII^e siècle: Hugues de Liotzne, ses ambassadeurs* (2 vol., 1877–81). For further works *see* Rochas, *Biogr. du Dauphiné,* tome ii, p. 87 (1860).

LIOTARD, JEAN ÉTIENNE (1702–1789), Swiss painter noted for his pastel portraits, was born at Geneva. He began his studies under Gardelle and Petitot. He went to Paris about 1723, studying under J. B. Massé and F. le Moyne on whose recommendation he was taken to Naples by the Marquis Puysieux. In



BY COURTESY OF NEW YORK ZOOLOGICAL SOCIETY

LION FISH (PTEROIS VOLITANS)

BY COURTESY OF NATIONAL GALLERY, LONDON

"A GRAND VIZIR," A PASTEL BY JEAN ÉTIENNE LIOTARD. IN THE NATIONAL GALLERY, LONDON

1735 he was in Rome. painting the portraits of Pope Clement XII and several cardinals. Three years later he accompanied Lord Duncannon to Constantinople; from there he went to Vienna in 1743 to paint the portraits of Empress Maria Theresa and her family. His eccentric adoption of oriental costume secured him the nickname of "the Turkish painter." He visited England. where he painted the princess of Wales in 1753, and went to Holland in 1756, where, in the following year, he married Marie Fargues. Another visit to England followed in 1772, and in the next two years his name figures among the Royal Academy exhibitors. He returned to his native town in 1776 and died there in 1789.

Liotard was an artist of great versatility, and though his fame depends largely on his graceful and delicate pastel drawings, of which "La Liseuse." the "Chocolate Girl" and "La Belle Lyonnaise" at the Dresden gallery are delightful examples. he achieved distinction by his enamels, copperplate engravings and glass painting. He wrote *Treutise on the Art of Painting,* and was an expert collector of paintings by the old masters. A portrait of the artist is in the Uffizi gallery, Florence: Italy.

LIOUVILLE, JOSEPH (1809–1882), French mathematician known for his work in analysis, the theory of numbers and differential geometry. was born at St. Omer and died at Paris. He graduated in 182; from l'École Polytechnique where, in 1833. he became professor. At the early age of 30 he was elected to the Académie des Sciences (Paris). and presently was appointed professor at the Sorbonne and the Collège de France. He founded (1836) and edited the *Journal* des *Mathématiques Pures et Appliquées,* which did much to raise and maintain the standard of French mathematics throughout the 19th century.

Liouville was a boldly original mathematician. His works. never collected, comprise about 400 memoirs and notes, more than 200 on the theory of numbers alone. In 1832–33, he investigated criteria for the analytic character of integrals of algebraic functions. Liouville was the first. in 1844, to prove the existence of transcendental numbers. and he constructed an infinite class of such numbers. He worked also in differential equations and boundary-value problems. His methods in this department became of capital importance in 20th-century mathematical physics, as well as in the theory of integral equations. In differential geometry, he contributed notably to the theories of applicability of surfaces and conformal transformations. The concept of geodesic curvature was introduced by Liouville. Nearly all of his work on the theory of numbers (1857–82) was published without indication of the means by which he had obtained his striking results, relating mostly to numerical functions, representation in quadratic forms and general formulas in parity functions. All have since been proved. In analysis, Liouville was the first to deduce the theory of doubly periodic functions from general theorems, including his own. in the theory of analytic functions of a complex variable. (E. T. B.; O. OE.)

LIPA, a municipality (with administrative centre and 45 *barrios* or districts), of the province of Batangas, Luzon, Philippines, about 90 mi. S. by E. of Manila, on high ground at the intersection of old Spanish military roads, east of the lake of Taal and near the railway running to Batangas. Pop. (1960) 69.342. It is one of the largest and wealthiest inland municipalities of the archipelago. Sugar, corn, cacao and tobacco are among the principal products. Coffee was formerly produced in considerable quantity, but many of the trees were destroyed during the insurrection of 1899–1902; others were destroyed by insects. Jusi cloth is woven in Lipa, and tied abacá (Manila hemp) is marketed in considerable volume. Tagalog is the vernacular.

LIPARI ISLANDS (ISOLE EOLIE; AEOLIAN ISLANDS), a group of volcanic islands located off the north shore of Sicily, in Messina province. They have a general "Y" shape, the base of the "Y" being the westernmost island, Alicudi, the northern tip being Stromboli and the southern tip being Vulcano. The other major islands are Lipari, Salina, Filicudi and Panarea. They have a total land area of 44 sq.mi. and a population (1951) of 14,782. Seismic and volcanic activity has been known since ancient times, and the Greeks believed the islands to be the home of Aeolus, king of the winds, hence the alternate name of the group. There are fumaroles on Lipari and Panarea; Vulcano and Stromboli are active. Pumice is exported from the islands, and the principal agricultural product is heavy malmsey-type wine from Lipari. There is regular steamer service to Milazzo, Messina and Naples.

Excavations in the 20th century have established an uninterrupted archaeological record from the Neolithic period. Ceramics and artifacts have been found, while the volcanic obsidian of the islands has been detected as far as Crete. 4 feature of archaeological research was substantiation of the legend that Aeolus came from Magna Graecia along the coast of south Italy rather than Sicily. Lipari (pop. [1957 est.] 3,731 [commune]) is the chief town, with the important Aeolian archaeological museum. Panarea has a Bronze Age village; Stromboli's spectacular volcano is a noted tourist attraction.

The Greeks established themselves in the islands in the 6th century B.C. Later there was a Carthaginian naval station. until the Romans took over in 252 B.C. In Roman days, as in the Fascist era, the islands served as a place of banishment for political prisoners. In medieval times they were conquered by the Saracens, who were expelled by the Normans in the 11th century. The islands frequently changed hands during the wars between the Angevins of Naples and the Sicilian kings in the 14th century. Alfonso V of Aragon annexed them to Naples. but Ferdinand II of Aragon finally united them to Sicily in the late 15th century. (G. KH.)

LIPCHITZ, JACQUES (1891–), one of the early revolutionaries of modern sculpture because of his participation in Cubism (*q.v.*) and his development of a new language for sculpture that was not based upon anatomy or the outward form of the human body. Born in Druskieniki. Latvia. Aug 22. 1891. Lipchitz studied and worked in Paris after 1909; by 1941, when he moved to New York, his international reputation was established. His new means of interpreting the human body esthetically and psychologically can be seen in "Man With a Guitar" (1915) and "Prodigal Son" (1931). In his "transparencies" of the 1920s Lipchitz was one of the first sculptors to introduce voids within his sculptured figures. His strongest art deals with tension, as in "Figure" (1926–30), and man's spiritual history, as in "The Virgin of Assy" (1948–54). Lipchitz always stressed the sculptor's transforming manipulation and shaping power.

There is a well-known portrait of Lipchitz and his wife by Amedeo Modigliani (*see* PORTRAIT PAINTING: *The 20th Century*).

See Henry R. Hope, The *Sculpture* of Jacques Lipchitz (1958); Robert Goldwater, *Lipchitz* (1959). (A E. EL)

LIPETSK, a town in the Lipetsk *oblast,* Russian Soviet Federated Socialist Republic. Pop. (1959) 156,000. The region was formed on Jan. 6. 1954, out of districts detached from the regions of Voronezh. Orel, Ryazan and Kursk. The city, on the right bank of the Voronezh river. was founded in the 13th century and razed to the ground by the Tatars a few decades later It was founded again in 1779. There are deposits of iron ore in the area. and Lipetsk is a centre for pig-iron production and related heavy industries.

LIPKA, JOSEPH (1883–1924), U.S. mathematician, was born at Briessin, Poland, in 1883. He emigrated to the U.S. as a child and was educated at Columbia university (Ph.D., 1912). A member of the faculty of the Massachusetts Institute of Technology, his earlier work, from 1908, was chiefly in applying differential geometry to dynamics and developing in Euclidean spaces of two or three dimensions the geometric properties of dynamical trajectories and related systems of curves. In 1921 he went abroad for study, especially with Tullio Levi-Civita of Italy. He subsequently published papers revolving about Levi-Civita's notion of parallelism. He generalized this notion by replacing the geodesics at the basis of it by the trajectories of a natural family, which suggested a new type of parallelism called "conformal parallelism." an idea of great value in problems in dynamics, and from it developed a new set of invariants that yield corresponding results bearing on trajectories. He died at Boston, Mass., on Jan. 24, 1924.

LIPMANN, FRITZ ALBERT (1899–), U.S. biochemist, received (with H. A. Krebs) the 1953 Nobel prize in medicine and physiology. Born in Konigsberg. Ger., on June 12, 1899, he studied medicine at the universities of Konigsberg, Munich and Berlin (M.D., 1922) and later studied chemistry (Ph.D., Berlin, 1927). He did early research in the laboratory of Otto Meyerhof (1927–30). After a short period with Albert Fischer at the Kaiser Wilhelm institute, Berlin, he followed him to Copenhagen to the newly established Biological Institute of the Carlsberg foundation (1932–39). Lipmann had earlier spent a year as a Rockefeller Foundation fellow at the Rockefeller institute (1931–32), and in 1939 joined the faculty of Cornell Medical school (New York city). He became a U.S. citizen in 1944. He was head of the Biochemical Research department, Massachusetts General hospital, Boston (1941–57), and after 1949 was professor of biological chemistry, Harvard Medical school, until he returned to the Rockefeller institute in 1957. His work influenced and developed understanding of biological energy transfer. He discovered vital metabolic catalysts. (G. E. Pn.)

LI PO or **LI TAI** PO (李白,李太白, 701–762), considered by many critics as China's greatest poet, was born in Pa-hsi (巴西) in Szechwan. He was a descendant, in the ninth generation, of the emperor Hsing-Sheng. At his birth, his mother had a dream in which she saw the planet, Chang-kêng (長庚星, Venus) and because of this omen he was named Po or "The Bright." At ten, he learned the *Book of* Odes and the *Book of History*. He was fond of fencing and developed a taste for drink, a passion for poetry, and a desire for adventure. After the age of 20, he wandered as far as Shantung, and then retired to the Min mountains (岷山) living the life of a *hsien* (仙, an immortal endowed with divine powers as an angelic man) together with five other sympathetic companions, King Chao, Han Chun, Pei Chêng, Chang Shuming and Tao Mien. Their coterie was known as the Six Idlers of the Bamboo Streams (竹溪六逸). Li Po was then summoned by the provincial examination board, who wished to award him governmental preferment, but he made no response. When Su Ting, the governor of Ichou, was introduced to him, he was struck by the poet's genius and said, "This man has conspicuous natural talents. If he had more learning, he would become a second Ssuma Hsiangju" (司馬相如, 126 B.C., the greatest poet of the Han dynasty).

About 742, he reached the capital, Changan (長安), where his poetry aroused the admiration of Ho Chihchang (賀知章), the minister of the emperor and the president of the Hanlin academy (翰林學院). About this time, there was a Korean messenger with an imperial document written in Korean. This nobody could read but Li Po. After being many times summoned by the emperor Ming Huang, Li Po appeared before him to receive promotion. At one time, while Li Po was drinking in low taverns, the emperor sent for him to compose a song; but Li Po was so drunk that his head and face had to be washed repeatedly with cold water before he could go to the pavilion. While the emperor played the flute, Yang Kueifei (楊貴妃), the court mistress, accompanied him on the guitar and Li Po drank and wrote verses, not returning to the Hanlin academy until after midnight.

Once, when Li Po was very drunk the emperor ordered Kao Lishih to take off the poet's shoes; Kao felt humiliated and persuaded Yang Kueifei that some of Li Po's poems were derogatory to her. She therefore dissuaded the emperor whenever he wanted to give high rank to the poet. His official failure was thus brought about. Finally the poet petitioned the emperor that he be allowed to go away, and he was given money and an imperial edict which enabled him to obtain wine free of charge wherever he should go. Li Po, together with Ho Chihchang, Li Shihchih, Li Chin, Tsui Tsungchih, Chu Chin, Chang Hsu and Chio Sui then went away, forming a new coterie called the Eight Immortals of the Wine Cup (酒中八仙).

Afterward Li Po drifted into the service of Prince Lin of Yung who, when he failed in certain of his designs, blamed Li Po. But he forgave him and the poet set out to go to his kinsman, Li Yanping. On his way he fell from the boat in which he was travelling while trying to kiss the reflection of moonlight in the water, and was drowned.

Li Po's style is unmatched for purity. He deals mainly with the themes, wine and women, and where emotions enter his verse they go deep into the heart of the reader. His work has strong imaginative and aesthetic appeal with an exquisite exactness of touch and extreme dexterity. Philosophy, religious or social, has no place in his work; to him the poet is no teacher or prophet, but a creator revealing beauty for its own sake.

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LIPPE, a former *Land* of the German Reich. bounded northwest, west and south by the Prussian province of Westphalia and northeast and east by the Prussian provinces of Hanover and Hesse-Nassau, and Waldeck-Pyrmont. It also possessed three small enclaves—Kappel, Lipperode and Grevenhagen in Westphalia. The area was 469 sq.mi., and the population (1939) 188,596, showed a density of 404 to the sq.mi. The area is hilly and consists chiefly of the basin of the Werre. which from Lage northward flows in a wide valley. From there the land rises to the higher hills which encircle it on the east. south and west (the Teutoburger Wald) borders. The forests of Lippe produce abundance of excellent timber, and consist mostly of deciduous trees, beech preponderating. The valleys contain good arable land, the tillage of which employs the greater part of the inhabitants. Small farms, the larger proportion of which are under $2\frac{1}{2}$ ac., are numerous, and their yield shows a high degree of prosperity among the peasant farmers. The principal crops are potatoes. beetroot (for sugar), hay, rye. oats, wheat and barley. Cattle, horses, sheep and swine are also reared. The industries are small and consist mainly in the manufacture of starch, paper, sugar. tobacco, meerschaum wares. and in weaving and brewing. Salzuflen is famous for its brine-springs. Each year, in spring, brickmakers leave the principality to return home in the late autumn. The roads are good. A railway intersects the country from Herford (on the Cologne-Hanover main line) to Altenbeken; and another from Bielefeld to Hameln traverses it from west to east. The constitution was drawn up in 1920. It provided for a representative chamber (*Landtag*) of 21 members. and an executive chamber (Landes prasidium) of 3. The courts of law were centred at Detmold. After 1933 the constitution was superseded by the administration of a National Socialist district leader (*Gauleiter*) appointed by Hitler.

History.—Lippe was inhabited in early times by the Cherusii, whose leader Arminius (Hermann) annihilated in A.D. 9 the legions of Varus in the Teutoburger Wald. It was afterward occupied by the Saxons and was subdued by Charlemagne. The founder of the princely family, one of the most ancient in Germany, was Bernard I (1113–1144), who received a grant of the territory from the emperor Lothiar, and assumed the title of lord of Lippe (cdler Herr *von* Lippe). From Count Simon VI (1555–1613) descended the Counts of Lippe-Biesterfeld and Lippe-R'eissenfeld, and the Princes of Schaumburg-Lippe. On the death of Prince Woldemar of Lippe in 1895, a dispute arose as to the succession between the various branches of the Lippe family, which was only definitely settled in 1905, when Count Leopold of Lippe-Biesterfeld became Prince of Lippe. Lippe, which had been made a principality in 1720 (confirmed in 1789) became a republic in common with the rest of Germany in Nov. 1918. In 1945, Lippe was incorporated into North Rhine-Westphalia.

LIPPE, a river of Westphalia, Ger., a right-bank tributary of the Rhine, rises near Bad Lippspringe under the western slope of the Teutoburger Wald and. after a course of 147 mi.. flows into the Rhine near Wesel. It is navigable, by the aid of 12 locks, downstream from Lippstadt. for boats and barges drawing less than four feet. The Lippe was once used for the transport of coal, timber and agricultural produce to and from Westphalia, but in 1930 it was replaced by a canal that follows its course from the Dortmund-Ems canal to the Rhine. The Lippe supplies water to the canal system of the Ruhr. The canal! which carries 6.000.000 tons of cargo annually, takes the largest barges that use the Dortmund-Ems canal. During the 1960s it was extended beyond the Dortmund-Ems canal toward Hamm. (R. E. Di.)

LIPPI, FILIPPINO (Filippo) (*c.* 1457–1504), Italian painter, son of Fra Filippo Lippi (*q.v.*) and the nun Lucrezia Buti, was a follower of his father and of Botticelli. He was born at Prato, probably in 1457. After Fra Filippo Lippi's death, Filippino entered the workshop of Botticelli. By 1473 he had finished his apprenticeship. The style of Filippino's earliest works stems from that of Botticelli; they include Madonnas at Budapest. Berlin and in the National gallery, London. where there is also an "Adoration of the Magi." Filippino's use of line throughout these panels is less sensitive and subtle than Botticelli's. In a group of paintings executed about 1480–8j he develops a harder and more individual style. The most notable of these are altarpieces in S. Michele at Lucca and the Museo di Capodimonte in Naples, and a panel of the "Journey of Tobias" in the Pinacoteca Sabauda. Turin. Despite the lack of dated or documented works, it is clear that by this time Filippino enjoyed a considerable reputation, since he is known to have been employed, along with Botticelli. Perugino and Ghirlandajo, on the frescoed decoration of Lorenzo de' Medici's villa at Spedaletto near Volterra, and at the end of 1482 was commissioned to complete work left unfinished by Perugino in the Palazzo della Signoria in Florence. No trace of either work survives. Soon after (probably 1483–84) he was entrusted with the completion of the frescoes in the Brancacci chapel in the Carmine, which had been left unfinished on Masaccio's death in 1428.

His most popular picture, the beautiful altarpiece of the "Virgin appearing to St. Bernard" (Badia. Florence), has been variously assigned to the years 1480 and 1486. In April 1487 Filippino Lippi signed a contract for the frescoed decoration of the chapel of Filippo Strozzi in Sta. Maria Novella, Florence. Work on this was delayed by a second commission for a fresco cycle. this time in Rome, where, on the recommendation of Lorenzo de' Medici, Filippino was invited to decorate the Caraffa chapel in Sta. Maria sopra Minerva. Nothing in Filippino's earlier works prepares for the vein of inspiration which he struck in the Caraffa chapel. where the roof is filled with four figures of sibyls, the right wall with frescoes of the "Miracle of the Speaking Crucihx" and the "Triumph of St. Thomas," and the altar wall with a fresco of the "Assumption."

On his return from Rome (probably 1491) Filippino Lippi executed a fresco of the "Sacrifice of Laocoon" for the villa of Lorenzo de' Medici at Poggio a Cajano, in which some of the decorative expedients used in the Caraffa chapel are again employed, and resumed work in the Strozzi chapel (completed 1502), the frescoes which look forward to the Tuscan Mannerism of the 16th century. Of the large number of panel paintings produced in this. Filippino's final phase, the most remarkable are an "Adoration of the Magi" in the Uffizi (painted for S. Donato a Scopeto in 1496) and an altarpiece of the "Deposition" commissioned for the high altar of SS. Annunziata in Florence and completed after Filippino's death by Perugino (Uffizi, Florence). Filippino died on April 18. 1504.

See A. Scharf, *Filippino Lippi* (1935); K. Neilson, *Filippino Lippi* (1938). (J. W. P.-H.)

LIPPI, FRA FILIPPO (Lippo) (1406–1469), one of the best-knonn and most influential Tuscan painters of the 1jth century, was born in Florence in 1406. His father, a butcher, died during Lippi's boyhood, and the boy was given over by his mother to the Carmelite friars of Sta Maria del Carmine in Florence. where on June 18, 1421, he took his first vows. He is mentioned in 1430 as a painter in the community records. where his name appears in Jan. 1432 for the last time. Filippo Lippi was thus trained a5 a painter under the shadow of Masaccio's and Masolino's frescoes in the Brancacci chapel in the Carmine. These influences are reflected in what is probably his earliest work.

NATIONAL GALLERY OF ART, WASHINGTON, D.C., SAMUEL H. KRESS COLLECTION

"MADONNA AND CHILD." BY FRA FILIPPO LIPPI, ABOUT 1406–1469. IN THE NATIONAL GALLERY OF ART. WASHINGTON

a fresco formerly in the cloister (now transferred to canvas) commemorating the reform of the Carmelite order by Pope Eugenius IV in Feb. 1432. In the massive forms of the figures in this fresco and in its solidly constructed architecture Lippi reveals his study of Masaccio, though a latent decorative tendency (later to dominate his work) is already evident in the delicate palette and light tonality. At this point Lippi appears to have left Florence, and in the summer of 1434 was employed in S. Antonio at Padua.

His first dated work, a "Madonna" from Tarquinia Corneto, now in the Galleria Nazionale in Rome, belongs to the year 1437. Like the Carmine fresco, the "Madonna" of 1437 is a powerful and uncompromising work. Immediately after it. Lippi seems to have executed what is perhaps his finest and most characteristic panel painting, an altarpiece of the Annunciation in S. Lorenzo in Florence. This combines space structure of great sophistication with the simple emotionalism that ensured him lifelong popularity. On March 8, 1437, Lippi received the commission for an altarpiece for the Barbadori chapel in S. Spirito (now in the Louvre, Paris). Between 1441 and 1447 Lippi painted for the high altar of S. Ambrogio the great altarpiece of the "Coronation of the Virgin," now in the Uffizi. This includes on the right a self-portrait of the painter designated by the words, Is *perfecit* opus.

After about 1445 Lippi seems to have fallen under the influence of Fra Angelico, which is manifest in the relatively simple scheme of a second altarpiece of the "Coronation of the Virgin" painted for the convent of Monte Oliveto at Arezzo after 1444 (,Vatican gallery), as well as in a masterly *tondo* of the "Adoration of the

Magi" now in the National gallery. R'ashington. A second circular painting of somewhat later date (probably 1452), showing the Virgin and Child with scenes from the life of St. Anne in the background. exists in the Palazzo Pitti, Florence; in this too the problem of the circular field is solved with consummate mastery. Thereafter Lippi began work on his most ambitious project. the frescoed decoration of the choir of the cathedral at Prato illustrating the life of St. Stephen and that of John the Baptist. The commission for these important frescoes was first offered to Fra Xngelico and subsequently (1452) to Fra Filippo Lippi. Work on them appears to have continued until 1364. The bottom frescoes on each side of the choir are works of great solemnity and power. In 1466 Lippi commenced his last major work, the frescoes in the apse of the cathedral at Spoleto. Owing to the master's ill health these weak works were executed almost exclusively by members of his studio.

While in Prato Fra Filippo Lippi abducted from the convent of Sta. Margherita (of which he mas chaplainj a nun, Lucrezia Buti. who became the mother of the painter Filippino Lippi (*q.v.*) and who, according to Vasari, was depicted by Lippi in certain paintings.

Lippi died at Spoleto on Oct. 9, 1469.

See R. Oertel, *Fra Filippo Lippi* (1942). (J. W. P.-H.)

LIPPINCOTT, SARA JANE CLARKE (1823–1904), U.S. author and journalist, born Sept. 23. 1823, in Pompey, N.Y., was the daughter of Thaddeus and Deborah (Baker) Clarke. Educated in public and private schools, she published occasional verse at an early age and at nineteen was a contributor to *Godey's Lady Book*. Best known as "Grace Greenwood," she was the Washington correspondent for the *New York Times* and also the *New York Tribune*.

In 1853 she married Leander K. Lippincott and with him edited the *Little Pilgrim* for 12 years. She was the author of 18 books, including children's tales, historical sketches and travel books. Her last work. *Stories and Sketches*, was published when she was 70 years old. Her best known volumes are *Greenwood Leaves* (1850), a collection of articles and stories, and *Haps and Mishaps of a Tour in Europe* (1854).

She died at New Rochelle, N.Y.

LIPPMANN, GABRIEL (1845–1921), French physicist, invented the photographic reproduction of colour by what is known as the Lippmann interference process: for which he was awarded the 1908 Nobel prize in physics. He was born on Xug. 16. 1845, at Hollerich in Luxembourg of French parents who soon after his birth settled in Paris. He was educated at the École normale and the universities of Heidelberg and Berlin. becoming a member of the faculty of sciences in Paris in 1878. The whole of his life mas devoted to teaching and research. In 1883 he was appointed professor of physics and was subsequently director of the laboratory for physical research at the Sorbonne, and in the same year he was elected a member of the Paris academy of sciences. Of an original and independent mind, he made important contributions to many departments of physics, but especially to electricity. thermodynamics. optics and photochemistry. One of his earliest achievements was the construction of a capillary electrometer of extraordinary sensitivity. The principle of the Lippmann colour process was communicated to the academy of sciences in 1891, but it was not until 1908 that he was awarded the Nobel prize for physics for this work. He was president of the academy of sciences in 1912 and he was a foreign member of the Royal society of London. He died at sea on July 13, 1921. while returning from a visit to Canada. (W. J. Br.; X.)

LIPPMANN, WALTER (1889-), U.S. newspaper commentator and author of numerous books on public affairs. was born in New York city. Sept. 23, 1889. He graduated from Harvard in 1910. In writing on public events for more than 50 years thereafter: Lippmann made himself the foremost commentator in the United States and won a world-wide reputation. From the publication of his first book. *A Preface to Politics*, in 1913. it was evident that he had a discerning grasp of political trends at home and abroad. with a capacity to see where these trends were leading. After a brief apprenticeship with Lincoln Steffens on *Everybody's Magazine* and a briefer excursion into practical politics with the Socialist mayor of Schenectady, N.Y., he became one of the founders and associate editor of the *New Republic*. He was one of the brilliant young men who exerted a great influence on Woodrow Wilson, both through the pages of that liberal weekly and in direct consultation with the president. It was at Wilson's request that after wartime service with the U.S. military intelligence Lippmann served as an aide to Col. Edward M. House in Paris and contributed substantially to Wilson's fourteen points and to the concept of the League of Nations. Deeply disillusioned with the outcome of the Versailles conference, Lippmann returned to America and became editor of the *New York World*. When the *World* was sold, he began to write for the *New York Herald Tribune* an independent commentary that was syndicated to a large number of newspapers at home and abroad. Among more than a score of published books, his most influential works have been *Public Opinion* (1922), *A Preface to Morals* (1929) and *The Good Society* (1937). *Essays in the Public Philosophy* (1955) was criticized in some quarters because of its espousal of the concept of natural law as paramount. After 1938 Lippmann lived in Washington, D.C., with his wife, the former Helen Byrne Armstrong. In writing his commentary he traveled widely in the United States and in Europe, Asia and Latin America. (M. W. Ch.)

LIPPS, THEODOR (1851–1914), German psychologist and philosopher, was born July 28, 1851, at Wallhalben, and was professor successively at Bonn. Breslau and Munich. His fundamental principles assumed a dependence of consciousness upon the interaction between older experiences retained in a subconscious state and the entering sensations (apperception). Mind. he said, is the sum of these older experiences organized in a unity. The organization controls the course of perceiving, of recall and thinking and of action. Pleasure is harmonious interaction of the old upon the new; displeasure results from conflict of the different elements.

The best-known phase of his theory is his doctrine of *Einfühlung*, defined as projecting one's self into what is seen. One appreciates another's reaction by feeling one's self into the other. In his two-volume *Ästhetik* (1903–06) Lipps makes all artistic appreciation depend upon a similar self-projection into the object. Part of feeling is dependent upon definite induced bodily responses like imitation. A form is beautiful that is obviously adequate to a situation. A lithe but not emaciated human figure is beautiful. A column that is too slight apparently to support a weight put upon it arouses sympathy, it makes the observer strain unduly and so is unpleasant. In an experimental study of optical illusions (*Raumästhetik*, 1897) Lipps suggests that a vertical line is apparently longer than a horizontal one because it induces the observer to stretch up and the movement is assigned to the line. His publications include. in addition to those mentioned. *Grundtatsachen des Seelenlebens* (1883), *Die ethischen Grundfragen, zehn Vorträge*, 2nd ed. (1905), and *Leitfaden der Psychologie*, 3rd ed. (1926). Lipps died at Munich on Oct. 17, 1914. (W. B. Py.)

LIPPSTADT, a town in North Rhine-Westphalia, Ger., on the Lippe river, 20 mi. W. by S. of Paderborn by rail, on the main line to Dusseldorf. Pop. (1959 est.) 36,004. Lippstadt was founded in 1168 by the lords of Lippe. the rights over one half of the town passing subsequently to the counts of the Mark. which in 1614 was incorporated with Brandenburg. In 1850 the prince of Lippe-Detmold sold his share to Prussia. The Marien Kirche dating from the 13th century is built in the Transitional style. During World War II the town was bombed several times by the British R.A.F.

LIP-READING: *see* SIGN LANGUAGE.

LIPSCHITZ, RUDOLF OTTO SIGISMUND (1832–1903), German mathematician, was born in Konigsberg, East Prussia. on May 14, 1832. In 1847 he graduated from the Gymnasium and entered the University of Konigsberg. Later he was attracted to the University of Berlin by P. G. Lejeune Dirichlet, and on Aug. 9, 1853, he received his doctor's degree there. He spent his probationary year at the Gymnasium at Konigsberg and then taught at the Gymnasium of Elbing. In 1857 he became *Privatdozent* at Bonn. in 1862 he went to Breslau as *ausserordent-*

licher professor and in 1864 he returned to Bonn as *Ordinarius.* In 1873 he received an offer from Gottingen. but he declined it and remained at Bonn until his death on Oct. 7. 1903. For the year 1874–7j he was chosen unanimously as rector.

The mathematical work of Lipschitz was many-sided. including contributions ranging from the theory of numbers to mathematical physics. He did important work in the calculus of variations. Bessel's functions. Fourier series, potential theory and analytical mechanics. The direction of his thought was determined largely by Dirichlet and by the 1854 *Habilitationsschrift* of G. F. B. Riemann. Fundamentally an algebraist, he was yet interested in the foundations of mathematics. and in his *Lehrbuch der Analysis* (2 vol., Bonn, 1877–80) he sought to develop the subject from fundamental concepts. Following the lead of A. L. Cauchy. he formulated the well-known Lipschitz (or Cauchy-Lipschitz) condition in connection with the existence theorem for solutions of the differential $y'=f(x, y)$. His works include *Bedeutung der theoretischen Mechanik* (1866), *Wissenschaft und Staat* (1874) and *Untersuchungen über die Summen von Quadraten* (1886).

(C. B. Br.; X.)

LIPSIUS, JUSTUS (1547–1606), the Latinized name of Joest (Juste or Josse) Lips. Belgian scholar, born on Oct. 18 (Nov. 15, according to Amiel). 1547, at Overyssche. a small village in Brabant. near Brussels. He studied at the University of Louvain. In 1567 he published *Variarum Lectionum Libri Tres,* dedicated to Cardinal Granvella. who took him to Rome. where he stayed two years studying manuscripts and inscriptions. On his return he published *Antiquarum Lectionum Libri Quinque* (1 57j), which shows an advance forward. a sounder system of emendation by collation. He wandered over Europe a good deal. taught at Jena. Cologne. Louvain and Antwerp and finally became professor of history at Leyden. These changes must have involved some elasticity in the religions he professed. varying between Catholic at Cologne and Calvinist at Leyden. The 11 years at Leyden were his most productive period. It was then that he prepared his *Seneca,* perfected. in successive editions, his *Tacitus* and brought out a series of works. some of pure scholarship, others collections from classical authors. others again of general interest. Of this latter class was a treatise on politics (*Politicorum Libri Sex,* 1589), which caused trouble by his reactionary views on religious toleration. which was with difficulty smoothed down by the university authorities. In the spring of 1590 he went to Mainz, where he was reconciled to the Roman Catholic Church. The event deeply interested the Catholic world, and invitations poured in on Lipsius from the courts and universities of Italy. Austria and Spain. But he preferred to remain in his own country and finally settled at Louvain as professor of Latin in the Collegium Buslidianum. He continued to publish dissertations as before, the chief being his *De militia romana* (Antwerp, 1595) and *Lovanium* (Antwerp, 1605; 4th ed.. Wesel, 1671), intended as an introduction to a general history of Brabant. He died at Louvain on March 23 (some give April 24), 1606.

Lipsius' knowledge of classical antiquity was extremely limited. His greatest work was his edition of Tacitus. This first appeared in 1575, and was five times revised and corrected — the last time in 1606, shortly before his death. His *Opera Omnia* appeared in 8 vol. at Antwerp (1 585; 2nd ed.. 1637).

A full list of his publications will be found in van der Aa, *Biographisch Woordenboek der Nederlanden* (186j), and in *Bibliographie Lipsienne* (1886–88). In addition to the biography by A. le Mire (Aubertus Miraeus) (1609), the only original account of his liie, *see* M. E. C. Nisard, *Le Triumvirat littéraire au XVI^e siècle* (1852); A. Rass, *Die Convertiten seit det Reformation* (1867); P. Bergman's *Autobiographie de J. Lipse* (1,889); L. Galesloot, *Partirularitks sur la vie de J. Lipse* (1877); E. Amiel, *Un Publiciste du XVI^e siècle. Juste Lipse* (1884); and L. Miiller, *Geschichte der klassischen Philologie in den Niederlanden.* The articles by J. J. Thonissen of Louvain in the *Nouvelle Biographie générale,* and L. Roersch in *Biographie nationale de Belgique,* may also be consulted.

LIPSIUS, RICHARD ADELBERT (1830–1892) German Protestant theologian son of K H A Lipsius id 1861) nho was rector of the Thomasschule at Leipzig was born at Gera on Feb 14, 1830 He studied at Leipzig and eventually (1871) settled at Jena as professor. He helped to found the. Evangelical Protestant Missionary union and the Evangelical Alliance. and from 1874 took an active part in their management. He died at Jena on Aug. 19, 1892. Lipsius wrote principally on dogmatics and the history of early Christianity from a liberal standpoint. His chief works are *Philosophie und Religion* (1885) and *Lehrbuch der evang.-prot. Dogmatik* (1876; 3rd ed.. 1893).

His other works include *Die apokryphen Apostelgeschichten* (1883–90), *Hauptpunkte der christl. Glaubenslehre im Umriss dargestellt* (1889) and commentaries on the Epistles to the Galatians, Romans and Philippians in H. J. Holtzmann's *Handkommentar zum Neuen Testament* (1891–92).

See A. Neumann, *Grundlagen und Grundzüge der Weltanschauung oon R. A. Lipsius* (1896).

LIPTON, SIR THOMAS JOHNSTONE, 1st Bart. (1850–1931), British merchant and yachtsman, equally well known for his success with tea and for the gallant sportsmanship with which he accepted his failures in international yachting. was born at Glasgow, Scot.. on May 10, 1850. of Irish parents. who ran a small grocer's shop. He emigrated to the United States in 1865 and held various jobs for five years before returning to Glasgow.

There he opened a small provision shop, was very successful and established shops throughout the United Kingdom. To supply his retail shops on the most favourable terms. he purchased extensive tea, coffee and cocoa plantations in Ceylon and provided his own packing house for hogs in Chicago. He also acquired fruit farms, jam factories, bakeries and bacon-curing establishments in England. In 1898 his business was organized into Lipton, Ltd. He was knighted in 1898 and created a baronet in 1902, taking as his crest two arms holding sprigs of tea and coffee.

He was a keen yachtsman and as a representative of the Royal Clster Yacht club made five unsuccessful attempts between 1899 and 1930 to win the America's cup with yachts called "Shamrock" (*see* Yachting). Lipton won a reputation for being the "world's best loser," and in 1930 he was presented with a gold cup for sportsmanship by a group of Americans. He died in London on Oct. 2, 1931.

See Alec Waugh, *Lipton* Story (1950). (H. J. Sg.)

LIQUEFACTION OF GASES. It is somewhat uncertain when the idea that gases could be liquefied first arose. Lavoisier certainly expressed the view that if the earth were cooled to the temperature of outer space. part, at least, of its atmosphere would liquefy, but he made no attempt to liquefy any known gas. His associates. Monge and Clouet, were actually the first to succeed in this direction, liquefying sulfur dioxide by passing it into a glass tube cooled with a mixture of ice and salt. About the same time van Marum and Paets van Troostwyk (1790), compressing ammonia to see whether it obeyed Boyle's law, found that when a certain pressure was reached, the volume suddenly decreased rapidly and drops of liquid appeared. In the year 1799 Guyton de Morveau liquefied ammonia by cooling the gas to the temperature of a mixture of ice and calcium chloride. In 1805 Northmore compressed gases mechanically up to 1j atmospheres, and he appears to have liquefied chlorine.

The Early Work of Davy and Paraday.——No further experimental investigations can be traced until the year 1823, when papers were read before the Royal society by Sir H. Davy and his assistant M. Faraday (*Phil. Trans.,* 1923), describing experiments carried out at the Royal institution. In Faraday's first experiments chlorine hydrate, obtained by cooling chlorine water, was heated in a sealed tube to 100° C., when "chlorine was evolved from it under such pressure that it assumed the liquid form, appearing of a bright yellow colour, and sinking in the warm water without any tendency to mix with it." In a second paper he describes experiments with the apparatus shown in fig. 1. Compounds which liberated such gases as chlorine, or sulfureted hydrogen, were placed

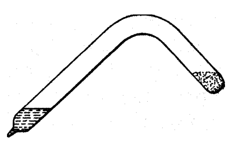


Fig. 1.—FARADAY'S EXPERIMENT

in the short limb of the tube, which was then hermetically sealed. The substance was heated, and the long limb of the tube was cooled in ice or in a freezing mixture; and in it the gases liquefied. A few weeks later Davy described the liquefaction of sulfureted hydrogen, and hydrochloric acid by compression! giving data for the pressures required to liquefy these gases at different temperatures. His paper is of importance. as it shows that in 1823 Davy had already installed apparatus for the compression and liquefaction of gases at the Royal institution. Ill health prevented him from continuing his researches in this direction.

Large Scale Liquefaction.— In 1834 Thilorier developed a method already in vogue for the manufacture of soda water and applied it to the condensation of carbon dioxide in large quantity. Two stout metal vessels. at first made of cast iron, but. after an accident, of copper, and lined with lead, served as the generator and receiver in Faraday's experiments. One of these was fitted with a cap which could be removed, and a cock, and in it was placed solid bicarbonate of soda and a vessel containing sulfuric acid. The other vessel was fitted with a stopcock only, and the two vessels were joined by a connecting tube which could be detached. The generator was charged and closed, and then rotated so as to mix the acid and soda. It was then connected with the receiving vessel, which was cooled in ice. and in this the gas liquefied. The stopcocks were then closed, the vessels were separated, and. by recharging the generator. a second and third charge of gas could be condensed in the receiver. Thilorier observed that the liquid expanded rapidly when heated. He also found that when the liquid was allowed to escape through a jet into a box lined with nonconducting material, a snowlike solid was formed. His observation that this solid carbon dioxide mixed with ether was a much more efficient refrigerant than the solid alone was a valuable contribution to the experimental side of the subject.

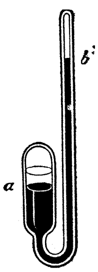
Faraday's Later Experiments.— The first to apply the results of Thilorier's work. which was carried out from a technical standpoint. to scientific investigations. was Faraday. His method of investigation was as follows. The mixture of solid carbon dioxide and ether was contained in an earthenware vessel of 100 cu.cm. capacity. which fitted into a larger earthenware vessel, three or four folds of dry flannel intervening. The temperature measured by an alcohol thermometer was —78° C., but by placing the apparatus under the receiver of an air pump and reducing the pressure to 1.2 in. of mercury, a temperature of —110° C. was reached.

There seems to be no definite evidence as to when the idea first originated that a pure liquid possessed a definite vapour pressure at a definite temperature. Dalton. early in the 19th century, had shown that the vapour pressure of water was independent of thc prcscncc of air in the space above it. and had measured the vapour pressures between the ice point and boiling point. Davy (*loc. cit.*) had observed that "the elasticity of vapours in contact with the liquids from which they are produced, under high pressures increases in higher ratio than the arithmetical one of temperature; but the exact law is not determined." and he had determined the relation of temperature and pressure for certain condensed gases. Faraday now took the subject up at the point at which Davy dropped it, and he determined the vapour pressures of all the gases which could be liquefied at teinperatures above —110° C., and at pressures up to 50 atmospheres. (*Phil. Trans.*, 1845.) Faraday was unable to liquefy hydrogen, oxygen. nitrogen. nitric oxide, and carbonic oxide, and the failure of others to succeed by using higher pressures gave rise to the idea that these gases were *permanent*, the term being still used. with recognized qualifications. An interesting investigation with the same object was that of Satterer (*Sitzungsberichte* d. *Wiener Akad., Ann. d. Phys., 1844–55*). Gases were compressed into a wrought-iron vessel. the pressure. which approached 3,000 atmospheres. being transmitted through mercury to a loaded piston. which acted as a manometer. The experiments failed in their object; but indicated the extent to which the permanent gases departed from Boyle's law regarding the relation between pressure, volume and temperature.

The Critical **State.**—We must now go back to 1822 when Cagniard de la Tour *(An. de Ch. et de Ph.* 21 and 22) proved that when a liquid was heated above a certain temperature it mas completely converted into vapour. He used the glass apparatus shown in fig. 2. the liquid being contained in the wide limb of the U-tube over mercury. the narrow limb serving as a manometer and the pressure being calculated from the volume of the air. The apparatus was heated in an air bath. He obtained the following results:

	Temperature of volatilization	Pressure
Ether	175° C.	38 atm.
Carbon bisulfide . .	258° C.	71 atm.

The experiments of Cagniard de la Tour are an example of the excellent nork carried out by French physicists of the period. They were. honever. completely lost sight of, and it was not till 1860 that the experiment nas repeated by Andrews, and the fundamental principle associated nith it was discovered. Andrews' discovery that for each substance there is a critical temperature above which it cannot be liquefied nas first made public in the 1863 edition of Miller's *Chenzical Physics* and in 1869 formed the subject of a Bakerian lecture under the title, "On the continuity of the gaseous and liquid states of matter."



FROM M. W. TRAVERS, "STUDY OF GASES" (MACMILLAN)

FIG. 2 —CAGNIARD LIE LA TOUR'S EXPERIMENT

Research of **Andrews.**—Andrews had attempted to liquefy the permanent gases by applying high pressures at temperatures down to —110° C. Failing to liquefy them. he turned his attention to the study of the process of liquefying carbon dioxide, with a view to throning light on the general problem of the liquefaction of gases. For this purpose he used an apparatus, now in the South Kensington museum. of which a diagram is shown in fig. 3. It consisted of twin steel tubes. flanged and capped at both ends, and connected laterally. Through glands in the upper caps glass tubes passed, of capillary bore above and closed at the top, the part inside the steel apparatus being 2.5 mm. bore, and open below. The tubes contained respectively carbon dioxide and air. over mercury with nhich the steel apparatus was filled. the air tube serving as a manometer. the pressure being assumed to be inversely proportional to the volume. Steel screw plungers passing through glands in the bottom of the apparatus served to regulate the volume and pressure. The glass tubes projecting outside the apparatus were surrounded by a nater bath with glass sides. He found that at temperatures below 31° C. liquid appeared in the tube containing the carbon dioxide when the air manometer indicated a definite pressure for each particular temperature, and that when liquefaction had commenced, the gas could be completely condensed nithout increase of pressure except such as could be attributed to the presence of traces of air in it. Near 31°, nhich he was the first to call the critical point. the space nhich had been occupied by the liquid at lower temperatures became filled with a "homogeneous fluid. which, nhen the pressure nas slightly reduced. or the temperature slightly lowered, exhibited a peculiar appearance of moving or flickering striae throughout its entire mass" At temperatures above 31° he found that the gas could be reduced in volume to that which it should occupy as liquid with complete continuity and without exhibiting a visible surface, hence the title under which the results of the work were published The results obtained are represented by the simple curves in fig. 4.

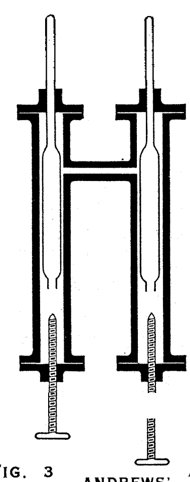


FIG. 3 —ANDREWS' APPARATUS USED IN INVESTIGATIONS ON THE CRITICAL STATE

These curves, called isothermals, representing the relationship of pressure and volume for a series of constant temperatures, are in heavy line. An isothermal for a temperature below the critical temperature represents the volume of the gas as diminishing as the pressure increases till the vapour pressure is reached, and the gas begins to liquefy. The volume then decreases without increase in pressure till the gas is completely liquefied, this part of the curve being a horizontal straight line. As the liquid is only slightly compressible the curve then ascends steeply. The part of the diagram within and below the dotted line represents conditions under which liquid and vapour can coexist. The critical isothermal has no horizontal portion, since the volumes of liquid and vapour are identical. Above the critical point the curves approach rapidly to the form of the hyperbola.

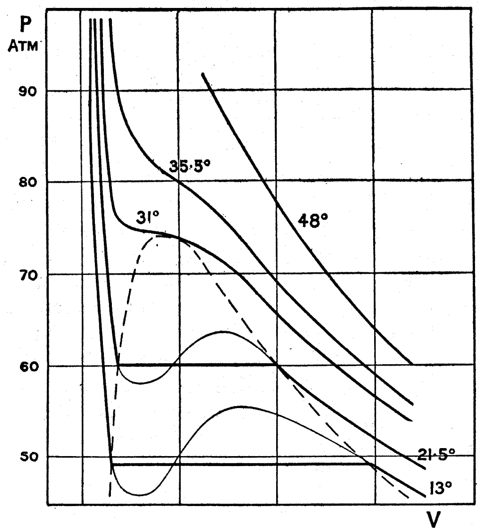


FIG. 4.—P.-V.-T. DIAGRAM FOR CARBON DIOXIDE. ILLUSTRATING THE WORK OF ANDREWS AND OF VAN DER WAALS

The experiments of Andrews fully explained his own failures, and those of Faraday and earlier investigators, to liquefy the so-called permanent gases. The significance of his work, can. however, be appreciated only when we consider the theoretical investigations to which it gave rise. Since the work of Regnault had first shown that the known gases departed more or less from the laws of Boyle and Gay-Lussac as expressed by the equation,

$$\frac{pv}{T}=R, \text{ a constant}$$

T being the temperature on the scale of a thermometer filled with the gas itself, approximately equivalent to the temperature on the absolute scale. to which reference will be made later. Many attempts had been made to modify the formula to accord with the facts so far as they were knoun. These, however, only included the volume and pressure relations of the gas, but in view of the discoveries of Andrews it was now obvious that the theoretical investigation must also take into account the existence of the liquid phase.

Van der Waals's Equation of State.—In 1873 there was published in Leyden a dissertation with the same title as Andrews' Bakerian lecture—"On the continuity of the liquid and gaseous states," by J. D. Van der Waals. The title has not, however, the same significance, and is used in a more exact sense than by Andrems. It implies that while the isothermals for temperatures which differ by a very small interval above and below the critical temperature are practically identical in form, the isothermal for the higher temperatures represents the gaseous state only. and that for the lower temperatures relates also to the liquid state. This was the first original paper published by the author who had for some years been engaged upon mathematical investigations, based upon the kinetic theory of gases and Laplace's theory of capillarity, and upon this work he based the theory which made him famous. Assuming the molecules of any particular gas to be all exactly similar hard elastic spheres of radius r, the volume occupied by n molecules in volume v is $b'=\frac{1}{6}nr^3\pi$. In accordance with the assumption as to the form of the molecule. the gas equation thus becomes $p(v-b)=RT$, where $b=4b'$. Now, while the molecules in the interior of a mass of gas are subjected to attractions by other molecules which are equal in all directions, so that the resultant attraction is negligible, the resultant attraction on the molecules in the surface layer is directed inward, and varies as the square of the volume. Allowing for the effect thus produced the equation now becomes:

$$\left(p+\frac{a}{v^2}\right)(v-b)=RT$$

This is known as the Van der Waals equation.

It may first be pointed out that the equation may also be written in cubic form

$$v^3-v^2\left(\frac{RT}{p}+b\right)+\frac{va}{p}-\frac{ab}{p}=0$$

One of the three roots of this equation must always be real, and the other two may be real or imaginary, so that for every value of p there may be one or three values of v. In a certain region, for the isothermals below the critical point. there are three real values of v for each value of p, so that the curves do not have the simple form indicated by the heavy lines but follow the sinuous lines.

The latter do not exhibit the discontinuity shown by the former, in which, for one particular value of p only, the vapour pressure, there are tao values of v, corresponding to the volumes of saturated vapour and of the liquid. This pressure and the corresponding volumes are indistinguishable on the Van der Waals curve, but at the same time, if the relations of volume, pressure and temperature under which the liquid and vapour phases are in equilibrium are known, the constants in the Van der Waals equation can be calculated from them with the same accuracy as from the data obtained from the compressibility of the gas. The meaning of the continuous curve has been the subject of much speculation. It has been suggested that the portion of it on the extreme right represents a condition of supersaturated vapour, and that on the left a state in which liquid exists at a pressure below its vapour pressure. The central portion must in any case bc without physical significance as it represent5 the pressure and volume as increasing together and decreasing together. As a matter of fact the Van der Waals equation is based upon the consideration of the behaviour of a single phase, which may change continuously into a second phase. but it does not contemplate discontinuity, or equilibrium between liquid and vapour. The form of the curve has no physical significance at all, but is merely a consequence of the mathematical treatment of the subject.

At the point C. the critical point $\frac{\partial p}{\partial v}=0$ and a line drawn parallel to the volume axis is tangential to the isothermal. At this point the three values of V are real and equal. and by a simple algebraical process we can obtain the values of the critical temperature, the critical pressure and the critical volume in terms of the constants of the equation:

$$T_c=\frac{8a}{27bR};\quad p_c=\frac{a}{27b^2};\quad v_c=3b;\quad p_cv_c=0.375RT_c$$

The following are the values of a and b for some of the common gases, when pressures are reckoned in atmospheres. and the volumes in litre-moles:

Gas	a	b
Hydrogen H_2	0.19	0.023
Oxygen O_2	1.36	0.0316
Carbon dioxide CO_2	3.61	0.0428
Sulfur dioxide SO_2	6.69	0.0565

The fundamental ideas which are expressed by the Van der Waals equation are undoubtedly true, but it could hardly be expected that from the simple assumptions upon which it was hased it would be possible to develop a complete theory of the gaseous and liquid state. The equation does not enable us to connect in a quantitative manner the properties of gases at low pressures. The ratio p_cv_c/T_c is not 0.375 pv/T, being generally nearer to 0.27 R/R. It is not possible to trace the isothermals for any distances by means of data calculated from the critical constants. However, the Van der Waals equation. even without modification, has been of very great value as a means of calculating the physical constants for gases and liquids approximately.

The Law of Corresponding States.—A second discovery which was made by Van der Waals is knonn as the law of corresponding states. This is really a mathematical consequence folloning on the assumption that the properties of the systems nith which we are dealing can be represented by an equation with two constants *a* and *b*, R depending merely on the quantity of material in this system, molar or otherwise. If then a series of diagrams are drawn like fig. 4, but representing the properties of different materials, such as carbon dioxide, benzene, etc.. it will be seen that they are very similar. and they can actually be made identical by altering the vertical and horizontal scales on which they are drawn. This may be done if we change the units from absolute units of temperature. pressure and volume. and represent these dimensions in terms of fractions or multiples of the values of the critical constants, thus,

for T we write $T/T_c=\theta$ the *reduced temperature*
,, p ,, ,, $p/p_c=\pi$ the *reduced pressure*
,, v ,, ,, $v/v_c=\phi$ the *reduced volume*

Equal values of θ, π and ϕ for different substances represent what are known as corresponding states. By substituting the reduced values in the equation it becomes

$$\left(\pi+\frac{3}{\phi^2}\right)\left(\phi-\tfrac{1}{3}\right)=\frac{8\theta}{3}$$

It will be noticed that the constants, *a*, b and *R* have vanished, and therefore all substances in corresponding states should behave alike. For instance, the isothermals of all gases represented in this manner should be identical. The law of corresponding states leads directly to certain useful approximations. The boiling point T_b of most liquids is approximately a corresponding temperature, since

$$T_b/T_c=0.62 \text{ (about)}$$

and as it can be shown that the latent heat of liquefaction L should be identical for liquid-gas systems at corresponding temperatures it follows that

$$L/T_b=\text{constant}$$

It was found by Trouton (*Phil. Mag.*, 1899) that for many liquids this rule holds good, thus:

Liquid	T_b	L	L/T_b
†Helium	4.29	22	5.1
†Hydrogen	29.4	214	10 5
†Oxygen	90.6	1,664	18.2
Ethyl ether	307	6,466	21.1
Chloroform	334.5	6,972	20.85
Benzene	353.2	7,370	20.85
‡Ethyl alcohol	357.2	9,972	28.40
‡Water	373	9,660	25.9

Trouton's rule does not hold good for liquids at very low temperatures†, nor for associating liquids‡.

An interesting instance of the application of the discoveries of Van der \1'aals was that of the Polish physicist Witkowski in the early 1880s. He determined the compressibility of oxygen and hydrogen down to the lowest temperatures which in the case of hydrogen mas that of liquid oxygen. From the data. he was then able to calculate the constants in the equation. The critical constants and boiling point of oxygen being known, he was then able to calculate these constants for hydrogen with remarkable accuracy, as later investigations showed.

	Calculated	Experimental
Critical pressure	13 atm.	12.8 atm.
Critical temperature	−240° C.	−239.9° C.
Critical density	0.033 grams per cu.cm.	0.031 grams per cu.cm.
Boiling point	−250° C.	−252.8° C.

Later, Kammerlingh Onnes used a similar process to estimate the constants for helium. Again. Ramsay and Young (*Phil. Mag.*, 1886) discovered a simple relationship between the vapour pressures of pairs of liquids, which holds good for associating liquids, but tends to break down at very low temperatures. If T_x and T_y, $T_{x'}$ and $T_{y'}$, are the absolute temperatures at which a pair of liquids have vapour pressures p and p', then

$$T_x/T_y=T_{x'}/T_{y'}+k(T_x-T_{x'})$$

when k is a constant for each pair of liquids. This formula enables us to calculate the vapour pressure for any substance over a wide range of temperatures, when the vapour pressures corresponding to two or more temperatures are known. The following is an illustration of the use of the method. The case is taken in which the vapour pressure of krypton was to be determined and water was the reference substance.

The values in columns 1 and 2 were the result of observation. The values in column 3 are the temperatures for water corresponding to the pressures in column 1. The values in column 4 are the ratios of the values 2/3. We then plot the values in column 4 against those in column 3, and draw a straight line

1 P(mm)	2 T_{kr}	3 T_{aq}	4 T_{kr}/T_{aq}
386.6	112.7	353.1	0.3174
11,970	170.9	474.3	0.3603
30,837	201.0	525.1	0.3828

5 p(mm)	6 T_{aq}	7 T_{kr}/T_{aq}	8 T_{kr}
600	366.5	0.3229	118.35
4,000	427.2	0.3449	147.3
30,000	523.6	0.3801	199.0

through the points set out. Values of T_{aq} in column 6, equivalent to any derived pressure indicated in column 5, are then readily selected, and from the graph the corresponding values of T_{kr}/T_{aq} in column 7 are read off. Multiplying the values in column 6 by those in column 7 we obtain the values in column 8. Thus we can calculate the vapour pressures over any range, up to the critical point.

Modifications of Van der Waals' Equation.—Various attempts have been made to modify the Van der Waals' equation, and a very large number of equations, nearly all of which are empirical, have been put forward. Thus Clausius proposed an equation

$$\left\{p+\frac{a}{T(v+c)^2}\right\}(v-b)=RT$$

to represent the experimental results of Amagat at very high pressures. This, and other equations, were carefully examined by Kammerlingh Onnes and all were found to be unsatisfactory. D. Berthelot (*Bureau Int. des Poids et Mesures*, 1907, vol. xiii) proposed an equation which, in the reduced condition, and for low pressures, may be written

$$\left(\pi+\frac{16}{3}\cdot\frac{1}{\theta\phi^2}\right)\left(\phi-\frac{1}{4}\right)=\frac{32}{4}\theta$$

From this equation we obtain

$$\frac{\partial(\pi\phi)}{\partial\pi}=\frac{1}{4}\left(1-\frac{6}{\theta^2}\right)$$

while from the Van der Waals equation

$$\frac{\partial(\pi\phi)}{\partial\pi}=\frac{1}{3}\left(1-\frac{27}{8\theta}\right)$$

The former expression enables us to calculate the values of $\frac{d(pv)}{dp}$ over a very wide range of temperature with a surprising degree of accuracy, the results showing deviations from experimental values which are comparable with experimental errors. These constants are of importance in evaluating the deviations of the gas scale from the thermodynamic scale of temperature.

Dieterici, whose work has been reviewed by F. H. MacDougall (J. of *Am. Ch. Soc.* 1916), has put forward equations, which, like the equations of Van der Waals, have a true physical meaning. We will consider his second equation, which is based on the following reasoning. In the interior of a fluid the attractive forces betneen molecules are balanced; at the surface there are unbalanced forces, of which the resultant effect is directed inward. Molecules of low velocity are unable to reach the surface; therefore the surface layer will decrease in density from the interior outward to the surface, where the density will depend on the exterior pressure. Only molecules having a velocity above a certain value mill penetrate this inhomogeneous layer and exert pressure on the walls of the containing vessel. If, now, we determine what fraction of the total molecules has a velocity greater than this value, then the external pressure will be that same fraction of the internal pressure. Omitting the details of the reasoning, from this assumption he arrives at the formula:

$$p=\frac{RT}{v-b}e^{\frac{-A}{RT}}$$

where e is the base of a natural logarithm, b is a function similar to the Van der Waals b and A is a cohesion function measured by the work done by a molecule in penetrating to the surface. Making the simple assumption that A is proportional directly to the volume, the equation becomes

$$p=\frac{RT}{(v-b)}e^{\frac{-a}{vRT}}$$

This equation differs materially from that of Van der Waals in that a and b are really variable with the volume, which makes it very difficult to apply. In some respects it represents a real advance upon the work of Van der Waals, and from it we can derive the expression:

$$p_c v_c=0.27\ RT_c$$

which accords with experiment. Recent attempts to apply modern concepts of atomic structure to the derivation of an equation of state have not led to any noteworthy success.

Thermodynamical Treatment of the Subject.—The experiments of Andrews paved the way for the work of Van der Waals, and after describing those experiments, which open a new period in the history of our subject, it was convenient to describe the theoretical developments to which they gave rise. Before dealing with the next phase in the experimental study of liquid-vapour systems, it is convenient to consider the process involved from the standpoint of thermodynamics. The starting point is now the law of conservation of energy. also known as the first law of thermodynamics. To illustrate this law we will suppose that when we supply a quantity of heat Q to a gas, the heat is utilized in increasing the internal energy of the gas by an amount U. If the gas expands it must overcome resistance; in other words it must do work W; and if Q, U and W are expressed in the same units we may write:

$$Q=U+W$$

It is obvious that the heat is drann from the surroundings and that work is done on the surroundings. and the energy U, which remains associated with the gas. is now the difference between the quantities W and Q. We will now consider nhat changes take place in the values of W, Q and U nhen the gas undergoes changes in temperature. pressure and volume. So long as a system. which may be a gas or liquid, or may contain both gas and liquid. undergoes no such change its internal energy must remain constact, and under certain conditions the internal energy may remain constant when the system undergoes change. This is illustrated by the well-known experiment of Gay-Lussac (1806), afternard perfected by Joule (1844). Two large vessels, connected by a stopcock. are immersed in a water bath. one vessel being exhausted and the other containing gas under pressure. When the temperature is constant, the stopcock is opened, so that the gas can distribute itself between the two vessels. After an interval, the temperature of the water bath is observed, and it is found to be unchanged. The gas has expanded, and though this may be at first sight contrary to experience, its temperature has remained unchanged. Now the experiment is arranged so that the gas expanding into a closed exhausted space, produces no external effect, mechanical or thermal, so that, if we assume the truth of the first law, since

$$W=0 \text{ and } Q=0, \text{ it follows that } U=0$$ w

The result obtained in the Gay-Lussac-Joule experiment would always be observed in the case of an ideal gas which obeys the simple law $pv=$RT, and gases such as air approximate to this very closely at moderate pressures. For the genera1 elementary treatment of problems in thermodynamics it is often convenient, and permissible, to assume that we are dealing with a perfect gas, and that the internal energy at constant temperature is independent of the volume, which is expressed by

$$\left(\frac{\partial U}{\partial v}\right)_T=0$$

In the case of an actual gas, which obeys a more complicated la such as that of Van der Waals, the internal energy depends on the distance between the molecules, *i.e.*, on the volume. and a change of temperature is expected when it expands without doing external work. This may be either a cooling or a heating and can be observed in a modification of the experiment, which will he described later. In any case the internal energy, U, is a unique function of the pressure, p, and temperature, T.

The relation above applies to a perfect gas during any change of volume at constant temperature. Suppose the gas expands in a cylinder with perfectly conducting walls, so that the temperature is kept rigorously constant while the gas does work through the piston. If the volume increases by dv at pressure p we can represent the work done by

$$W=\int p\,dv$$

Since $pv = RT$
$$W=RT\int_{v_2}^{v_1}\frac{dv}{v}=RT\log_e\frac{v_1}{v_2}$$
$$=RT\log_e\frac{p_2}{p_1}$$

If W, the work done, and Q, the heat supplied, were measured we should find that $Q=W$ and that the gas had served merely as a means of converting heat into work, the internal energy remaining constant. Since the mechanism in this hypothetical experiment is supposed to be perfect, the work done is now the maximum work which can be done by the gas when expanding isothermally.

When a liquid evaporates at constant temperature the volume increases at constant pressure, and the external work done is again expressed by:

$$W=\int p\,dv$$

The total quantity of heat absorbed in the process is

$$Q=H_2-H_1=U_2-U_1+\int p dv$$

where U_2 and U_1 are the internal energies of the gas and liquid, respectively. The quantity, $H=U+\int pdv$, calculated from some standard initial condition (*e.g.*, liquid at its normal boiling point), is called the total heat. Like the internal energy, it is a definite function of pressure and temperature in the gas phase. It is a convenient quantity in which to express energy changes in refrigeration processes, and has been tabulated for all gases of interest. In the case of the evaporating liquid, the change of internal energy is much larger than the work of expansion. Thus, use of a liquid for refrigeration allows a greater exchange of energy than a gas. for a given change of volume.

Adiabatic **Expansion.**—We may now consider what happens when a gas is allowed to expand, doing work, hut in such a manner that no heat is absorbed, that is to say adiabatically. This actually happens in the high-pressure vessel in the Gay-Lussac-Joule experiment. and it becomes obvious when. in a modification of the experiment by Joule. the vessels are contained in separate water baths. Though the temperature of the water in the bath enclosing both vessels has not altered, in the modified experiment, the water around the high-pressure vessel generally becomes cooled, and the water around the low pressure vessel generally becomes equally heated. If the cock is closed the moment expansion has taken place. when the temperature has finally become uniform, the pressure in the high-pressure vessel is found to be less than in the low-pressure vessel. The gas which remains in the high-pressure vessel may be supposed to do work in imparting kinetic energy to that part of the gas which flows into the lox-pressure vessel. As the change takes place very rapidly no heat is absorbed. The kinetic energy of the moving mass of gas reappears as heat energy when the gas is brought to rest in the second vessel.

In order to analyze this problem we must first consider the change which takes place when a gas is heated. Suppose that one gram molecule of a gas is heated from T to $T+dT$, so that the pressure remains constant. The heat absorbed by the gas can be represented by $dQ=C_pdT$, where C_p is the (molar) specific heat at constant pressure.

If now we first of all consider the gas to be heated through an interval dT at constant volume, the increase in the internal energy is given by:

$$\left(\frac{\partial U}{\partial T}\right)_v dT=C_vdT$$

C_v being the specific heat of the gas at constant volume. If now the gas is allowed to expand. doing maximum work, till the original pressure is reached. the work done is:

$$dW=p\ dv=RdT$$

Then since dQ= $dU+dW$,

$$C_pdT=C_vdT+RdT$$
$$C_p=C_v+R$$

Now since in any adiabatic process $dQ=O$,

$$C_vdT+p\ dv=O$$

Substituting $p=RT/v$, and integrating:

$$C_v\log_eT+\mathrm{R}\ \log_ev=\text{Constant}$$

Writing γ for C_p/C_v, and substituting C_p-C_v for R,

$$\log_eT+(\gamma-1)\ \log_ev=\text{Constant}$$

or

$$Tv^{(\gamma-1)}=\text{Constant}$$

and writing gas equation in the form:

$$\log_eP+\log_ev-\log_eT=\text{Constant}$$

we obtain

$$\log_eP+\gamma\log_ev=\text{Constant}$$

or

$$pv^\gamma=\text{Constant}$$

This equation, which gives the form of the adiabatic curves for a perfect gas, shows that these. when represented on a pv diagram, are steeper than the isothermal curves. indicated by full lines (fig. 5). Suppose that a gas is compressed isothermally. so that the p–v relations are represented by the isothermal ab. When the point bb' is redched the gas is allowed to expand adiabatically. If the adiabatic curve (pv^γ=const.) passes nithin the region p–v on the diagram which represents conditions under which liquid can exist, as at d, partial liquefaction will result, as happened in the case of the experiments of Cailletet.

Liquefaction by Adiabatic **Expansion.**—When liquefaction does not take place the fall of temperature resulting on expansion from pressure p_1 to pressure p_2 is given by the following expression derived from the above.

$$\frac{T_1}{T_2}=\left(\frac{p_1}{p_2}\right)^{\frac{\gamma-1}{\gamma}}$$

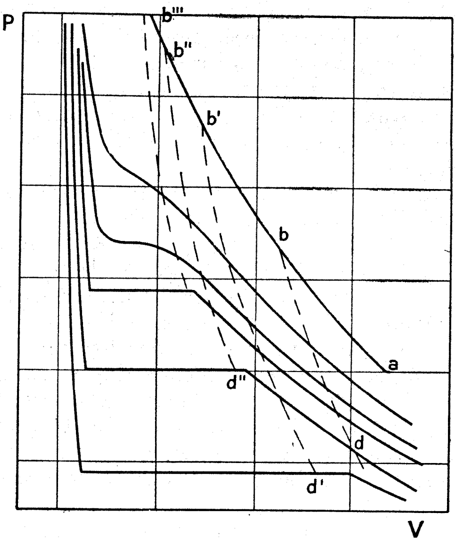


FIG. 5.— ADIABATICAND ISOTHERMAL CURVES FOR PURE GASES

The next experimental work of importance following the work of Andrews. and to which the theory which we have just considered applies, is that of Louis Cailletet. He used an apparatus, similar in principle to that of Andrews. The gas was confined over mercury in a glass tube. the capillary part of which projected outside a steel chamber, the lower part of which also contained mercury to which pressure was transmitted by means of water from a compression pump. The first gas to be investigated was acetylene, uhich was liquefied by pressure alone at the air temperature (critical temperature 35° C.). However, on one occasion when the acetylene had been compressed to a degree insufficient to liquefy it, the release valve on the compression pump was opened. and immediately, as the gas within expanded, the capillary tube was seen to be filled with a dense mist. Cailletet did not at first realize that the cause of the appearance of the mist nas the adiabatic cooling and partial liquefaction of the acetylene, and he put it down to the presence of impurity in the gas. As a second experiment with acetylene, prepared with great care, yielded the same result. he next filled the apparatus with nitrous oxide, and again observing the formation of mist on expanding the gas, he came to the conclusion that the phenomenon was due to the actual liquefaction of the gas. It was difficult to realize that such intense cooling could be effected by expanding so small a quantity of gas in a capillary tube, but having realized that this could be done, Cailletet at once proceeded to attack the problem of liquefying the so-called permanent gases. Methane, carbon monoxide and oxygen were in turn compressed to **300** atmospheres in the same apparatus, cooled to −29° C. in a bath of sulfur dioxide boiling under reduced pressure, and then allowed to expand by releasing the pressure.

In each case the tube was seen to fill with the dense mist, indicating that liquefaction had taken place, though no liquid was actually seen.

See also HEAT; LOW-TEMPERATURE PHYSICS; THERMODYNAMICS.

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LIQUEURS. A liqueur (from the Latin *liquefacere,* "to make liquid") is a spirit which has been sweetened and flavoured with fruit or herbs. The alcoholic content of a liqueur, which is usually high, as well as the medical herbs which it frequently contains, are both agents which have been recognized as curative and digestive since the middle ages. Liqueurs are also often used as a liquid centre for chocolates.

There are three kinds of liqueur: (1) those with one herb predominating in their flavour; (2) those with only one fruit; (3) those with a mixture of flavouring agents. Kiimmel, made from caraway or cumin seeds, and framboise, made from raspberries, are good examples of the first two types, while Bénédictine is made of about 30 different herbs and other ingredients.

There are two main methods of making liqueurs. The first is by distilling all the ingredients together, the resulting distillate being sweetened and sometimes coloured. The second is to add an infusion of herbs, or fruits, to the base spirit; this is the method generally followed as it preserves the freshness, colour and bouquet of the ingredients. The best liqueurs are usually made upon a Cognac base.

It is easy to confuse liqueurs with spirits or with bitters (*q.v.*). When a liqueur is made upon a brandy or gin base it may be sold as a brandy or a gin, such as cherry brandy or sloe gin—but these are liqueurs, since they are sweetened. An unsweetened spirit cannot be called a liqueur; there is, for instance, a genuine unsweetened Hungarian and Yugoslavian brandy called Slivovitz, distilled from plums. Confusion may be deepened when the same name is used for both liqueurs and brandies; there is a sweet apricot brandy — a liqueur — as well as an unsweetened spirit made from apricots, and also known as apricot brandy. While sloe gin is a liqueur, lemon and orange gin are ordinary dry gins, with fruit added for flavouring. Although combined spirits are sometimes referred to as liqueurs, they should not be unless sweetened. Similarly, "liqueur brandy" is a misnomer; the word liqueur only refers here to its use as a *digestif* or to its specially good quality.

Bitters can be used as *digestifs* but they are usually *apkritifs.* They differ from liqueurs in that they are only very slightly sweetened, if at all.

The making of liqueurs was practised from earliest times. In 460 B.C. Hippocrates says that the ancients distilled herbs and plants, and because certain herbs were noticed to cure illness or to be effective as tonics, liqueur-making had a close association with early medicine and with medieval astrology. The Saxon word "wort" means a plant used for medicine. Certain plants were believed to keep away evil spirits, sometimes if they were merely pinned to a door. The remedies were certainly effective when they were administered; aniseed, caraway seed and mint, for instance, were long known to help digestion. Nicholas Culpepper, writing in the 17th century, advises "a water distilled from (angelica) root" for the same purpose; angelica is frequently used in liqueurs, together with many other herbs, such as coriander, fennel. wormwood, gentian, amber, hyssop and thyme. *(See* Culpepper's The *Complete Herbal.)*

A particular area of the world will often produce a variety of herb or fruit which is best for liqueur-making, and it is there that the industry will be situated. For example. the small apricot that is found in the fle-de-France is the only one that will make abricotine, and the wild blackthorn of Devon and Comwall makes the best sloe gin. The fruit must always be picked at its ripest, and even slightly blemished fruit discarded.

See also ALCOHOLIC BEVERAGES, DISTILLED; BÉNÉDICTINE, D.O.M.; CHARTREUSE; CRÈME DE MENTHE; KÜMMEL.

See M. I. Fisher, *Liqueurs* (1952). (C. C. H. F.)

LIQUIDAMBAR, LIQUIDAMBER or SWEET GUM, a product of *Liquidambar styraciflua* (family Hamamelidaceae), a tree native to the United States, Mexico and Central America. The earliest record of the tree appears to be in a Spanish work by F. Hernandez, published in 1651, in which he describes it as a large tree producing a fragrant gum resembling liquid amber, whence the name. In Ray's *Historia Plantarum* (1686) it is called *Styrax liquida.*

Liquidambar was introduced into Europe in 1681 by John Banister. a missionary collector sent out by Bishop Compton, who planted it in the palace gardens at Fulham. The gum resin yielded by this tree has no special medicinal virtues, being inferior in therapeutic properties to many others of its class. It has long been used in France as a perfume for gloves, etc. It is mainly produced in Mexico. *(See* SWEET GUM.)

LIQUIDATION. A British joint stock company, being a purely artificial body created by law, can only be brought to an end by legal process. This legal process is called liquidating or winding up the company.

A company may be wound up (1) Voluntarily, by the passing of a special or extraordinary resolution that it be wound up, and the appointment of a person to act as liquidator. The liquidator so appointed has to convene a meeting of creditors. and the creditors may, if they think fit, pass a resolution deputing some named person to apply to the court to appoint another person to act as liquidator, either with or in place of the existing liquidator. Ordinarily, the court would act upon such a request in cases where the company appeared to be insolvent. (2) Under the supervision of the court. This form of procedure is now practically obsolete. (3) Compulsorily. Here the procedure is analogous to that in bankruptcy. The official receiver takes charge of the company's affairs in the first instance! and it is the duty of the directors of the company to supply him with a sworn statement of its affairs. This statement of affairs is submitted by the official receiver to separate meetings of the creditors and contributories (or shareholders). Each meeting has a right to nominate a liquidator, who may be the official receiver; the official receiver reports the result of the meetings to the court, and the court thereupon appoints a liquidator.

Duties **of Liquidator.**—Whatever form the liquidation takes, it is the duty of the liquidator (1) to realize the assets of the company to the best advantage; (2) to adjust the rights of contributories *inter se, i.e.*, to determine what calls must be made upon the partly paid shares of the company (if any) in order to provide for the payment of its debts, and to do justice to the different classes of shareholders; (3) to investigate the causes of liquidation, and if necessary to institute proceedings against any persons who may have contributed to its failure; (4) to distribute the proceeds of the realization of the assets among those entitled to participate, having regard to the priorities provided by law; (5) to close the liquidation, and provide for the final dissolution of the company.

On the appointment of a liquidator, the directors and all the former officers of the company cease to function, and the liquidator becomes the only officer capable of acting in the name of the company and using its common seal. In so doing he acts as agent of the company only.

Debenture holders are secured creditors only to the extent of any specific or general charge that they may hold upon the assets of the company. Usually, a receiver is appointed to look after their special interests; but, in the absence of a receiver. it is the duty of the liquidator to see that. subject to payment of proper costs, the proceeds of the sale of all assets charged in favour of debenture holders are applied (subject only to the rights of preferential creditors) first in satisfaction of debenture holders' claims.

In the absence of express provision to the contrary, every share in the company carries equal rights and responsibilities. Thus, if all the shares are not fully paid, the rights of the respective holders cannot be adjusted until either the partly paid shares have been fully paid up, or a sum has been returned to the holders of fully paid shares equal to that uncalled upon the partly paid shares. But, of course, no return can be made to shareholders until all the debts of the company have been paid. (L. R. D.)

United States. — Although both liquidation and winding up are terms in use in the United States. the legal process is most frequently called dissolution; and the dual forms refer t~ voluntary and involuntary dissolution. Liquidation is often used in the narrower sense of the actual disposition of the company's assets.

In a voluntary dissolution the directors usually act as liquidating trustees. In involuntary dissolution the receiver appointed by the court will liquidate the assets. There is no formal creditors' meeting provided for although such meetings are often called and act in an advisory capacity.

In comparing involuntary dissolution with bankruptcy, it should be noted that the bankruptcy statute excludes from its operation railroad, banking and insurance companies. The United States supreme court has further held that in many circumstances a public utility company may be compelled to continue operating even though its stockholders wish to dissolve. In such a case neither bankruptcy nor liquidation would be available to a railroad company. It has, however, been held that when a railroad company is operating at a continuous loss the courts and legislatures must allow it to liquidate. (J. L. WE.)

LIQUID STATE, THE. The states of aggregation of chemical substances are classified as gas, liquid and solid. Gases and liquids are distinguished from solids by the property of fluidity. Elastic solids resist both tensile and shear deformation with stresses proportional to the strains. They are therefore capable of supporting shearing stress at equilibrium. The representative fluid, obeying the Newtonian law of viscosity, resists shear deformation only with a stress proportional to the rate of strain. Fluids are therefore incapable of supporting shearing stress and, under the action of gravity, flow to adapt their shapes to those of their containers. The mechanical distinction between fluids and solids is not sharp. Many substances, notably certain high polymeric materials, exist in states exhibiting mechanical properties intermediate between those of the elastic solid and the viscous fluid.

Each substance possesses a critical temperature above which there exists but a single fluid phase. Above the critical temperature there is no distinction between gas and liquid. At each temperature below the critical there exists a pressure, called the vapour pressure, at which two fluid phases are capable of coexistence. The more dense is designated as the liquid and the less dense as the vapour. At pressures exceeding the vapour pressure the liquid is stable. At pressures less than the vapour pressure the vapour or gas is stable.

The boiling point of a liquid under constant external pressure is the temperature at which the vapour pressure becomes equal to the external pressure. Heated at constant pressure, a liquid remains stable until its boiling point is reached, when it is transformed to vapour with the absorption of heat. The heat absorbed in the vaporization of unit mass of liquid is called the latent heat of vaporization.

In general, substances possess one or more crystalline solid modifications. Some or all of them may be capable of coexistence with the liquid phase. At a specified external pressure, the temperature at which a crystalline solid and the liquid coexist is called the melting point of the solid or the freezing point of the liquid. When a liquid is cooled to the freezing point, it is transformed into the solid with the liberation of heat. The heat liberated when unit mass of liquid is transformed into solid is called the latent heat of fusion. Noncrystalline solids, for example glassy or vitreous materials, generally do not possess definite melting points, but soften gradually to a liquid phase with increasing temperature. Noncrystalline solids are frequently unstable with respect to transformation to crystalline phases, but the rate of transformation may, as in the case of glasses, be exceedingly slow.

Substances are observed to possess triple points of specified temperature and pressure at which solid, liquid and gas may coexist. At pressures below that of the triple point the liquid is no longer stable. When the solid is heated below the triple point pressure, it sublimes to vapour without passing through an intermediate liquid phase.

Liquids in contact with their own vapours or with air possess a property called surface tension which, unless opposed by external forces, causes the interface to reduce to minimum area. Therefore, in the absence of gravity and other external forces, the stable form of a mass of liquid is spherical. Surfaces between a liquid and a solid or another immiscible liquid are also characterized by interfacial tensions, which determine whether the liquid in question will wet or spread on the other material.

As a rule, substances possess only one liquid modification. Exceptions are found in the case of helium which possesses two liquid forms and in certain substances, for example para-azoxyanisole, which possess optically anisotropic liquid crystalline phases as well as a normal liquid phase.

The Molecular Structure of Liquids.—The structure of substances on the molecular scale is determined by a balance between the ordering influence of intermolecular forces and the disordering influence of thermal motion. At low temperatures the influence of intermolecular forces predominates to give the well-ordered structural characteristics of the crystal lattice. At high temperatures the influence of thermal motion predominates to give the random and featureless structure of a gas. The structure of liquids corresponds to a degree of order intermediate between that of the crystalline solid and that of a gas.

The structure of an ideal crystal is characterized by a high degree of order and organization in the arrangement of the atoms and molecules of which it is composed. This order is described by the theory of space lattices. There exists a fundamental unit of structure composed of a small number of atoms or molecules in a definite geometrical configuration. The crystal lattice is built up as a periodic reproduction of the fundamental unit in the three directions of space. Real crystals possess various types of disorder such as mosaic structure and lattice dislocations as well as thermal disorder associated with lattice vibrations and lattice defects.

When a crystalline solid melts to the liquid, the long-range order of the crystal lattice is destroyed. However, a residue of local order persists in the liquid state. Each molecule maintains a partially ordered arrangement of its neighbours which is a blurred replica of that of the crystal lattice. This vestigial order lacks the long-range character of that of the crystal lattice and becomes imperceptible at distances greater than several molecular diameters.

The local order characteristic of the liquid state is described by the radial distribution function $g(R)$, defined as the ratio of the average local molecular density $\rho(R)$ at a distance R from an arbitrary molecule to the bulk density ρ_0 of the liquid.

$$\rho(R) = \rho_0 g(R) \qquad (1)$$

A radial distribution function everywhere equal to unity corresponds to a completely random or disordered structure. Departures of $g(R)$ from the value unity measure the local order established by a molecule in the arrangement of its neighbours. For the representative liquid, $g(R)$ is a curve which possesses a series of rapidly damped maxima and minima. The positions of the maxima roughly correspond to the first several co-ordination shells of the crystal lattice characteristic of the solid state of the material. The minima correspond to distances intermediate between co-ordination shells. The local order described by the radial distribution function lacks the sharpness of crystalline order and is appreciable only at distances of a few molecular diameters. The resemblance of liquid structure to crystalline structure is therefore limited to a domain of molecular dimensions in the vicinity of any molecule. The radial distribution function specifies only the average local density, from which significant statistical fluctuations must occur as the neighbours of a specified molecule are interchanged with other molecules in the course of thermal motion.

The experimental determination of the radial distribution function is based upon the measurement of angular distribution of intensity of X-rays scattered by the liquid, according to techniques developed by F. Zernicke and J. A. Prins and by P. Debye and H. Mencke. A beam of monochromatic X-rays is allowed to traverse a small sample of the liquid, confined in a glass capillary or in the form of a jet. The intensity of the scattered radiation is recorded as a function of scattering angle on a photographic plate, in an ionization chamber. or with a Geiger-Miiller counter. An X-ray scattering photograph of a liquid resembles to a certain extent a Debye-Scherrer powder diagram of a crystalline solid. However. instead of the well-defined rings of maximum intensity of the powder diagram, a liquid gives only a few broad and diffuse rings of rapidly diminishing intensity.

From the intensity $I(\vartheta)$ of the X-rays scattered by a liquid in a direction making an angle ϑ with the incident beam, the radial distribution function may be calculated with the aid of the Fourier integral theorem. The relationship may be expressed in the following manner,

$$g(R)-1=\frac{1}{2\pi^2 R}\int_0^\infty si(s)\sin(sR)ds$$
$$i(s)=(I/I_e-Nf^2)/Nf^2 \tag{2}$$
$$s=(4\pi/\lambda)\sin\theta/2$$

where I_e is intensity of radiation scattered by a single electron, λ the X-ray wave length, and f the form factor of the atoms of which the liquid is composed. The Fourier integral may be evaluated with the aid of an harmonic analyzer or other mechanical computing devices.

Although the X-ray scattering technique is strictly applicable only to a monatomic liquid, it may be employed in an approximate fashion to obtain worthwhile qualitative information concerning the structure of polyatomic liquids when the scattering can be principally attributed to a single type of atom or when the form factors of the several types of atoms composing the molecules are not significantly different in magnitude.

Quasi-crystalline models of local liquid structure may be used to advantage in the interpretation of the radial distribution function. While it is recognized that long-range crystalline order is absent, the local arrangement of the neighbours of each molecule is regarded as a blurred replica of the first several co-ordination shells of a single crystal lattice or of a superposition of several lattice types. The number of neighbours in each diffuse co-ordination shell is estimated as the integral of $4\pi R^2\rho_0 g(R)$ under the corresponding peak of the radial distribution function.

Quasi-crystalline analysis of the radial distribution functions of the liquid metals, for example sodium and mercury, leads to the conclusion that the local structure corresponds to a close-packed arrangement of spheres. J. D. Bernal and R. H. Fowler have employed the quasi-crystalline model with great success in interpreting the structure of liquid water. The liquid is regarded as a three-dimensional net in which each water molecule is linked to four neighbours by hydrogen bonds. By superposing co-ordination structures of the β-quartz, trydymite, and closed-packed types, a radial distribution function, yielding an X-ray scattering curve in substantial agreement with experiment, may be constructed. At low temperatures the β-quartz structure predominates, and at high temperatures the contribution of the closed-packed structure increases. Many of the anomalous properties of water, for example, the maximum density at 4° C., are accounted for by the Bernal-Fowler model.

The structure of the liquid paraffin hydrocarbons has been interpreted along similar lines by B. E. Warren. In these liquids, the structure approximates the arrangement realized in the axial close-packing of slender rods. The X-ray scattering curves of the aliphatic alcohols exhibit inner peaks not observed for the corresponding hydrocarbons. This peak may be qualitatively interpreted, if it is assumed that the alcohol molecules are linked in chains by hydrogen bonds between the hydroxyl groups, while the aliphatic radicals remain approximately close-packed as in the corresponding hydrocarbons. Similar qualitative interpretations of the structures of many organic liquids can be made.

The investigation of the relation between liquid structure and intermolecular forces involves difficult problems in statistical mechanics which have received only partial solution. The statistical mechanical theory of molecular distribution in liquids has been studied by J. E. Mayer and J. G. Kirkwood. An approximate integral equation relating the radial distribution function to the potential of intermolecular forces has been formulated by J. G. Kirkwood and solved by Kirkwood and E. Monroe for a system of rigid spherical molecules with out attractive forces. The theoretical distribution function possesses the general characteristics of the experimentally determined radial distribution functions for representative liquids.

The Thermodynamic and Mechanical Properties of Liquids.—The thermodynamic properties of an homogeneous liquid in equilibrium are determined by its equation of state,

$$p=f(T,v) \tag{3}$$

which specifies the pressure p as function of the temperature T and the specific volume v, and by its specific heat as a function of temperature at a constant value of the pressure. The equation of state cannot be expressed in closed form in terms of elementary mathematical functions, but simple analytical approximations may be used for limited ranges of the variables. In general, the compressibilities and thermal expansion coefficients of liquids are not very sensitive to pressure, away from the critical state. However, the compressibility decreases slowly with increasing pressure.

Heterogeneous equilibrium between liquid and vapour or liquid and crystalline solid is described by the Clapeyron equation.

$$\frac{dp}{dT}=\frac{L}{T\Delta v} \tag{4}$$

where L is the heat absorbed and Δv is the specific volume increment in the transition. This differential equation determines the pressure p as a function of temperature T for states of coexistence of the liquid and the contiguous phase. Thus, when applied to liquid-vapour equilibrium, it determines the vapour pressure as a function of temperature.

According to statistical mechanics, the thermodynamic behaviour of a liquid is determined on the molecular scale by the forces acting between the molecules of which it is composed. The intermolecular force between a pair of molecules is one of repulsion at small distances and one of attraction at large distances. The repulsion at small distances prevents molecules from interpenetrating to an appreciable extent and gives them an effective size. The attraction at large distances is called the van der Waals force and is responsible for the general cohesive properties of matter. The potential $V(R)$ of a pair of chemically saturated spherical molecules or atoms, for example argon, situated at a distance R from each other may be approximately represented by the expression, formulated by J. E. Lennard-Jones,

$$V(R)=\frac{\lambda_1}{R^s}-\frac{\lambda_2}{R^6} \tag{5}$$

where λ_1 and λ_2 are constants and s is an exponent in the neighbourhood of 12. The first term, dominating at small intermolecular distances, gives rise to repulsion, and the second, dominating at large distances, gives rise to the van der Waals attraction.

According to J. E. Mayer, the pressure p is related to the potential of intermolecular force $V(R)$ and the radial distribution function $g(R)$ in the following manner,

$$pv=RT-\frac{2\pi N}{3}\rho_0\int_0^\infty R^3\frac{dV}{dR}g(R)dR \tag{5}$$

where V is the molar volume, N is Avogadro's number, R the gas constant, and T the absolute temperature.

The molar heat of vaporization is related to the potential of intermolecular force and the radial distribution function through the formula,

$$L=RT-2\pi N\rho_0\int_0^\infty R^2V(R)dR \tag{6}$$

where the symbols have the same significance as in equation (5).

The statistical mechanical theory of liquid structure has been approached from another standpoint by H. Eyring and J. Hirschfelder and by J. E. Lennard-Jones and A. F. Devonshire. In these theories the quasi-crystalline model of local liquid structure is employed to estimate the free volume accessible to each molecule, in which it is supposed to execute gas-like thermal motion. The free volume is much smaller than the total volume per molecule, since each molecule is caged by its neighbours. According to the free volume theories, the equation of state has the form,

$$p=RT\left(\frac{\partial\log v_f}{\partial v}\right)_T-\left(\frac{\partial E}{\partial v}\right)_T \tag{7}$$

where v_f is the free volume and E is the molar internal energy. The several free volume theories prescribe different models upon which to base the calculation of v_f. They have been very successful in reproducing the empirical equations of state of many liquids.

In fluid mechanics the relation between the stress tensor σ and the rate of strain $\dot{\epsilon}$ is of primary importance. For the Newtonian fluid in which the principal shearing stresses are proportional to the corresponding rates of strain, this relation is

$$\sigma=-(p+\tfrac{2}{3}\eta\nabla\cdot u)1+2\eta\dot{\epsilon} \tag{8}$$

where 1 is the unit tensor, u the fluid velocity and η the coefficient of viscosity. The stress law of equation (8) when introduced into the equation of motion leads to the Navier-Stokes equation,

$$\rho\frac{du}{dt}=\rho F-\nabla p+\eta\nabla^2 u+\frac{\eta}{3}\nabla\nabla\cdot u \tag{8}$$

where ρ is the density and F is the external force acting on unit volume of the fluid. The Navier-Stokes equation together with the equation of continuity,

$$\nabla \cdot (\rho u) = -\partial\rho/\partial t \tag{10}$$

describes the motion of viscous fluids. The study of the solutions of these equations under appropriate initial and boundary conditions constitutes the science of hydrodynamics.

The coefficient of viscosity of a liquid is related to its structure and the intermolecular forces in a complicated way. According to Eyring, it may be represented in the form,

$$\eta = \frac{a_1 h}{a_2 a_3 a^2} e^{-\Delta F \pm /RT} \tag{11}$$

where h is Planck's constant and AF* is the free energy of activation for the elementary flow process. In this equation, a_1 is the dimension of the unit of flow perpendicular to the direction of flow, a_2 and a_3 the dimensions parallel to the direction of flow, and a the distance moved by the unit of flow in the elementary process.

Electrical and Optical Properties of Liquids.—With the exception of the liquid metals, molten salts, and solutions of salts in ionizing solvents, the electrical conductivities of liquids are very small. In the liquid metals the conductivity is electronic. In molten salts and solutions of salts the conductivity is electrolytic, that is the electric current is carried by the ions of the salt. For example, in an aqueous solution of sodium chloride, the current is carried by the ions Na^+ and Cl^-.

The dielectric constants of nonpolar liquids, for example benzene, the molecules of which do not possess permanent electric dipole moments, do not differ greatly from unity and generally are in the range 1.00 to 3.00. The dielectric constants of polar liquids, for example water, the molecules of which possess orientable electric dipole moments, are generally one or two orders of magnitude larger than those of nonpolar liquids. Thus the dielectric constant of water is approximately 80 at 25 C. With the exception of liquid crystalline phases, liquids are optically isotropic. In nonpolar liquids the refractive indices for the visible spectrum do not differ greatly from the square roots of their dielectric constants measured in the radio or audio frequency spectrum. In polar liquids, the refractive indices for light in the visible spectrum are of the same magnitude as those of nonpolar liquids.

The absorption spectra of liquids in the visible and ultra-violet region of the spectrum reflect the electronic structure of their component molecules and do not differ markedly from the absorption spectra of the substances in the vapour state. However, on account of the perturbing influence of intermolecular forces, changes in frequency and intensity, as well as the broadening and blurring of the band structure of the vapor spectrum, are observed. The infra-red and Raman spectra of liquids may differ markedly from those of their vapours, because of the presence of structural irequencies characteristic of the liquid state. Such structural frequencies are analogous to the lattice vibrational frequencies which give rise to the residual ray spectrum of ionic crystals.

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LIQUORICE. The hard and semi-vitreous sticks of paste, black in colour and possessed of a sweet, somewhat astringent taste, known as liquorice paste or black sugar, are the inspissated juice of the roots of a leguminous plant, *Glycyrrhiza glabra,* the *radix glycyrrhizae* of pharmacopoeia. The plant is cultivated throughout the warmer parts of Europe, especially on the Mediterranean shores, and to some extent in Louisiana and California. The roots for use are obtained in lengths of three or four feet, varying in diameter from $\frac{1}{4}$ to 1 in., they are soft, flexible and fibrous, and internally of a bright yellow colour, with a characteristic, sweet pleasant taste. To this sweet taste of its root the plant owes its generic name *Glycyrrhiza* (the sweet-root), of which the word liquorice is a corruption. The roots contain grape-sugar, starch, resin, asparagine, malic acid and the glucoside glycyrrhizin, $C_{24}H_{36}O_9$, a yellow amorphous powder with an acid reaction and a distinctive bitter-sweet taste. On hydrolysis, glycyrrhizin yields glucose and glycyrrhetin.

Stick liquorice is made by crushing and grinding the roots to a pulp, which is boiled in water over an open fire, and the decoction separated from the solid residue of the root is evaporated till a sufficient degree of concentration is attained, after which, on cooling, it is rolled into the form of sticks or other shapes for the market. The preparation of the juice is a widely extended industry along the Mediterranean coasts; but the quality best appreciated in Great Britain is made in Calabria and sold under the names of Solazzi and Corigliano juice. Liquorice enters into the composition of many cough lozenges and other demulcent preparations; and in the form of aromatic syrups and elixirs it has a remarkable effect in masking the taste of nauseous medicines.

LIQUOR LAWS AND LIQUOR CONTROL. Laws to regulate or prohibit the manufacture, sale and transportation of beverage alcohol or intoxicating liquors are of ancient origin everywhere and are growing more numerous and complex in all countries. They are found more often and in greater variety as tax measures ostensibly for the purpose of raising revenue, but even here the dominant motive is usually the social aim to combat the evils of alcoholism and promote public health, public order and social welfare.

Another factor of growing importance from the middle of the 19th century has been the rapid urbanization, industrialization and mechanization of modern life in the leading nations of the world. There is a consequent wider recognition of the need for sobriety as a safeguard to public order and physical efficiency.

There are four general methods of legislative control of the liquor traffic:

1. *Licensing,* the oldest and most widely used method.
2. *The no-private-profit Scandinavian or company system,* which seeks to ensure disinterested management by entrusting a monopoly of sale of liquor to a body of citizens who have no personal interest or profit in it.
3. *State monopoly,* where the state retains the wholesale or retail trade, or both, in its own hands, takes the profits as public revenue and of course retains complete control.
4. *Restriction or limited prohibition,* which is usually a system of high licence with local option or local veto.

The licence systems of the United Kingdom and the United States respectively exemplify two main principles of licensing. In the U.K. is found a single homogeneous system gradually evolved after centuries of experience with the licensing principle, whereas in the U.S. before and after the era of national prohibition many different systems were coexistent as a result of the quasi sovereignty of the individual states. Also, U.S. law and legislative practice have never varied the traditional common-law theory of a licence as a temporary permit, revocable for violation of the conditions upon which it was granted and terminable at the will of the issuing authority upon the expiration of the brief term —usually one year—for which it was granted, and without vesting any property right in the expectation of renewal.

THE UNITED KINGDOM

The English System.—The common law of England imposes no control on the keeping of inns, taverns and alehouses, apart from the requirement that they shall not constitute a nuisance. Statutory control, however, commenced in the reign of Edward VI with the act of 1552, which introduced the system of licensing and brought common ale, or tippling, houses under the vigilance of justices of the peace. The licensing system, with its object of suppressing the vice of drunkenness by limiting the number of public houses and by other controls, developed through the centuries and was extended by the insistence that the granting of a magistrate's certificate was a condition precedent to the allocation of an excise licence, which constitutes the sole authority for the sale of liquor.

Control by the lay justices, exercising their local knowledge within the framework of the general law as to the desirability of granting applications, is accordingly the foundation of liquor control in the country. Such control by the justices is practically complete, but there are for historical reasons certain exemptions from their control. In the case of R. v. *Graham Campbell ex parte A. P. Herbert* (1935 1 *K.B.* 594), in which an application was made for summonses against the kitchen committee of the house of commons for having unlawfully sold by retail intoxicating liquor within the precincts of the house, it was held that the bulk of the provisions of the Licensing acts were quite inapplicable to the house of commons, and that the jurisdiction of the courts was excluded by the privilege of parliament. All who are free of the Company of Vintners in the City of London derive exemption from letters patent of James I; and similarly unprejudiced by the licensing legislation are the chancellors, masters and scholars of the University of Cambridge who need neither a justices' nor an excise license for the sale of wine. Naval and military canteens also enjoy exemption. The Carlisle area stands outside the general scheme of licensing control being subject to a system of state ownership instead. No person unless acting on behalf of the secretary of state for home affairs may sell intoxicating liquor by retail in the Carlisle district or supply it in any licensed premises or registered club. Ancillary functions exercisable by the home secretary in this area include the provision and maintenance of hotels and inns where accommodation and inns are provided and alcoholic liquor is sold. The state management of the liquor trade in operation in the Carlisle area was extended to all "new towns" declared to be such by the New Towns act, 1946, but state management of the trade in these towns was withdrawn in 1952 and became once more confined solely to the Carlisle area. Committees, however, were constituted in the new town areas to determine the number, nature and distribution of licensed premises in these places. In extending the system of state management the government had followed a recommendation made by the royal commission on licensing which was appointed in 1929 and had reported in 1932 (Cmd. 3988). Other recommendations included the retention of existing closing hours: the more rapid reduction of licences; more definite encouragement of specific education on the subject of alcohol; and the creation of a national licensing commission to supervise and assist the proposed reform measures. No action was taken on the last two proposals, and the question of the grant or refusal of licences remains exclusively nithin the competence of the local benches, subject to appeal to and confirmation by quarter sessions, as explained below.

The main provisions relating to the law of licensing administration were eventually consolidated, and are for the most part to be found in the Licensing act, 1953, and the Customs and Excise act, 1952. The 1953 act defines intoxicating liquor to mean spirits, wine, beer, porter, perry and sweets (i e , liquor made from fruit and sugar which has undergone fermentation) and any fermented, distilled or spirituous liquor that cannot for the time being be sold without an excise licence, but does not include beer or porter which on analysis of a sample is found to be of an original gravity not exceeding 1,016 degrees and to be of a strength not exceeding 2 degrees of proof. The 1952 act classifies the excise liquor licences that may be authorized under the folloning heads. (1) manufacturers'; (2) wholesale dealers'; (3) retailers'; (4) occasional; (j) passenger aircraft; (6) passenger vessel; (7) railway passenger vehicle.

Methods and Conditions of Licensing. — For the purpose of granting a retailers' licence England and Wales are divided into licensing areas comprised oi committees of five or five members of the petty sessional division of a county and a borough having a separate commission of the peace. The divisional licensing justices (there must be a quorum of at least three) receive applications for the granting of a new licence, or the renewal or transfer of an old, at their general annual meeting which takes place at the "brewster sessions" in the first fortnight in February in each year, and they are empowered to exercise their unrestricted discretion in dealing with these applications as they think fit and proper. Before the hearing of a request in respect of a licence the applicant must give certain public notices in the local press and also advertise his intention to the local police and outside the parish church. The meeting of the justices must take place in public. The proceedings are of a quasi-administrative order, the meeting of the justices not constituting a court of summary jurisdiction for licensing purposes. All qualified justices are entitled to sit. The discretion of the justices although an absolute one is required to be exercised judicially. Any person liable to suffer from real bias may not sit as a licensing justice and if he does the order may be quashed on that ground. A person financially interested in a brewery. for example. may not sit though a teetotaller may. The justices in the exercise of their discretion must take into consideration both the character of the application and of the premises. The applicant must not be any sheriff's officer, or a person who has been convicted of felony or certain other offenses. and must be of good repute. The premises must be structurally adapted to the class of licence required. The magistrates may in granting the licence impose such conditions as to the alteration of the structure of the premises as they think fit. S o alteration in any on-licensed premises may be made without the consent of the justices. At the hearing any member of the public may be heard in objection to the application provided that such objection is advanced on public grounds. All evidence must be tendered on oath.

The decision of the justices whether to grant the application is by majority vote. Once granted the licence continues in force for a period of one year. The grant of a new licence requires confirmation by the county or borough Confirming and Compensation committee at quarter sessions. In the event of failure to renew an old licence, compensation is payable after reference has been made to the compensation authority which may award a figure to be paid as calculated on the difference between the value of the premises as licensed and as unlicensed; such a sum is met out of an "insurance" fund subscribed to by all licence holders, the compensation being thus subsidized by the trade itself. This principle of compensation was first introduced by the Balfour act in 1904 and has been responsible for bringing about a reduction in the number of public houses in the country.

Any person who thinks himself aggrieved by the refusal of the licensing justices of any licensing district to grant a renewal of a licence may appeal to quarter sessions. There is, however, no such right of appeal against the refusal to grant a new licence. The appeal takes the form of rehearing and quarter sessions has power to hear and determine the matter and to make any such order as it thinks fit. No appeal is permissible to the superior courts of the country. But the divisional court of the queen's bench division exercises a supervisory jurisdiction over inferior bodies acting in a judicial capacity by means of the prerogative writs of mandamus, certiorari and prohibition, and is thus enabled to remedy any defects in justice which may have been done. The writ of mandamus was described by Sir William Blackstone as "a command issuing in the King's name from the King's Bench and directed to any person, corporation or inferior court of jurisdiction, requiring them to do some particular thing therein specified, nhich appertains to their duty or office." Thus, as in R. v. *Walsall Justices* (3 C L.R. 100), the justices can be ordered to hear and determine an application that they had refused to entertain. The issue of the writ is at the discretion of the court. The writ of certiorari permits the divisional court to examine the proceedings of the inferior body to see whether its order has been made within its jurisdiction and enables it to quash a decision when it is made in excess of jurisdiction, as for example where bias or fraud has been present, or where an error of law appears on the face of the record. Prohibition is the warrant which can issue from the divisional court to prevent the justices from exceeding their jurisdiction, or from infringing the principles of natural justice.

The grant of a justices' licence entitles the holder as of right to an excise licence which constitutes the authority for the sale of liquor, but upon forfeiture of the justices' licence the excise licence becomes void. Any person who sells by retail any intoxicating liquor without a justices' licence authorizing him to hold an excise licence is liable to a fine of £50 or to a period of imprisonment for one month. The holder of a justices' licence shall cause to be painted on the premises in a conspicuous position his name with the addition of the word "licensed"

Under the common law of England the holder of a licence is not under a legal duty to open during the permitted hours, nor to serve all comers unless he be a common innkeeper. in which case special rights and obligations as between landlord and guest arise, giving the licence holder no right to pick and choose whom he will serve. In general throughout the United Kingdom there is strict supervision of the beverage liquor traffic. and in addition to the penalties provided under the Licensing act the stringent sanction of disqualification is available with which to deal with defaulting licensees. Hence it is incumbent on the holder of a licence not to permit drunkenness or any violent, quarrelsome or riotous conduct to take part on the premises, or sell any intoxicating liquor to a drunken person. He must not permit his premises to be the habitual resort of reputed prostitutes, or knowingly harbour thieves or reputed thieves. He must not knowingly harbour or allow any constable being on duty to remain on the premises unless he is there in the execution of his duty. He must not allow his house to be used for gaming or betting. He must close his premises. if ordered by the justices so to do, in the event of a riot.

Permitted Hours.—The 1953 act fixes the permitted hours during which on-licensed premises may remain open to the public. The conception of limitation of hours of opening has been found to be the most effective means of reducing abuse of alcoholic beverages, and for psychological reasons the legislature deemed the word "permitted" to be more acceptable than "closing" or "forbidden." It is an offense. punishable by £30 fine, for any person to serve to another any intoxicating liquor to be consumed on or off the premises. outside the permitted hours, unless he is resident on the premises or is consuming a drink with a meal which has been ordered within half an hour after the conclusion of the permitted hours. or unless he is a bona fide friend of the landlord being entertained on the premises at the landlord's own expense. The permitted hours are as follows:

On *Week* Days.—A period of eight hours a day beginning not earlier than 11 A.M. and ending not later than 10 P.M. with a break of at least two hours after noon. The justices are, however, authorized to alter the hours to suit special requirements of the district to a period of eight and a half hours a day commencing not earlier than 8 A.M. and finishing not later than 10.30 P.M. If no hours are fixed by the justices then these will prevail: 11.30 A.M. to 3 P.M. and 5.30 P.M. to 10 P.M. In the metropolis the hours are different. The metropolis is the administrative county of London together with an area outside that county but within the four-mile radius from Charing Cross. There nine hours are permitted. with a break of at least two hours in the afternoon! commencing not earlier than 10 A.M. and finishing not earlier than 10.30 P.M. and not later than 11 P.M. The justices may make special orders of exemption in exceptional circumstances such as on an occasion of local or national rejoicing.

On Sundays, *Christmas* Day *and* Good Friday.—The number of permitted hours in both the metropolis and elsewhere is limited to five, of which not more than two shall be between noon and 3 P.M.; and not more than three between 6 P.M. and 10 P.M.; except that in Wales and Monmouthshire there shall be no permitted hours on Sundays or on Christmas day when it falls on a Sunday. Unless the justices resolve to the contrary Sunday hours are from 12.30 P.M. to 2.30 P.M. and from 7 P.M. to 10 P.M.

Protective Provisions.—The 19j3 act contains protective provisions in respect of young persons. No child under the age of 14 is allowed into any bar. Liquor is not allowed to be sold for consumption on the premises to any person under the age of 18; but if, however, the individual is 16 or over he may take beer, porter, cider or perry with his meal provided that it is consumed in an open part of the premises and not at the bar. A bona fide error as to the age of the child is a good defense to a charge under this head. By the Children and Young Persons act, 1933, it is an offense for anybody to give intoxicating liquor to any child under the age of five save in a case of medical necessity.

The Licensing act protects the customer by making it an offense to sell liquor otherwise than in a standard imperial measure. Credit sales are forbidden and a customer must pay cash for the drink at the time that it is sold. Furthermore by the Sale of Spirits acts, 1750 and 1862 (popularly known as the Tippling acts), no action can be brought to recover any debt or sum of money alleged to be due in respect of the sale of any ale. porter, beer, cider or perry which was consumed on the premises where sold or supplied: or in respect of any money or goods lent or supplied, or of any security for, in or toward the obtaining of any such ale, porter, beer, cider or perry. There is a right of recovery if the spiritous liquor was bona fide bought at any one time to the amount of 20*s*. or more, or sold to be consumed off the premises and delivered at the residence of the purchaser in quantities less at any one time than a reputed quart.

Clubs.—Clubs which sell intoxicating liquor come under the control of the Licensing act. 1953, the provisions of which require registration as a condition to the supply of sale of drink. The secretary of a registered club is bound in the January of each year to furnish to the clerk of the justices a return containing certain statutory particulars. At the same time he must deliver to the commissioners of inland revenue a statement of purchases of intoxicating liquor over the period of the preceding year. Penalties are imposed for the supplying or keeping of liquor in an unregistered club. Magistrates are empowered if reasonable cause be shown to issue search narrants for the entry into clubs by constables to ensure that the lam is not being evaded. The permitted hours for the sale of drinks in clubs is fixed as a period not exceeding nine hours in the metropolis. falling between 11 A.M. and 11 P.M.; and of eight hours without the metropolis, falling between 11 A.M and 10 P.M. The rules restricting sales within these hours are. however, not applicable to a member of the club who is residing on the premises.

Scotland and Northern Ireland.—A practically parallel method to the system of licensing control of liquor as in force in England and Wales is to be found in Scotland and Northern Ireland. The duties and powers of the Scottish licensing courts are laid down in the Licensing (Scotland) acts, 1903 to 1949. The registration of clubs is a function of the sheriff. Applications for certificates for the sale of excisable liquor in Scotland for the year ending 1953 numbered 8,435 of which 8.343 were granted. In Clster control is effected in the main by the Intoxicating Liquor Licensing acts (Northern Ireland), 1923 and 1927. Provision is made thereby for the closing on Sunday and Christmas day of licensed premises and the permitted hours are fixed at an hour beginning not earlier than 10 A.M. and ending not later than 9 P.M. for rural areas, and 10 P.M. in urban districts or towns.

Rules on Drunkenness.—The Licensing act exemplifies the preventive measures taken to control liquor at its source. Other statutory provisions are also designed to discourage drunkenness and to strengthen liquor control. Underlying the criminal law of the country is the principle expounded by the house of lords in the leading case of R. v. Beard (1920 A.C. 249). Beard had ravished a girl of 13 and in order to prevent her from screaming had placed his hand on her mouth and at the same time pressed his thumb upon her throat with the result that she died of suffocation. On his trial for murder his sole defense was that he was so drunk that the jury ought to return a verdict of manslaughter. Lord Birkenhead, the lord chancellor, in his judgment laid down the modern rules on drunkenness as follows: (1) that insanity whether produced by drunkenness or otherwise is a defense to the crime charged; (2) that evidence of drunkenness which rendered the accused incapable of forming the specific intent essential to, constitute the crime should be taken into consideration with the other facts proved in order to determine whether or not he had this intent; (3) that evidence of drunkenness falling short of a proved incapacity in the accused to form the intent necessary to constitute the crime, and merely establishing that his mind was affected by drink so that he more readily gave way to some violent passion, did not rebut the presumption that a man intended the natural consequences of his acts. In *R.* v. *McCarthy* (1954 2 A.E.R. 262) it was held by the court of criminal appeal that unless a man is in such a complete and absolute state of intoxication as to make him incapable of forming the intent charged, drunkenness which may lead him to attack another in a manner which no reasonable, sober man would do cannot be pleaded as provocation reducing the crime from murder to manslaughter if death results.

Drunkenness by the common law of England is not an offense in itself. But by statute drunkenness accompanied by some other action may be. Thus if a person is found drunk in any highway or other public place, whether a building or not: and is incapable of taking care of himself he is liable to be apprehended and on conviction to pay a fine of 10*s*. Every person who in any highway or other public place, whether a building or not, is guilty while drunk of riotous or disorderly behaviour, or who is drunk while in charge on any highway or other public place of any carriage, horse, cattle or steam engine, or who is drunk when in possession of any loaded firearm, commits an offense. Any person who, being on any premises licensed for the sale of any intoxicating liquor whether for consumption on or off such premises, shall procure or attempt to procure any intoxicating liquor for consumption by any drunken person, or who shall aid and abet any drunken person in obtaining or consuming any intoxicating liquor on any premises so licensed, shall be liable on summary conviction to a fine not exceeding £2 or to imprisonment for one month. By the London Hackney Carriages act, 1843, it is an offense to be drunk during employment as a driver of a hackney or stage carriage. By s. 287 of the Merchant Shipping act, 1894. it is an offense to be drunk and persist, after being refused admission on that account, in attempting to enter a passenger steamer; it is also an offense, being drunk on board a passenger steamer, to refuse to leave when requested; and similar provisions are made applicable to air travel by virtue of the Civil Aviation act, 1949.

By s. 15 of the Road Traffic act, 1930, any person who when driving or attempting to drive, or when in charge of a motor vehicle on a road or other public place, is under the influence of drink or drugs to such an extent as to be incapable oi having proper control of the vehicle may be arrested without warrant and is liable on summary conviction to a fine not exceeding £50 or to a term of imprisonment not exceeding four months. The accused may elect, before the hearing of the case by the magistrates, to trial by judge and jury; if he does so. he is liable on conviction to a term oi imprisonment not exceeding six months or to a fine or to both. In addition a person so convicted shall be disqualified for a period of 12 months from the date of the conviction from holding or obtaining a driving licence unless the court for "special reasons," peculiar to the facts which constitute the offense (as opposed to personal matters of hardship to the accused), thinks fit to order otherwise, and without prejudice to the power of the court to order a longer period of disqualification.

The Inebriates acts, 1879–98, make provisions for the licensing by local authorities of retreats and reformatories for habitual drunkards. A "habitual drunkard" is a person who, not being amenable to any jurisdiction in lunacy. is notwithstanding by reason of habitual intemperate drinking of intoxicating liquor at times dangerous to himself or others, or incapable of managing himself or his own affairs. Whether drunkenness is occasional or habitual is a question of fact for the court. A separation order can be made by a court of summary jurisdiction in favour of a wife on the ground that her husband is a habitual drunkard or a drug addict. Any habitual drunkard who is found to be such may upon conviction on indictment of an offense, and if the court be satisfied that the offense was committed under the influence of drink, be ordered by the court to be detained in a reformatory for a period not exceeding three years.

TABLE I.—*Offenses of Drunkenness Proved in England and Wales, 1938–53*

Year	Men	Women	Total	Number per 10,000 of population aged 15 years and over
1938 .	46,832	7,686	54,518	16.84
1942 .	22,772	4,663	27,435	9.23
1946 .	17,090	3,455	20,545	6.04
1952 .	48,694	5,194	53,888	15.78
1953 .	48,539	5,035	53,574	15.65

Source: *Offences of Drunkenness* (Cmd. 9284, *H.M.S.O.*, London, 1954).

Offenses **of** Drunkenness.— In a home office White Paper on *Offences* of *Drunkenness* (Cmd. 9284) presented by the home secretary to parliament in 1954, statistics of the number of offenses of drunkenness proved in England and Wales for the year 1953 as compared with the number of offenses proved in previous years are available. These statistics, dealing as they do with the incidence of drunkenness at different age groups according to national police districts, show that drink never became the problem in World War II that it was in World War I. They also show that the contemporary problem of drink is principally a big-town problem.

TABLE 11.—*Number of Offenses of Drunkenness Proved in 1953 per 10,000 of Population Aged 15 Years and Over, by Districts*

Cities and boroughs	Number per 10,000
London city	288.17
Liverpool city	63.30
Birmingham city	48.28
Portsmouth	24 67
Brighton	14.67
Carlisle city	:0.57
Exeter city	9.36
Bristol city	8.84

Source: *Offences of Drunkenness* (Cmd. 9284, H.M.S.O., London, 1954).

TABLE III.—*Annual Average of Convictions for Drunkenness in England and Wales, 1930–53*

Offense	1930–34	1935–39	1940–44	1945–49	1950	1951	1952	1953
Simple drunkenness .	18,804	22,903	15,207	1	,	8 0	,	24,559
Drunkenness with aggravations .	26,084	28,583	16,509	13,924	25,276	27,956	27,993	27,386
Offenses by licensed persons .	1,468	1,425	1,084	536	659	683	707	593
Other offenses.	3,874	3,949	3,622	1,913	2,387	2,790	2,911	3,150

Source: *Crime Statistics fur England and Wales for 1953* (Cmd. 9199, H.M.S.O., London, 1954).

The report of the commissioner of police of the metropolis for the year 1953 (Cmd. 9236) showed that the number of premises licensed in London for the sale of intoxicating liquor was 7,818 for that year and the number of off-licensed premises 3.665; and that there were 41 licences for wine and spirit (excise dealers) and 78 for theatres. There were 19.022 arrests (16,276 men and 2,746 women) for drunkenness and drunkenness with aggravations within the metropolitan police district and proceedings were taken under s. 15 of the Road Traffic act, 1930, against 576 persons deemed to be under the influence of drink or a drug when driving or in charge of motor vehicles; of these last 414 were convicted, 24 being sentenced to terms of imprisonment and 396 being disqualified for holding or obtaining a driving licence. A total of 361 persons were charged with drunkenness and at the same time with more serious offenses; 6 men and 1 woman were convicted of drunkenness attributed to the drinking of methylated spirits; and 8 men and 1 woman were convicted of drunkenness believed to be attributable to the drinking of surgical spirit. Of the 77,545 arrests in the metropolitan police district which were dealt with in the courts. 24.5% were on account of drunkenness. Drink or drugs were considered by the police to be contributory factors in 0.3% of road accidents caused by drivers and motorcyclists. (P. B. C.; W. T. Ws.)

TABLE IV.—*Net Receipts From Excise, 1951–54*

Year ended March 31	Beer	Spirits	Liquor and other licences
1951	£249,146,244	£75,813,968	$4,423,823
1952	£248,165,812	£67,077,362	£4,461,071
1953	£243,372,425	£74,647,061	£4,490,018
1954	£242,031,712	£81,068,978	£4,509,469

Source: 45th *Report* of the Commissioners of Her Majesty's Customs and Excise for the year ended March 31, 1954 (Cmd. 9358, H.M.S.O., London, 1954).

THE **BRITISH** COMMONWEALTH

In Canada liquor legislation was based fundamentally on the licence system of the United Kingdom, but in its development it also followed closely the United States system. Thus, while the provinces had laws of varying stringency, they usually provided for licences modified by local veto. In 1901 the privy council decided the constitutional controversy over the respective powers of the dominion and the provinces; importation and manufacture were to be controlled by the dominion, distribution and sale by the provinces. Exceptions are the Northwest Territories and the Yukon, where retail is controlled by the dominion. Also, the Canada Temperance act is a dominion statute which applies to the whole of Canada.

The Canada Temperance act, 1878 (the Scott act), provided for local option in any city or county on petition oi one-fourth of the electors at three-year intervals. Under this act a rapid growth of dry areas in the maritime provinces took place, while in other areas where the Scott act was unpopular dry territory spread under provincial statutes. National prohibition. which received a majority of 13.68; in a total vote of more than 500,000 in an 1898 plebiscite. never gained enough support to secure enactment by the dominion government. Xfter 1901 there was much legislation analogous to the C.S. Wilson and Webb-Kenyon acts *(see* PROHIBITION) to protect dry territory from invasion from surrounding n-et areas. Unlike the United States. Canada. in abandoning total prohibition, abandoned also the licence system in favour of state monopoly. The Canada Temperance act. 1952, provided that upon the petition of one-fourth of the electors in any city or county an election must be held and if a majority is in favour part ii of the act takes effect by order in council. This prohibits the sale or keeping for sale of intoxicating liquor in the city or county. and the taking of liquor into it. Liquor purchased outside the city or county for personal use may be delivered to a person at his residence. A petition to revoke part ii results in a vote. and if a majority in favour is obtained a further order in council declares it revoked. Manufacturers' licences are granted to distillers and brewers under the Excise act. 1952. Under the Importation of Intoxicating Liquors act. 1952, the importation of liquor into any province from outside Canada or from another province is prohibited unless consigned to her majesty, the executive government or a government agency vested with the right of dealing in intoxicating liquor. (C. E. Ww.)

Other British commonwealth countries have in general followed the English model and have been less repressive in their policies of licensing and liquor control than Canada.

In Australia the existing licence legislation in all six states makes provision for some sort of local option and for machinery for the reduction of the number of licences where it seems desirable or where local opinion votes are in favour of reduction. In 1928 a special state-n-ide referendum was taken in New South Wales on state-wide prohibition with compensation. It resulted in a majority of 500,000 against prohibition in a total vote of 1,268,119, being more than 88% of the qualified voters. All the states except South Australia have a fixed maximum for licences above which the licence board may not go except under special conditions such as demand of increased population. The licence reduction boards in New South Wales and Victoria (and similar machinery in all other states) exist for the reduction of licences where it seems desirable or local-option votes so direct. Funds for compensation for licences refused renewal are derived from special taxes usually assessed on the volume of the liquor trade. Provision is made for a poll usually about once every seven years. and in some states total prohibition may be voted on when these polls are taken.

In New Zealand three state-wide polls were taken after 1919 on prohibition without compensation. state purchases and continuance of licence. Continuance won bv small majorities in all three. though prohibition obtained a plurality in tno polls.

In the Union of South Africa since the Licence act of 1928 some reduction in the number of licensed premises has taken place. (S. McC. L.)

CONTINENTAL EUROPE

Before World War I continental European countries gave little legislative attention to the liquor traffic. It was generally licensed for revenue purposes but control of beverage alcohol as a means of combating the evils of alcoholism was left to the local authorities and to ordinary police regulation. There were notahle exceptions. In Russia. Sweden. Norway, Finland and Estonia important experiments were made with various forms of liquor control and prohibition. A strong and growing temperance and total abstinence movement in most countries. wholly individualistic in character, dated from the latter part of the 19th century in the countries of northern Europe. especially in Finland. Norway, Sweden and Denmark. It was only a little less active in northern central countries like Germany. Switzerland. Belgium and the Netherlands. but was weaker in France and Slav countries and ineffective or nonexistent in southern Europe—Italy, Greece, Spain and Portugal. World War I stimulated liquor control because of the need for food and manpower conservation, but most legislative measures aimed at reducing the consumption of beverage alcohol were weakened or disappeared in the postwar years. After the outbreak of war in 1939, in spite of greater food shortages and the need for the conservation of alcohol and grains for war uses. there was less governmental interference with beverage alcohol except in Germany, and partially in Switzerland and France.

Cnder the basic Licensing act of 1880 France imposed some restrictions on places with on licences but left their regulation largely to local authorities. The number of public houses increased to 1 to every 81 persons in 1900 and was reported to be 1 to 80 in 1938, a proportion only exceeded by Belgium. The Local Government act. 1894, empowered municipal authorities to fix the usual conditions, hours of closing, etc.. attached to licences. Taxation of the trade, then light. was greatly increased. Manufacture and sale of absinthe was prohibited by the act of March 16, 1913, but the act was weakly enforced and there were many equally deleterious substitutes. The whole tax and regulatory policy, as far as there was one, was directed against spirits and to protect the wine industry. Even the consumption of spirituous liquors greatly increased. The per capita consumption of distilled liquor in France in the period 1928–32 was 5.52 litres, five times that of Denmark, four times that of Great Britain. more than twice that of Norway or the Netherlands and 25% higher than Sn-eden. Home distillers were said to number 1,500,000 and they enjoyed a tax exemption on ten litres of pure alcohol for personal use.

After World War II both the production and consumption of alcoholic drinks in France went down, but according to some estimates 8.000.000 persons were still engaged either directly or indirectly in the liquor trade in France in 1955. The premier P. Mendès-France announced measures in Nov. 1954 for the tightening up of the liquor laws. In an endeavour to combat the national problem of alcoholism the following restrictions were announced: no alcoholic drinks might be sold for consumption on the premises between 5 A.M. and 10 A.M.; taxes on drinks were to be increased by 20%; stricter penalties were to be imposed for offenses of drunkenness and against the licensing laws. Café proprietors breaking these laws rendered themselves liable to a fine of 1.000.000 fr. or to a term of imprisonment for one year; previously the penalty had been a fine of 24.000 fr. and imprisonment for eight days. (See also PROHIBITION.)

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(S. McC. L.; W. T. Ws.; P. B. C.)

UNITED STATES

Adoption of the 21st amendment to the U.S. constitution on Dec. 5, 1933, ended the experiment in national prohibition and returned to the states the primary responsibility for regulating the liquor traffic. But the federal government retained an important role, as demonstrated by the following list of its more significant activities in the field of alcoholic beverage control: licensing those (except brewers) who produce, sell at wholesale. rectify, blend, bottle or import alcoholic beverages, and conditioning the licence on observance of all federal laws relating to alcoholic beverages; imposing detailed requirements concerning the construction and equipment of plants in which alcoholic beverages are produced, stored. bottled or rectified: supervising and inspecting the operation of those plants; regulating the labelling and advertising of alcoholic beverages in interstate commerce: prohibiting unfair trade practices involving exclusive outlets. "tied houses." commercial bribery and consignment sales; restricting bulk sales; regulating bottle manufacturers and bottle sizes; requiring reports concerning materials used in the manufacture of distilled spirits; levying and collecting taxes; and prohibiting the transportation and importation of alcoholic beverages into states in violation of state laws. The federal liquor control agency is the alcohol and tobacco tax division of the internal revenue service of the department of the treasury. The administration of the division is decentralized into geographical regions.

h'otwithstanding the extent and significance of federal regulation, liquor control is essentially a state problem. There were in the mid-1950s three general systems of state control: (1) statewide prohibition (Mississippi and Oklahoma); (2) state monopoly, *i.e.*, state-owned stores for the sale of alcoholic beverages (Alabama, Idaho, Iowa, Maine, Michigan, Montana, New Hampshire, North Carolina, Ohio. Oregon, Pennsylvania, Utah, Vermont, Virginia, Washington, West Virginia and Wyoming; (3) licensing of those engaged in the liquor traffic (all of the rest of the states and the District of Columbia). This classification is accurate only in the roughest sense, because. (1) In approximately three-fourths of the states there are provisions for local option which permit voters of a particular subdivision of the state to prohibit the sale of certain kinds of alcoholic beverages in the subdivision; the Distilled Spirits institute estimated that on Jan. 1, 1954, approximately 24,000,000 people, including those in Mississippi and Oklahoma, resided in areas which prohibited the sale of distilled spirits. (2) In both the prohibition and monopoly groups there are states which license certain classes of retail outlets. Thus the "dry" states of Mississippi and Oklahoma respectively license the sale of beverages which contain not more than 4% and 3.2% of alcohol by weight; the "monopoly" in Wyoming extends only to wholesale sales; other monopoly states limit their operations to package sales for off-premise consumption, while licensing other types of retail sales.

Despite the monopoly experiment in a number of states, the dominant mechanism of post-repeal liquor control in the states was licensing private trade.

Prior to national prohibition, administration of alcoholic beverage control legislation generally was vested in local officials, with results that were not always wholesome. At repeal, persuasive voices urged the desirability of a single state licensing board. A few states followed that recommendation and gave a state agency exclusive control; at the other extreme, some states resurrected the system of local control; but the majority of states licensing the sale of alcoholic beverages provided for local and state participation in the licensing process. In the latter group there were wide variations in the degree of responsibility allocated to local and state officials. An additional complicating factor was the circumstance that a number of states provided for a de novo judicial review of licensing determinations. These provisions caused duplication, diffused the licensing responsibility, hindered uniform application of licensing standards and tended to put the judiciary into politics.

The evils of the saloon were in large part responsible for adoption of national prohibition, and the resolve to prevent revival of the saloon explained many features of post-repeal licensing statutes. Thus, although before prohibition the saloon licence usually authorized sales of all kinds of alcoholic beverages for both on-premises and off-premises consumption, post-repeal statutes generally required separate licences for different kinds of beverages and provided for sales by the package for off-premises consumption or for sales by the glass for on-premises consumption. Some states restricted sales of spirituous liquors to hotels, restaurants and clubs. Approximately two-thirds of the regulatory statutes provided for limitation of the number of licences issued; about half of these directed licensing authorities to take into consideration factors such as public convenience and advantage, reasonable public demand or the public interest; the remainder prohibited issuance of new licences when the ratio of existing licences exceeds a stated proportion of licences to population. Other measures designed to prevent recurrence of evils associated with the pre-prohibition saloon included limiting hours of sales, requiring that the premises be visible from the outside, prohibiting sales to minors, habitual drunkards and other interdicted persons, banning deceptive acts or those tending to induce the purchase or consumption of alcoholic beverages (such as sales on credit), regulating advertising, forbidding interlocking relationships between manufacturers. wholesalers and retailers, granting licences only to citizens of good repute and moral character not convicted of a felony or of violating state or federal alcoholic beverage control laws.

(See also PROHIBITION.)

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(CK. B.)

LIRA (plural LIRE), equal to 100 centesimi, the monetary unit of Italy.

The lira has its origin in the monetary system introduced in Europe by Charlemagne, who based it on the pound *(libra)* of silver. No lira coins were struck during the middle ages and the lira remained strictly a money of account. By the 16th century several of the Italian states actually struck lira coins which varied considerably, however, in weight. One of the states which used the lira as its monetary unit was the kingdom of Sardinia, and this currency was adopted in all of Italy when it became unified under Sardinian leadership.

In 1862 the lira. which up to then had been divided into 20 solidi, was redefined and the decimal system was introduced. In 1866 Sardinia joined the Latin Monetary union and the value of the lira became equal to the French. Swiss and Belgian francs. Because of the wars of unification Italy had great difficulties in maintaining the value of the lira at par with that of the other currencies of the Latin Monetary union. There were periods of payments restriction, regulated exchanges and other measures infringing upon the freedom of money markets. Budget reforms in the 1880s and a banking reform in 1894, as well as the general improvement in the world economic situation after 1896, contributed to a stabilization of Italy's international accounts around the turn of the century and from 1903 to 1914 the lira showed stability and strength.

As in most other European countries, World War I wrought havoc with the Italian currency, and the effect of World War II was as disastrous. With the devaluation of the pound in Sept. 1949, the Italian dollar exchange was also affected, and the lira fell from 575 to $1 to 628 to $1. In the latter 1950s the exchange rate was 62j lire to U.S. $1. (B. F. H.)

LIRI or GARIGLIANO, a river of central Italy (anc. Liris), which rises at Cappadocia. 7 mi. W. of Avezzano, and traverses a beautiful valley between lofty mountains, followed by the railway from Avezzano to Roccasecca. At Isola del Liri are two fine waterfalls.

Below Ceprano, the ancient Fregellae. after it has issued from the mountains, the Liri is joined by the Sacco (anc. Trerus) formed by the union of several torrents between Palestrina and Segni, and the Melfa from the mountains northeast of Atina, and runs through a broader valley. It then turns through the mountains southwest of the Via Latina and falls into the sea just below Minturno, after a course of 104 mi.

LISA, MANUEL (1772–1820), pioneer Missouri river fur trader, was born in New Orleans on Sept. 8, 1772. The son of Christopher de Lisa, a native of Spain, he entered the fur trade at St. Louis at an early age and soon became one of the leading traders on the upper Mississippi. A monopoly of the trade with the Osage Indians (granted to him by the Spanish government in 1802) ended with the transfer of the upper portion of the Louisiana territory to the U.S. in 1804.

Lisa became associated with a number of successful fur companies, including the St. Louis Missouri Fur company, of which William Clark of the famous Lewis and Clark expedition was resident agent. Lisa himself led a number of expeditions and in 1807 established a trading post at the mouth of the Big Horn river. The following year he built Ft. Raymond there for trade with the Crow Indians. It was later known as Ft. Manuel, and was the first such outpost in the area.

Ft. Manuel was abandoned in 1811. In a famous race that year the river barge of a party led by Lisa overtook, at the Niobrara river, a group of boats sent out by the John Jacob Astor interests. Near what later became the site of Omaha, Lisa established Ft. Lisa, which from 1813 to 1822 was the most important post on the Missouri, controlling trade with the Omaha, Pawnee, Otoe and other neighbouring Indians.

In 1814 William Clark, who had left the fur company and become governor of the Missouri territory, appointed Lisa subagent for the Indian tribes on the Missouri above the mouth of the Kansas river.

Lisa died at St. Louis on Aug. 12, 1820.

LISBON (LISBOA), the capital and chief port of Portugal, stands at the westernmost point of Europe, on the right bank of the Tagus (Tejo), near its entrance to the sea. Built on the slopes of a range of small hills above the river's mouth and estuary (the former a channel two miles wide and eight miles long, and the latter a bay two miles long and seven miles broad), the city is one of the most spectacular in Europe, rivaling Naples and Istanbul in its wide views, the distinctive silhouette of its buildings and its enclosed situation. Round its tiled and multicoloured buildings is a belt of vines, parks, gardens and woods, broken by villas, cottages and farms. The entrance to the fine natural harbour is protected by coastal defenses along the river mouth and on the hills behind. The climate. at its best in the autumn. is temperate (average annual temperature 60° F., average rainfall 29.45 in.). Pop. (1960) 818,382.

ROGER COSIER FROM MONKMEYER

THE ALFAMA, THE OLDEST PART OF LISBON, HAS NARROW AND WINDING STREETS

Its position as the centre of government gives Lisbon the movement and vitality of a great capital. There is, however, a difference in character between its different districts. The oldest part of the city is the Xlfama. or eastern district. where narrow, winding streets crowd down to the river between a jumble of houses. Above them towers the castle, Moorish in origin, but named after St. George to commemorate the Anglo-Portuguese alliance (1386). In this area is the Sé, the Roman-Gothic cathedral, built in 1147 and partially destroyed by the earthquakes of 1344 and 17jj. It contains the tomb of St. Vincent, who was accompanied in his search for the "Sacred Headland" by two legendary ravens which form part of the city's coat of arms. The nearby monastery of São Vicente, rebuilt at the end of the 16th century by Filipe Terzi, contains the pantheon of the Portuguese kings. Other notable buildings in this area are the church of S. Antonio, near the Se, built in honour of St. Anthony of Lisbon; the 1jth-century ruined palace, Casa dos Bicos; the remains of the Moorish walls; and the façade of the Conceicao (formerly Misericordia) church. Each hill of the line running to the north is crowned by a church or monastery, and on the slopes of São Gens is the district of the Mouraria, the old quarters of the converted Saracens.

The central district of Lisbon is the Baixa, which was built after the earthquake of 1755 and stretches from the river bank to the old outskirts in the north. The streets are broad. geometrically aligned and broken by spacious squares, of which the most central is the Terreiro do Paço with its fine equestrian statue (1775) of King Joseph I, which gives the square its English name—Black Horse square. This square, which was planned by the marquis de Pombal as the official entrance to the town, is approached through a triumphal arch. In Rossio square, the converging point of Lisbon's traffic, are two decorative fountains and the beautiful Dona Maria II theatre. This square is also famous for its black and white mosaic, 100 yd. wide. The Baixa is still the centre of Lisbon's commercial life. and in it are concentrated most of the public services.

To the west extend a number of districts, each possessing its own distinctive character, reflecting the epoch in which it was built.

The most modern part of the town lies to the north. The expansion of Lisbon in this direction, begun at the end of the 18th century, took on a new impetus when the parts known as the Avenidas Novas were planned after the opening of the Avenida da Liberdade, Lisbon's most famous avenue, in 1880. Forty years later, another great expansion took place, and entirely new districts were urbanized, absorbing the small villages on the fringe of the town. The transference of various public offices there relieved traffic congestion in the Baixa; there are also such modern buildings as the airport, sports stadiums, hospitals, schools, etc.

Despite the destruction of the great earthquake of 1755, Lisbon still has many notable old buildings. Besides those already mentioned in the Alfama district are the Carmo church. an old 14th-century convent, with crossed arches open to the sky; the Estrela Basilica, built at the request of Queen Maria I, the towers and dome of which are visible from all points; the bold Águas Livres aqueduct, built in the time of John V, which brings water from the reservoir north of the town to supply the public fountains, drinking troughs and domestic services; the 15th-century Jerónimos church, built to commemorate the discovery of the sea route to India; and the Tower of Belem, built at the same time, which stands like a sentinel at the mouth of the Tagus and forms part of Lisbon's coat of arms. The national assembly sits in an old 16th-century Benedictine convent; the same building houses the collection of national archives, called: after its original home, the Torre do Tombo collection. There are two notable palaces, the Ajuda, a richly furnished early 19th-century building, and the palace of Belem at the foot of the Ajuda slopes, the residence of the president.

There are many signs of the close bonds between Portugal and the British Isles—the English have always been the largest foreign colony after the Spaniards, and in former days there was a private quay for English ships. The Corpo Santo monastery was founded in the 17th century by Irish Dominicans; there is a Presbyterian church, an English college, and in the English cemetery, founded in 1717 and planted with cypresses, are buried Henry Fielding, the novelist, and Philip Doddridge, the Nonconformist divine.

Many of Lisbon's 18th-century squares contain statues, of which, besides the statue of Joseph I, already mentioned, the most notable are the Obelisco dos Restauradores, commemorating the campaign which freed Portugal from Spain; the monument to King Peter IV. who gave the country its constitutional charter, in Rossio square; and the monument to the marquis de Pombal in the square that bears his name.

As well as the squares. which give a spacious feeling to the central district, there are several parks and gardens. At the northern end of the Avenida da Liberdade is the Parque Eduardo VII, so-called to commemorate Edward VII's visit to the city. Others are the Parque Florestal at Monsanto, planted since the 1920s to protect the town from the prevailing wind; the Campo Grande, a big wooded promenade to the north; the botanical garden at Ajuda; and the zoological garden in the Parque das Larangeiros.

One of the most interesting of many museums is the Museu dos Coches, in the old royal riding school, which possesses an unrivaled collection of state carriages, coaches, two-wheeled chaises and 17th-, 18th- and 19th-century sedan chairs. Others include those for ancient and modern art, archaeology, ethnology and military objects. There are two municipal museums also.

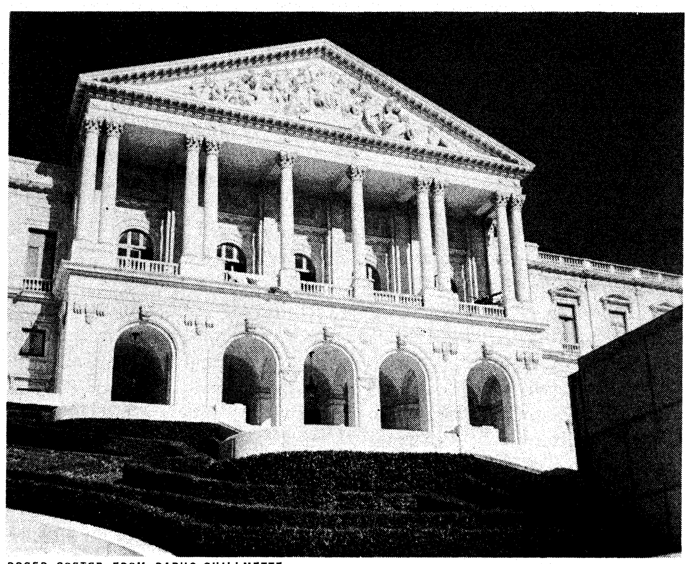
The university was re-established in Lisbon in 1911 and a technical university was founded in 1930.

The surroundings of Lisbon form part of its charm. On both banks of the Tagus are noble country houses set in beautiful gardens. On the north bank, apart from Sintra (*q.v.*), is the 18th-century palace of Queluz, built by a French and a Portuguese architect in the style of a French chhteau. On the opposite bank is the 16th-century Bacalhoa, famous for its azure tiles. The coastal strip north of the Tagus from Algés to the south of Cape Roca is known as the "Portuguese Riviera" and attracts many visitors. Its centre is Estoril.

Communications, Trade and Industries. — Lisbon has four railway stations; communication with its outlying districts is by electric train. Within the city four escalators facilitate transportation in the most hilly districts. Between the two banks of the river, which are lined with landing stages, docks and warehouses, there is a constant service of launches and ferries.

Its position at the westernmost point of Europe has made Lisbon an important port of call. Its airport, Portela de Sacavem, 63 mi. outside the town, is an intersection point for many world airlines; its estuary and fine natural harbour give anchorage for naval vessels as well as for liners and cargo boats; and it is connected by road and railway with the great European capitals, as well as with the Portuguese hinterland. It is an important transshipping and entrepôt centre, handling about 60% of Portugal's foreign trade. Its exports are chiefly agricultural and forestry produce (olive oil, wine, fruit, cork, timber) and tinned fish (sardines in particular). The chief imports are coal, raw cotton, mineral oil and cereals. The city's industries include the making of chemicals, textiles, soap, pottery and paper, sugar refining, flour milling and ship repairing.

History. — The origin of Lisbon is clouded by a number of fantastic legends. The derivation of its name from the word *Olisipo* gave rise to the story that it had been founded by Ulysses: it may actually have been Phoenician in origin. During the Roman domination (205 B.C. to the 4th century A.D.) it was elevated to the dignity of a *municipium* by Julius Caesar, and called *Felicitas Julia.* Occupied by the Alani (Alans), the Suebi (Suevi) and the Visigoths in the jth century, it was captured by the Moors at the beginning of the 8th century and called by them Lixbuna, a name derived from an old *citania* or Roman castle on the summit of the hill on which stands the Castel de S. Jorge. Few traces remain of these successive dominations: some stones recall the famous Roman theatres, temples and baths; there are traces of the primitive fortifications of the Visigoths as they were modified by later invaders; and of the Moorish domination little is to be seen except the nucleus of the castle and traces of agricultural customs and methods in the surrounding countryside. The city was invaded twice during the Moorish domination — by the Normans in 844 and by Alphonso VI of Leon in 1093 — and in 1147 was captured for Christendom by Afonso Henrigues, after a siege lasting several months: in which he was helped by a Christian crusade including Normans. Flemish and English. In 1256 Afonso III transferred the seat of his government and court to Lisbon from Coimbra. The town, which had 15,000 inhabitants at the time of the conquest, doubled its population and extended westward. King Diniz (Denis) founded the university in 1290 (it was transferred to Coimbra in 1537), and after the town had been besieged, devastated and burned by the Castillians in 1375, it was further strengthened by additional defenses which enabled it to withstand the second Castillian invasion in 1384.



ROGER COSTER FROM RAPHO-GUILLMETTE

PALACIO DAS CORTES AT LISBON. WHERE THE NATIONAL ASSEMBLY SITS, WAS IN THE 16TH CENTURY A BENEDICTINE CONVENT AND BECAME A GOVERNMENT BUILDING IN 1834

In 1390 Lisbon was made an archbishopric, and in the following centuries its importance grew with the opening of the sea route to India, the discovery of Brazil and the widespread voyages of Portuguese mariners. It became a great commercial port and the centre for the distribution of the riches of the Spanish overseas empire from 1580 to 1640. It was from Lisbon that the Spanish Armada sailed in 1588. The city's political importance was diminished during the union of the Castilian and Portuguese monarchies, but it regained its old splendour under John V.

Because it is built on rocks of tertiary formation, Lisbon has always been subject to earthquakes, those of the 15th and 16th centuries being notably destructive. In Nov. 1755 it suffered its severest shock; a great part of the town was destroyed and about 40,000 people were killed. The tremor was felt throughout Europe and much valuable aid was received, especially from England, Portugal's oldest ally. It was reconstructed by engineer-architects under the direction of the marquis de Pombal, who can be said to have created a new town based on internationally accepted principles but with a markedly Portuguese style.

During the late 18th and early 19th centuries, political events prevented Lisbon's progress. The three invasions by Napoleon's troops and the subsequent Peninsular War, in which the two rival factions at court struggled for possession of the throne, so disturbed Lisbon's life that it took a long time to settle down. In the 20th century there was considerable development, and during World Wars I and II Lisbon was able to offer refuge to about 200,000 foreigners. (G. DE. M. S.)

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LISBURN, a market town and urban district of County Antrim, N.Ire., on the Lagan river, 8 mi. S.S.W. of Belfast by road. Pop. (1961) 15,691.

Lisburn is the cathedral city of the diocese of Down and Connor. The cathedral. with its conspicuous spire, was built in 1623 in "Plantation Gothic" style. The English author. Jeremy Taylor, was bishop of Lisburn from 1661 until his death in 1667. In 1627 the town was granted by Charles I to Viscount Conway who built the castle and introduced English and Welsh settlers. The castle was besieged in 1641 during the Irish wars and accidentally burned down, along with the rest of the town, in 1707 and the grounds are now a public park. The district was the scene of further warfare when Cromwell's forces occupied it from 1649, and the town served as winter quarters for the duke of Schomberg's army in 1689 before the Boyne campaign. The town and district of Lisburn became the centre of the Ulster linen industry when William III invited Louis Crommelin and other French Huguenot refugees to settle there and establish it. Flax spinning and linen manufactures are still carried on in Lisburn, and at Lambeg, 1½ mi. toward Belfast, is a linen-bleaching centre and the Linen Research institute. Furniture is made at Lisburn and carpets at Finaghy nearby.

The ruins of Castle Robin, 3 mi. N. of the town, stand on the slopes of White mountain; the building dates from the time of Queen Elizabeth I. Lisnagarvey Broadcasting station, the Northern Ireland transmitter of the British Broadcasting corporation, is on Blaris moor, 2 mi. S. of Lisburn.

LISIEUX, a town of northwestern France, capital of an *arrondissement* in the *département* of Calvados, lies in the valley of the Touques, 30 mi. E. of Caen by rail. Pop. (1954) 14,511. In the time of Julius Caesar, Lisieux, under the name of Noviomagus, was the capital of the Lexovii.

Though destroyed by the barbarians, by the 6th century it had become one of the most important towns of Neustria. Its bishopric, suppressed in 1802, dated from that period. In 911 it was included in the duchy of Normandy by the treaty of St. Clair-sur-Epte. Civil authority was exercised by the bishop as count of the town.

In 1136 Geoffrey Plantagenet laid siege to Lisieux, which had taken the side of Stephen of Blois; it fell in 1141. In 1152 the marriage of Henry II of England to Eleanor of Guienne was celebrated in the cathedral. Thomas à Becket took refuge there, and some vestments used by him are shown in the hospital chapel. Taken by Philip Augustus and reunited to France in 1203, the town was a frequent subject of dispute during the Hundred Years' War, the religious wars and those of the League.

Being an important road junction, Lisieux was a target for Allied bombs in World War II, two-thirds of the city being destroyed in June 1944. It was rebuilt on modern lines. Sixteenth-century towers are all that remain of the old fortifications. Most of the ancient Norman houses, formerly a feature of the town, were burned down.

Of the church of St. Jacques (late 15th century), which contained Renaissance glass and old stalls and frescoes, only the walls were left.

St. Peter's cathedral (12th–16th century), the oldest Gothic church in Xormandy, contemporary with those of Canterbury and Sens, is still standing, with its lantern tower over the crossing, and the two towers surmounting the west façade. The old episcopal palace, now used for civil purposes, contains a beautiful hall (the salle *dorée*). Most of the manufacturing industries—brewing, tanning, machinery and condensed milk manufacture—have been moved out of town. Yet trade in grain! cattle, butter, cheese and apples, is still carried on. Lisieux has become a centre of pilgrimages to Ste. Thérèse, the Little Flower, a young Carmelite who died in 1897 and was canonized in 1925. The Basilique, a massive building in the Romano-Byzantine style, dedicated to her, was consecrated by Pope Pius XII, then nuncio to France, in 1937. (C. Pn.)

LISKEARD, a market town and municipal borough of Cornwall, Eng., 13 mi. E. of Bodmin by road, in the Bodmin parliamentary division. Pop. (1951) 4,391. Area 4.2 sq.mi.

Liskeard stands 6 mi. from the sea on high (400 ft.) ground between the deep wooded valleys of the East Looe and Seaton rivers. The name (*Ilys* caer) indicates that in Celtic times it was a seat of jurisdiction and was fortified. Ruins of a castle nere still visible in the 16th century. William the Conqueror gave the manor to Robert of Mortain, from whom it passed to the earls of Cornwall. Liskeard was the centre of the Cornish kings, the last of whom, King Doniert (d. *c.* goo), lived there. In 1240 it was created a free borough by Richard, earl of Cornwall, king of the Romans, who vested in the burgesses nearly al! the rights of a corporate town. The corporation in its modern form dates from 1 j86.

Liskeard was one of the four Cornish tin-mining towns. An agricultural town, Liskeard became known for its cattle fairs held every Monday and the great annual fair of St. Matthew held on Oct. 2. The public library acquired the Leonard Courtney collection of rare Cornish books.

LISLE, ALICE (*c.* 1614–1685) commonly known as Lady Alice Lisle: was born about 1614. In 1630 she married John Lisle (d. 1644), who was one of the judges at the trial of Charles I, and became a member of Cromwell's house of lords. for which reason she acquired her courtesy title. After her husband's death, Lady Alice lived at Moyles court, near Ringwood. Although of royalist leanings, she showed sympathy with the dissenting ministers under the persecutions they suffered during the reign of Charles II.

On July 20, 1685, a fortnight after the battle of Sedgemoor, the elderly Lady Alice agreed to shelter John Hickes, a well-known Konconformist minister, at Moyles court. Hickes, a fugitive from Monmouth's army, brought with him Richard Nelthorpe, also a partisan of Monmouth, and under sentence of outlatvry. The two men passed the night in the house. On the following morning they were arrested, and their hostess, who had denied their presence in the house, was charged with harbouring traitors.

Her case was tried by Judge Jeffreys at the opening of the "Bloody Assizes" at Winchester. She pleaded that she had no knowledge that Hickes's offense was anything more serious than illegal preaching, that she had known nothing previously of Nelthorpe (whose name was not included in the indictment, but was, nevertheless, mentioned to strengthen the case for the crown) and that she had no sympathy with the rebellion. The jury reluctantly found her guilty and, the law recognizing no distinction between principals and accessories in treason, she was sentenced to be burned. James II allowed beheading to be substituted for burning. Jeffreys ordered that the sentence should be carried out that same afternoon, but a few days' respite was granted and she u-as executed in Winchester market place on Sept. 2, 1685.

By many her death was regarded as a judicial murder, and one of the first acts of the parliament of William and Mary reversed the attainder on the ground that the prosecution was irregular and the verdict injuriously extorted by "the menaces and violences and other illegal practices" of Jeffreys.

See Cobbett's Complete Collection of State Trials, compiled *by T.* B. Howell, 33 vol. (London, 1809–26).

LISMORE, an island in the entrance to Loch Linnhe, Argyllshire, Scot., 5 mi. N.W. of Oban, 94 mi. long and 1¾ mi. broad. Pop. (1951) 191. It divides the lower end of the loch into two channels, the Lynn of Morvern on the west and the Lynn of Lorne on the east.

The name is derived from the Gaelic *lios mòr,* "great garden," from the fertility of the soil. The shallow limestone lochs have an extremely rich flora. Several ruined castles stand on the coast, and the highest point is 500 ft. Steamers call at Achnacroish, and there is a ferry to Port Appin. A Columban monastery was founded in Lismore by St. Moluag about 592. About 1200 the see of Argyll was separated from Dunkeld by Bishop John, "the Englishman," and Lismore soon afterward became the seat of the bishop of Argyll. The small cathedral has been restored, and is used as the parish church.

The Rev. John Macaulay, grandfather of Lord Macaulay, and the Rev. Donald M'Nicol (1735–1802), who took up the defense of the Highlands against Samuel Johnson, were ministers of Lismore.

LISMORE, a town in the northeast of New South Wales, Austr., situated on the Richmond river (*q.v.*), 6j mi. from its mouth at Ballina and 22 mi. from the same town by road. Coal occurs in the neighbourhood and the timber reserves were formerly largely exploited. Lismore is the centre of the chief dairy district of the state (average annual temperature: 76°–57.6° F.; average annual rainfall: 52.37 in.), with butter factories which export to the United Kingdom. The growing of sugar cane, after a decline, has recovered ground.

The town is well built. lies on the main North Coast railway (Sydney and Brisbane), has connections by motor coach with the northern highlands (Tenterfield, etc.) and with Brisbane, and, by river steamer, with Ballina and the sea (coastal trade). Pop. (1947), 15,214.

LISMORE, a little market town and furmer seat of a diocese in Co. Waterford, Ireland. 43 mi. W.S.W. of Waterford by rail. Pop. (1951) 1,089. It is situated on a hill rising steeply from the Blackwater.

The original name of Lismore was Maghsciath. A monastery founded there by St. Carthagh in 633 became celebrated as a seat of learning. The bishopric, said to have originated with this foundation, was united to that of Waterford in 1363. In the 9th and beginning of the 10th centuries the town was repeatedly plundered by the Danes, and in 978 the town and abbey were burned by the men of Ossory. Henry II received in Lismore castle the allegiance of the archbishops and bishops of Ireland. In 1581 the manor was granted to Sir Walter Raleigh. The Roman Catholic bishop of Waterford and Lismore has his seat in Waterford city. The Protestant dioceses of Waterford and Lismore were united in 1833 with those of Cashel and Emly, and the bishop of these united sees has his seat in Waterford.

The baronial castle, erected by King John in 1185, was the residence of the bishops till the 14th century. It was besieged in 1641 and 1643, and in 1645 it was partly destroyed by fire. On the summit of the height is the cathedral of St. Carthagh mostly of the 17th century, with portions probably of the 12th and 13th and considerable additions in the 19th. There is some river trade and the town is the centre of a salmon fishery district.

LISSA (Serbo-Croatian Vis; Lat. Issa), an island in the Adriatic sea belonging to Yugoslavia and occupied by Italy in World War I Lissa lies 31 mi. S. by W. of Spalato, and is the outermost island of the Dalmatian archipelago. Its greatest length is $10\frac{1}{2}$ mi.; its greatest breadth $4\frac{1}{2}$ mi. In shape it is long, as are most of the islands on this longitudinal coastline. The central plain is fertile. Its culminating point is Mount Hum (1,942 ft.), on the southwest. Lissa, the capital. contains the palace of the old Venetian counts Gariboldi, the former residence of the English governor, the monastery of the Minorites and at a little distance to the west the ruins of the ancient city of Issa.

Lissa is said to have been settled by people from Lesbos, the Issa of the Aegean. The Parians, assisted by Dionysius the Elder of Syracuse, introduced a colony in the 4th century B.C. During the First Punic War (265–241 B.C.) the Issaeans with their beaked ships helped the Roman Duilius; and the great republic, having defended their island against the attacks of Agron of Illyria and his queen Teuta, again found them serviceable allies in the war with Philip of Macedon (*c.* 215–211). As early as 996 the Venetians ruled the island, and, though they retired for a time: before the Ragusans, their power was effectually established in 1278. Velo Selo, then the chief settlement, was destroyed by Ferdinand of Naples in 1483 and by the Turks in 1571. The present city arose shortly afterward. During the Napoleonic wars, the French held Lissa until 1811, and during this period the island prospered greatly, its population increasing from 4,000 to 12,000 between 1808 and 1811. In the latter year the French squadron was defeated by the British (see below). In 1812 the British established an administrative system, under native officials, in Lissa and the adjoining islands of Curzola and Lagosta. All three were ceded to Austria in 181j. The islanders gain their livelihood by viticulture, for which Issa was once famous, by sardine fishing and by the distillation of rosemary oil. Pop, about 10,100. After World War I Lissa passed to Yugoslavia.

Battles of Lisa.—Two naval actions have been fought in modern times near this island. The first took place on the 13th of March 1811, and was fought between a Franco-Venetian squadron, under the command of an officer named Dubourdieu (of whom little or nothing else is known), and Captain (afterward Sir) William Hoste with a small British force. The Franco-Venetian squadron (Venice was then part of the dominions of the emperor Napoleon) consisted of six frigates, of which four were of forty guns, and of five corvettes or small craft. The British squadron was composed of three frigates, the "Amphion." 32 (Capt. William Hoste), the "Cerberus" (Capt. Henry Whitby) and the "Active," 38 (Capt James A. Gordon). With them was the "Volage," 22 (Capt. Phipps Hornby). The action has a peculiar interest because the French captain imitated the method of attack employed by Nelson at Trafalgar. He came down from windward in two lines parallel to one another, and at an angle to the British squadron. Captain Hoste was not compelled to lie still as the allies did at Trafalgar. He stood on, and as the two French lines had to overtake him as he slipped away at an angle to their course, one of them got in the way of the other. Captain Hoste materially forwarded the success of his manoeuvre by leading the foremost French ship, the "Favorite," 40, on to a reef, which was known to himself, but not to the enemy. Both squadrons then turned, and the Franco-Venetians falling into great confusion mere defeated in spite of the gallant fighting of the individual ships. Two prizes were taken and Dubourdieu was killed.

The second naval battle of Lissa was fought between the Austrian and Italian navies on the 20th of July 1866. The island, then in possession of the Austrians, was attacked by an Italian squadron from Ancona of 12 ironclads and 22 wooden vessels. One of the ironclads was damaged in a bombardment of the forts. and two were detached on other service, when an Austrian squadron of 7 ironclads, one unarmoured warship the "Kaiser" and a number of small craft which had left Fasano under the command of Admiral Tegethoff came to interrupt their operations. The Italian admiral Persano arranged his ships in a single long line ahead, which allowing for the necessary space between them meant that the Italian formation stretched for more than 2 mi. Just before the action began Admiral Persano shifted his flag from the "Re d'Italia." the fourth ship in order from the van, to the ram "Affondatore," the fifth. This made it necessary for the "Affondatore" and the ships astern to shorten speed, and, as the leading vessels stood on, a gap was created in the Italian line. Admiral Tegethoff, who was on the port bow of the Italians, attacked with his squadron in three divisions formed in obtuse angles. The Italians opened a very rapid and ill-directed fire at a distance of 1,000 yds. The Austrians did not reply till they were at a distance of 300 yds. Under Tegethoff's vigorous leadership, and aided by the disorder in the Italian line, the Austrians brought on a brief, but to the Italians destructive, mêlée. They broke through an interval between the third and fourth Italian ships. The unarmed Austrian ships headed to attack the unarmed Italians in the rear. At this point an incident occurred to which an exaggerated importance was given. The Italian ironclad "Re di Portogallo" of 5,600 tons, in the rear of the line, stood out to cover the unarmoured squadron by ramming the Austrians, She was herself rammed by the wooden "Kaiser" (5,000 tons), but received little injury, while the Austrian was much injured. The "Kaiser" and the wooden vessels then made for the protection of Fort San Giorgio on Lissa unpursued. In the centre, where the action was hottest, the Austrian flagship "Ferdinand Max" of 5,200 tons rammed and sank the "Re d'Italia." The Italian "Palestro" of 2,000 tons was fired by a shell and blew up. By midday the Italians were in retreat, and Tegethoff anchored at San Giorgio. His squadron had suffered very little from the wild fire of the Italians. The battle of July 20 was the first fought at sea by modern ironclad steam fleets, and therefore. attracted a great deal of attention. The sinking of the "Re d'Italia" and the ramming of the "Portogallo" by the "Kaiser" gave an immense impulse to the then popular theory that the ram would be a leading, if not the principal, weapon in modern sea warfare. This calculation has not been borne out by more recent experience, and indeed was not justified by the battle itself, in which the attempts to ram were many and the successes very few. The "Re d'Italia" was struck only because she was suddenly and most injudiciously backed, so that she had no way on when charged by the "Ferdinand Max."

For the first battle of Lissa see James's *Naval History,* vol. v (1837). A clear account of the second battle will be found in Sir S.

Eardley-Wilmot's *Development* of *Navies* (London, 1892); *see* also H. W. Wilson's *Ironclads in Action* (London, 1896). (D. H.)

LISSITZKY, EL (ELIEZER) (1890–1941j, Russian abstract painter. designer and architect, was born in Smolensk, on Nov. 10, 1890. He studied engineering at Darmstadt, Ger., and returned to Russia in 1919, where he painted his first constructivist composition, "Proun No. 1." Chagall then appointed Lissitzky as a teacher of art in Vitebsk. In 1921 he became professor at the state art school in Moscow, but left Russia at the end of the year when the Soviet government turned against modern art. He went to Germany first and later to Switzerland. Between 192j and 1928 Lissitzky lived in Hanover and on request of the Landesmuseum (directed by Alexander Dorner) designed an "abstract gallery" (destroyed 19363 on entirely original principles. In the U.S. Lissitzky exhibited first in 1924 at the Société Anonyme. He was co-founder of a number of periodicals propagating the most progressive tendencies of the 1920s. In the winter of 1928–29 he returned to Moscow, where he executed his advanced constructivist ideas in official soviet exhibitions and publications for abroad. Lissitzky died in 1941. His experiments in spatial constructions led him to devise new techniques in exhibiting, printing, photomontage and architecture, which have been of considerable influence in western Europe.

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LI SSU (280?–208 B.C.), Chinese statesman; devoted a lifetime to the task of welding the warring Chinese states of his time into a single centralized bureaucratic empire, applying for this purpose the efficient but ruthless ideas of the totalitarian political philosophy known as Legalism. As minister to the ruler of the state of Ch'in, he saw his goal realized when, in 221 B.C., that monarch completed his conquest of the other Chinese states and assumed the title of Shih Huang Ti, "First Sovereign Emperor."

Li was born a commoner in the state of Ch'u (at the present Shang-ts'ai, southeastern Honan), studied under the Confucian philosopher Hsiin-Tzu (*q.v.*), and then (247) entered Ch'in to begin almost 40 years of service under the later first emperor. For most of the radical political and cultural innovations made in the Ch'in empire after 221 (for which *see* SHIH HUANG TI), Li, rather than the first emperor, was primarily responsible. Most spectacular (but not most significant) was the "burning of the books" of 213, for which Li has been execrated by later scholars.

Following the first emperor's death in 210, Li became involved in the plot of the eunuch Chao Kao to void the proper succession. In 208 this eunuch turned on Li himself and had him executed at a time when the Ch'in empire was already disintegrating as the result of rebellion. Despite this tragic end to Li and his work he set a lasting imprint on Chinese history in a way that few other men succeeded in doing.

See also CHINA: *History: The Ch'in Dynasty.*

See Derk Bodde, *China's First Unifier, a Study of the Ch'in Dynasty as Seen in the Life of Li Ssu* (1938); also other items listed under SHIH HUANG TI. (D. BE)

LIST, (GEORG) FRIEDRICH (1789–1846), German advocate of tariff protection to stimulate national industrial development. mas born in industrial Reutlingen. Württemberg, on Aug. 6. 1789. Largely a self-educated man. he advanced rapidly in government service. taught briefly at Tübingen university, then rose to prominence as founder and secretary of an association of middle- and south-German industrialists favouring abolition of the tariff barriers dividing the German states. Exiled to the U.S. in 1825 for his liberal viens. List encountered in Philadelphia the Hamiltonian view of national development, the "American System" of Henry Clay and the anti-Ricardianism of Henry Carey, After becoming a naturalized C.S. citizen he returned to Germany in 1832 as U.S consul at Leipzig. List professed a qualified version of his original position in favour of free trade. A national economy in an early state of industrialization requires tariff protection, List argued, and although protectionism entails the loss of certain immediate gains of foreign trade, this loss constitutes the equivalent of an "educational capital" invested in unfolding a nation's productive potentialities. List feared that entrepreneurs in long-established centres of industry would by unfair means of international competition prevent a young country's industrialization, thus: (1) preserving for the old countries not only markets but a flow of cheap raw materials as well; and (2) maintaining the old country's ability to accumulate capital at an accelerating rate. while retarding capital accumulation in underdeveloped areas of the world.

These persuasive arguments for tariff protection ignore the fact that honever politically divided might be the nations of western civilization, they were in List's time as they are now, the common heirs of a basic technology of mechanized production, transportation and communication. This commonalty of technology synchronized their mutual economic development more closely and more harmoniously than List supposed. By contrast, economic nationalism splinters the common market and decimates the common technology. Strident economic nationalism in backward areas (those without technology) so far from inducing a home-growth of capital, disrupts the inflow of needed capital equipment and technical personnel.

The works of List, principally the *National System of Political Economy* (1909; German original, 1841), have the residual value of exposihg at its roots the fallacy of generalizing into a plea for economic nationalism the occasionally relevant temporary policy of protecting "infant industries." List died by his own hand on Nov. 30, 1846, in Kufstein. Aus.

BIBLIOGRAPHY.—Margaret E. Hirst's *Life of Friedrich List* (1909) contains a bibliography and a reprint of List's *Outlines of American Political Economy* (1827); *see* also H. Ritschl, *Friedrich List: Leben und Lehre* (1947); C. Brinkmann, *Friedrich List* (1949). (G.W. Z.)

LISTA Y ARAGON, ALBERT0 (1775–1848), Spanish poet, critic and mathematician, was born in Triana, a suburb of Seville, Oct. 1j, 1775. As a youth he showed unusual mathematical talent, and at the age of 20 he was made professor of mathematics in a nautical college in Seville. He distinguished himself as a poet and critic and was appointed to the chair of rhetoric and poetry in the university of Seville in 1807.

During the French invasion he was exiled in France, where he remained for four years. Among his many published works were, *Lectures on the Dramatic Literature of Spain* and a *Treatise on Pure and Mixed Mathematics.*

He died on Oct. 15, 1848.

LISTED SECURITIES. The two principal subdivisions of the market for outstanding securities are the securities exchanges and the over-the-counter markets. Listed securities are those which are marketed through the facilities of the exchanges. All other securities are unlisted and are transferred in the over-the-counter markets.

Each securities exchange has its own set of listing requirements, those of the New York stock exchange being the most comprehensive. A company acquires a listed status by making formal application to the department of stock list of the exchange. The formal application, however, is usually preceded by preliminary discussions to discover any obstacles to listing. The company must submit its financial statements and must divulge information concerning its history and business, properties owned, management, capitalization, and business, financial and accounting policies. The company also shows on distribution forms the number of security holders and total number of shares held in each size bracket and also the ten highest holdings of the security. The exchange prefers a wide distribution of stock, with a minimum of 1,500 stockholders. The company must have substantial assets or demonstrated earning power. It must also sign certain listing agreements requiring it to make financial statements available to the public and to perform certain acts considered to be in the interests of security holders.

The application is passed upon first by the department of stock list and then by the board of governors of the exchange. If approved, the exchange certifies this fact to the Securities and Exchange commission. The company then files a registration statement with the commission. Normally registration becomes effective 30 days after receipt by the commission of the registration statement and the exchange certification, and trading in the security begins on the effective date.

On the American Stock exchange (formerly the New York Curb exchange) listed and unlisted issues are traded—an exception to the statement above that unlisted issues are traded only in the over-the-counter market. Before 1934 a member of the curb exchange could request the exchange to permit trading in an unlisted issue. This is in contrast to fully listed issues, application for which is made by the issuing company. After 1934 the Securities Exchange act virtually prevented additions of unlisted issues to the stock trading list, but trading in unlisted issues accepted before that date remained important. However, the New York stock exchange, where all issues are fully listed, is so important relative to the curb and other exchanges. that the total volume of trading in unlisted issues is small. In Jan. 1951, for example, securities sold on the New York stock exchange totalled 87% of the market value of security sales on all U.S. exchanges.

The American Stock exchange and other exchanges are less rigid in their requirements than is the stock exchange; they are more willing to list securities of companies in a developmental stage; and most have lower listing fees.

The London stock exchange publishes an official list of securities admitted to quotation. Companies whose securities are admitted to this list furnish about the same data as in listing on the New York stock exchange. Financial statements are especially emphasized. A complete record of price movements from day to day is published for securities on this list. There is also published a supplementary list of securities not officially quoted. These securities are of some public interest but the companies have not complied with the rules required for entry on the official list.

When a company's securities are well-known and widely distributed, it may be advantageous to list the security and thus attract the interest of investors who insist upon purchasing only listed securities. The company may find that the price-earnings and price-dividend ratios of outstanding securities are thus increased, and the cost of funds decreased when new issues are sold. On the other hand, listing often involves loss of interest on the part of over-the-counter dealers who have theretofore been making a market for the issue, with resultant decreases in price after listing has occurred.

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LISTER, JOSEPH JACKSON (1786–1869), English scientist and father of Joseph Lister, was born in London, Jan. 11, 1786. He became a wine merchant by trade, but his interest lay in lenses even as a child, and in 1824 he began the work on the compound microscope which was to be his chief contribution to science. In 1830, in a paper, "On the Improvement of Compound Microscopes," which he read before the Royal society, he made public the results of six years' work on the microscope. During that time he had discovered the principle of aplanatic foci, which enabled him to outline to W. Tulley, a noted optician, the methods for constructing a powerful achromatic microscope which mould transmit images with almost no distortion. It was distortion which had previously prevented the microscope from taking its proper place in scientific research.

In addition, Lister made important studies on mammalian blood and invented the photographer's tripod. He died in Upton, Essex, Oct. 24, 1869.

LISTER, JOSEPH LISTER, 1ST BARON (1827–1912). English surgeon and founder of antiseptic surgery, was born at Upton, Essex, on April 5, 1827. His father, Joseph Jackson Lister, F.R.S., became eminent in optical science by perfecting the achromatic lens and improving the compound microscope. Joseph Lister received his M.B. and F.R.C.S. at University college, London, in 1852, having been trained under the two noted physiologists, Wharton Jones and William Sharpey. In the autumn of 1853, Lister went to Edinburgh with an introduction from Sharpey to James Syme (*q.v.*) whose house surgeon he became. In 1856 he married Syme's daughter, and soon afterward was made assistant surgeon to the Royal infirmary, where he gave his first course of lectures on surgery. In the following year he produced his classic paper on "The Early Stages of Inflammation," an investigation in which his interest had already been roused by his contact with gangrene and pyaemia in University college hospital, London. About the same time, he began work on the coagulation of blood, a subject related to the early stages of inflammation.

On his appointment to the chair of surgery at Glasgow in 1860, Lister at first busied himself with his articles on amputation and on anaesthetics for Timothy Holmes' *A System of Surgery, Theoretical and Practical.* He then resumed his researches on inflammation, which took on a new meaning after his attention was drawn in 1865 to the work of Louis Pasteur. Pasteur (*q.v.*) had shown that putrefaction, like other fermentations, was due to microbes coming from the air. Lister at once saw that if putrefaction was caused neither by the spontaneous generation of germs nor by the oxygen in the air—two predominating theories of his day—there was some chance of preventing it. But how were the organisms in the air to be destroyed before they entered the wound? Of three possibilities, filtration, heat and chemical agents, he selected the last for experiment.

The first experiment was made in 1865 upon a compound fracture, the agent used being carbolic acid. It was applied to the wound undiluted, so as to form with the blood a dense crust. The results, after a first failure, were so satisfactory that Lister wrote his paper "On a New Method of Treating Compound Fracture, Abscess, etc.," for the *Lancet* between March and July 1867, and at the British association in Dublin, in the same year, spoke of the value of his methods. However, the caustic property of undiluted carbolic acid made it unsuited for general surgery. It was necessary to mitigate its action by blending it with some inert substance, and the endeavour to find this substance which would provide antiseptic efficiency with the least possible irritation of the tissues formed the subject of experiments continued for many years. Lister found most satisfactory a mixture of crystallized carbolic acid and shellac (lac plaster) which, when spread on calico and painted with a solution of gutta-percha in benzine, passed through the gutta-percha without adhering to the skin so firmly as to prevent drainage.

Lister now turned his attention to the arrest of haemorrhage in aseptic wounds. It had long been the practice to employ silk or flax for tying arteries, long ends being left to provide escape of the pus. Lister hoped that if, by antiseptic means, the thread were deprived of microbes, it would no longer cause suppuration, but might be left with short cut ends to become embedded permanently among the tissues of the wound. An extensive series of experiments led him to adopt ultimately a sulphochromic catgut.

In 1869 Lister succeeded his father-in-law, Syme, in the chair of clinical surgery of Edinburgh. There his chief accomplishments were his researches in bacteriology, his substitution of the dressings of absorbent gauze for the nonabsorbing lac plaster and his attempt to provide an atmosphere free from microbes by means of a spray of a 1–20 watery solution of carbolic acid. The irritating properties of this spray soon led to its abandonment and replacement by the principles of asepsis whereby bacterial infection was avoided by scrupulous cleanliness of operating room, instruments and personnel.

In 1877 Lister accepted the chair of surgery at King's college, London, which he held for 15 years. While there, the publication of Robert Koch's book on the aetiology of traumatic infectious diseases led him to experiment with various mercurial preparations as disinfectants. In 1896 he retired from practice, but not from scientific study. From 1895 to 1900 he was president of the Royal society, and in 1896 president of the British association. In 1883 he was created a baronet, and in 1897 was raised to the peerage as Baron Lister of Lyme Regis. Among the coronation honours in 1902, he was nominated an original member of the new Order of Merit. He died at Walmer, Kent, on Feb. 10, 1912. The best monument to Lister is the Lister Institute of Preventive Medicine, London—of which he was one of the founders at its inception as the British Institute of Preventive Medicine in 1891. It was modelled on the Pasteur institute in Paris. On the continent he was even more renowned, the German surgeons, especially Karl Thiersch and Richard von Volkmann, being the first to adopt his ligature technique and his aseptic treatment, which had greatly reduced the prevalent surgical pests—pyaemia, septicaemia, erysipelas and hospital gangrene. Among Lister's contributions to general surgery, R. J. Godlee *(see* below) mentions his new amputation through the condyles of the femur, his new operation for excision of the wrist joint and for carcinoma of the breast, his improved surgery of the bladder and urethra and his introduction of such instruments as the aortic tourniquet, the wire needle: the ear hook, the sinus forceps, the urethral bougies and the forceps for extracting stones from the prostatic urethra.

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LISTER, THOMAS HENRY (1800–1842), English author, was educated at Cambridge university. He held several minor government positions until 1836, when he was made the first registrar-general of births, deaths and marriages of England and Wales, the office having just been created. His best-known literary work was his novel *Granby* (1826), which was well thought of in the early 19th century. He was also the author of six other novels, *Herbert Lacy, Romance of Real Life, Flirtation, Yes and No, Arlington* and *Hulse House;* a play, *Epicharis;* and a biography, *The Life and Administration of Edward, First Earl of Clarendon, with Original Correspondence and Authentic Papers never before published.* He died June 5, 1842, at Knightsbridge.

LISU (LISAW, YAWYIN), a tribe inhabiting the Salween valley in northern Burma, believed to have migrated southward from the Tibeto-Chinese borders, and still in a migratory condition. They belong to the group called *protomorphus* by Haddon, otherwise described as having Caucasian affinities. They are divided into clans with names suggesting totemism, *e.g.,* fish-, bee-, hemp-people. Some customs suggest Indonesian affinities, viz., spirit- and ancestor-worship; burial in the fields; use of bark or leather cuirasses. They keep hunting dogs, use cross-bows with poisoned arrows and cultivate maize and buckwheat. Houses are built on the ground. The men wear short hair or pigtail, the women two plaits or horns over the ears.

See Litton, *Report on Upper Salween* (Rangoon, 1906); Enriquez, *A Burmese Arcady* (1923). (J. H. H.)

LISZT, FRANZ (1811–1886), Hungarian pianist and composer, was born on Oct. 22, 1811, at Raiding, Hungary. His appeal to musicians was made in a threefold capacity, and we have, therefore, to deal with Liszt, the unrivalled pianoforte virtuoso (1830–48); Liszt, the conductor of the "music of the future," at Weimar, the teacher of Taussig, Bulow and a host of lesser pianists, the eloquent writer on music and musicians, the champion of Berlioz and Wagner (1848–61); and Liszt the prolific composer, who for some 3j years continued to put forth pianoforte pieces, songs, symphonic orchestral pieces, cantatas, masses, psalms and oratorios (1847–82). As virtuoso he held his own for the entire period during which he chose to appear in public; but the militant conductor and prophet of Wagner had a hard time of it; and the composer's place is still in dispute.

Liszt's father, a clerk to the agent of the Esterhazy estates and an amateur musician of some attainment, was Hungarian by birth and ancestry, his mother an Austrian-German. The boy's gifts attracted the attention of certain Hungarian magnates, who furnished 600 gulden annually for some years to enable him to study music at Vienna and Paris. At Vienna he had lessons in pianoforte, playing from Karl Czerny of "Velocity" fame. and from Salieri in harmony and analysis of scores. In his 11th year he began to play in public there, and Beethoven came to his second concert in April 1823. During the three years following he played in Paris, the French provinces and Switzerland. and paid three visits to England. In Paris he had composition lessons from Paer. and a six months' course of lessons in counterpoint from Reicha. In the autumn of 1825 the handsome and fascinating *enfant gâté* of the salons and ateliers—"La Neuvième Merveille du monde"—had the luck to get an operetta *(Don Sancho)* performed three times at the Académie Royale. The score was accidentally destroyed by fire! but a set of studies *à la* Czerny and Cramer, belonging to 1826 and published at Marseille as 12 Études, op. i, is extant and shows remarkable precocity. After the death of his father in 1828 young Liszt gave pianoforte lessons in Paris, got through a good deal of miscellaneous reading and felt the influence of the religious, literary and political aspirations of the time. He attended the meetings of the Saint-Simonists, lent an ear to the romantic mysticism of Père Enfantin and later to the teaching of Abbé Lamennais. He also played Beethoven and Weber in public—a very courageous thing in those days.

The appearance of the violinist Paganini in Paris, 1831, marks the starting point of the supreme eminence Liszt ultimately attained as a virtuoso. Paganini's marvellous technique inspired him to practise as no pianist had ever practised before. He tried to find equivalents for Paganini's effects, transcribed his violin caprices for the piano and perfected his own technique. After Paganini he received a fresh impulse from the playing and the compositions of Chopin, who arrived in 1831, and yet another impulse of equal force from a performance of Berlioz's *Symphonie Fantastıque, épisode de la vie d'un artute,* in 1832. Liszt transcribed this work, and its influence ultimately led him to the composition of his "Pokmes symphoniques" and other examples of orchestral program music.

From 1833 to 1848—when, with characteristic indifference to material considerations, he gave up playing in public—he was the prince of pianists. Five years (1835–40) were spent in Switzerland and Italy, in semi-retirement in the company of the comtesse d'Agoult (*q.v.*), by whom he had three children, one of them afterward Frau Cosima Wagner. These years were devoted to further study and were interrupted only by occasional appearances at Geneva, Milan, Florence and Rome and by annual visits to Paris, when a famous contest with Thalberg took place in 1837. The enthusiasm aroused by Liszt's playing and his personality—the two are inseparable—reached a climax at Vienna and Budapest in 1839–40, when he received a patent of nobility from the emperor of Austria and a sword of honour from the magnates of Hungary in the name of the nation. During the eight years following he was heard at all the principal European centres. He gained much money and gave large sums in charity. His munificence with regard to the Beethoven statue at Bonn made a great stir. The monument was completed at his expense and unveiled at a musical festival conducted by Spohr and himself in 1845.

In 1848 he settled at Weimar with Princess Sayn-Wittgenstein (d. 1887), and remained there till 1861. During this period he acted as conductor at court concerts and on special occasions at the theatre, gave lessons to a number of pianists, wrote articles of permanent value on certain works of Berlioz and the early operas of Wagner and produced those orchestral and choral pieces upon which his reputation as a composer mainly depends. His efforts on behalf of Wagner, then an exile in Switzerland, culminated in the first performance of *Lohengrin* on Aug. 28, 1850. Among other works produced during this period for the first time or revived with a view to the furtherance of musical art were Wagner's *Tannhauser, Der fliegende Hollander, 'Das Liebesmahl der Apostel,* and *Eine Faust Overtüre,* Berlioz's *Benvenuto Cellini,* the *Symphonie Fantastique, Harold en Italie, Roméo et Juliette, La Damnation de Faust,* and *L'Enfance du Christ*—the last two conducted by the composer—Schumann's *Genoveva, Paradise and the Peri,* the music to *Manfred* and to *Faust,* Weber's *Euryanthe,* Schubert's *Alfonso und Estrella,* Raff's *König Alfred,* Cornelius' *Der Barbier von Baghdad* and many more.

It was Liszt's habit to recommend to the public such works as he produced not merely by performing them as admirably as possible but also by explanatory articles or essays, such as his two masterpieces of sympathetic criticism, the essays *Lohengrzn et Tannhäuser à Weirnar* and *Harold en Italie,* which articles found many readers and proved very effective. They are now included together with articles on Schumann and Schubert, Chopin and others in his *Gesammelte Schriften* (6 vol., Leıpzig).

The compositions belonging to the period of his residence at

Weimar comprise two pianoforte concertos, in E flat and in A, the *Todtentanz,* the *Concerto pathétique* for two pianos, the solo sonata *An Robert Schumann,* sundry *Études,* 15 *Rhapsodies Hongroises,* 12 orchestral *Poèmes symphoniques, Eine Faust Symphonie,* and *Eine Syrnphonie zu Dante's "Divina Cornmedia,"* the 13th Psalm for tenor solo, chorus and orchestra, the choruses to Herder's dramatic scenes "Prometheus," and the Missa solennis known as the *Graner Fest Messe.*

Liszt retired to Rome in 1861 and joined the Franciscan order in 1865. The Princess Wittgenstein, it has been said, was determined to marry him, and since neither he nor her family wished their connection to take this form, Cardinal Hohenlohe quietly had him ordained. From 1869 onward he—now the Abbé Liszt—divided his time between Rome and Weimar, where, during the summer months, he received pupils—gratis as formerly—and from 1876 up to his death at Bayreuth on July 31, 1886, he also taught for several months every year at the Hungarian Conservatoire of Budapest.

Liszt's pianoforte technique was based on the teaching of Czerny, who brought up his pupil on Mozart, a little Bach and Beethoven, a good deal of Clementi and Hummel, and a good deal of his (Czerny's) own work. Classicism in the shape of solid, respectable Hummel on the one hand, and Karl Czerny, a trifle flippant, perhaps, and inclined to appeal to the gallery, on the other, these gave the musical parentage of young Liszt. Then appears the Parisian Incroyable and grand seigneur—"Monsieur Lits," as the Parisians called him. Later, we find him imitating Paganini and Chopin, and at the same time making a really passionate and deep study of Beethoven, Weber, Schubert, Berlioz. Thus gradually was formed the master of style—whose command of the instrument was supreme and who played like an inspired poet.

Liszt's strange musical nature was long in maturing its fruits. At the pianoforte his achievements culminated in the two books of studies, twice rewritten, and finally published in 1852 as *Etudes d'exécution transcendante,* the *Etudes de concert* and the *Paganini Studies;* the two concertos and the *Todtentanz,* the sonata in B Minor, the Hungarian Rhapsodies and the fine transcriptions of Beethoven's symphonies (the 9th for two pianofortes as well as solo), and of Berlioz's *Symphonie Fantastique,* and the symphony *Harold en Italie.* In his orchestral pieces Liszt was the great apostle of program music *(q.v.),* and in that capacity may be said to have established his most conspicuous claim, apart from his achievements as a pianist, to a place in musical history.

Of his own orchestral works the *Dante* and *Faust* symphonies are generally considered the best. The subject of the *Dante symphony* (1847–55) was particularly well-suited to Liszt's temperament and offered good chances for the display of his peculiar powers as a master of instrumental effect. In the *Faust symphony* (1854–57) the moods of Goethe's characters—Faust, Gretchen and Mephistopheles—are depicted in three instrumental movements, with a chorus of male voices supplying a kind of comment, by way of close. The method of presentation in both symphonies is by means of representative themes *(Leztmotif),* and their combination and interaction. Incidents of the poem or play are illustrated or alluded to as may be convenient, and the exigencies of musical form are not unfrequently disregarded for the sake of special effects. Of the 12 Poèmes symphoniques, *Orphke* is perhaps the most consistent from a purely musical point of view and is exquisitely scored, while *Les Prkludes, Tasso* and *Mazeppa* contain many happy pages.

In the choral numbers of the five masses, and in the oratorios *Die Heilige Elisabeth* and *Chrzstus,* there are also fine movements, even if those works as a whole can never be regarded as commensurate with the high aims and genuine religious fervour which went to their making. More truly inspired than most of these larger works are some of Liszt's songs.

Speaking generally of Liszt it may be said that the man was greater than his music. Distinguished by the rarest magnanimity of nature and generosity of soul, he laboured even more energetically to advance the cause of others than his own; most conspicuously of all. of course, in the case of Wagner. and if only for his labours in this regard, and as a fearless champion of all that was noblest in the art, alike ancient and modem, he deserves ever to be held in lasting honour and remembrance.

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LISZT, FRANZ VON (1851–1919), German jurist, cousin of the composer, Franz Liszt, was born in Vienna on March 2, 1851. He qualified in 1875 as a teacher of criminal law at Graz in Austria, was a professor at Giessen (1879), Marburg (1882), Halle (1889), and in Berlin in 1899. In 1912 he became a member of the Fortschrittliche Volkspartei (Progressive People's party) in the Reichstag.

Liszt's life work was the scientific foundation and reform of the criminal law of which the basic principles are contained in his treatise *Der Zweckgedanke im Strafrecht* (1882). It opposes the principle of regarding punishment as a reprisal and sets up the claim of systematic prevention of a special nature. In the fight against the law-breaker, Liszt, together with the Dutchman Van Hamel and the Belgian Prins, founded the *Internationale Kriminalistische Vereinigung* (International Criminalist Union) in 1889, in which all reforms which became the basis of modern criminal law were initiated.

Liszt's claims in favour of conditional sentence and pardon as well as postponement of punishment later passed into practice. At Marburg he created the Criminalist seminary, at which later in Halle and especially in Berlin students from all lands met. Liszt was also a leading authority on international law. He died at Seeheim on June 22, 1919.

His chief works are *Meineid und falsches Zeugnis* (1876); *Lehrbuch des deutschen Strafrechts* (1881, 21st ed. 1919); *Lehrbuch des Völkerrechts* (1898, 11th ed., 1918); *Strafrechtsfälle zum akademischen Gebrauch* (13th ed. 1922); *Strafrechtliche Aufsatze und Vorträge* (1905). *See* also *Abhandlungen des Kriminalistischen Seminars* (1889, etc.); *Mitteilungen der Internationalen Kriminalistischen Vereinigung* (1890, etc.).

LITANY, a word used by Eusebius and Chrysostom, commonly in the plural, in a general sense, to denote a prayer or prayers of any sort, whether public or private. It is similarly employed in the law of Arcadius *(Cod. Theod.* xvi tit. 5, leg. 30). But some trace of a more technical meaning is found in the epistle *(Ep.* 63) of Basil to the church of Neocaesarea, in which he argues, against those who were objecting to certain innovations, that neither were "litanies" used in the time of Gregory Thaumaturgus. The nature of the recently introduced litanies, which must be assumed to have been practised at Neocaesarea in Basil's day, can only be conjectured. Probably they had many points in common with the *rogationes,* which, according to Sidonius Apollinaris, had been coming into occasional use in France about the beginning of the 5th century, especially when rain or fine weather was desired, and, so far as the three fast days before Ascension were concerned, were first fixed, for one particular district at least, by Mamertus, or Mamercus, of Vienne in A.D. 477. It is assumed that they were penitential and intercessory prayers offered by the community while going about in procession, fasting and clothed in sackcloth.

In the following century the manner of making litanies was to some extent regulated for the entire eastern empire by one of the *Novels* of Justinian, which forbade their celebration without the presence of the bishops and clergy, and ordered that the crosses which were carried in procession should not be deposited elsewhere than in churches, nor be carried by any but duly appointed persons. The first synod of Orleans (A.D. 511) enjoins for all Gaul that the "litanies" before Ascension be celebrated for three days. On these days all menials are to be exempt from work, so that everyone may be free to attend divine service. The diet is to be the same as in Quadragesima; clerks not observing these rogations are to be punished by the bishop. In A.D.

517 the synod of Gerunda provided for two sets of "litanies," the first of which were to be observed with fasting for three days, from Thursday to Saturday in the meek after Pentecost; the second for three days from November 1. The second council of Vaison (529), consisting of 12 bishops, ordered the *Kyrie eleison*, first introduced at this time from the eastern Church, to be sung at matins, mass and vespers.

A synod of Paris (573) ordered litanies to be held for three days at the beginning of Lent, and the fifth synod of Toledo (636) appointed litanies to be observed throughout the kingdom for three days from December 14. The first mention of the word litany in connection with the Roman Church goes back to the pontificate of Pelagius I (555–560) but implies it was at that time already old. In 590 Gregory I, moved by the pestilence which had folloned an inundation, ordered a "litania septiformis," sometimes called *litania major*, that is to say, a sevenfold procession of clergy, laity, monks, virgins, matrons, widows, poor and children. It must not be confused with the *litania septena* used in church on Easter Even. He is said also to have appointed the processions or litanies of April 25 (St. Mark's day), which seem to have come in the place of the ceremonies of the old Robigalia. In 747 the synod of Cloveshoe ordered the litanies or rogations to be gone about on April 25 "after the manner of the Roman Church," and on the three days before Ascension "after the manner of our ancestors." The latter are still known in the English Church as rogation days. Games, horseracing and junketings were forbidden; and in the litanies the name of Augustine was to be inserted after that of Gregory. The reforming synod of Mainz in 813 ordered the major litany to be observed by all for three days, barefoot and clothed in sackcloth and ashes. The sick only were exempted.

As regards the form of words prescribed for use in these "litanies" or "supplications," documentary evidence is defective. Sometimes it would appear that the "procession" or "litany" did nothing else but chant *Kyrie eleison* without variation. There is no reason to doubt that from an early period the special written litanies of the various churches all showed the common features which are now regarded as essential to a litany, in as far as they consisted of (1) invocations, (2) deprecations, (3) intercessions and (4) supplications. In details, however, they must have varied immensely. The offices of the Roman Catholic Church recognize two litanies, the "Litaniae majores" and the "Litaniae breves," which differ from one another chiefly in the fullness with which details are entered upon in each of the four parts. It is said that in the time of Charlemagne the angels Orihel, Raguhel and Tobihel were invoked, but the names were removed by Pope Zacharias as really belonging to demons. In some mediaeval litanies there were special invocations of S. Fides, S. Spes and S. Charitas.

The litanies, as given in the breviary, are at present appointed to be recited on bended knee, along with the penitential psalms, in all the six week-days of Lent when ordinary service is held. Without the psalms they are said on the feast of Saint Mark and on the three rogation days. A litany is chanted in procession before mass on Holy Saturday. The "litany" or "general supplication" of the Church of England, which is appointed "to be sung or said after morning prayer upon Sundays, Wednesdays and Fridays, and at other times when it shall be commanded by the ordinary," closely follows the "Litaniae majores" of the breviary, the invocations of saints being of course omitted. A similar German litany will be found in the works of Luther. In the Roman Catholic Church there are a number of special litanies peculiar to particular localities or orders, such as the "Litanies of Mary" or the "Litanies of the Sacred Name of Jesus."

There was originally a close connection between the litany and the liturgy (*q.v.*). The ninefold *Kyrie eleison* at the beginning of the Roman mass is a relic of a longer litany of which a specimen may still be seen in the Stowe missal. In the Ambrosian liturgy, the threefold *Kyric eleison* or Lesser litany occurs thrice, after the *Gloria in excelsis*, after the gospel and at the end of the mass. On the first five Sundays in Lent a missal litany is placed before the *Orntio super populum* and, on the same five Sundays, in the Mozarabic rite before the epistle. In Eastern liturgies, litanies are a prominent feature, as in the case of the deacon's litany at the beginning of the *Missn fidelium* in the Clementine liturgy and immediately before the *Anaphora* in the Greek liturgy of St. James.

LITCHI (LYCHEE; also spelled lichi, leechee. etc.), the fruit of *Litchi chinensis*, a tree of the family Sapindaceae, believed to be native to southern China and adjacent regions. It has been the favourite fruit of the Cantonese since ancient times; neither the orange nor the peach is held to equal if. Its introduction into the western world, however. came relatively late. It is recorded to have reached Jamaica in 1775.

The first lychee fruits to mature in Florida—where the tree has attained commercial importance—are said to have ripened in 1916. A fen trees introduced into California in the 19th century have occasionally produced fruits but. in general. conditions there are apparently unfavourable for their successful establishment. Around the Mediterranean are a few hearing trees; in South Africa a small horticultural industry is based upon lychee production. The tree is cultivated in numerous parts of India and has received horticultural attention in the Hawaiian Islands. Occasional trees are to he seen in tropical America.

The lychee will tolerate about as much cold as the orange. It does not produce rood crops in climates which are hot and humid throughout the year. The tree must be subjected to a period of cold weather annually or. failing this. a long dry season. In short. something must discourage vegetative growth and induce flowering. Even at best. the lychee has a strong tendency toward alternate or irregular production.

The tree is a handsome one, developing a compact crown of bright green foliage. beautiful the year round. The leaves are compound. composed of two to four pairs of elliptic to lanceolate leaflets two to three inches long. The flowers, small and inconspicuous. are borne in terminal panicles sometimes a foot in length. The fruits. which are produced in clusters. arc oval to round. strawberry-red in colour and an inch or slightly more in diameter. The brittle outer covering encloses white, translucent flesh and one large seed. The flavour is subacid. sprightly, delicious, suggesting that of a Muscat grape.

About 50 varieties have been described from southern China. of which No Mai and Haak Ip are considered to be among the best. In Florida the Brewster, from Fukien province in China. has attained commercial importance; Groff, a Hawaiian production, and Bengal, from India inhere there are several varieties). are considered excellent. In South Africa the most important commercial lychee is one which had its origin in Mauritius.

The tree is propagated by seed and by air layering. When moved to the permanent orchard. lychees are set 25 to 3j ft. apart. They require very little pruning and no unusual cultural attention. though they should have abundant moisture around the roots most of the time. The trees come into production at three to five years of age. (W. Po.)

LITERARY AND HISTORICAL SOCIETIES. Literary societies may he generally divided into three sorts: the academy, established as an arbiter of literary taste and linguistic correctness: the authors' club. a fellowship of authors to further individual or collective creative work; and the learned society of letters, an organization devoted to criticism and scholarship in the field of literature.

The academy; best exemplified by the French Académie Française (founded 1635), has historically been an important literary power on the European continent. hut has never really existed in the English-speaking countries. The British Academy (1901) and the American Academy of Arts and Letters (1904), although similar societies, have made no claims as official literary courts.

Authors' clubs have generally been short-lived unions, unable to survive the original members or even the original members' personal squabbles. Among the better knon·n have been the Scriblerus club (formed about 1713) of Alexander Pope, Jonathan Swift, John Gay. Richard Congreve and others; the Literary club (formed 1764) of Samuel Johnson, Edmund Burke, Oliver Goldsmith. Joseph and Thomas Warton. Edward Gibbon and others;

and the earnest Transcendental club (formed 1836) of Ralph Waldo Emerson, Bronson Alcott, Henry David Thoreau, Margaret Fuller and others in Concord, Mass.

The learned societies, so important today, represent one of the earliest forms of modern literary organization. The Society of Antiquaries of London was founded in 1572, but characteristically it was not incorporated until 1751, when widespread interest in such scholarly activity was first beginning. For the remainder of the 18th century and throughout the 19th the number and the activities of such literary groups continued to grow: the Society of Antiquaries of Scotland (1780); the Manchester Literary and Philosophical society (1781); the Royal Society of Literature (182 j); the Philological society (1842); the American Philological association (1869); the Modern Language Association of America (1883); and the Modern Language association (1893).

The movement in renewed vigour continued into the 20th century with the founding of such societies as the English association (1906), the Modern Humanities Research association (1918) and the English institute (1939).

The learned societies perform a valuable service to letters by offering centres for discussion, an organized means of preservation of literary monuments and literary knowledge and an opportunity for scholarly publication. The periodical and occasional publications of many of the societies have long been of first importance in literary scholarship.

Some societies, more restricted in scope, have been devoted to individual authors or to particular literary periods and interests and have accordingly served as similar but more limited centres of activity. Representative among these have been the Shakespeare society (1840), the New Shakespeare society (1874) and the Shakespeare association of America (1923); the Dickens fellowship (1902); the Melville society (1945); the Early English Text society (1864); the Folk-Lore society (1878); the Linguistic Society of America (1924); and even the Grolier club (1884), devoted to bibliography and the aesthetics of printing.

BIBLIOGRAPHY.—*The World of Learning,* 5th ed. (1954); *Scientific and Learned Societies of Great Britain* (annual); Robert E. Spiller *et al.* (eds.), *Literary History of the United States,* rev. ed. (1953); H. R. Steeves, *Learned Societies and English Literary Scholarship* (1913). (E. T. BN.)

Historical **Societies.**—Man seems to be born with an instinct for history just as he has a gregarious instinct and a desire for food. The historical instinct is not as elemental as that of self-preservation, but once man has reached a stage of civilization sufficient to satisfy his desire for food and other physical needs he will want a history. And the knowledge of the past he wants is always the history of the group or unit or institution that he considers the most important. Judgment as to this has varied from time to time but certainly during the 19th and 20th centuries the all-important group to which ultimate allegiance has been given is the nation. People have thought in terms of it and consequently the history which the American people have needed and sought has been the history of the United States. In spite of the dominance of national history mankind has always wanted to have a history of the other groups, religious, social, economic or professional, to which he belongs and of the local areas in which he lives.

The result has been the establishment of a multitude of societies to promote the study and writing of the history of all sorts of human activities and interests. Nowhere, perhaps, are there more such societies than in the United States. If more prolific in organizing societies, the Americans were only continuing one of the many practices known in the mother country. The earliest of the learned societies in Great Britain was the Society of Antiquaries of London founded in 1572 and from 1717 continuously active in promoting historical and archaeological knowledge.

In the United States the American Historical association. founded in 1884, is the national organization for professional scholars in all branches of history. Its membership is open to anyone who wishes to join, but in fact nearly all who do join are on the faculties of the institutions of higher learning. Nearly always they are also members of one or several of the other national societies which are devoted solely to some branch of history.

Thus the Mississippi Valley Historical association, which was organized in 1907 for scholars living in the central portion of the United States but which by mid-century included members from all sections, concerns itself solely with American history. The Economic History association. the Mediaeval Academy of America, the Southern Historical association, the Business Historical society. the Agricultural History society, the American Catholic Historical association and the Hispanic-American Historical association are typical examples of national groups composed of persons interested in the branches of history indicated by the names of the organizations. Again, although anyone can join these societies, the members are nearly all professors of history in colleges or universities. As a rule these societies have no building of their own nor any fixed location other than the office of the scholar who serves as secretary. They meet regularly once or twice a year either on a university campus or in some large hotel when numerous scholarly papers containing the results of the research of the authors are read and the small internal business of the organization is transacted. In every case a journal or scholarly periodical is published. In fact the publication of such a journal with many book reviews by means of which the members can keep abreast of the latest findings in the field is frequently a chief reason for forming the society. Some of the groups also publish volumes of documents or other historical materials. Often fellowships or prizes are awarded to assist young scholars and to encourage superior work. The small expenses of these organizations are met by income from the annual dues paid by the members.

Although these national societies dominate and set the standards for historical scholarship, they are greatly exceeded in number, range of activities and wealth by the various state historical societies. In the older states historical societies were founded long before there was a historical profession and when the writing and study of history were avocations of clergymen, lawyers and retired businessmen. Prominent among these are the Massachusetts Historical society (1791), the Historical Society of Pennsylvania (1824), the Maryland Historical society (1843) and the New York State Historical association (1899).

In the states west of the Allegheny mountains the state historical societies were established when a different climate of opinion prevailed. They typically receive most of their financial support from state appropriations rather than from membership dues and are frequently associated physically and functionally with the state university.

Unlike the national organizations the state historical societies have among their members many who are not professors of history but who join either because of an active interest in local history or because of the social prestige of being known as a fellow member of the "first" families in that locality. The scholarly activities are normally controlled by the professional scholars among the members. The most valuable service performed by the state societies is the collection and preservation of historical materials. Nearly every society has its own building and in many of these are rich archives which make it possible for historians to do original research. The Draper collection in the State Historical Society of Wisconsin library and the gift of the Adams family papers to the Massachusetts Historical society are notable examples of what has been done. Supplementing the manuscript collections are libraries which in some instances are both large and valuable. Most of the state societies publish journals containing articles, usually by members of the academic world, and original source materials. Efforts are made in these periodicals to make good history available and attractive to the public. Success is not always achieved. The same desire to reach the public is responsible for the many historical museums maintained and operated by the state historical societies.

Still more numerous but of much less importance are the large number of societies which are concerned with the history of some small area or city or town. Typically they receive little or no support from government and their ability to carry on extensive activities is correspondingly low. Typically also they have a much higher percentage of nonacademic members. The richer and better ones are likely to have a historical museum.

In Great Britain there is no one national organization occupying a dominant position comparable with that of the American Historical association. The Royal Historical society and the Historical association are not so clearly the agency of the historical profession. In England too there are many societies devoted to some particular aspect of history. Corresponding to the American state historical societies are the English county societies which exist in nearly every county. There are also numerous societies which focus their attention on smaller areas. (W. S. HT.)

LITERATURE (ARTICLES ON). Literature in its varied aspects is treated extensively in the *Encyclopedia Britannica.* For information on specific subjects or writers the reader should consult the Index volume; this article is a general survey.

Literatures of the World.—The two great branches of classical literature are discussed in detail under GREEK LITERATURE and LATIN LITERATURE. The various literatures of the world are surveyed on national lines. in such articles as ENGLISH LITERATURE: FRENCH LITERATURE; AMERICAN LITERATURE: JAPANESE LITERATURE; RUSSIAN LITERATURE; etc.

These articles are supplemented by biographies of all major authors: SHAKESPEARE. WILLIAM; DANTE; GOETHE. JOHANN WOLFGANG VON; TOLSTOY, LEO NIKOLAYEVICH; and of schools of writers, such as ANNALISTS. In the case of authors commonly known by a pseudonym, the biography is under that form of the name: "Mark Twain," for example, is under the heading TWAIN, MARK rather than Samuel L. Clemens. Major anonymous works are treated in separate articles; *e.g.,* ANGLO-SAXON ,CHRONICLE and ROMAN DE LA ROSE. Various folk and legendary figures are the subjects of separate articles; *e.g.,* FAUST and BUNYAN, PAUL; see also FOLKLORE and FOLK-SONG.

Ideas. institutions, and movements that are closely related to the literature of the period are frequently the subject of separate articles; in connection with the Transcendentalist movement in the U.S., for example, *see* BROOK FARM.

Literary **Genres.**—Many articles are concerned with literature with respect to style, form or purpose. The two major divisions of imaginative literature—prose and poetry—are each the subject of a major article. Various genres are treated in separate articles: *e.g.,* COMEDY; SATIRE; PARODY; and PASTORAL. The article DRAMA is extensive. The various forms of prose writing are discussed in such articles as NOVEL; SHORT STORY: BIOGRAPHY; MYSTERY AND DETECTIVE STORIES: and SCIENCE FICTION. There are also separate articles on the kinds of poetry—EPIC POETRY; BALLAD; etc. (For the various stanzaic forms *see* below.)

Literary Composition.—The article STYLE is a general discussion of the subject. RHETORIC is primarily a survey of the art of eloquent speech: PUBLIC SPEAKING discusses some modern techniques. VERSE is a statement oi the principles of prosody; METRE discusses metrics in English. There are a number of articles on the different metres, *e.g.,* HEXAMETER and DACTYL: *see* also such articles as BLANK VERSE and FREE VERSE and the articles on the various stanzaic forms—SOYNETSPENSERIAN STANZA; and others. The different kinds of metaphorical language are discussed in the article FIGURES OF SPEECH.

Criticism and Scholarship.—The criticism of literature—both its history and its method—is discussed in CRITICISM; a particular area is discussed in DRAMATIC CRITICISM. The article AESTHETICS is concerned with theories of the beautiful in literature. The method of literary scholarship is discussed at some length in TEXTUAL CRITICISM. A related article. BIBLIOGRAPHY, deals to some extent with bibliography of subject matter, and INDEX indicates where subject bibliographies are to be found. CLASSICAL SCHOLARSHIP is a historical survey of the study, in all its aspects, of the civilization of ancient Greece and Rome. Learned societies are listed in the article LITERARY AND HISTORICAL SOCIETIES. Additional information will be found in the biographies of critics and scholars.

Related Articles.—The way in which the contents. form, making, distribution and use of books are related to one another in the society that they serve is the subject of the article BOOK. Public collections are discussed in LIBRARIES: information on private collections will be found in BOOK COLLECTING. which is mainly concerned with the principles and methods of building a specialized collection. Specific kinds of books are discussed in such articles as DICTIONARY and ENCYCLOPAEDIA. The study of books as physical objects is the primary subject of the article BIBLIOGRAPHY; related to this area of study are the articles BOOKBINDING; BOOK COLLECTIXG; and BOOKPLATE. Also of interest, though somewhat further afield. are the articles PALAEOGRAPHY and ILLUMINATED MANUSCRIPTS.

Books for children are discussed in CHILDREN'S LITERATURE. The article PUBLISHING is primarily concerned with book publishing; related articles include CENSORSHIP and COPYRIGHT. The article JOURNALISM offers in brief compass a survey of the field; NEWSPAPER traces the development of newspapers in many countries and discusses the organization of a newspaper office; PERIODICAL treats of journals and magazines. Specialized aspects are discussed in PROOFREADING and REPORTING. See also references under "Literature (Articles on)" in the Index volume.

LITHGOW, a town of New South \Vales, Austr., lying on the central tableland in a valley of the Blue mountains. 96 mi. N.W. of Sydney by rail. Altitude 3,000 ft. Pop. (1954) 15,128.

Lithgow stands in the heart of the western coal field which possesses steam as well as coking coal. The state coal mine and a state electricity power station are in Lithgow. It is one of the chief industrial centres of Australia with a small-arms factory. brickworks, woolen mills, sawmills and many light industries. Near by is the famous zigzag railway, an engineering marvel now superseded by tunnels. and Hassans Walls lookout, from which can be seen a vast panorama of Blue mountain valleys.

LITHIUM, a chemically reactive metallic element which resembles somewhat the other alkali metals. sodium, potassium, rubidium and caesium with which it is classified in group I of

TABLE I.—*Uses of Lithium*

Field	Application	Form
Agriculture	Tobacco culture	Lithium carbonate
	Soil moisture retention	
	Fungicides	
Air Conditioning . .	Moisture absorption	Lithium bromide
	Dehumidification	Lithium chloride
Atomic Energy .	Proton production	Lithium metal
	Tritium production	Lithium hydride
	Power development	
	Atomic hydrogen	
Batteries	Primary cells (dry batteries)	Lithium chloride
	Storage batteries (alkaline type)	Lithium hydroxide
Bleaching . . .	Production of solid, soluble, and stable bleaching agents	Lithium hypochlorite Lithium peroxide
Ceramics	Porcelain enamels	Lithium carbonate, manganite, titanate, silicate, zirconate and cobalite
	Ground coats and cover-coats on steel and aluminum for acid resistance, improved bonding, lower firing temperature	Lithium minerals
	Pottery glazes	
	Special glasses	
Chemicals . . .	Production of miscellaneous litliium compounds	Lithium carbonate
	Catalysts	
Gas Puriiication . .	Removal of trace impurities in helium, argon, etc.	Lithium metal
	Carbon dioxide removal	Anhydrous litliium hydroxide
Heat Transfer . .	Stable low melting point	Lithium nitrate
	Salt mixtures	
Iron and Steel . .	Nodular iron grain refinemerit in steels	Lithium metal and alloys
	Desulfurization of steel	Lithium carbonate
Nonferrous Metals	Chrome bronzes, high-conductivity copper castings	Magnesium alloys High-purity litliium metal
	Bronze, nickel, silver, monel and precious metal castings	
	Bearing metals	
	Aluminum castings	
	Lithium metal cartridges	
Petrolcum . .	Catalyits	Lithium metal
	Sulfur removal	Lithium hydride
	Lubricants	Lithium hydroxide
	Low-temperature greases	Lithium stearate
Pharmaceuticals	Reagent to produce antihistamines	Lithium amide
	Reagent to produce synthetic vitamins	Lithium metal
Plastics . .	Stabilizers	Lithium stearate
	Catalysts	Lithium lactate Lithium carbonate
Rescue and Signal Work	Balloon inflation	Lithium hydride
	Flares	Lithium nitrate
Welding	Fluxes for aluminum and magnesium	Lithium chloride Lithium fluoride

the periodic system. However, as the first member of the group, lithium is unique and has certain properties which render it distinct from its congeners and somewhat similar to magnesium and several other metals of group II. For example, lithium is the only element of its group to react with nitrogen to form a nitride, Li_3N, whereas all of the metals of group II undergo a similar reaction. It is also unusual in that it is the lightest of all solid elements and at ordinary temperatures has a higher specific heat than any other substance except water.

Lithium was discovered in 1817 by A. Arfvedson in Sweden who, while analyzing the mineral petalite, found that the sodium compounds which he separated were contaminated by an alkali which did not respond to the chemical tests for the only other known alkali. potassium. The name lithium (from the Greek, *lithos*, "stone") was proposed by J. J. Berzelius. Small amounts of the free metal were probably obtained in the early 1880s by Sir Humphry Davy but it was first isolated in quantity in 1855 by R. Bunsen and A. Matthiessen who electrolyzed fused lithium chloride.

Uses.—Lithium was generally unknown and had few uses for more than a century after its discovery. The United States, the world's largest producer, averaged 290,000 lb. of lithium carbonate (or its equivalent) per year for 1935–39. During World War II a peak of 2,790,000 Ib. was reached (1944); this was exceeded in every year after 1950, reaching more than 30,000,000 lb. per year before 1960. The metal has been used as a constituent of certain light metal alloys, with magnesium and aluminum-zinc alloys and in heavy-duty lead bearing alloys. It is used as a degasifier in the production of high-conductivity copper and bronze castings and is also used in the synthesis of vitamin A. Lithium compounds are used in lubricants and ceramics, which consume the largest quantities. and in air conditioning. welding and brazing. Nuclear applications include H-bombs, nuclear power and high-energy fuels.

Occurrence and Production.—It is estimated that lithium constitutes about 0.0065% of the igneous rocks of the earth. Because of its high chemical activity, the element occurs only in combination and its compounds are widely distributed hut in small concentrations. Traces of lithium are found in animal tissue. plants (especially tobacco), the soil and a large number of minerals. Small quantities occur in sea water and in some springs. The few minerals which contain lithium in quantities sufficient for commercial extraction are: spodumene $LiAl(SiO_3)_2$, petalite $LiAl(SiO_2)_2(SiO_3)_2$, Iepidolite $(Li,K,Na)_2Al_2(F,OH)_2(SiO_3)_3$, amblygonite $LiAl(F,OH)PO_4$ and triphylite $Li(Fe,Mn)PO_4$.

Producing countries of lithium minerals include the United States and Canada. Australia, Argentina and Brazil and a number of countries in Africa (Southern Rhodesia in the Federation of Rhodesia and Nyasaland, South-West Africa, Uganda, Republic of South Africa, Republic of the Congo and Mozambique).

Lithium compounds are separated from the minerals by various methods. Generally, in the case of spodumene, the ore is heated to approximately 1,100° C. to decrepitate the mineral from the y, or hard form. to the β, or soft form (see SPODUMENE). The decrepitated material is ground. mixed with strong H_2SO_4, and heated to 150°–2joo C. to render the lithium soluble as a sulfate.

In the second case (petalite) limestone is mixed with the ore or concentrates and heated to approximately 1,100° C. The decrepitated material thus formed with the calcined lime is ground and leached to produce a solution of lithium hydroxide.

Phosphate ores (amblygonite) are treated with strong sulfuric acid recovering the lithium as sulfate and recovering also the phosphorus as a sodium or calcium acid phosphate. The lithium and other soluble sulfates are extracted with water and from the purified solution the crude lithium carbonate is precipitated.

The crude carbonate is converted to the dry anhycirous chloride or bromide which is separated from the impurities by use of an organic solvent. *e.g.*, amyl alcohol, a mixture of ethyl alcohol and diethyl ether. or pyridine.

Lithium metal is obtained by the electrolysis of a fused lithium chloride and potassium chloride salt mixture containing 40%–50% of lithium chloride. Other methods of reduction have been tried but fused salt electrolysis is the process used commercially.

Properties.—Lithium is a white metal with a silvery lustre which quickly tarnishes when exposed to moist air. Its symbol is Li. atomic number 3, chemical atomic weight 6.940. Two naturally occurring stable isotopes with mass numbers 6 (7.5%) and 7 (92.5%) are known; radioactive isotopes, 8 (half life 0.83 sec.) and 9 (0.17 sec.) have been prepared. It has a hardness of 0.6 on Mohs' scale and is harder than the other alkali metals but softer than lead which it resembles in ductility. The crystal lattice of the metal is of the body-centred cubic structure with the distance of closest approach of the nuclei equal to 3.03 Å (angstrom unit $= 10^{-8}$ cm.). Its spectrum like those of the other alkali metals is comparatively simple and is characterized by a bright-red line (6,708 Ă) and a fainter orange line (6,104 Å).

For additional physical and atomic properties see Table II.

TABLE II.—*Numerical Properties of Lithium*

Electron configuration	$1s^2\ 2s^1$
Density of solid at 20° C., g. per c.c.	0.53j
Atomic volume c.c.	12.97
Melting point °C.	186
Boiling point °C.	1336
Ionization potential, volts	5.390
Potential for $Li \rightleftarrows Li^+ + e$ at 25° C., volts	3.045
Heat of hydration of gaseous ions kg.cal. per mole.	123
Electronegativity	1.0
Heat of sublimation at 25° C, kg.cal. per mole	36 44
Specific heat at 27° C., cal. per g.	0.81
Metallic radius, Å	1.55
Ionic radius in crystals, A	0.60

Lithium is an active metal and a strong reducing agent. readily giving up its 2s electron to form lithium ion, Li^+. It reacts with water at ordinary temperatures liberating hydrogen and forming a solution of lithium hydroxide. a strong base or alkali. Lithium burns in air forming the oxide. Li_2O; at red heat it unites with hydrogen forming the hydride. LiH; it reacts with the halogens and at higher temperatures with phosphorus, arsenic. antimony. carbon, silicon, sulfur and selenium. It is not as reactive as the other alkali metals but in common with them dissolves in liquid ammonia to give a highly conducting coloured solution. It is thought that the colour is caused by single electrons and electron pairs which are trapped in cavities of the liquid rather than by solvated electrons. The normally stable nuclei of lithium undergo transformations when bombarded with rapidly moving particles: with protons. $Li^6H^1 \rightarrow He^4 + He^3$ and $Li^7 + H^1 \rightarrow 2He^4$; with deuterons, $Li^i + H^2 \rightarrow Li^8 + H^1$; with neutrons, $Li^6 + N^1 \rightarrow He^4 + H^3$. In the last reaction, used to prepare tritium, the lithium is bombarded with slow moving neutrons which are produced in a uranium pile (*see* DEUTERIUM AND TRITIUM).

Compounds.—The compounds of lithium are predominantly ionic and their chemical properties are in part those of the lithium ion. This ion. the smallest of the alkali group. attracts an electron more strongly than the others and is more easily reduced to the metal. It also attracts water molecules most strongly with the liberation of a large amount of energy. thereby facilitating the reaction of lithium metal with water. As a result, lithium has a high electrode potential in water solution. greater than that of caesium, instead of the lowest of the group which might be expected from the ionization potential.

Lithium hydride is a white solid with a crystalline structure of the sodium chloride type and a melting point of 680° C. Electrolysis of the fused compound liberates lithium at the cathode and hydrogen at the anode. It is typical of the class of ',saltlike" hydrides which are formed by the elements of groups I and II. Lithium aluminum hydride. $LiAlH_4$, and lithium borohydride, $LiBH_4$, in common with lithium hydride are strong reducing agents and react with water to liberate hydrogen and form the metal hydroxides. Lithium aluminum hydride is extensively used as a reducing agent in organic syntheses.

Lithium carhonate, Li_2CO_3, a sparingly soluble salt is used in the preparation of a number of other lithium compounds, in ceramics for producing glazes and in manufacturing special grades of glass. The bicarbonate, $LiHCO_3$, is soluble in water. Lithium fluoride. LiF, has the highest heat of formation of all of the alkali halides and is one of the most stable compounds known. It is somewhat insoluble and is used in soldering and welding fluxes. The bromide. LiBr. used as a drying agent in air conditioners and the iodide, LiI, used in photography are both soluble. The nitrate, $LiNO_3$, the sulfate, Li_2SO_4, the sulfide, Li_2S, and the perchlorate, $LiClO_4$, are all soluble while the normal phosphate, Li_3PO_4, and the oxalate, $Li_2C_2O_4$, are insoluble.

Organolithium compounds; *e.g.,* butyllithium. C_4H_9Li, and phenyllithium, C_6H_5Li, used for introducing alkyl or aryl groups into organic molecules, are prepared by the reaction of lithium with the appropriate organic halides. The reaction of these organolithium compounds with a variety of other substances is a common preparative procedure: resembling somewhat the methods involving the Grignard reagents (organomagnesium compounds). Organic salts of lithium, the benzoate, citrate. salicylate and the acid tartrate as well as inorganic salts were formerly employed in medicine, some for the elimination of uric acid in the treatment of gout and rheumatic conditions. However. the tolerated dose of lithium cannot form the relatively soluble lithium urate in the presence of the quantities of sodium and potassium normally in the blood serum and accordingly lithium salts have been largely superseded in medicine by other diuretics.

Determination. — Lithium may be identified by the use of a spectroscope or by the red colour it imparts to a flame. It is gravimetrically determined in the presence of the other members of the group by extraction of the chloride with amyl alcohol. Another procedure involves the use of the flame photometer; a lithium salt solution is fed to a flame, the light passes through a prism and one of the characteristic lines impinges upon a photoelectric cell. *See* also Index references under "Lithium" in the Index volume.

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LITHOCARPUS is a genus of about 100 species of evergreen onklike trees of the beech family, all native to Asia except one species that is abundant along the coast of Oregon and California. This native species. *L. densiflora* (formerly *Quercus densiflora*), commonly known as tanbark oak. is important for its bark which is used in tanning leather. Because of the ornamental value it is adapted in warmer temperate regions as a garden and lawn tree. (J. M. BL.)

LITHOGRAPH, a planographic print made by a process that relies on the natural antipathy of grease to water. This article considers the lithograph in art; for the commercial printing process *see* LITHOGRAPHY. Lithographs as an art form are printed on specially constructed presses from a drawing. usually on stone (hence the name. from the Greek *lithos,* "stone," and *graphein,* "to write"), but metal plates can also be used. These processes are described in the section on technique, which follows the section on history.

HISTORY

ORIGIN

Lithography is one of the very few graphic mediums that has a recorded origin; it was invented in 1798 by a Bavarian. Aloys Senefelder, who documented his discovery and subsequent experiments in *Vollstandiges Lehrbuch der Steindruckerey* (1818; Eng. trans., A *Complete Course of Lithography*). The term *Steindruck* ("stone printing," *i.e.,* lithography) was not Senefelder's original name for the process. Actually the use of stones mas incidental to his experiments, which were concerned with what he termed chemical printing; his objective was a cheap form of commercial printing that would enable him to publish his own dramatic productions. According to Senefelder, the use of stone as a printing surface came to him in 1796. when, by force of circumstance. he jotted down a laundry list for his mother with a greasy pencil on a piece of stone. It occurred to him that the markings on the stone could be left in relief if the rest of the surface were etched away. His earliest experiments were from these etched stones. as well as metal plates, printed in relief. Further experimentation led, in two years, to the type of flat-surface printing that is called lithography. By the time his book appeared in 1818. Senefelder had experimented with and described every process in modern lithography.

Senefelder'? interest in lithography was a purely commercial one. To this end he accepted an offer from the music publisher Johann Anton André to establish himself at Offenbach and to train persons in the new process. As a result of this kind of partnership, and at André's suggestion, patents were secured in various localities, including London.

19TH CENTURY

Germany. — In Bavaria, under the impetus of Senefelder's press at Munich, commercial lithography proceeded to develop as a reproductive medium; the first important publication was a facsimile edition of Albrecht Dürer's *Missal of Maximilian* in 1808, redrawn on stone by Johann Nepomuk Strixner. Other reproductive lithographs were produced in great quantities by the Quaglios, Karl von Piloty and others.

An abortive attempt to produce an original lithograph was made by the Bavarian count Torring-Seefeld in 1800. His views of the Lake of Worth. as well as similar attempts by Professor Mitterer and his pupil Angelo Quaglio, failed. E. J. Aurnhammer, a professor at the Gymnasium of Regensburg, sent 12 landscape subjects on stone to Senefelder in 1802 for printing in Munich, but only 6 survived. In the publication *Polyautographische Zeichnungen vorzüglicher Berliner Künstler* of 1804 appeared a lithograph by Johann Gottfried Schadow, who can be credited with being the first German artist of merit to take up lithography. Schadow produced 45 lithographs in all. Another contributor to this publication. as well as its publisher, was the painter Wilhelm Reuter. who had interested himself with the process since 1801. The architect Karl Friedrich Schinkel also made a few lithographs; one of a Gothic church done in 1810 is an exceptionally fine pen lithograph. For the greater part of the 19th century, lithography was not very highly regarded by the most competent artists. However. mention should be made of Joseph Kriehuber, the favourite portraitist of the Vienna school, who drew many of his heads on stone. Adolf von Menzel, also well known as a book illustrator in wood engraving, kept the art alive with competent technical knowledge and accomplished drawing, displaying a special virtuosity with the white scratched-line technique. Toward the end of the century. Hans Thoma took up the medium. experimenting with colour prints and encouraging other artists; and Otto Greiner worked many of his figure studies on stone.

France. — The first attempt at lithography in France was unsuccessfully conducted by Frederic Andre, while the earliest effective French trials by Pierre Nolasque Bergeret were published not in France but by an English art dealer, Bell, in 1801. The first lithograph drawn and produced in France is considered to be "Le Mercure" by Bergeret, done in 1804. However. lithography did not receive official recognition until 1809, when the director-general of museums, Vivant Denon, drew a Holy Family at Senefelder's shop in Munich.

Lithography developed in France as in no other country. Gradually taking hold of the imagination of both amateur and professional artists. the new medium appealed as an autographic way to reproduce drawings. Most of the work of the early French lithographers, Carle Vernet. N. T. Charlet. who produced around 1,000 prints. Eugène Lami and Denon, was drawn in simple black lines with a minimum of shading. The painter Eugène Delacroix took up lithography and became a master of the technique; his professional stature added prestige to the new process, by which he produced nearly 100 prints, including illustrations to *Faust, Hamlet* and other dramas. Other outstanding artists of this early period were Eugène Isabey and the immensely influential Théodore Géricault, who lithographed many studies of horses. Pierre Paul Prud'hon, Théodore Chassériau and Auguste Raffet were other significant contributors to the art.

From 1820 to 1863 there appeared a monument to lithographic illustration in the form of Baron I. J. S. Taylor's *Voyages pittoresques et romantiques dans l'ancienne France,* with contributions by Isabey, Géricault, Célestin Nanteuil and many others.

The most prolific figure in 19th-century French lithography was undoubtedly Honoré Daumier, who, between 1830 and his death, in 1879, made nearly 4,000 caricatures. These appeared in the political journals and newspapers of his era and earned him an unshakable place in the great tradition of art and humour. Paul Gavarni followed closely as a chronicler of fashionable Paris.

A decline set in everywhere around mid-century, due not only to excessive commercialization of lithography but also to the newly developed technique of photography and its application to the various reproductive processes. A revival from this setback came about in the decade of the '70s. Camille Corot began working in the medium in 1871; his work includes 18 pieces. Edgar Degas tried lithography for the first time in 1874; a tireless innovator, he saw in it yet another outlet for his versatile talents. Édouard Manet, whose first work on stone was done in 1862, illustrated Poe's "The Raven" in 1875; Camille Pissarro made his first 12 lithographs in 1874. Rodolphe Bresdin created some lithographs, even transferring some of his etchings to stone. His pupil Odilon Redon practically abandoned painting for lithography from 1883 to 1899, creating eerie and mystical subjects.

Colour lithography, already used by Manet for his plate "Polichinelle" in 1876 and by Jules Chéret, a pioneer of the colour poster, reached its zenith in the 1890s. Henri de Toulouse-Lautrec, a technical innovator, a magnificent poster artist and a great portrayer of the theatre and the arts of the 19th century, executed his "Moulin Rouge"—his first colour poster—in 1891. To the Impressionists also, colour was all important; Édouard Vuillard was producing such colour masterpieces as his *Douze Lithographies en couleurs* during this decade; and Pierre Bonnard. his *Quelques Aspects de la vie de Paris.* Other powerful artists who turned their hands to lithography in the last quarter of the century were Paul Gauguin, Eugène Carrière, Pierre Puvis de Chavannes and Ignace Fantin-Latour.

England.—Lithography in England received its initial impetus from Senefelder himself and his business associates. In 1800 they went to London to obtain a patent and to arouse interest in the new process. The patent was obtained in 1801; the promotional effort took the form of a publication entitled *Specimens of Polyautography . . .* appearing in 1803. Several well-known artists contributed to this first example of lithographic production in England: Benjamin West, Henry Fuseli and Thomas Stothard among others. West's design of the angel at the tomb of Christ is dated 1801 and may be considered the first lithograph of true merit to have been produced.

Despite this promising start, the English did not seem to take to the new medium very readily. Charles Hullmandel issued a series of *Twenty-four Views of Italy* in 1818 and later, in 1821, brought out 12 designs of *Various Subjects Drawn From Life on Stone* by Géricault, who was in London at the time. James Ward did a series of 14 *Celebrated Horses* in 1823, and Richard Parkes Bonington executed some very accomplished colour lithographs, particularly for Baron Taylor's book. Other English artists, such as Samuel Prout, James Duffield Harding and Thomas Shotter Boys, helped continue the tradition; but the process fell into the general pattern of decline until revived in the latter decades of the century by the American expatriate James Abbott McNeill Whistler. Although his work seems slight—particularly his delicate nudes—his influence was strongly felt, perhaps because his colourful career gave an added interest to anything with which he concerned himself.

Elsewhere in Europe.—Lithography had but one important adherent elsewhere on the continent—the great Spanish painter and etcher Francisco Goya, who drew, in all, 23 lithographs. Among them are four bullfight scenes that are a landmark of technical virtuosity and compositional strength.

United States.—The first lithograph produced by an American was the one mentioned above by West in 1801, for he was actually an American working in England. So far as lithography on the American continent is concerned, however, the introduction of the process to the United States is credited to Bass Otis of Philadelphia, Pa. In 1818 Otis etched on stone a portrait of Abner Kneeland for a frontispiece to a book of sermons by that clergyman. However, a little view of a mill, appearing in the July 1819 issue of the *Analectic Magazine,* is regarded as the first true American lithograph. Rembrandt Peale was among the first artists to employ the medium. Other important early figures were Thomas Doughty; George Lehman, who lithographed scenes in Pennsylvania; J. C. Wild, who executed an important set of Philadelphia views; August Kollner; Christian Schussele, an influential art instructor; Albert Newsam, a deaf-mute artist and lithographer of hundreds of portraits; and M. E. D. Brown.

When reviewing lithography of the 19th century in the U.S.. there must be taken into account the tremendous output of the publishers Nathaniel Currier and James Merritt Ives, who produced well over 6.000 lithographs after the designs of such well-known artists as George Inness, A. F. Tait, Louis Maurer. F. F. Palmer. Eastman Johnson and many others (*see* CURRIER & IVES). The publishing houses of Sarony and Major, and the Kelloggs, were also prolific. Not to be forgotten is Winslow Homer, who made a strong contribution with his *Campaign Sketches* of the American Civil War.

20TH CENTURY

The painter-lithographer tradition again declined during the early part of the 20th century. French artists, such as Degas, Paul Signac, Auguste Renoir, Bonnard, Jean Louis Forain, Vuillard, Maurice Denis, T. A. Steinlen and Mary Cassatt, as yet unrecognized in her native America, seemed to be working in isolation so far as their work influenced the medium elsewhere. In England the Senefelder club was formed in 1909 to provide an outlet for artists working in lithography. Augustus John. John Copley, Ethel Gabain, Charles H. Shannon and William Rothenstein were a few who kept the art lively. In Germany the Expressionist school was coming to the fore. Though its work was not immediately understood or appreciated, it gradually received recognition as one of the most powerful molders of 20th-century art. Käthe Kollwitz, the Norwegian Edvard Munch, Lovis Corinth, Max Slevogt, Max Liebermann, E. L. Kirchner, Emil Nolde, Max Beckmann, Ernst Barlach, Oskar Kokoschka, Paul Klee, the American Lyonel Feininger and George Grosz were among the group that challenged the ideal of beauty by rugged emotional display.

In the United States Joseph Pennell, whose work both in the U.S. and England, as well as his book on lithography (1st ed., 1898), made him an important proponent of the medium, led a strong group followed by George Bellows, "Pop" Hart, Bolton Brown. Albert Sterner, Arthur B. Davies, Childe Hassam, Rockwell Kent and hlabel Dwight, as well as Max Kahn, Stow Wengenroth. Benton Spruance, Adolf Dehn, Francis Chapin, George Biddle, William Gropper and Robert Riggs.

During this century an exciting group of lithographs came from the leading painters of Mexico: José Clemente Orozco, Diego Rivera, David Alfaro Siqueiros, Jean Charlot and Rufino Tamayo. In England, where lithography never was very popular, the names of Graham Sutherland, Henry Moore and Robert Colquhoun stand out.

It was from the school of Paris. however, that a vigorous revival of lithography came. To those giants of painting, Henri Matisse. Marc Chagall, Georges Rouault, Fernand Léger, Georges Braque and, above all, Pablo Picasso, with his prodigious output, is owed the tremendous popularity of the medium. Their influence has been international not only in stimulating all the graphic arts but also in freeing them from superficial limitations of size, technique and other preciousness. The colour lithograph, along with other colour-print processes, now rivaled paintings in size and attractiveness.

Printers and Publishers.—It should be remembered that most of the work of the school of Paris came about through the availability of dedicated lithographic printers. In Paris the firms of Fernand Mourlot and "Papa" Desjobert, with their enthusiasm and encouragement. made possible much of mid-20th-century lithography, Their accomplishment, however, is a timeless one, for it has ever been true that the greatest flowerings of lithography have come about as a result of the dedication of a few printers serving many artists — stimulating and easing the way for the production of great lithographs. Senefelder himself spent his life spreading information on the technique that he invented and stimulating production through his ability to print. The names of Bolton Bronn, Lawrence Barrett and Lynton Kistler are to be remembered in the U.S.; Thomas R. Way, Whistler's printer in England, and before him. Hullmandel will not be forgotten. In France the names of Clot, Rose Joseph Lemercier, Godefroy Engelmann, Charles Motte, Delpech and Charles Philibert de Lasteyrie du Saillant will be recalled, as well as those of the publishers Ambroise Vollard and David Kanweiler. In Germany Paul Cassirer and the Marées society were important as publishers. (K. McN.)

TECHNIQUE

Lithographs are made as follows: (1) The stone is grained. (2) The outline of the picture to be reproduced is drawn on the stone. (3) The drawing is done with tusche or crayon containing grease. (4) The stone is etched. placed in position on the press bedplate and washed with turpentine. which removes the soap and wax from the tusche or crayon. (5) The stone is dampened and rolled (inked). The drawing on the stone repels the water. The thin film of nater on the bare parts, in addition to repelling ink, actually prevents the inked roller from touching those areas of the stone. Therefore, only those parts of the stone that have been drawn on with the grease material receive the ink, and all bare parts of the stone that have been moistened nith water do not take the ink and do not print. It is then covered first with a piece of dampened printing paper, then with backing. which consists of two or three clean blotters, next with the tympan (a piece of hard fibreboard) and printed. The stone is dampened and rolled for each successive print. Hundreds, or thousands if necessary, of prints can be made from a stone or zinc plate. Lithographs can be made in multiple colours by printing with coloured inks. using a separate stone for each colour.

The Stone. — The best lithographic stones come from Solnhofen and Kelheim in Bavaria. Of a form of limestone found deep in the earth, they are of even thickness and perfectly flat. Stones are classified according to colour: blue (hard), blue-gray (medium) and yellow (soft). Blue-gray stones are preferred by artists. Both stones and metal plates must be grained with an abrasive to prepare them for the drawing. Stones are grained by rubbing together in a circular motion two stones with wet carborundum grit between them. Their positions are occasionally reversed, and more grit and water are added until any former design has completely disappeared. The size of the grit determines the texture of the drawing surface. Care must be taken to protect the stone from grease, dandruff. saliva or fly specks. A piece of cloth. tissue or a barrel stave is used as a bridge to prevent the hand from touching the stone while the artist is working on it.

The Drawing. — A nongrease crayon is used to sketch the outline of the drawing on the stone. The drawing should be reversed. since a print comes off the stone as a mirror image of the drawing.

Several drawing techniques are used in making lithographs. Lithographic crayons are supplied in both stick and pencil form in a wide range of grades from no. 0 (very soft) to very hard Copal no. 5. Tusche is supplied in bottles and in stick form. The liquid kind, often called ink, makes solid black areas nhen applied with a brush, and thin, sensitive lines when applied with a pen. Stick tusche, uhich must be dissolved in water. is used for wash lithographs called lithotints and for dry-brush lithographs. Smutty, close-grained dark grays are made by rubbing dark areas with a piece of felt or by scraping and shaving with a razor blade. Razor blades are used to soften hard. dark edges and sometimes are used to lighten or scrape out parts and make interesting textures. When a lithograph is to have a solid, dark-gray undertone for the background, such a tone can be laid on the clean, blank stone with a lightly inked composition roller Parts of the tone can be scraped away or washed out with gasoline to make light areas, and dark areas can be added with tusche and crayon.

Areas can he lightened and textured by laying a piece of tissue paper on the stone and crosshatching over it with a lead pencil or stylus When the tissue paper is peeled off some of the crayon will adhere to the underside of the paper. Crisp white lines are scratched into dark areas with sharp-pointed tools: razor blade, needle, penknife. etc. The result often resembles a wood engraving. Sharp tools are useful for making dark tones lighter by picking out some of the dots that make up the tone. Small areas can be erased by placing a pinch of carborundum grit or flint on the spot and regrinding with the flat bottom surface of a glass bottle stopper. Striking textural effects are obtained by use of an ink eraser.

To make a lithographic engraving, a fairly soft stone is grained with extra fine carborundum grit or flint. The stone is lightly etched. smoothed nith cloth and dried. The drawing is made with a lithographer's engraving needle. which has five facets. Wide shallow lines are made by pulling the needle — not pushing it — to scratch through the gum, barely into the stone. Errors are corrected by applying a thin gum covering. which then can be engraved again. When the engraved drawing is finished, first light machine oil. then lithographic ink, is rubbed in. The printing is done in the usual way, described below.

Lithographic printing is a difficult and complicated operation and is usually done by a professional printer rather than by the artist.

The Etch. — Before printing, lithographs must be etched. to set the drawing to the stone, and cleaned of excess grease that has spread out from the drawings. The etching solution for stones is prepared by pouring a few ounces of gum solution. *i.e.*, about equal parts by volume of water and gum acacia, into a small bowl and adding half a teaspoonful of nitric acid. The gum solution desensitizes the surface not drawn on, decreasing its affinity for grease; the acid eats away any invisible particles of grease that may be on the surface but, when in the correct solution, does not affect the drawing itself. which is protected by the wax in the lithographic crayon. Etching solution is applied to the stone with a large soft brush.

The amount of acid required for the etch solution depends upon many factors. such as room temperature, hardness of the stone, type and age of the drawing and strength of the acid. Often, some parts of the drawing that require a stronger etch than other parts must be gone over with a brush and a stronger solution.

Printing. — Having properly etched the stone, the printer removes the excess gum with a rubber plate scraper and fans it dry. Then he gently rubs it with a damp cloth and a few drops of gum solution. After it has dried, the printer washes off the crayon drawing with turpentine and a soft cloth, leaving the drawing invisible. apparently destroyed; but it is preserved. of course, in the grease still remaining in the pores of the stone. He then rubs ink or asphaltum into the stone. As soon as this has dried, the stone is sponged with water and rolled with a grained roller well charged with lithographic ink. Lithographic ink comes out of pound cans in tarlike chunks; it must be kneaded and thinned with lithographic varnish before using. A small amount is spread onto a slab of stone. and the roller is charged with ink by rolling it briskly over this slab until it produces an audible hissing sound

A lithograph is printed on a specially constructed press, which has a traveling bedplate that carries the freshly inked stone with dampened paper. backing and tympan under a leather-covered scraper. When the crank is turned. the inked image is rubbed or scraped off the stone onto the paper as it is forced through the press. The scraper is kept well greased to reduce friction. Lithographic presses weigh several hundred pounds.

The first few prints "pulled" (printed) are light. because the stone has absorbed some of the first ink applied. Printing can be interrupted at any time to make corrections. Small areas can be scratched out or lightened with a razor blade and the areas lightly swabbed with a 2% solution of phosphoric acid When additional work is to be added, the stone must first be counteretched. This is done by inking the stone, dusting it with rosin to dry the ink and washing it with a saturated solution of alum (called counter-etch solution). The new work is added and the stone etched again. Then the whole process of preparation and printing is done exactly as before.

If the prints keep getting darker as the edition progresses, the stone must be re-etched. To do this the printer inks it, dusts it. etches it again, washes it out and prints it as before. If the stone is to be put away for future printing, it should be rolled, dusted, etched very lightly and covered with thin paper while wet.

Transferring. — Many print makers prefer to draw lithographs on paper and have a printer transfer the drawing to stone or zinc for printing. Such transfers often require some additional work to be done on the plate or stone. either by the artist or printer before printing. Transfer lithographs are easily identified because their texture is like the paper they were drawn on. Special transfer papers are available. but any thin paper will do. When an artist draws on paper for transfer he does not have to reverse the drawing. The drawing medium must contain grease.

The drawing must be softened by soaking it for a few minutes in a tray filled with a solution of about 30 drops of nitric acid for each quart of water. The stone or plate used for the transfer must be larger than the print, smoothly grained and warmed slightly. The lithographic press is used to transfer a drawing to the stone. In transferring the drawing while still moist, it is placed face down on the stone or plate and covered with aluminum foil, backing and tympan. The press is adjusted and set for extra pressure to make transfers.

The drawing, when transferred to stone or plate, will appear weak. but some of the grease will have penetrated the stone, and the design will come up stronger when it is printed. Transfer lithographs should be lightly etched before printing; otherwise they are printed in the same manner as originals. Sometimes transfer lithographs darken during the printing and must be etched again.

Metal Plates. — Lithographs can be made in the same manner on zinc or aluminum plates, which are bought already grained. Metal plates are preferred by some artists because of their convenience in handling. They are very sensitive to grease and are especially suitable for transfers and for lithotints. The technique for drawing on zinc is the same as for drawing on stone. Textural effects are limited. The metal is hard and cannot be scraped or scratched for corrections.

The process for preparing plates varies slightly from that used for stones. After a zinc or aluminum plate has been drawn upon, it is regummed and dried. Then it is etched, washed out with turpentine and nater, rubbed up with asphaltum, washed with water, rolled with ink and printed without being allowed to dry again until the edition has been printed.

The etch solution for zinc plates is about 4 oz. of gum solution and 1 tsp. of chloric acid and 12 drops of phosphoric acid; for an aluminum plate, 4 oz of gum arabic and 15 or 20 drops of phosphoric acid. Commercial preparations are sold for etching zinc and metal plates.

See also ETCHING; references under "Lithograph" in the Index volume; and articles on most of the artists mentioned in this article. (L. BA.)

See Felix *H.* Man, ***150*** *Years of Artists' Lithographs* (1953); *J. and* E. R. Pennell, *Lithography and Lithographers* (1915).

LITHOGRAPHY is one of the most widely used methods of printing. In its usual commercial or industrial application it is known as offset lithography because the inked image is first printed on a rubber cylinder, which then offsets or transfers the image to paper or other material. The process is also known as photolithography, photo-offset, offset and planography. Because of the flexibility of the rubber cylinder, lithography can be used to print on tin, wood, cloth, leather and rough, as well as smooth, paper. For a discussion of lithography as an art farm, *see* LITHOGRAPH.

In lithography the matter to be printed is neither raised above (as in letterpress) nor sunk below (as in intaglio) the surface of the plate but remains on the surface, or plane. For this reason the process is sometimes called planography. Lithography is based upon the principle that grease and water do not mix: ink is deposited on grease-treated printing areas, while the nonprinting parts, which hold water, reject the greasy ink.

Lithography is used mainly to produce printed matter that is required in large quantities; *e.g.,* calendars, greeting cards, bank checks and deposit slips, booklets, letterheads, books, magazines, newspapers, maps, posters, billboards, stamps, labels on tin cans, packaging and other advertising matter. Posters can be lithographed on rotary presses either by offset or by direct printing from the plate. Since most posters require strong colour, direct presses are usually used.

Offset lithography is particularly advantageous in long runs (over 10.000) of large-sized sheets. Only gravure can compete with it in certain types of work. Letterpress plates cannot be made so large as offset plates, while silk-screen and collotype methods are suited, for other reasons, mainly for short press runs. *(See* PRINTING PRESS.)

History. — The lithographic process was invented by Aloys Senefelder (*q.v.*) of Munich, Ger., in 1798. Senefelder had experimented for several years in an effort to discover a cheap method of printing plays and sheet music. In making the first lithographs he used a variety of calcium carbonate stone (limestone) that is found mainly in Bavaria; it has a porous texture that absorbs grease and water. He also suggested the use of grained metal plates. *i.e.,* plates treated so as to give them a granulated surface, but they did not come into general use until the 20th century, when they gradually replaced Bavarian limestone. However, stone is still preferred by artists for making hand-printed lithographs.

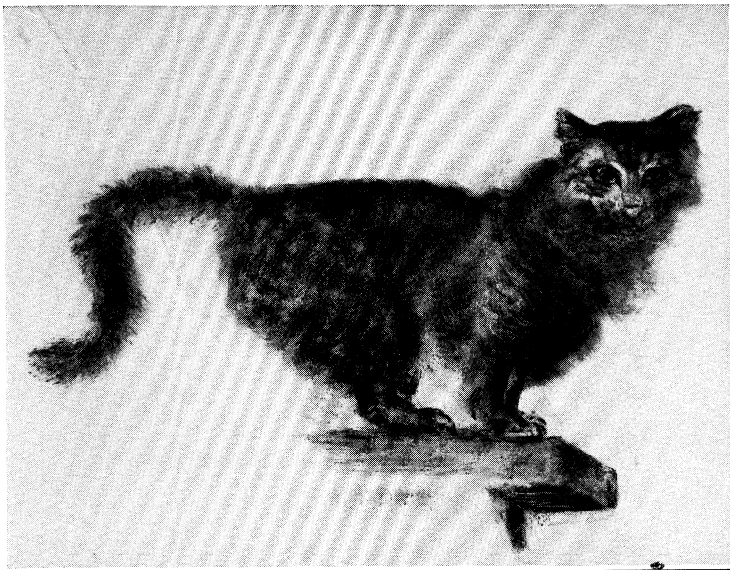
Up to 1818, when Senefelder published a technical description of lithography, the process was used sparingly because the procedural techniques were kept secret. Artists in England, France and Germany published work from 1803 on, but the first lithograph in the United States, drawn by Bass Otis, was not published until 1819 (in the *Analectic Magazine).* After 1825 lithography advanced rapidly.

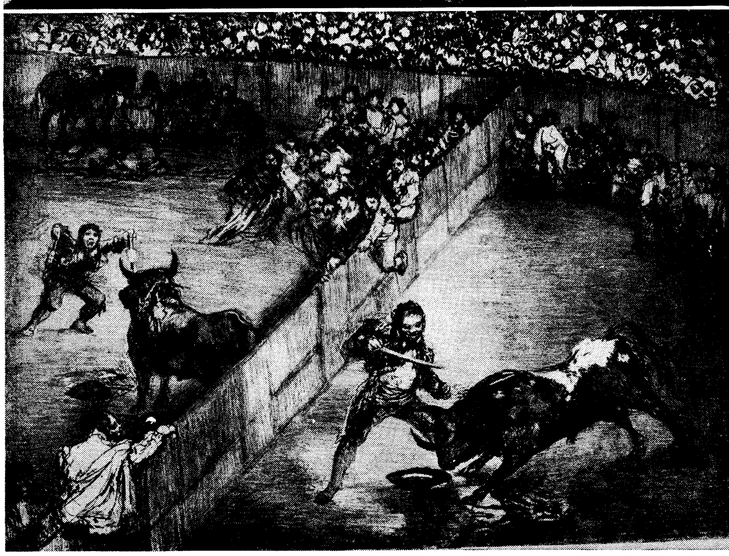
Many firms were established for producing a variety of commercial work and for distributing popular topical, historical and religious subjects to a wide audience. The best known of these publishers was Currier & Ives (*q.v.*) of New York. The firm was founded in 1857, although Nathaniel Currier published work from 1834 on. The lithographs were printed in black ink and were often hand-coloured by an assembly line of women, each of whom applied a separate tint of water colour.

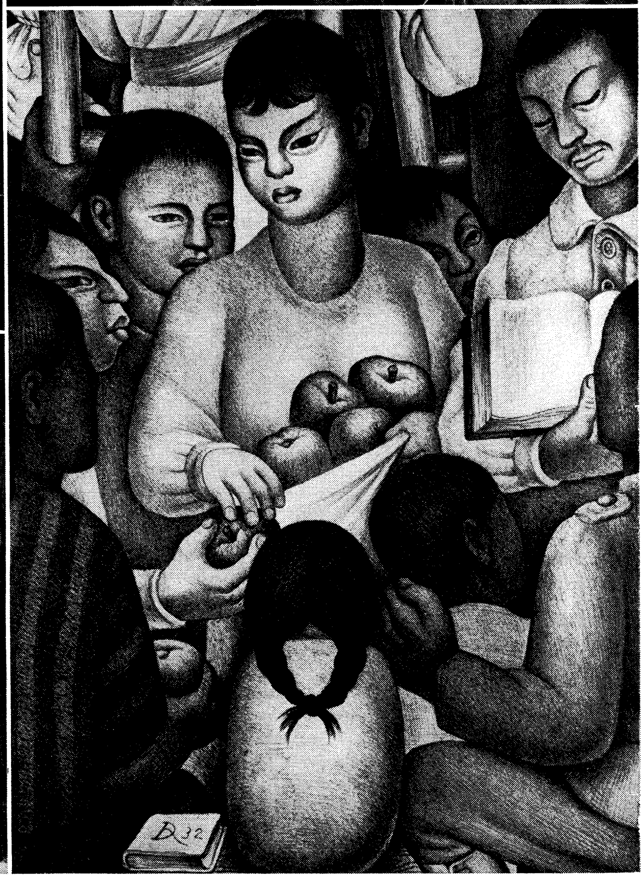
Some good early work was done in colour lithography (using printed colours) by Godefroy Engelmann in 1837 and Thomas S. Boys in 1839, but the method did not come into wide commercial use until 1860. It then became the most popular method of colour reproduction for the remainder of the 19th century. These products were called chromolithographs. chromos or oleographs. They were made by preparing a separate stone by hand methods for each colour (tint) to be used and printing one colour in register over another. Sometimes as many as 30 stones were employed for a single subject.

The steam-driven lithographic press was perfected by Hughes & Kimber of England about 1865 and introduced into the United States in 1866. These presses utilized automatic rollers to moisten and ink the stone, while the paper was pressed into contact by a revolving cylinder. P. S. Duval, writing in the *American Encyclopaedia of Printing* (1871), said that about 450 hand presses and 30 steam presses were in operation in the country at that time. The power press made it possible to print larger stones than ever before, with sizes up to about 44 by 64 in. Although the offset method of printing was first patented by John Strather of England in 1853, the first practical application of this principle came in the 1870s. when rubber offset rollers were used on flat-bed presses for printing on tin and other metals.

The rotary press for lithographic printing came into use in the late 1890s. Lightweight zinc sheets, which could substitute for the heavy stones, were curved around cylinders for rotary printing. Two main cylinders were used, one for carrying the plate and the other for carrying the paper. Early rotary presses could







BY COURTESY OF (TOP LEFT, TOP RIGHT) LAWRENCE BARRETT, (CENTRE LEFT, BOTTOM LEFT) PHILADELPHIA MUSEUM OF ART, (BOTTOM RIGHT) THE CLEVELAND MUSEUM OF ART, GIFT OF THE PRINT CLUB OF CLEVELAND

19TH- AND 20TH-CENTURY LITHOGRAPHS

Top left: "Angora Cat" by Lawrence Barrett (1897–), U.S. Drawn on stone with dry brush and tusche

Top right: "Girl With a Bouquet" by Peppino Mangravite (1896–), U.S. A combination of scratching, scraping and drawing, with most of the middle tone applied by roller and ink

Centre left: Still life by Pablo Picasso (1881–), Spanish. Crayon drawing with some scratching

Bottom left: "Bull Fight" by Francisco Goya (1746–1828), Spanish. Crayon on stone

Bottom right: "Tree of Life" by Diego Rivera (1886–1957), Mexican

LITHOGRAPH

BY COURTESY OF (TOP LEFT BOTTOM LEFT, BOTTOM RIGHT) THE CLEVELAND MUSEUM OF ART (TOP LEFT GIFT OF THE PRINT CLUB OF CLEVELAND (BOTTOM LEFT) GIFT OF RALPH KING (BOTTOM RIGHT) MR AND MRS LEWIS B WILLIAMS COLLECTION (TOP RIGHT) THE COLORADO SPRINGS FINE ARTS CENTER

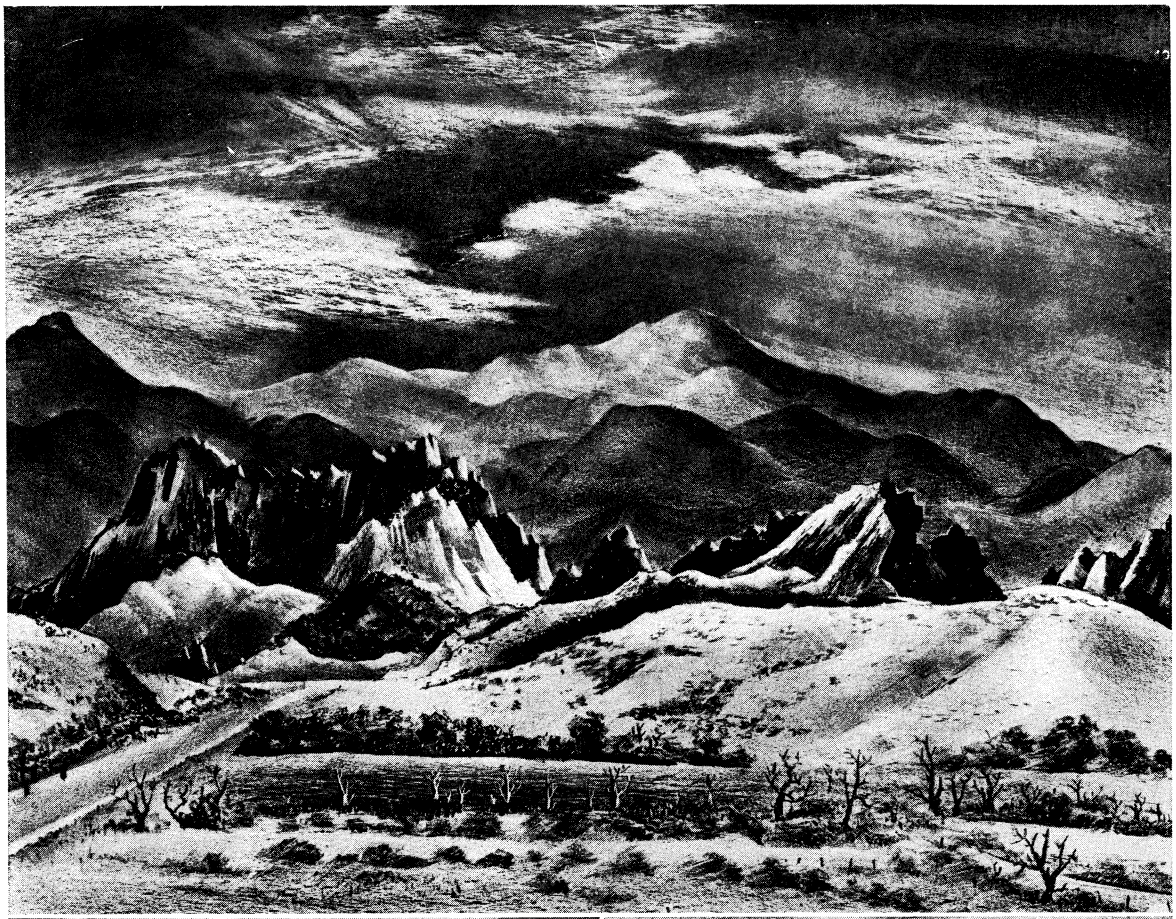
LITHOGRAPH TECHNIQUES

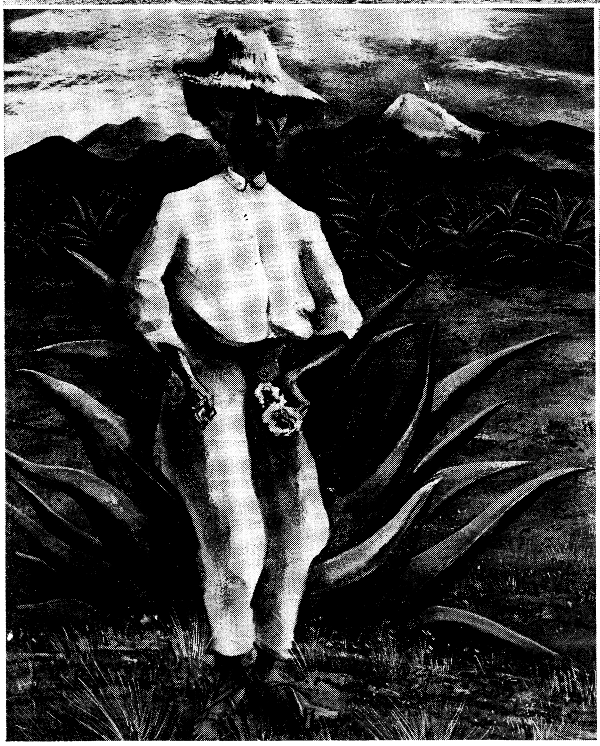
Top left: Self-portrait by Käthe Kollwitz (1867–1945), German. Drawn on paper and transferred to stone

Top right: "Rabbit" by Rico Lebrun (1900–), U.S. Stone rolled with ink for middle tones. Highlight was scraped out and crayon drawing added

Bottom left: "May Belfort" *by* Henri de Touiouse Lautrec (1864–1901), French. Crayon drawing with tusche

Bottom right: "Figure in a Doorway" by Thomas Stothard (1755–1834), English. Pen drawing with tusche





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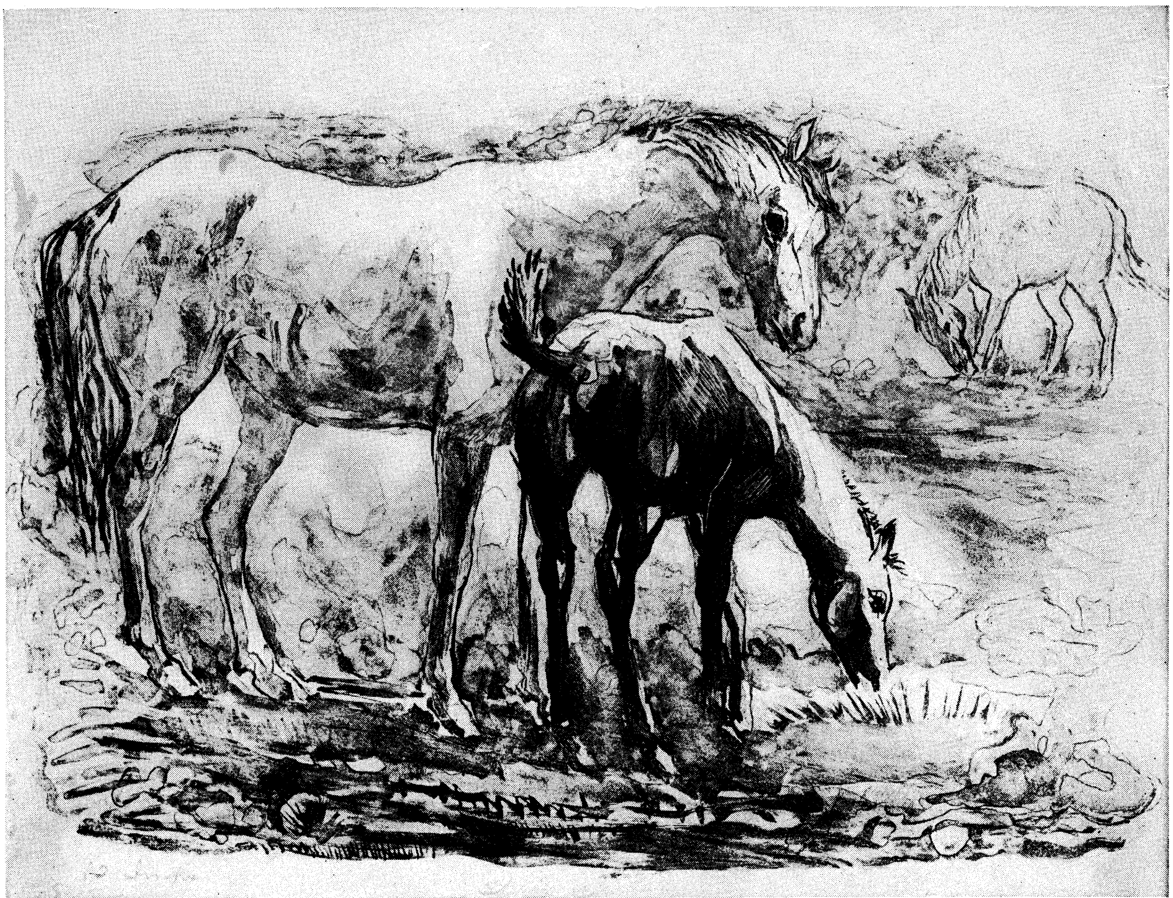
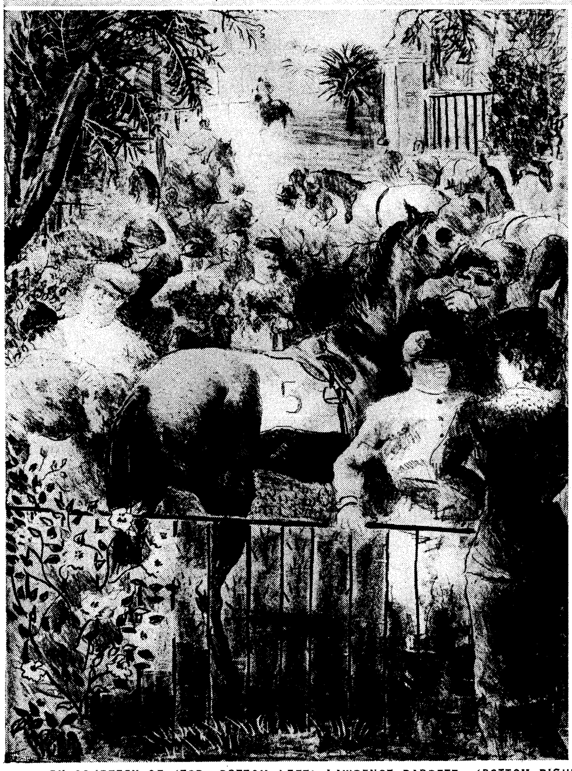
U.S. AND FRENCH LITHOGRAPHS

Top: "The Garden of the Gods" by Adolf Dehn (1895–), U.S. Textural effects in the sky were obtained by rubbing with an ink eraser, in the mountains and rocks by scraping *Bottom left:* "The Man From Orizaba" by Dehn. Done on stone with crayons, a piece of felt, a razor blade and eraser *Bottom right:* An illustration for an edition of Shakespeare's "Hamlet" by Eugène Delacroix (1798–1863), French. A typical 19th-century use of crayon on stone





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LITHOGRAPH STUDIES OF MEN AND HORSES

Top: "Spring" by Lawrence Barrett (1897–), U.S. Lithotint on stone

Bottom left: "Unsaddling Paddock — Hialeah" by Randall Davey (1887–), U.S. Crayon with felt rubbing and some scratching and scraping

Bottom right: Book illustration by J. L. Géricault (1791–1824), French. An early lithograph done on stone print about 1,100 impressions per hour, about double the performance of the flat-bed power press then in use.

As soon as photography became a practical process in 1839 because of work by Louis J. Daguerre of France and William Henry Fox Talbot of England, efforts were made to adapt it to lithography. Among early experimenters nho reproduced line drawings were Joseph Dixon of the Cnited States in 1840 (his technical description, however. was not published until 1854) and Frédéric Zurcher of France in 1842.

Late in 1852 Rose Joseph Lemercier, a Parisian lithographer, together with Charles Barreswil, Nicolas P. Lerebours and Louis Alphonse Davanne, made the first photolithographic half tones (prints in a gradation of tones). They used bitumen of Judea (asphalt) for sensitizing the surface of a grained lithograph stone and developed the image, made through a paper negative, with ether. This slow, expensive and dangerous method was superseded by the albumin process patented by Alphonse Poitevin in 1855: this process, which was essentially the same as the albumin process still used in the early 1960s, employed dichromated solutions of albumin, gum or gelatin as light-sensitive coatings.

In 1857 Eduard I. Asser in Holland invented the phototransfer process, which he patented in England in 1860. In this process a photographic image on sensitized paper is inked and transferred to the printing surface. Henry James of England, in 1859, first used grained zinc to replace stones in making phototransfers. J. W. Osborne of Australia improved the transfer process in 1859 and made it commercially feasible for reproducing engravings, pen and ink drawings, maps and other line work.

James A. Cutting and Lodowick H. Bradford made the first lithographic half tones in the United States, in 1858. The first use of the half-tone screen in lithography was made by Edward and James Bullock of England in 1866. They employed a glass surface or a translucent paper sprinkled with opaque dots. These produced half-tone prints with a granular texture

William A. Leggo of Canada made half tones in 1869 through a glass screen coated nith darkened collodion and ruled with crossing lines drawn with a diamond point. The resulting prints had a dot structure similar to that made from a modern half-tone screen. (This is composed of two sheets of glass, each covered with fine lines runaing in a diagonal direction; the sheets of glass are fastened together so that the lines form right angles. The resulting crosslined squares break up a reflected image into dots of varying sizes. depending upon the amount of light that penetrates the transparent squares.)

Offset methods for printing on paper were developed separately in the United States shortly after 1900 by Ira W. Rubel of New Jersey. Alex Sherwood of Illinois and A. W. and Charles Harris of Ohio. Rubel, in collaboration with Sherwood, made the first good press in 1906; this later became the Potter press. The Harris brothers, about one month after the Rubel press appeared on the market, made the first press to be commercially exploited. Many of the initial steps in improving offset lithography were taken by William C. Huebner of the United States, who developed the precision all-metal camera, step-and-repeat machines (widely used to produce multiple images on an offset plate) and plate-coating machines.

The use of colour half tones, which was limited before 1920. expanded rapidly after that date because of the introduction of improved methods of dot etching and improved techniques of registration (superimposing one colour over another) The new etching method permitted better tone control by making it possible to reduce the size of the dots when desired.

Offset presses vary greatly in size. The largest can accommodate sheets as large as 52 by 76 in. and can print up to six colours in a single run. Paper can be fed from a roll (web printing) and cut to the desired size in the press after printing. Usually. however, single sheets are fed in. Some offset presses can print on both sides of the paper simultaneously.

Hand Methods. — The method of preparing stones for hand printing. which is still the lithographic method preferred by artists, has remained substantially unchanged since Senefelder's time. The materials and procedures of the 19th-century lithographer are duplicated in almost every respect by the contemporary hand printer. Three types of stone are used: blue-gray, gray and yellow. The latter, which is very soft, is for coarse work only. The stone is grained to provide an even texture for receiving the drawing. This is done by sprinkling a hard. powdered abrasive. such as flint or carborundum, on the stone. adding water as a lubricant and rubbing with another stone in a flat, rotating motion. After the graining is completed, the drawing is made on the stone or is transferred from a sheet of specially prepared paper. The stone is etched by brushing on a solution of gum arabic (acacia) and nitric acid; the solution also desensitizes the surface to, *i.e.*, lowers its affinity for, grease. Next the stone is rubbed with a solution of gum arabic, the drawing is washed off with turpentine and the stone is rubbed with asphalt (asphaltum) to strengthen the greasy areas. Finally, the stone is coated with water and inked for printing.

The printing is done on a press that exerts a sliding or scraping pressure. The pressure is exerted through a bar of wood that is immovably fixed at the top and is covered at the bottom by a strip of greased leather. The stone to be printed is covered with dampened paper and a flexible backing board and is placed on the press bed, which is then raised by a lever to make firm contact with the scraper. The printer moves the bed horizontally, and the paper is pressed against the inked stone by the sliding pressure of the scraper. When the scraper reaches the end of the stone. the bed is lowered and the backing board and the inked paper are removed.

Types of Plates. — There are four basic types of offset plates: paper. albumin, deep-etch and bimetallic. Copy can be typed directly on special paper for printing on small office-type presses; such plates can produce 5,000 to 10,000 copies under average conditions. The albumin and deep-etch processes, which employ photographic techniques, are for longer runs. Albumin plates can produce up to 25.000 impressions; deep-etch plates are capable of several times this number. Bimetallic plates, which also are made photographically. are extraordinarily durable, being capable of printing more than 1,000.000 impressions. These plates are made from two different metals, one of which holds water and repels grease, while the other, which composes the printing image. attracts greasy ink.

Preparation of **Copy** and Plates. — Photolithography: since it is a duplicating process, requires material to reproduce. This material. which is known as copy. can consist of typographic matter. water colours, oil paintings, line drawings, hand lettering and photographs, either alone or in combination.

Copy is usually prepared as a paste-up that combines type matter with other line copy (black and white. such as line drawings). The type matter is taken from proofs ("repro proofs") of type that are made on high-quality proof presses especially constructed for reproduction ("repro") purposes. Type matter also may be taken from photocomposition. (See TYPESETTING: *Filmsetting.*) If photographs and other tone copy are to be included in the plate. their position and size are indicated on the paste-up by outline. A photographic negative is then made of the paste-up. This can be enlarged or reduced as desired.

A negative of the tone copy (photographs or wash drawings) is made separately in a camera that holds a half-tone screen. which breaks up the tone image into tiny dots. The half-tone negative is cropped to proper size; *i.e.*, the size that fits the space left for it on the paste-up. The line negative and the half-tone negative are "stripped" (fastened) together on a glass-topped layout table over a light. This unit (combination of line and half-tone negatives) is placed on a sheet of paper called "goldenrod" because of its colour; the goldenrod is translucent enough to be seen through on a layout (stripping) table but opaque enough to block light during exposure for platemaking. Openings are cut in the goldenrod paper where the negatives are positioned. The negatives are then fastened in place with opaque cellophane tape. The entire layout. or flat, is now ready for exposure on the thin. light-sensitive. albumin-coated metal plate.

The zinc or aluminum plate is grained or roughened to produce a foundation that will hold the sensitized coating firmly. hold water in the nonprinting parts and prevent the ink from spreading in the printing areas. The usual method of graining is to fasten the plate in a trough. cover it with water and an abrasive, such as sand or carborundum powder, and add a layer of steel marbles. The trough is geared to move horizontally and slightly up and down. This causes the marbles to roll and rub the abrasive into the plate, thus creating a fine, even texture. Plates are sometimes grained by chemicals — a hot solution of a monobasic salt of phosphoric acid, *e.g.*, monobasic sodium phosphate, for zinc and a hot solution of sodium hydroxide or aluminum potassium sulfate for aluminum. Most lithographic printers purchase and use pregrained plates rather than graining their own.

The grained plate is thoroughly washed and then counteretched, usually in a solution of acetic acid or hydrochloric acid. Counteretching removes dirt and metal oxides and sensitizes the plate to. *i.e.*, increases its affinity for. grease. Some shops etch the plate to make it more water receptive. The plate is now coated with a solution of albumin and light-sensitive ammonium dichromate. This operation is carried out on a machine that whirls the plate and spreads the coating evenly. The entire layout, or flat, is placed on the sensitized plate, and both plate and layout are locked in a vacuum frame, from which the air is withdrawn to ensure close contact for sharp photographic printing. The frame is exposed to strong light. usually from an arc lamp. which penetrates the transparent areas of the negative (type. lines and half-tone dots) and hardens the albumin underneath. The albumin under the opaque areas of the negative and the goldenrod paper remains soft and water soluble.

Exposure is often made on a photocomposing, or step-and-repeat, machine. This device produces multiple images of the original subject on one large plate. After an exposure is made! the subject is moved to the next position and again exposed. This procedure is continued as long as desired. or until the entire plate is covered. Since the machine is a precision instrument, with accuracy to one-thousandth of an inch. it is particularly valuable in colour work in which exactness of register is essential. All kinds of copy can be handled by this machine. which also is adaptable to all other photographic printing processes.

The exposed plate is then rubbed with greasy developing ink to strengthen the printing image. After the developing ink is washed off with water. which also removes the soft albumin, the plate is etched with a solution of gum arabic. This desensitizes the bare grained metal to grease and dissolves any albumin that might cling to the edges of the image. Cellulose gum (sodium carboxymethyl-cellulose\. which often is substituted for gum arabic. produces a more durable printing surface. The plate is now ready for printing.

Plates made by the deep-etch process can be used for longer runs than plates made by the albumin process. The printing areas of deep-etch plates are slightly below the surface of the plate. These plates. therefore. hold more ink and are less subject to wear. This platemaking method differs slightly from the albumin process. The plate is sensitized in the usual may but in the vacuum frame is exposed behind a positive rather than a negative. It is then developed with a lactic acid solution to remove the unhardened coating. Next it is etched in the image areas to eat away the bare metal: the light-hardened film is not affected. After being washed with anhydrous alcohol to remove the etch, it is dried and covered with lacquer. After being developed in the usual way, the plate is scrubbed with water to remove the light-hardened film that covers the unetched portions. These unetched areas will hold water in printing, while the etched areas will hold the ink.

Printing. — Offset printing is done on a press that is composed, basically. of three rotating cylinders — a plate cylinder, to which the metal plate is fastened; a blanket cylinder covered by a sheet of rubber; and an impression cylinder that presses the paper into contact with the blanket cylinder. The plate cylinder comes in contact first with a series of moistening rollers that deposit a thin film of water in the granulations of the bare metal. A series of inking rollers then passes over the plate. The ink is rejected by the water-holding areas but is accepted by the greasy image. after which it is transferred to the rubber blanket. This inked image (type. drawings, half tones) is then offset to the paper traveling around the impression cylinder.

Decalcomania. — Decalcomanias are designs that are printed on specially prepared paper to form films that can be transferred to any surface. These films, which usually are called decals (transfers), are widely used for decorating and labeling any objects that cannot be run through a press. Decals are made in a variety of ways. depending upon the needs to be served. The regular decal applied to such objects as typewriters and trucks, for example. begins with a sheet of porous paper coated with a solution of starch, albumin and glycerin. The design that will be seen is printed first; several coats of opaque white. which will not be seen after application, are then added: and the decal is finished with a coat of water-soluble glue called "stickative." When the decal is moistened and applied to the object, to which it adheres. the moistened backing paper is removed, and the design becomes permanently affixed. The stickative becomes water resistant soon after application.

Decals applied to windows are printed in reverse order. The layers of opaque white ink are printed first and the design last in order to be seen when in contact with the glass. Decals for china and kitchen ranges are printed with mineral colours and are fired to resist heat.

Office Offset Presses. — Small offset presses. or duplicators, are used in offices. as well as in printing shops. They can print on sheets from 3 by 5 in. to $9\frac{3}{4}$ by 14 in. at speeds from *3,000* to *6.000* impressions per hour. Paper-base plates, or masters. can be made by typing with a special ribbon or by drawing. writing. tracing or lettering with a special pencil or ink. Corrections can be made with an ordinary eraser. For reproducing photographs, type and illustrations. zinc or aluminum plates are prepared as in the standard commercial offset method. However, these images appear rather gray because they require heavier inking than can be supplied by the duplicator's inking mechanism. The press is especially useful for printing office forms. sales letters and other matter on letterheads. Numerous kinds of paper-base plates have been developed for short or long runs, and plastic plates have come into use.

See also PRINTING: POSTER: *Beginnings of the Modern Posier;* PHOTO-ENGRAVING: *Halftone Plates.*

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(J. KA.)

LITHOPONE, a mixture of barium sulfate, $BaSO_4$, and zinc sulfide. ZnS, in approximately equal molecular proportions used as a white pigment in the manufacture of paints. *See* PAINTS. CHEMISTRY OF.

LITHOSPHERE, the solid crust of the earth (Gr. *lithos*, "a stone," and *sphaira*, "a sphere"). Below the loose soil and subsoil is solid crustal bedrock, which consists of such sedimentary rocks as sandstone and limestone, resting on a thicker base of igneous and metamorphic rocks. These materials form an outer granitic layer from 6 to 20 mi. thick. Below is a second somewhat thicker stratum probably composed of a basaltic rock. These two layers form the earth's crust. Beneath them is heavier rock that may be partly molten. The earth's crust is affected by tectonic movements which are manifested by folds and breaks in the crustal rocks and by the rise of molten lava which may erupt at the surface in volcanoes. (W. E. P.)

LITHUANIA (Lith. LIETUVA, Pol. LITWA, Ger. LITAUEN), a country of northeastern Europe, bounded north by Latvia, east and southeast by Belorussia, south by Poland and west by the Kaliningrad *oblast*, Russian S.F.S.R., U.S.S.R., and the Baltic sea.

The territory so defined forms the so-called ethnic Lithuania. Historic Lithuania covered a far larger territory, comprising the whole of Belorussia and, for a time, part of the Ukraine. From Aug. 3. 1940, ethnic Lithuania was a component republic of the U.S.S.R.

Physical Geography. — The country is flat and low lying, its northwestern half being less than 300 ft. above sea level. while the southeastern half lies between 300 ft. and 600 ft. above sea level. In the west there is hilly land with a highest altitude of 748 ft. south of Siauliai, but the highest point in Lithuania is a hill of 843 ft. west of Trakai (Troki). The country is overlaid with glacial deposits. in some places 400 ft. thick. The typical bottom moraine. with erratics from Finland. extends over most of it, and glacial furrows. striae and elongated troughs run northwest and southeast. as do the eskers. Sand dunes extend along the shores of the Baltic. The Lithuanian plain is chiefly watered by the Niemen (Nemunas), which rises in Belorussia and empties into the Kuronian gulf. Its right-bank tributaries are the Neris (Wilia) and Dubysa (Dubissa). In the north the Musa is an affluent of the Latvian Lielupe river, while another Latvian river. the Venta, has its source south of Telsiai. Nearly 2.000 small lakes, Drysviaty being the largest, dot the landscape. The climate varies from maritime along the coast to modified continental in the east. Centrally located Kaunas has an average temperature of 23.3° F. in January and of 65.3" F. in July, with an average precipitation of 24 in. For four months of the year the temperature is usually below freezing point and 160 days are rainy, half of these in late summer. Except for a little alluvial soil, principally near the major rivers, most of the country's farmland is low in organic material.

In 1939 forests covered about 17% of the area, while 49% was arable land, 25% meadows and pastures and 8% peat bogs, marshes and swamps. The most important trees are fir (40%), pine (28%) and aspen (13%); but birch, alder and oak are of some consequence. More than 226 kinds of birds. 35 kinds of wild animals, 12 kinds of amphibians and 7 kinds of reptiles are native. Especially common are hares, foxes, wolves, badgers, squirrels, deer, wild hogs and otters. Elk, beaver, grouse and black stork became almost extinct during World War I. About 40 species of fish can be enumerated in the fresh waters, while the Kuronian gulf is rich in brill, whiting, smelt, sole and herring. There are no mineral resources worth mentioning.

HISTORY

Lithuanians belong to the Baltic group of nations, which included also the Prussians to the west and the Latvians to the north. The Prussians were exterminated by the Teutonic Order in the 13th century. The Latvians, together with the Finno-Ugrian Estonians, were conquered during the first three decades of the 13th century by the German Knights of the Sword who in 1237 joined the Teutonic Order. (See ESTONIA.) The Lithuanians. protected by the primeval forest which almost entirely covered their land, resisted the German pressure. However, Samogitia (Lithuanian Zemaitija), the cradle of the Lithuanian people. lying between Prussia and Livonia, two lands already in the hands of the Teutonic Order, was an object of German covetousness. Under this threat the Lithuanian tribes united in the middle of the 13th century under Mindaugas (Mendog or Mindove). He and his family were baptized in 1251 and two years later, in his capital at Kernave (Kiernow) on the Neris, he was crowned the first and only king in Lithuanian history by the authority of Pope Innocent IV. Mindaugas was assassinated in 1263 and the Lithuanians returned to paganism.

In the second half of the 13th century Traidenis (Trojden) was the ruler of Lithuania (1269–82). He probably was the founder of the dynasty known as that of Gediminas or Gedymin (*q.v.*). Under Mindaugas, shortly after the destruction of Kievan Rus by the Tatars, Lithuania began to expand eastward and southward to the lands inhabited by Belorussians, but Gediminas was the real empire builder of what later became known as historic Lithuania. He made Vilnius (Wilno) the capital in 1323. When he died in 1341, Lithuania's frontiers extended across the upper Dvina to the northeast, to the Dnieper to the southeast and to the Pripet marshes in the south. The warlike but small Lithuanian nation could not colonize this vast territory. but it maintained its control over it because the ruling class had shown an undoubted political talent and a spirit of religious toleration.

Gediminas divided his empire among his seven sons. Soon, however, only two remained to continue their father's policy of expansion. Algirdas (*q.v.*), who had Vilnius as his capital. succeeded to the title of grand duke and undertook the defense of Lithuania against the Tatars and Muscovy; Kestutis (Kiejstut), with his seat at Trakai, reigned over ethnographic Lithuania and as such defended it against the Teutonic Order. Algirdas died in 1377 and left to his son Jagiello (Jogaila) an empire including Kiev, which came under Lithuanian suzerainty in 1361 or 1363. Jagiello's position was difficult because in 1381 his uncle Kestutis drove him from Vilnius, proclaiming himself grand duke of Lithuania. His Orthodox elder brothers tried to convince him that Lithuania's interests lay in an alliance with Muscovy and accession to the Orthodox Church, while his pagan younger brothers recommended a pro-Polish policy with acceptance of Roman Catholicism. In 1382 Jagiello defeated Kestutis.

Polish-Lithuanian Union. — The German danger was great because in 1365 the Teutonic Knights took Kaunas and from 1378 the whole of Samogitia was in their hands. The feud between Jagiello and Kestutis' son Vytautas (Witold or Witowt, *q.v.*) was a further complication. Having escaped from Jagiello's prison, Vytautas found sanctuary in the Teutonic Order's land. On Aug. 14, 1385, at Kreva (Krewo), Jagiello concluded with Polish ambassadors an agreement that he would forever unite Lithuania and Rus with the Polish crown if he could marry the 12-year-old Queen Jadwiga of Poland and become king of Poland. Jagiello went to Cracow, was baptized on Feb. 15, 1386, receiving the name of Wladyslaw, married Jadwiga and on March 4 was crowned king of Poland.

The Lithuanians outside the German-occupied Samogitia were baptized by the Polish clergy in 1387. In 1392 a reconciliation took place between Jagiello and Vytautas. who became lieutenant governor of Lithuania. A great warrior. Vytautas dreamed of the conquest of Moscow and destruction of the Golden Horde. To consolidate his rear, in 1398 he confirmed the cession of Samogitia to the Teutonic Order, but on Aug. 12, 1399, on the Vorskla river, suffered a defeat at the hands of the Tatars. His eastern dream having vanished, Vytautas became more inclined to accept Jagiello's policy of turning in concert against the Teutonic Order.

In 1401 new Polish-Lithuanian agreements were concluded at Vilnius and confirmed at Radom between Jagiello and Vytautas and between the two estates. The Lithuanian boyars promised that in the event of Vytautas' death they would recognize the king of Poland as the grand duke of Lithuania, while Polish nobility accorded to Vytautas the title of grand duke of Lithuania, declaring that if Jagiello died without an heir they would not elect a new king without consulting the Lithuanians. Almost immediately after these agreements. Vytautas supported the revolt of the Samogitians against the German rule. The knights replied by a military expedition against the grand duchy. As the Poles and the Lithuanians were not yet in a position to risk a major war, Samogitia had once more to be abandoned (1404). Five years later, however, a new Lithuanian rebellion was in progress. Once more the order accused Vytautas of treachery and asked the Poles whether they would assist the Lithuanians again. Grand Master Ulrich von Jungingen was informed of the absolute solidarity between the two nations. A great war was inevitable.

The claim of the Teutonic Order to be combating Polish-Lithuanian "pagans" deceived many a western European knight into moving east to save Christianity. The decisive battle, one of the most important in European history, took place on July 15, 1410, at Grunwald, near Tannenberg, and Polish-Lithuanian forces inflicted a crushing defeat upon the order. German supremacy in the Baltic countries was broken, although the first peace treaty of Torun (Thorn), concluded on Feb. 1, 1411, was a moderate one. Samogitia returned to Lithuania until the death of Jagiello and Vytautas. On Sept. 27, 1422, however, the order was forced to agree that Samogitia, by now baptized, was Lithuanian forever.

In the meantime, at Horodlo, on Oct. 2, 1413, a new pact of union was concluded between Poland and Lithuania. The principles of the union remained unchanged, but the autonomy of the grand duchy was made permanent: after Vytautas' death the king of Poland would appoint another grand duke in agreement with the representatives of both countries. Vytautas died on Oct. 27, 1430, and Jagiello on May 31, 1434, but the latter was survived by the two sons he had by his fourth wife, Zofia (Sophia) Holszanska, a Lithuanian princess whom he married in 1422. His second son, Casimir IV (1447–92), king of Poland and grand duke of Lithuania, continued the struggle against the Teutonic Order and his efforts were crowned by the second treaty of Torun (Oct. 14, 1466) when the order had to restore Pomorze to Poland. After the death of Casimir a crisis arose in Polish-Lithuanian relations because the Lithuanian boyars elected grand duke Casimir's son Alexander, while the Poles chose his brother John Albert (Jan Olbracht). The Polish-Lithuanian personal union lapsed, but, on the death of John Albert in 1501, the Lithuanians insisted that their grand duke should be king of Poland too.

The Poles agreed and the senates of the two countries decided at Piotrkow that thenceforth the king of Poland should always be grand duke of Lithuania. The Teutonic Order was no longer a menace, but in the east there appeared another and greater danger. Ivan III, the grand duke of Muscovy, in 1480 assumed the title of sovereign of all Rus and the major part of historic Lithuania was Belorussian-speaking. Belorussian was the language in which was written the statute of the grand duchy adopted in 1529 (revised in 1566 and 1588).

On July 1, 1569, at Lublin, a common Polish-Lithuanian sejm or parliament transformed the personal union into a real one. In the course of the ensuing two centuries both the Lithuanian and Belorussian nobilities of historic Lithuania became Polonized, but the two peasantries continued to use their own languages. On the eve of the partitions of Poland, the grand duchy of Lithuania covered an area of 120,500 sq.mi. with a population (1791 est.) of about 3,850,000. There were 1,420,000 Belorussians (36.9%), 1,005,000 Poles (26.1%), 770,000 Lithuanians (20%), 385,000 Jews (10%), 140,000 Russians, 95,000 Latvians (in Latgale), 30,000 Germans and 5,000 Karaims. From the point of view of religion this population comprised 1,500,000 Uniates, 1,470,000 Roman Catholics, 250,000 Orthodox, 140,000 Raskolniki (dissidents from the Orthodox Church), 60,000 Protestants, 385,000 Jews, 40,000 Moslems (Polish or Belorussian-speaking Tatars) and 5,000 Karaims.

Under Russian Rule.—While at the first (1772) and the second (1793) partitions of Poland only Belorussian lands of the grand duchy of Lithuania were annexed by Russia, at the third partition (1795) ethnic Lithuania suffered the same fate, the only exception being the province of Suwalki, the northern part of which was Lithuanian speaking, which became part of Prussia, now the name of a German kingdom. In 1806 Suwalki was incorporated into the duchy of Warsaw, which in 1815 was annexed by Russia. The congress of Vienna added to the style of the Russian tsars the titles of king of Poland and grand duke of Lithuania.

Under Russian rule historic Lithuania comprised six provinces (gubernyas): Vilnius (Vilna in Russian), Kaunas (Kovno), Grodno, Minsk, Mogilev and Vitebsk, with a governor general residing at Vilnius. When the Poles rose against Russia in 1830–31 the insurrection extended to the Lithuanian provinces before it was suppressed. The Polish rising of 1863 also spread into Lithuania and its repression there was particularly severe, 180 insurgents being hanged and 9,000 deported to Siberia.

On March 25, 1839, the Uniates were forced to join the Orthodox Church and the next year the Lithuanian statute was replaced by Russian codes. The tsarist government treated the "Territory of the Northwest"—as historic Lithuania was called after 1832—as an integral part of Russia. From 1864 to 1905 the policy of Russification extended to every domain of public life. It was forbidden to publish newspapers, periodicals or books in Polish or Belorussian, while books in Lithuanian could be printed if the Russian alphabet was used. Russian was the only language of teaching in the schools. The Roman Catholic religion was persecuted.

Lithuanian Renaissance.—The Lithuanian people resisted the policy of Russification because they remained faithful to ancient language and traditions, and to their religion. By abolishing the serfdom of peasants throughout the empire in 1861, the tsarist government hoped that in the lands inhabited by non-Russian populations a wedge would be introduced between the peasants and the gentry and that the former, by acquiring the right to be proprietors, would be more easily Russified. The Russians hoped that such a process would be easier in Lithuania proper where the landlords were mainly Poles. It was a miscalculation. Besides the clergy, a new Lithuanian intelligentsia of peasant origin began to emerge in the 1880s. In 1883 Jonas Basanavicius (1851–1927), a country doctor, launched the first Lithuanian newspaper, Ausra ("Dawn"): published at Tilsit (East Prussia) and smuggled into Lithuania. Ausra was suppressed three years later, but in 1889 was replaced by *Varpas* ("Bell"), edited by Vincas Kudirka (1858–99); it continued to appear until 1904.

When the manifesto of Oct. 30, 1905, granted freedom of speech to the peoples of the Russian empire, two daily newspapers appeared at Vilnius, one Polish (Kurjer *Litewski*) and one Lithuanian (*Vilniaus Zinios*). On Dec. 4–5, 1905, Basanavicius called a congress of about 2,000 delegates to Vilnius. The congress demanded territorial autonomy for Lithuania with a democratically elected *seimas*. The frontiers of the national Lithuanian state were to be drawn according to the freely expressed wish of the peoples concerned. Soon afterward the teaching of Lithuanian language in schools was granted.

Independence Restored.—During World War I the Germans occupied a great part of historic Lithuania. On Sept. 18, 1915, the German armies entered Vilnius. The German government authorized the gathering at Vilnius, on Sept. 18–22, 1917, of a congress of 200 Lithuanian delegates and the election of the 20-member *Lietuvos* tnrybu or council of Lithuania. The congress called for an independent Lithuanian state within the ethnographical frontiers and with Vilnius as capital. As the leaders of the tnryba (Antanas Smetona [*q.v.*], Steponas Kairys, Jurgis Saulys and others) rejected all idea of union or federation with Poland, the local Poles refused to co-operate with the *taryba*. On Feb. 16, 1918, the taryba proclaimed an independent Lithuanian state and the dissolution of all political connections that had existed with other nations. Germany recognized this on March 24 with the proviso of a "perpetual alliance" of Lithuania with the reich. On July 11 the crown of Lithuania was offered to Wilhelm von Urach, a Roman Catholic duke of Wurttemberg, but the offer was withdrawn on Nov. 2, and the final solution of the question of the form of government mas referred to the constituent assembly. Meanwhile, the supreme power was vested in a three-man presidium (Smetona, Fr. Justinas Staugaitis and S. Silingas) which on Nov. 5 designated Augustinas Voldemaras (1883–) as the first premier of independent Lithuania. He formed a government on Nov. 11, 1918.

Lithuania was still under German occupation, but when the German troops had evacuated Vilnius, the city was entered on Jan. 5, 1919, by the Red army and a Communist Lithuania government, appointed by the All-Russian Central Executive committee on Dec. 23, 1918, was installed. It was headed by Vincas Mickevicius-Kapsukas (1880–1935). The Voldemaras government moved to Kaunas which, on Jan. 17, however, was also occupied by the Red army. The Germans remained in the western part of Lithuania, which from Feb. 1919 was controlled by the German army under Gen. Count Rudiger von der Goltz.

The *Polish-Lithuanian* Dispute.—Marshal Joseph Pilsudski, the head of the restored Polish state, proposed two alternatives for Lithuania. Either an independent state might be set up within purely ethnographic frontiers, that is, without Vilnius and its region which had a Polish majority, or a larger state including Vilnius; but in the latter case some sort of a federal link with Poland would be indispensable. On April 20, 1919, the Polish army led by Pilsudski took Vilnius from the Red army, which enabled the Lithuanians to re-enter Kaunas. In the following summer the Polish forces moved to the Dvina in the north and to the Berezina in the east. Against Lithuania they occupied the demarcation line fixed by the Inter-Allied committee presided over by Marshal F. Foch. This "Foch" line. adopted by the Supreme council on July 27, 1919, ran to the west of the Grodno-Vilnius-Daugavpils railways and more or less coincided with the eastern ethnographic frontier of Lithuania. On July 12, 1920, when the Polish army was retreating, the Kaunas government concluded in Moscow a peace treaty by which the Soviet Union "ceded" to Lithuania not only Vilnius, but also Lida and Grodno. After Pilsudski's final victory, the Red army, which occupied Vilnius on July 14, left it on Aug. 26 while the Lithuanian army entered the city. On Sept. 5, 1920, the Warsaw government appealed to the League of Nations. A Polish-Lithuanian conference met at Suwalki and a partial armistice was signed on Oct. 7. Nevertheless Pilsudski ordered Gen. Lucjan Zeligowski to seize Vilnius. with its mainly Polish population, and this was done on Oct. 9. Zeligomski set up a government of central Lithuania. A new armistice. restoring the Foch line, was signed on Nov. 29, 1920.

Meanwhile the council of the League of Nations had made many attempts to settle the Polish-Lithuanian dispute. The last of the series was a Polish-Lithuanian conference which opened in Brussels on April 20. 1921, at which a plan for a Lithuania composed of two cantons, Kaunas and Vilnius. each with separate self-government, and federated with Poland, was recommended. But the Lithuanians wanted Vilnius without any ties with Poland. Zeligowski then ordered elections to be held in central Lithuania on Jan 8, 1922, to a special diet of 106 members which would decide the future of the area in dispute; 55% of the inhabitants took part in the poll in Vilnius city and 65% in the province. On Feb. 20, 1922. the diet voted for the incorporation of the province with Poland. However, under the treaty of Versailles, the principal Allied powers had to determine the Polish frontiers that remained undefined. In the Polish-Soviet peace treaty signed at Riga (March 18. 1921), the Soviet government had declared its disinterestedness in the Polish-Lithuanian dispute. The council of the League of Nations, on Feb. 3, 1923, adopted a final resolution fixing a Polish-Lithuanian line of demarcation almost identical with the Foch line, leaving the decision as to the frontier to the Conference of Ambassadors in Paris. On March 15, 1923, the Conference of Ambassadors recognized the line of Feb. 3 as the final frontier between the two states. Lithuania, however, refused to accept this decision. (See also VILNIUS.)

Foreign Relations. — Lithuania was received into the membership of the League of Nations on Sept. 22, 1921. On Sept. 28, 1926, a Soviet-Lithuanian treaty of nonaggression was signed in Moscow. On Sept. 12, 1934, at Geneva, a treaty of good will and cooperation was concluded by Lithuania. Latvia and Estonia. Lithuania's relations with Germany were jeopardized by nazi propaganda in the Klaipeda (Memel) territory.

In March 1935, at a trial of Klaipeda nazis, most of the accused were found guilty of high treason. On March 17, 1938, Poland demanded of Lithuania the immediate opening of the frontier, acceptance of the cession of Vilnius and the establishment of normal diplomatic relations. Lithuania yielded to these demands. In February and May 1938 the Lithuanian government released the convicted nazis and in October abolished martial law in the Klaipeda territory. On Dec. 11, at the election of the Klaipeda *Landtag,* the nazis won 25 seats out of a total of 29. On March 21, 1939, Lithuania was presented with another ultimatum which meant the loss of its only port. (See also MEMEL.)

Home Politics.—On April 4, 1919, Smetona became provisional president of the republic and Kazys Slezevicius (1890–), a Social Democratic leader, succeeded Voldemaras as premier. On May 15, 1920, the newly elected constituent assembly met at Kaunas and its right-centre majority elected as president Aleksandras Stulginskis, the leader of the Farmers' union. On Aug. 1, 1922, a democratic constitution was adopted providing for a seimas of 80 elected for three years by proportional representation. As the *seimas* elected on Nov. 12, 1922, had no clear-cut majority, it was dissolved and a new election on June 5, 1923, restored the right-centre majority. The election of May 8-10, 1926, gave a small majority to the left-wing parties. On June 7, 1926, Kazys Grinius (1866–1950), the leader of the Peasant party, was elected president while Slezevicius became premier. However, in the night of Dec. 16-17, 1926, a coup d'état took place in Kaunas. It was prepared by the small Nationalist party and backed by the army. Grinius resigned and Smetona was elected president; Voldemaras was again premier. On May 15, 1928, he issued a new constitution which was to be submitted to a national referendum within ten years; but on Sept. 19, 1929, he was forced to resign and his Fascist organization, the Iron Wolf, was dissolved. Smetona was now in full control. Voldemaras, attempting to regain power in 1934, was arrested and imprisoned for high treason committed with German support, but was granted an amnesty in 1938. A new constitution, adopted on Feb. 12, 1938, was to provide the basis for a return to parliamentary institutions.

Independence Lost.—A secret protocol to the German-Soviet treaty of nonaggression of Aug. 23, 1939, stipulated that in the event of a territorial and political rearrangement in the areas belonging to the Baltic states, the northern boundary of Lithuania should represent "the boundary of the sphere of influence of Germany and the U.S.S.R." During the German-Polish war German diplomacy made frantic efforts to induce Lithuania to attack Poland so that the former might thus become an ally and protégé of the reich. Lithuania chose to remain neutral and the secret protocol to the German-Soviet treaty of Sept. 28, 1939, revised the previous agreement by deciding that "the territory of Lithuania falls on the sphere of influence of the U.S.S.R."

First Soviet Occupation. — On Oct. 10, 1939, a mutual assistance treaty was signed in Moscow, in accordance with which Lithuania was compelled to admit Soviet garrisons and to grant air bases. The Vilnius area was given to Lithuania, but was limited to 3,680 sq.mi. with a population of 549,000. (The province of Vilnius "ceded" by the U.S.S.R. in 1920 had measured about 12,450 sq.mi. and had a population of 1,275,000.) On June 15, 1940, however, Lithuania was confronted with an ultimatum demanding immediate formation of a "friendly" government. On the same day the country was occupied by the Soviet army. Smetona fled to Germany and later left for the United States. (He died in Cleveland, O., on Jan. 9, 1944.) Antanas Merkys, the premier, Stulginskis, the former president, and many other Lithuanian leaders were arrested and deported to Siberia. An obscure journalist, Justas Paleckis, became premier. A rigged election of July 14–15 produced a seimas which, on July 21, unanimously requested the incorporation of Lithuania in the Soviet Union. On Aug. 3, 1940, the Moscow supreme soviet readily acceded to the request and Lithuania was declared a constituent republic of the U.S.S.R. In the night of June 14–15, 1941, 30,455 members of the Lithuanian intelligentsia were deported to Siberia. Including other deportees and about 5,000 political prisoners executed at the time of the hasty departure of the Soviet forces, the country suffered during the first Soviet occupation a loss of about 45,000 people.

German Occupation.—A few days after the German attack on the Soviet Union (June 22, 1941) the whole of Lithuania was in German hands. On July 17, 1941, Hitler announced the creation of the "Ostland" province including the three Baltic states and Byelorussia. The commissioner general for Lithuania was Adrian von Renteln who, on Aug. 5, dissolved the provisional government formed on June 23. A policy of German colonization was inaugurated and by July 1943 about 4,700 German families were settled in Lithuania. The Germans executed almost all Lithuanian Jews.

Second Soviet *Occupation.*—Vilnius was taken by the Soviet army on July 13, 1944, and by the end of the year Lithuania was again under Soviet occupation. Fleeing before the Soviet armies, about 80,000 Lithuanians reached the western zones of Germany, but about 60,000 were rounded up in the eastern zone and sent to Siberia. In Lithuania proper, during 1945–46, about 145,000 Lithuanians were removed from their native land. The third mass deportation, ordered in connection with the forced collectivization of agriculture, took place on March 24–27, 1949, when about 60,000 Lithuanians were sent to north Russia or Siberia.

POPULATION AND ECONOMY

Territory and Population.— In its frontiers from 1923 to 1938 the area of Lithuania was 55,670 sq.km. or 21,494 sq.mi., including the Klaipeda (Memel) territory (1.081 sq.mi.). Between 1923 and 1939 the population of Lithuania, excluding Klaipeda, rose from 2,029,000 to 2,441,800. The latter figure included 2.056,100 Lithuanians (84.2%), 78,100 Poles (3 2%), 185.600 Jews (7.6%), 61.000 Russians (2.5%), 47,000 Germans and 14,000 others. The population of the Klaipeda territory was estimated in 1938 at 154,000, including 86,000 Lithuanians, 59 000 Germans and 9,000 Jews. In March 1939 Lithuania lost Klaipeda. but in October it gained the Vilnius territory (3,680 sq.mi.), nhose population was estimated at 549,000, including 369 000 Poles, 84,000 Jews, 61.000 Lithuanians, 17,000 Russians. 15,000 Byelorussians and 3,000 others. At that time Lithuania had an area of 24,093 sq.mi. with a total population of about 2,990,800. After World War II Klaipeda returned to Lithuania, which now covered an area of 65,200 sq km. or 25,174 sq.mi.

Normally, that is, without deportations and war losses, the total population within post-1945 frontiers would have been about 3,032,000. Of 447,100 Poles perhaps 100,000 were deported during the first Soviet occupation; between 1946 and 1948 about 178,-000 were repatriated to Poland. The number of Lithuanians living in Lithuania fell between 1939 and 1949 from 2,203,100 to about 1,809,000. According to official Soviet sources, the population of Lithuania in 1959 was 2,713,000.

Vilnius, the capital, in 1931 had 196,345 inhabitants, including 128.600 Poles, 54,600 Jews and about 2,000 Lithuanians; by 1959 its population had increased to 235.000, including about 80,000 Russians, 70,000 Lithuanians and 40,000 Poles, Kaunas had in 1959 a population of 214.000, Klaipeda (1959) 89,000, Siauliai (1959) 60,000 and Panevezys (1957 est.) 37,100.

Religion.— According to the 1923 census, excluding Klaipeda, Roman Catholics formed 80.5% of the population, Protestants 9.5%, Orthodox 2.5% and Jews 7.3%. In the Klaipeda territory were 91.7% Protestants and 5.3% Roman Catholics. In April 1926 the Vatican declared Lithuania a church province with an archbishop at Kaunas and four bishops at Vilkaviskis, Telsiai, Kaisedorys and Panevezys.. According to a Vatican source, by July 1950, out of 1,332 clergy left free until 1947, about 1.000 had been arrested and deported.

Education.--On Jan. 31, 1938, there were 2,599 primary schools with 5,613 teachers and 301,188 pupils. There were 100 secondary schools with 19,939 pupils as compared with 38 schools and 9,213 pupils in 1919. There were also eight institutions of higher education, including Kaunas university, with a total of 4,400 students. In 1955 there were about 3,200 primary schools with 430,000 pupils, 230 vocational schools with 21 5,000 pupils. 110 secondary schools with 35,000 pupils, and 14 institutions of higher education (including the universities of Vilnius and Kaunas) with 4,500 students.

National Economy.— Before World War II Lithuania was a predominantly agricultural country and in the 19jos still kept this character, although industrialization had made great progress. In 1938 about 2,742,600 ha. were arable land. The land reform of Feb. 16, 1922, fixed 80 ha. as a maximum limit for a farmstead; it expropriated 717,968 h a belonging to about 2,300 large landowners (Poles, Russians and Germans) and created about 45,000 new farms. Although the entire agricultural land was divided into about 287,380 small and medium farmsteads of from 4 ha. to 24 ha., agricultural production considerably increased.

After World War II agriculture was collectivized. In 1950 there were 6,549 collective farms; by 195j they were reduced to 1,795 bigger ones. But production in the mid-1950s was believed to have dropped by 60% as compared with the 1937–39 annual averages.

Peat is the only national fuel, reserves of hydroelectric power are modest and timber and flax are the main local raw materials. In 1946 the country had 2,192 industrial enterprises, but food processing formed about a half of the total value of industrial production. The production of electricity amounted in 1950 to about 190,000,000 kw.hr. In 195j plans were adopted for a hydroelectric power station at Petrasunai, near Kaunas, on the

Table I.—*Agricultural Production*
(in metric *tons*, pre-1939 area)

Crop	1909–13	1919–23	1937–39
Rye	496,700	523,700	627,200
Wheat	85,300	75,800	242,800
Barley	158,800	161,000	276,500
Oats	265,900	288,300	406,100
Potatoes	795,900	1,407,600	2,327,500
Flax, fibre	24,200	22,500	28,700

Table II.—*Livestock*

Item	1913*	1919*	1925*	1938*	1950†
Cattle	918,000	480,000	1,339,000	1,004,000	657,000
Pigs	1,138,000	750,000	1,488,000	1,117,000	1,005,000
Sheep	1,152,000	806,000	1,455,000	1,224,000	293,000
Horses	451,000	280,000	497,000	521,000	227,000

*Pre-1939 area. †Post-1945 area.

Niemen river, which, when completed, was to produce annually about 350,000,000 kw.hr. Between 1939 and 1951 the number of persons employed in agriculture was reduced from 1,126,100 to 975,400, while the number employed in industry and handicrafts rose from 153,300 to 370,800.

Finances.—The 1939 budget of independent Lithuania was balanced at 341,785,274 lits. The lit, a national currency introduced on Aug. 16, 1922, was worth 10 U.S. cents, but in 1935 it rose to 16.67 U.S. cents. In Dec. 1939 the note circulation was 165,930,000 lits. After the annexation of the country by the U.S.S.R. the lit was exchanged at the rate 0.90 roubles= 1 lit. Under the Soviet regime Lithuania, as every other soviet socialist republic. contributed to the common budget and from the total revenues of the union a certain part was allotted to local expenditure. In 1953, for instance, the total revenue from Lithuania amounted to 4.081,500,000 roubles, but only 1,j10.801.000 roubles were allotted to the republic's budget. In 1956 the allocation was 1,908,122,000 roubles.

Communications.—In 1948 the country had 2,087 km. of railways, including j26 km. of narrow gauge. Except for about three winter months, the Niemen is navigable from Kaunas to Klaipeda (260 km.) for steamships and throughout its length within Lithuanian frontiers for floating and rafting. The port of Klaipeda was entered in 1938 by 1,544 vessels totalling 910,819 net registered tons, as compared with 789 vessels of 303,000 net registered tons in 1913. Annual goods traffic in the port in 1935–38 averaged 630,000 metric tons. including 145,000 tons in export.

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(K. Sm.)

LITHUANIAN LANGUAGE. The Lithuanian language, spoken by over 3,000,000 people, primarily in Lithuania, but also by numerous emigrants in the U.S.. Canada. South America, Australia and Siberia, belongs to the Baltic branch of the Indo-European family. It did not become an official administrative language until 1918.

History.—Although not officially recognized, a literary language had been in existence since the 16th century. The earliest Lithuanian text, which is also the earliest Lithuanian document, is a translation of a Polish Protestant Catechism (1547) by Mosvydas (Mosvidius or Mažvydas, d. 1563). All Lithuanian writings of' the 16th century are of religious character. The most important for the study of the language is the *Postilė* of 1599 by Mikalojus

Daukša (1527–1613). The language differs in many respects from modern Lithuanian: longer endings (especially in the dative plural), a directive and an adessive case, strong Slavonic influence in vocabulary and syntax differences in accentuation. Essentially the same characteristics are found in the language of the first half of the 17th century as represented by Constantine Sirvydas (1579–1631), the first Lithuanian lexicographer.

The Lithuanian literary language, from its beginning through the 19th century, is not uniform, but is based on the dialects of the various authors The dialects are divided into two main groups, Low Lithuanian or Shamaitish (sometimes called Samogitian) and High Lithuanian or Aukshtaitish. High Lithuanian is more archaic. Modern standard Lithuanian is based on the southern subdivision of the West High-Lithuanian branch, which is also the language of the Prussian Lithuanian pastor-poet Christian Donalaitis-Donalitius (1714–80). In the 19th century however, three literary languages were competing for recognition: (1) a Low-Lithuanian form. mainly represented by Dionizas Poška (1757–1830), Simon Stanevičius (1799–1848), Simon Daukantas (1793–1864), and Bishop Matthew Valančius (1801–75); (2) the East High-Lithuanian poetic language of Bishop Anton Baranauskas (1835–1902); and (3) the West High-Lithuanian language used in various underground publications as well as in East Prussia. The dialect used by Donalaitis was elevated to a standard language for all of Prussian Lithuania by the grammarian and lexicographer Friedrich Kurschat (1806–84) whose work was seconded by G. H F. Nesselmann (1811–81) and August Schleicher (1821–68). In the 1880s, Jonas Jablonskis (1861–1930), born in Suvalkų Naumiestis (not far from the former Russian-German border), became interested in his own native language while studying at the University of Moscow under F. Fortunatov (1848–1914), and began to study it with the help of Kurschat's and Schleicher's grammars. Jablonskis became the "father of the modern Lithuanian standard language." based on his own dialect.

Characteristics.— Lithuanian is highly inflected, mith eight cases. nominative (*miẽstas* "city"), genitive (*miẽsto*), dative (*miẽstui*). accusative (*miẽstą*). vocative (*miẽste*). instrumental (*miestù*), locative (*miestè*). illative (*miẽstan* "into the city"). In the modern standard language there are also remnants of a directive case (*galóp* "toward the end") and an adessive case (*Dieviẽp* "with God"), both of which occur regularly in the texts of the 16th and 17th centuries. There are three numbers: singular, plural and dual (the latter optional). In the nominative singular the nouns. which are grouped into five declensions, have one of the following endings: -as, -is, *-ys, -a, -ė*, -i, *-us, -uo*. There are regularly two grammatical genders (masculine and feminine) with some traces of the Indo-European neuter in the adjective. No article is used with nouns. Adjectives appear in two forms: indefinite and definite. While otherwise very conservative, the language is unexpectedly progressive in the formation of the comparative and superlative degrees of the adjectives and adverbs, there being no irregular comparison. The illative, directive and adessive cases are innovations which did not exist in the Indo-European parent language. While the Old Lithuanian (16th century) locative plural in *-su* is apparently inherited from Indo-European, the modern locative plural in -se is a former illative; *i.e.*, the accusative case extended by means of a postposition

The inherited verbal system is simplified to some extent. There are only four simple tenses: present, future (formed with *-s-*), preterite or past, and imperfect or habitual preterite. Each of these tenses forms only an indicative. There is only one subjunctive (derived from the infinitive) for all tenses. The imperative is formed from the infinitive and the infinitive ends always in -ti (*eĩti* "go," *dúoti* "give," *darýti* "do." dirbti "work," etc.). Lithuanian, like Sanskrit, is rich in participles. There are two sets of participles (active and passive) for the present, future, and preterite; the imperfect has only an active participle. The passive participles are used in the formation of the passive voice. Like Russian and Polish, Lithuanian makes a rigid distinction between durative and perfective aspects, but it differs by not using the perfective aspect as a substitute for the future tense. The reflexive verb is highly developed. While in the main the Lithuanian verb continues the Primitive Indo-European &conjugation (thematic verbs), there are some traces of the mi-conjugation (nonthematic verbs). As in declension, there are three numbers also in conjugation (dual optional). On the other hand, there is only one form for the third person of the three numbers in each of the tenses.

Lithuanian is extremely rich in diminutives and endearing forms which are derived from nouns and adjectives alike. Diminutive nouns may express either smallness or affection or even contempt, while diminutive adjectives express intensification of the meaning. The strong emotional appeal of the diminutives supplies the language with effective poetic expressions and gives the Lithuanian folk-songs their appeal. The vocabulary is immensely rich, abounding in onomatopoetic formations. The language is possessed of a continually productive creative power; no dictionary can ever include all Lithuanian words.

The word accent is free. It is not indicated in the orthography, except in grammars and texts especially prepared for students. There is no general rule fixing the accent; nor does the main stress alnays remain on the same syllable throughout the whole paradigm. Furthermore dialects vary widely in their accentual systems. The standard accent of every Lithuanian word, with all indications necessary to ascertain its shifts in various paradigms, is given in the Lithuanian-German dictionary (see Bibliography, below).

Lithuanian is written in the Latin alphabet with 32 letters, some of which are conventional letters supplied with diacritic signs. All consonants, except j (= y as in "you"), have a hard or velar and a soft or palatalized pronunciation. There are roughly 11 different vowels (monophthongs), 6 short and j long, all of them clear cut without any diphthongization. There are also the diphthongs ai, *au*, ei, *ui*, ie, *uo*, and the combinations (treated as diphthongs) al, ar, *am, an*, el, er, *em, en, il*, ir, *im*, in, *ul, ur, um, un*.

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LITHUANIAN LITERATURE. The beginning of the history of Lithuanian literature was, in comparison mith that of other European peoples; greatly retarded. Although in the 13th and 14th centuries the Lithuanians had already created a great empire extending from the Baltic to the Black sea, yet in state affairs their native language was not used in writing but gave place to Ruthenian (Byelorussian) and, in later centuries, Latin. This circumstance undoubtedly impeded the use of Lithuanian in literature. Only in the 16th century did the temporary spread of Protestantism in Lithuania and the complementary Roman Catholic Counter-Reformation engender concern for the popular welfare and so create more favourable conditions for development. Lithuanian literature may be divided into four epochs.

1. The first known Lithuanian printed book is the Catechism of M. Mažvydas (Konigsberg, 1547). Later there appeared the religious writings of J. Bretkūnas (J. Bretke, 1535–1602). In 1701 the New Testament mas published and in 1727 the entire Scriptures. Until 1700 books were almost exclusively of a religious character. There are, however, several publications outside this category, among which the first dictionary of the Lithuanian lan-

guage, K. Sirvydas' *Dictionarium trium linguarum* (1629), is noteworthy. To this epoch belong 8 j authors and 70 publications.

2. In the 18th century religious literature was mingled with books of a secular tendency, including grammars, dictionaries and popular songs. Also to this period belongs the celebrated poem of Kristionas Donelaitis (Donalitius) (1714–80) entitled "The Four Seasons," written in hexameters and depicting village life throughout the year (printed in 1818). The 18th century gave Lithuanian literature 61 authors and 198 printed publications.

3. The 19th century heralded a new trend in Lithuanian literature. During its first half a significant national and literary movement, mostly emanating from the alumni of the Vilnius university, was characterized by an attempt to create a Lithuanian literary language and to extol the ancient history of Lithuania and its heroic figures. The most noteworthy names of this period are: Simanas Stanevičia (1799–1848), Dionyzas Poška (between 1 745 and 1765–1830), Simanas Daukantas (1793–1864) and many others less well known. Worthy of mention at the beginning of the 19th century is the poet Rev. A. Strazdas-Strazdelis (1763–1833), who does not belong to the foregoing group. and was the author of many religious and secular songs. A typical feature of Lithuanian literature of this epoch is its pseudo-classicism and a sentimentality borrowed from the west. Only in a few writers does romanticism appear, generally as idealization of the past.

Two events signalize the second half of the 19th century. The first was the prohibition in 1864 by tsarist Russia of the printing of Lithuanian books and writings in Latin characters, Lithuania being then under Russian rule. The second was the national renaissance movement. Lithuanians boycotted the prohibition by printing books and newspapers in so-called Lithuania Minor or Prussian Lithuania, then under German rule, which were smuggled across the frontier. Lithuanian literature of the national renaissance epoch is characterized by a specific utilitarianism. Its aim was to rouse the national consciousness, to fight against denationalizing alien influences (Russian, Polish, German) and to rally the Lithuanian people for the struggle to achieve national and political independence of Russia. Two writers who do not properly speaking belong to that period but rather to its preparatory stage are Bishop M. Valančius (1801–75), noted for his religious, educational and other writings in the sphere of belles-lettres, and Bishop A. Baranauskas (1835–1902), a poet, whose *Anykščių Šilelis* ("The Grove of Anykščiai") is his greatest work.

The Lithuanian national renaissance extends from 1883, when Jonas Basanavičius founded in Lithuania Minor the newspaper *Aušra* ("Dawn"), until 1904, when the Russian government repealed the prohibition against the printing of Lithuanian books in Latin characters. To this epoch belong the following distinguished names: Basanavičius (*q.v.;* 1851–1927), famous as a collector of folklore and publicist, commemorated as the "father of the Lithuanian national renaissance"; Vincas Kudirka (1858–99), a publicist and short-story writer; J. Mačiulis-Maironis (1862–1932), the most famous Lithuanian poet, called the "poet-prophet of the Lithuanian renaissance," noted for both his dramatic and lyrical poetry; V. Storasta-Vydūnas (1868–1953), born in Lithuania Minor, a philosopher, poet and dramatist; J. Biliūnas (1879–1907), a short-story writer; and J. Tumas-Vaižgantas (1869–1933), a publicist and literary critic. Authoresses included J. Zymantiené-Žemaité (1845–1921), the most famous short-story writer of the period; and S. Pšibilauskiené-Lazdynų Peléda (1867–1926) and N. Pečkauskaité-Šatrijos Ragana (1878–1930), both of whom wrote novels and short stories.

4. After 1904 and especially during the period of Lithuania's independence (1918–40) Lithuanian literature gradually lost its adaptable character and undertook the task of educating the reader. The young poets and prose writers of this period showed a tendency to formalism but this crisis was speedily overcome and the new Lithuanian literature became more expressive. New and more prominent literary names came to the fore, such as V. Krévé-Mičkevičius (1882–1954), the novelist and dramatist; V. Putinas-Mykolaitis (1893–), a novelist, dramatist and pioneer of the modern Lithuanian romance; J. Baltrušaitis (1873–1944), a lyrical poet of the first rank in Lithuanian and Russian; B. Sruoga (1896–1947), and K. Binkis (1893–1942), both poets and dramatists; J. Savickis (1891–1952), novelist and story writer; F. Kirša (1891–), poet; P. Vaičiūnas (1890–), dramatist; K. Šeinius (1889–), novelist and short-story writer; and S. Čiurlioniené (1886–), novelist and dramatist. Poets of the younger generation included J. Aistis-Aleksandravičius (1904–); B. Brazdžionis (1907–); A. Miškinis (1905– d. ?); H. Radauskas (1910–).

Among younger prose writers were A. Vaičiulaitis (1906–), novelist, short-story writer and literary critic; J. Grušas (1901–), novelist and dramatist; J. Jankus (1906–), novelist; V. Alantas (1902–), novelist and dramatist; F. Neveravitius (1900–), historical novelist and dramatist; L. Dovydénas (1906–), novelist; B. Babrauskas (1910–), literary critic. Among authoresses were N. Mazalaité (1907–), novelist and short-story writer; P. Orintaité (1907–), novelist; K. Grigaityté (1910–), poetess; S. Neris (?–1945), poetess; G. Tulauskaité (1908–), poetess; and many others.

When Lithuania in 1940 and again in 1944 was occupied by the Soviet Union the Lithuanian writers remaining in the country were compelled to follow the line dictated to them by the Communists. Those working in the free world, about 100 in number, tried to continue the creation of a Lithuanian national literature.

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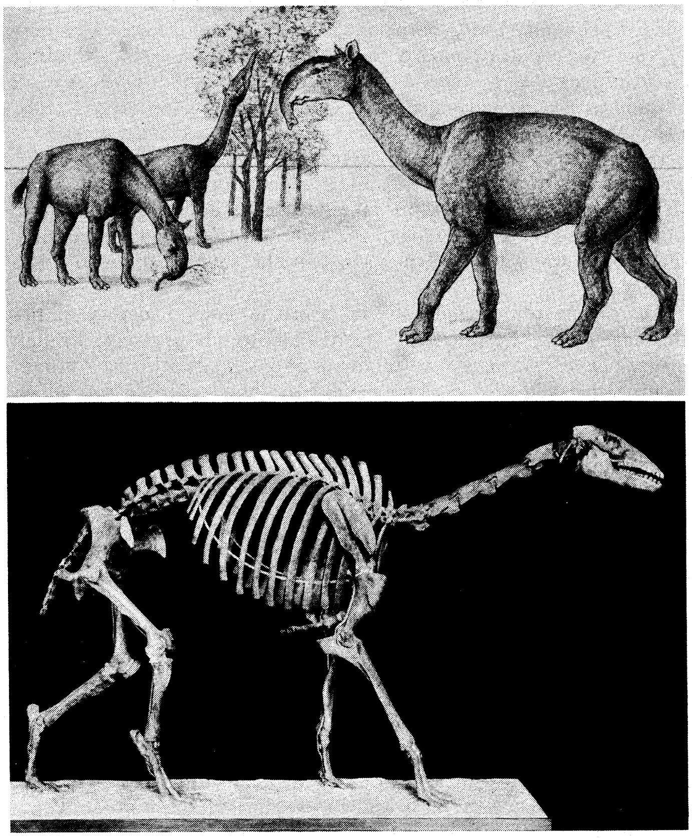
(F. Ns.)

LITKE, FYODOR PETROVICH, COUNT (1797–1882), Russian arctic explorer, geographer and naval officer whose influence on Russian science, geography in particular, was very great, was born on Sept. 28, 1797, in St. Petersburg. His grandfather (who spelled his name Liitke) had emigrated from Germany. In 1812 Litke joined the imperial navy and took part in a voyage round the world under V. M. Golovnin in 1817–19. During the four summers 1821–24 Litke commanded an arctic expedition which mapped the west coast of Novaya Zemlya and studied the adjacent southeastern part of the Barents sea. In 1826–29 he went round the world again, this time in command of a scientific expedition in the sloop "Senyavin." and made important surveys and collections in the Bering strait region and the western Pacific (Bonin and Caroline Islands). From 1832 to 1848 he was tutor to Tsar Nicholas I's second son Constantine. Litke was one of the founders of the Russian Geographical society in 1845 and was at its head from that time until 1873, with the exception of the seven years 1850–57 when he was admiral in command of the ports of Revel (Tallin) and Kronstadt. He was president (1864–81) of the Imperial Academy of Sciences, taking particular interest in astronomy and magnetism. He wrote a large volume on each of his two major expeditions, and many scientific papers. The Geographical society instituted a Litke medal upon his retirement. He died on Oct. 20, 1882. (T. E. A.)

LITMUS, a mixture of dyes, the chief constituents of which are azolitmin and erythrolitmin. It is the oldest and most commonly used acid-base indicator. In an acid solution the dye turns red and in a basic solution it turns blue. Litmus was originally prepared by the action of air, ammonia and an alkali carbonate on certain species of lichens (*Lecanora tartarea* and *Roccella tinctoria*) found in the Netherlands. It can be synthesized directly from β-orcinol. Litmus is usually used in the form known as litmus paper, an absorbent paper impregnated with the dye. When moistened with the solution under test, the paper changes colour. An alcoholic solution of litmus is sometimes used. A few drops added to the solution under test causes the whole solution to turn colour. *See* also INDICATOR, CHEMICAL.

LITOPTERN, any of the herbivorous, hoofed mammals (ungulates) of the order Litopterna, an extinct group confined to South America during the long period of isolation of that continent from all others. Litopterns, derived from the most primitive hoofed mammals, the condylarths. were abundant from the Paleo-



BY COURTESY OF THE AMERICAN MUSEUM OF NATURAL HISTORY

RESTORATION DRAWING (ABOVE) AND SKELETON CAST (BELOW) OF MACRAUCHENIA, A GENUS OF THE EXTINCT ORDER OF HOOFED MAMMALS, **LITOPTERNA**

cene to the Pliocene epochs (about 70,000,000 to 2,000,000 years ago) and finally became extinct during the Pleistocene (about 1,000,000 years ago). They were represented very early by two distinct families. Proterotheriidae and Macraucheniidae.

Early proterotheriids were barely distinguishable from condylarths. By the Miocene epoch (about 25,000,000 years ago) the feet in some genera showed a remarkable specialization, the number of toes having been reduced from five to three and even to one. The foot of *Thoatherium* closely resembled that of the present day one-toed horse, but had progressed even further in the reduction of the lateral digits. Conservative members of this family persisted into the Pliocene, the time of extinction of this branch of the litopterns.

The Macraucheniidae reached a three-toed condition early in their history, but did not progress beyond this stage. The teeth of macrauchenids, in contrast to those of proterotheriids, develop high crowns with complex patterns of crests and ridges in the molars. The last genus known, *Macrauchenia,* was probably camellike in size and appearance. The skull was marked by a reduction of the nasal bones and development of a short proboscis. The neck and limbs were long. the body and tail short. Remains were first brought to light in Patagonia by Charles Darwin. and since his discovery, numerous specimens, including complete skeletons, have been found in the pampean deposits of Argentina.

During the late Pliocene and the Pleistocene a land corridor developed between North and South America, permitting invasion of the southern continent by herbivores and carnivores from the north. Concurrently some South American mammals pushed northward, but many of the once highly successful groups, such as the litopterns, already somewhat impoverished, were unable to survive the competition with their North American adaptive counterparts. Among the casualties was *Macrauchenia,* whose extinction marked the end of the once abundant litopterns. *See* UNGULATA.

See A. S. Romer, ***Vertebrate Paleontology*** (1945); W. B. Scott, ***A History of Land Mammals in the Western Hemisphere,*** rev. ed. (1937).

(E. C. O.)

LITOTES, a rhetorical figure in which emphasis is secured for a statement by turning it into a denial of the contrary, *e.g.,* "a citizen of no mean city," *i.e.,* a citizen of a famous city. *See* FIGURES OF SPEECH: *Figures of Degree of Emphasis.*

(G. W. A.)

LITTLE ENTENTE, a mutual defense arrangement among Czechoslovakia, Yugoslavia and Rumania during the period between World Wars I and II directed against German and Magyar dominance in the Danubian area and destruction of the freedom and territorial acquisitions won by those states in 1918 as a consequence of World War I. It was based upon the treaty of Aug. 14, 1920 concluded at Belgrade between Yugoslavia and Czechoslovakia, joined by Rumania in treaties with Czechoslovakia on April 23 and with Yugoslavia on June 7, 1921. By a treaty of Aug. 31, 1922 the three states undertook broader obligations of economic and political co-operation and by that of May 21, 1929 they agreed that the renewal of the treaty of Alliance should be automatic at the end of each five-year period. At the same time they signed a treaty for the peaceful settlement of their differences in accord with the League of Nations model treaty of conciliation and arbitration of 1928.

Fascist Italy had been an enemy of the little entente from the beginning but the advent of Adolf Hitler to power in Germany on Jan. 30, 1933 challenged the whole structure of central Europe. On Feb. 16, 1933 the little entente states strengthened their bonds against this menace. Under the able leadership of Eduard Benes, Nicolae Titulescu and Bogoljub Jevtic, as well as King Alexander of Yugoslavia, a veritable, if short-lived, diplomatic federation was constituted. The new pact created a permanent council composed of the three foreign ministers or their delegates to meet three times a year and to direct a common policy. A permanent secretariat was established, one section of which was to function at Geneva, the seat of the League of Nations.

The little entente took a lead in urging effective sanctions against Japan from 1931 to 1933 and successfully protested against Mussolini's proposal in March 1933, of a four-power pact to revise treaties without consultation with the smaller states of Europe in substitution of the League's processes. Though signed in June 1933 by Italy, Germany, Great Britain and France this project was not implemented. On July 4, 1933 the little entente signed a nonaggression agreement with the U.S.S.R.; on Feb. 9. 1934 Yugoslavia and Rumania joined Turkey and Greece to form the Balkan entente (*q.v.*); and on May 16, 193j Czechoslovakia. motivated by the Nazi menace, signed an alliance with the U.S.S.R., following the French-Soviet alliance by two weeks. From its first meeting at Prague in Jan. 1934, the economic council of the little entente laid foundations for closer economic collaboration among the three countries, attempting to include in this work Austria and Hungary.

The assassination of King Alexander of Yugoslavia and Jean Louis Barthou, foreign minister of France. at Marseilles on Oct. 9, 1934 weakened the little entente. Prince Paul, the regent of Yugoslavia, supported Milan Stojadinovic, who dominated the country as premier from 193j to 1939, in a policy of rapprochement toward Italy, Bulgaria and Germany, thus striking at the vitals of both the little entente and the Balkan entente. The vacillating foreign policy of France and the division between France and Britain in respect to Italy and Germany further weakened the little entente. At the Bratislava conference of Sept. 1936. Yugoslavia seemed determined to follow an independent policy and the council of the little entente virtually acknowledged the right of each of the member states to do so. The last conference of the council was held at Yugoslavia, on Aug. 21, 1938. An unsuccessful attempt was made to conciliate Hungary by an offer of equality in armaments in return for the promise of a peaceful policy. Despite the reluctance of the Stojadinovic government, both Yugoslavia and Rumania, at the time of the Munich crisis! in accordance with the terms of their alliance, warned Hungary not to attack Czechoslovakia. But with the appeasing attitude of Great Britain and France, there was little question of the outcome. The Munich accord of Sept. 30, 1938 permitted Germany to annex the Sudeten area of Czechoslovakia. and destroyed the little entente by destroying Czechoslovakia. the keystone of the system. (Q. 'If',)

LITTLEHALES, GEORGE WASHINGTON (1860–1943), U.S. hydrographer, was born in Schuylkill county, Pa.. on Oct. 14, 1860. and graduated irom the U.S. naval academy in 1883. He then studied at Columbian (later George Washington) university, Washington, D.C. He was hydrographic engineer of the U.S. Hydrographic office irom 1900 until his retirement in 1932, and professor of nautical science at George Washington university from 1913 to 1927. From 1919 to 1922 he was chairman of the American Geophysical union's section of physical oceanography and from 1921 to 1932 vice-president of the oceanography section of the International Union of Geodesy and Geophysics. He was the author of numerous works on navigation, hydrography and related subjects. Littlehales died on Aug. 12, 1943.

LITTLEHAMPTON, a seaport, seaside holiday town and urban district in the Arundel and Shoreham parliamentary division of West Sussex, Eng., at the mouth of the Arun, 14 mi. E.S.E. of Chichester by road. Pop. (1951) 13,939. Area 4 sq.mi. Backed by the South Downs and with long sandy beaches, it caters to many vacationists every year and also has a harbour, accessible in good weather, with a small home and foreign trade. Timber, granite and fertilizers are imported and grain for seed exported. Lifeboats are made in the local boatyards.

LITTLE MAGAZINE, the term applied to a certain kind of periodical published irom 1890 through much of the 20th century. Little magazines flourished in the United States and England. though French writers (especially the *symboliste* poets and critics, 1880–*c.* 1900) often had access to a similar type of publication and German literature of the 1920s was also indebted to them. The name, probably derived by analogy from "little theatre," signifies most of all a nonprofessional and noncommercial manner of editing, managing and financing. A composite description of the little magazines' motives for existing and of their careers would most usefully take this iorm: a little magazine usually begins with the object of publishing literary work of some artistic merit which is unacceptable to commercial magazines for any one or all of three reasons—the writer is unknown and therefore not a good risk; the work itself is unconventional or experimental in form; or it violates one of several popular notions of polite moral, social or aesthetic behaviour. In addition, several little magazines were employed as direct forums for the advancement of entirely new ideas in literature such as those of the *symbolistes* of France and the imagists of the United States and England, or of social and political perspectives on a culture as in the leftist magazines of the 1930s in the United States and England.

As a consequence of these peculiarities, little magazines mere frequently in the advance guard of modern literature. They lacked both the financial stability and the restrictive editorial controls of established commercial magazines and were likely for both reasons to take risks and make bold moves beyond the limits set by public taste at any given time. Frequently the little magazines advanced new developments in literature which were subsequently assimilated by a culture, the time lag usually being about two decades. Foremost in the ranks of such sponsorship of literature were *Poetry: a Magazine of Verse* (1912), especially in its early years under the vigorous guidance of Harriet Monroe; the more erratic and often more sensational *Little Review* (1914–29) of Margaret Anderson; a group of English magazines in the second decade of the 20th century, of which the *Egoist* (1914–19) and *Blast* (1914–15) were most conspicuous; and Eugene Jolas' *transition* (1927–38). In all but the last of these, a major guiding spirit was the L.S. poet and critic, Ezra Pound; he served as "foreign correspondent" of both *Poetry* and the *Little Review,* maneuvered the *Egoist* from its earlier beginnings as a feminist magazine (*The New Freewoman,* 1913) to the status of an *avant garde* literary review, and with Wyndham Lewis jointly sponsored the two issues of *Blast.* In this case, the little magazines showed the stamp of a single vigorous personality; similar strong and dedicated figures in little magazine history were the U.S. poet, William Carlos Williams (whose name appears in scores of little magazines. in one capacity or another); the British critic and novelist, Ford Madox (Hueffer) Ford, editor of the *Transatlantic Review* (1924–25) and contributor to many others; and Gustave Kahn, a minor French poet but a very active editor associated with several French *symboliste* periodicals.

From the point of view of the writer, the little magazines rendered two essential services: their pages were accessible to him when he was still unknown, and they conducted campaigns designed to publicize and broadcast reputations in foreign countries. Both of these services persisted throughout little magazine history, though the stress upon them varied in the several stages of that history.

There were four principal periods in the general history of little magazines. In the first, from 1890 to about 1915, French magazines served mainly to establish and explain a literary movement; British and U.S. magazines, to disseminate information about and encourage acceptance of continental European literature and culture. In the second stage, 1915–30, when other magazines, especially in the United States. were in the vanguard of almost every variation of modern literature, a conspicuous feature was the expatriate magazine, published usually in France but occasionally elsewhere in Europe by young U.S. and British critics and writers. The major emphasis in this period was upon literary and aesthetic form and theory and the publication of fresh and original work, such as that of Ernest Hemingway (in the *Little Review, Poetry, This Quarter* and elsewhere), T. S. Eliot (in *Poetry,* the *Egoist, Blast),* James Joyce (in the *Egoist,* the *Little Review, transition),* and many others. The third stage, the 1930s, saw the beginnings of many leftist magazines, started with specific doctrinal commitments which were often subjected to considerable editorial change in the career of the magazine. *Partisan Review* (1934) was perhaps the best-known example of these in the U.S., as was the *Left Review* (1934–38) in England.

The fourth period of little magazine history began about 1940. One of the conspicuous features of this period was the critical review supported and sustained by a group of critics, who were in most cases attached to a university or college. Examples of this kind of periodical were, in the L.S., *The Kenyon Review,* founded by John Crowe Ransom in 1939, and in Great Britain, *Scrutiny,* edited by F. R. Leavis (1932–53). This and related kinds of support such as that of publishers maintaining their own reviews or miscellanies. represented a iorm of institutionalism which was radically different from the more spontaneous and erratic nature of the little magazines of earlier years. These magazines generally favoured criticism over creation and tended to stabilize and slow the growth of experiment in new literature. In the second half of the 20th century the prospects were, however, that the little magazine might at any time break out from newly established limits and recover at least in part its earlier freedom, if only as a protest against the dangers of too strict a standardization of the creative life.

See also the articles on most of the editors and writers mentioned above.

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(F. J. HN.)

LITTLE ROCK, the largest city and capital of Arkansas, U.S., the seat of Pulaski county, is on the south bank of the Arkansas river near the centre of the state at a dividing line between the mountains and the plains. It is the principal centre of commerce and manufacturing for the region. The population was 102.213 in 1950, and 107.813 in 1960. The population of the Little Rock–North Little Rock standard metropolitan statistical area, which includes North Little Rock, Jacksonville. Cammack Village and Sherwood, was 156,085 in 1940; 196.685 in 1950 and 242,980 in 1960.

Bernard de la Harpe, exploring the Arkansas in 1722, saw two conspicuous rock formations on the river banks which he named *La Petite Roche* and *La Grande Roche* (or *Le Rocher Français*). Near the smaller rock was a settlement of Quapaw Indians, and La

Harpe made this his trading post. In later years, the "little rock" became the abutment for a railway bridge. The "big rock," on the North Little Rock side of the river and two miles upstream from the smaller formation, was the site of an army post and later became the location of a veterans administration hospital. In 1812, William Lewis, a hunter and trapper, built his home at the "little rock." In 1819 Arkansas became a territory with its capital at Arkansas Post. The site of Little Rock was surveyed in 1821, and the territorial capital was moved there the same year. Little Rock was incorporated as a town in 1831 and chartered as a city in 1836. A board-manager form of municipal government was adopted in 1957.

Little Rock was strongly anti-Union at the outbreak of the American Civil War, and the U.S. arsenal which had been strengthened by the federal government was seized by state authorities Feb. 8, 1861. In Sept. 1863, Gen. Frederick Steele's Union troops occupied the city, and a pro-Union government was set up. In the 1880s Little Rock became an important communication centre with the expansion of the state railways, and began to develop commercially and industrially. Industry in the greater metropolitan area experienced a marked and diversified growth in the 1940s mainly because of the proximity of raw materials and an adequate labour supply, and in the 1960s included cottonseed, wood products, light bulbs, roofing granules, watches and clocks, electric motors, nonwoven fabrics and food products. There are large railroad shops across the river, and bauxite mines just outside the city. The surrounding agricultural region produces large crops of cotton, alfalfa, potatoes, rice! fruits and vegetables. Within a short distance are vast stands of high grade timber and large deposits of coal. oil and natural gas. Other mineral resources in the region are marble, clay. flint, granite and barite.

Little Rock is noted for its three capitols, one of which served the territorial government. The meeting place of the territorial legislature between 1821 and 1836 is preserved in the Territorial Restoration, along with a block of buildings of the period including the first print shop of the *Arkansas Gazette,* one of the first newspapers to be published west of the Mississippi. The Old Statehouse. the capitol from 1836 until 1912, is a remarkable work of antebellum architecture. It is on the site of an Indian burial ground and has a commanding view of the Arkansas river. The Territorial Restoration and the Old Statehouse. containing interesting authentic furnishings, are open to the public. The present state capitol is on a knoll near the business district and is flanked by other governmental buildings. It is of Xrkansas marble and is patterned after the capitol at Washington! D.C.

Several state institutions are located at Little Rock, including the main branch of the state mental hospital, the schools for the blind and deaf; also medical units, a graduate centre and graduate institute of technology of the University of Arkansas. Other educational institutions include Little Rock university (1927), privately endowed; Philander Smith College (1868), a Methodist school for Negroes; the Arkansas Law school (1916), a private institution; St. John's Seminary (1930), Roman Catholic; Arkansas Baptist college, for Negroes (1884) and Shorter college (established as Bethel institute in 1886), an African Methodist Episcopal school for Negroes at North Little Rock. Little Rock's Robinson Memorial auditorium houses a convention hall, lecture hall: committee rooms and a music hall seating 3.000 persons.

The metropolitan area has several parks, including MacArthur park which surrounds the birthplace of Gen. Douglas MacArthur and is the former site of an army post at which the general's father was stationed. The 36 ac. of shaded grounds include a museum of natural history, a band shell and a museum of fine arts. The 200-ac. War Memorial park has a zoo, a swimming pool, a golf course, an archery range, an amusement park, a baseball park and the War Memorial stadium. The Arkansas Livestock showgrounds at Little Rock is centred about the T. H. Barton coliseum. The Governor's mansion, at the opposite end of Center street from the Old Statehouse, is a stately structure completed in 1950. The Georgian colonial two-story brick executive mansion is on a 6.25-ac. plot. The Albert Pike Memorial temple, state headquarters for Freemasonry, is a magnificent block long structure in the downtown area. Adams field, the municipal airport, is one mile from the main street. Veterans', Roman Catholic and Baptist hospitals are in the area. Camp Pike of World War I, renamed Camp Joseph T. Robinson in the 1940s, was an important military training centre. In the mid-1950s, the Little Rock air force base was built near Jacksonville.

Bishops of the Roman Catholic (St. Andrew's cathedral), Protestant Episcopal (Trinity cathedral), Methodist and African Methodist Episcopal churches maintain residence at Little Rock, and several other denominations have state headquarters and churches there.

From Sept. 1957 the city was the focus of world attention. The immediate issue was the right of nine Negro children to attend Central high school under a gradual desegregation plan adopted by the city school board, in accordance with the 1954 decision of the U.S. supreme court holding racial segregation in public schools as unconstitutional. Their attendance set off a series ,of legal battles and one of the 20th century's great tests of power between the federal and a state government. Gov. Orval E. Faubus ordered state militia to prevent Negroes from attending school, but the state was enjoined from interf ring by Pres. Dwight D. Eisenhower who sent federal troops to maintain order throughout the year 1957–58. After various legal maneuvers, the city's public high schools were closed during the following school year, but were reopened in Aug. 1959 with several Negroes in attendance at Central and Hall high schools. City police dispersed a small mob of whites at Central on opening day, and token integration was accomplished without further incident. (K. W. P.)

LITTLE SISTERS OF THE POOR, a religious order of the Roman Catholic Church, was founded in Brittany, France, in 1839 for the care of destitute old people. The order depended and still depends on alms as its sole means of support.

One of its founders was a servant girl, Jeanne Jugan, who was interested by Abbé Augustin Marie le Pailleur of the town of St. Servan in joining other young women in charitable work for the aged. The order provided shelter and support for its charges and based its constitutions on the rule of St. Augustine. adding the vow of hospitality to those of poverty, chastity and obedience.

Homes were established in various parts of France and the order soon spread to other countries. Its first home in the Cnited States was opened at Brooklyn, N.Y., in 1868. The general mother house was at St. Pern, France.

LITTLE THEATRE MOVEMENT: *see* THEATRE: *20th Century: United States: Community Theatre.*

LITTLETON, SIR THOMAS (c. 1407–1481), English judge. best known as the author of *Littleton on Tenures,* was born, it is supposed. at Frankley House, Worcestershire. perhaps in 1407, and certainly not later than 1422. He is said by Sir Edward Coke to have "attended one of the universities." He was probably a member of the Inner Temple where he lectured on the statute *De Donis Conditionalibus.* He appears to have been recorder of Coventry in 1450; he became sergeant-at-law in 1453 and was afterward a justice of assize on the northern circuit. .In 1466 he was made a judge of the common pleas and in 1475 a knight of the Bath. He died, according to the inscription on his tomb in Worcester cathedral, on Aug. 23, 1481.

Littleton wrote his *Tenures,* a brief text on property, the first of the classical texts on English law not written in Latin and uninfluenced by Roman law, probably after his appointment to the common pleas, for the instruction of his son. Richard. It soon became the most celebrated treatise on English law and was acclaimed by Sir Edward Coke "the most perfect and absolute book that was ever written in any human science." Composed in law French. the *Tenures* was principally a scientific account of the English land law of the middle ages unmodified either by the doctrines of the chancellors. such as uses, or by later common law innovations: such as contingent remainders and conveyances barring entails. Intended as a first book in law, it served countless generations of lawyers not only in England but also in America both before and after the Revolution.

The edition by Lettou and Machlinia of 1481 or 1482 was the earliest treatise on English law ever printed and among the first ten books to be published in London. An English translation by William Rastell appeared early in the 16th century. The division of the text into sections dates from the edition of William West (1581). The most famous form of the *Tenures* was Sir Edward Coke's *First Institute,* known as *Coke Upon Littleton,* the first edition of which appeared in 1628.

See E. Wambaugh, *Littleton's Tenures in English* (1903); W. S. Holdsworth, *History of English Law,* 2:571–590 (1936). (S. Tt.)

LITTLE TURTLE (*c.* 1752–1812), American Indian chief of the Miami tribe, who became a popular hero among the settlers, was born in a village (later named after him) on the Eel river near Fort Wayne, Ind. Noted for military prowess and oratorical ability: Little Turtle was one of the most important Indian leaders in the Northwest territory. On Nov. 4, 1791, he led the Indians to a crushing victory on the Wabash river over federal troops under the command of Gen. Arthur St. Clair. In 1795, after the defeat of the Indians by Gen. Anthony Wayne at Fort Recovery and Fallen Timbers, Little Turtle, who was not in command at the latter battle, signed the treaty of Greenville, by which the Indians ceded to the United States much of Ohio and parts of Illinois, Indiana and Michigan. Thereafter he was a strong advocate of peace, and he successfully resisted the efforts of the Shawnee chief Tecumseh to induce the Miami to join his confederacy. He subsequently signed other treaties with the United States before his death at Fort Wayne on July 14, 1812.

LITTRÉ, MAXIMILIEN PAUL ÉMILE (1801–1881), French philologist and positivist philosopher, whose dictionary is one of the outstanding, lexicographic accomplishments of all time, was born at Paris on Feb. 1, 1801. He was educated at the Lycée Louis-le-Grand, where he had for friends Louis Hachette and Eugène Burnouf. He then studied the English and German languages, and classical Sanskrit literature and philology. Littré intended to become a doctor, and had completed his studies when his father's death in 1827 made it necessary for him to begin earning money. He began to teach classics, and in 1835 became a regular contributor to the *National,* and eventually director of the paper. In 1839 appeared the first volume of his edition (completed 1862) of the works of Hippocrates, which secured his election the same year into the Académie des Inscriptions et Belles-Lettres. He also became a friend of Auguste Comte and popularized his ideas.

About 1844 he started working on his great *Dictionnaire de la langue française.* In the revolution of July 1848 he took part in the repression of the extreme republican party in June 1849. His essays, contributed during this period to the *National,* were collected together and published under the title of *Conservation, révolution et positivisme* in 1852, and show a thorough acceptance of Comte's doctrines. Later he differed with Comte's more mystic ideas, but he concealed his differences.

After Comte's death in 1858 Littré felt free to publish his own ideas in his *Paroles de la philosophie positive* (1859), and at still greater length in his work in *Auguste Comte et la philosophie positive* (1863).

About 1863, after completing his Hippocrates and his Pliny, he set to work in earnest on his French dictionary. In the same year he was proposed for the Académie Française, but rejected, owing to the opposition of Mgr. Dupanloup, bishop of Orleans, who denounced him as the chief of the French materialists. He also at this time started with G. Wyrouboff the *Philosophie Positive,* a review which was to embody the views of modern positivists. Literary work absorbed him until the overthrow of the empire compelled him to take a part in politics. He felt himself too old to undergo the privations of the siege of Paris, and retired with his family to Brittany, from which he was summoned by Gambetta to Bordeaux, to lecture on history; and then to the senate to which he had been elected by the department of the Seine. In Dec. 1871 he was elected a member of the Académie Française in spite of the renewed opposition of Dupanloup, who resigned his seat rather than receive him.

Littré's dictionary was completed in 1873. An authoritative interpretation is given of the use of each word, based on the various meanings it had held in the past. He died on June 2, 1881.

LITURGICAL MOVEMENT, ROMAN CATHOLIC. New insight into the corporate nature of the liturgy, as "the worship rendered by the Mystical Body of Christ in the entirety of its Head and members" (Pius XII, *On The Sacred Liturgy,* p. 20, America Press, New York, 1954), produced the Catholic Liturgical movement. Besides the essential sacramental efficacy of mass and sacraments *ex opere operato,* it exploits graces available *ex opere operantis Ecclesiae,* enabling priests and people to take a more active part in these rites. "The Mass by its very nature," states a papal instruction of Pius XII, "requires that all those who are present should take part in it each in the way proper to him" *(Sept. 3 Instruction on Participation in the Mass.* Copyrighted by The Order of St. Benedict, Inc., Collegeville. Minn., 1958, p. 8).

St. Pius X, with chant restoration in mind, stressed the Christian spirit to be had by taking active part in the common song and prayer of the church. He favoured missal translations and made possible daily communion and early first communion for children. He also tried to establish congregational singing and in 1913 started breviary reforms not yet completed by the early 1960s. Gradually such measures had far-reaching effects.

Fired by the pontiff's vision of active lay participation, liturgical scholars (Benedictines mainly) began promoting liturgy. Missal use, dialogue mass, vernacular vespers or compline and study weeks were found in Austrian, Belgian, Dutch, French, German and other centres. These local and widely differing liturgical movements came, with the accession of Pius XII in 1939, under papal direction, and bishops were asked to appoint diocesan directors. Indeed, Pius XII made the movement a major part of his regime. Three encyclical letters, *On the Mystical Body* (1943), *On the Sacred Liturgy* (1947) and *On Sacred Music* (1955), and countless minor documents relating to the movement came from his pen. He provided for bilingual rituals, a new Latin psalter, Holy Week reform, evening mass, a new eucharistic fast and simpler rubrics as a first phase of breviary reform; he also promoted the World Congress of Pastoral Liturgy: at Assisi (1956). The instruction quoted above, *On Active Participation,* was issued only a few days before the collapse that ended in his death. Some of these measures were optional, others mandatory. Each one was part of a program which he appraised: "The liturgical movement is thus shown forth as a sign of the provident dispositions of God for the present time, of the movement of the Holy Ghost in the Church, to draw men more closely to the mysteries of the faith and riches of grace which flow from the active participation of the faithful in the liturgical life." ("Allocution," in *The Assisi Papers,* 1957. Copyrighted by The Order of St. Benedict, Inc., Collegeville, Minn.) Practice naturally follows more slowly; rigid uniformity in nonessentials is hardly to be expected. The movement strongly influences sacred music, art and architecture; it is felt more and more in educational circles, and gives greater depth to pastoral ministry.

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LITURGY, in the technical language of the Christian Church, the order for the celebration and administration of the Eucharist. The word (from the Greek meaning public service) came to be used in a more general sense to denote any or all of the various prescribed forms of public worship. In this article the liturgy is treated in the stricter sense.

There are nine main families or groups of liturgies, four of them being of Eastern and five of them of Western origin and use. They are known either by the names of the apostles with whom they are traditionally connected, or by the names of the countries or cities in which they have been or are still in use.

The Syrian Rite (St. James).—The principal liturgies to be enumerated under this group are the Clementine liturgy, so called from being found in the eighth book of the Apostolic Constitutions, which claim in their title, though erroneously, to have been compiled by St. Clement, the 1st-century bishop of Rome; the Greek liturgy of St. James; the Syriac liturgy of St. James. Sixty-four more liturgies of this group have existed, the majority being still in existence. Their titles are given in F E. Brightman's *Liturgies,* Eastern and Western (1896), pp. lviii.–lxi

The Egyptian Rite (St. Mark).—This group includes the Greek liturgies of St. Mark, St. Basil and St. Gregory, and the Coptic liturgies of St. Basil, St. Gregory, St. Cyril or St. Mark; together with certain less known liturgies the titles of which are enumerated by Brightman (*op.* czt. pp. lxxiii. lxxiv.). The liturgy of the Ethiopian church ordinances and the liturgy of the Abyssinian Jacobites, known as that of the Apostles, fall under this group.

The Persian Rite (**SS. Adaeus** and Maris).—This Nestorian rite is represented by the liturgy which bears the names of SS. Adaeus and Maris together with two others named after Theodore of Mopsuestia and Nestorius. This group has sometimes been called "East-Syrian." The titles of three more of its now lost liturgies have been preserved, namely those of Narses, Barsumas and Diodorus of Tarsus. The liturgy of the Christians of St. Thomas, on the Malabar coast of India, formerly belonged to this group, but it was almost completely assimilated to the Roman liturgy by Portuguese Jesuits at the synod of Diamper in 1599.

The Byzantine Rite.—The Greek liturgies of St. Chrysostom, St. Basil and St. Gregory Dialogus, or The Presanctified, also extant in other languages, are the living representatives of this rite. The Greek liturgy of St. Peter is classified under this group, but it is merely the Roman canon of the Mass, etc., inserted in a Byzantine framework, and seems to have been used at one time by some Greek communities in Italy. To this group also belongs the Armenian liturgy, of which ten different forms have existed in addition to the liturgy now in general use named after St. Athanasius.

The Hispano-Gallican Rite (St. John).—This group of Latin liturgies, which once prevailed very widely in Western Europe, has been aimost universally superseded by the liturgy of the Church of Rome. Where it survives, it has been more or less assimilated to the Roman pattern It prevailed once throughout Spain, France, northern Italy, Great Britain and Ireland The term "Ephesine" has been applied to this group or family of liturgies, chiefly by English liturgiologists, and the names of St. John and of Ephesus, his place of residence, have been pressed into service in support of a theory of Ephesine origin, which, however, lacks proof and may now be regarded as a discarded hypothesis. Other theories represent the Gallican to be a survival of the original Roman liturgy, or an importation into Western Europe from the East through a Milanese channel.

The Mozarabic Liturgy.—This was the national liturgy of the Spanish church till the close of the 11th century, when the Roman liturgy was forced upon it. Its use, however, lingered on, till in the 16th century Cardinal Ximenes, anxious to prevent its becoming quite obsolete, had its books restored and printed, and founded a college of priests at Toledo to perpetuate its use. It survives now only in several churches in Toledo and in a chapel at Salamanca, and even there not without certain Roman modifications of its original text and ritual.

Gallican Liturgy.—This was the ancient and national liturgy of the church in France till the commencement of the 9th century, when it was suppressed by order of Charlemagne, who directed the Roman missal to be everywhere substituted in its place. All traces of it seemed for some time to have been lost until three Gallican sacramentaries were discovered and published by Thomasius in 1680 under the titles of *Missale Gothicum, Missale Gallicum* and *Missale Francorum,* and a fourth was discovered and published by Mabillon in 1687 under the title of *Missale Gallicanum.* Fragmentary discoveries have been made since. Mone discovered fragments of eleven Gallican masses and published them at Carlsruhe in 1850. Other fragments from the library at St. Gall have been published by Bunsen (*Analecta Ante-Nicaena,* iii. 263–266), and from the Ambrosian library at Milan by Cardinal Mai (*Scriptt.* Vet Vat. *Coll.* iii. 2. 247). A single page was discovered in Gonville and Caius College, Cambridge, published in Zeitschrift fiir Kath. Theologie, vi 370.

Ambrosian Liturgy.—Considerable variety of opinion has existed among liturgical writers as to the proper classification of the "Ambrosian" or "Milanese" liturgy. If we are to accept it in its present form and to make the present position of the great intercession for quick and dead the test of its genus, then we must classify it as "Petrine" and consider it as a branch of the Roman family If, on the other hand, we consider the important variations from the Roman liturgy which yet exist, and the traces of still more marked variation which confront us in the older printed and ms. copies of the Ambrosian rite, we shall detect in it an original member of the Hispano-Gallican group of liturgies, which for centuries underwent a gradual but ever-increasing assimilation to Rome. We know this as a matter of history, as well as a matter of inference from changes in the text itself Charlemagne adopted the same policy towards the Milanese as towards the Gallican church. He carried off all the Ambrosian church books which he could obtain, with the view of putting Roman books in their place, but the completion of his intentions failed, partly through the attachment of the Lombards to their own rites, partly through the intercession of a Gallican bishop named Eugenius (Mabillon, *Mus.* Ital. tom. i. Pars. ii. p 106). It has been asserted by Joseph Vicecomes that this is an originally independent liturgy drawn up by St. Barnabas, who first preached the Gospel at Milan (De *Missae* Rit. 1 capp. xi, xii), and this tradition is preserved in the title and proper preface for St. Barnabas Day in the Ambrosian missal (Pamelius, ***Liturgicon,*** i. 385, 386), but it has never been proved.

The Roman Rite (St. Peter).—There is only one liturgy to be enumerated under this group, viz. the present liturgy of the Church of Rome, which, though originally local in character and circumscribed in use, has come to be nearly co-extensive with the Roman Catholic Church, sometimes superseding earlier national liturgies, as in Gaul and Spain, sometimes incorporating more or less of the ancient ritual of a country into itself and producing from such incorporation a sub-class of distinct Uses, as in England, France and elsewhere. Even these subordinate Uses have for the most part become, or are rapidly becoming, obsolete.

The date, origin and early history of the Roman liturgy are obscure. The first Christians at Rome were a Greek-speaking community and their liturgy must have been Greek, and is possibly represented in the so-called Clementine liturgy. But the date when such a state of things ceased, when and by whom the present Latin liturgy was composed, whether it is an original composition, or, as its structure seems to imply, a survival of some intermediate form of liturgy—all these are questions which are waiting for solution.

The Roman liturgy seems to have been introduced into England in the 7th, into France in the 9th and into Spain in the 11th century, though no doubt it was known in both France and Spain to some extent before these dates. In France certain features of the service and certain points in the ritual of the ancient national liturgy became interwoven with its text and formed those many varying mediaeval Gallican Uses which are associated with the names of different French sees.

The chief distinguishing characteristics of the Roman rite are these: (a) the position of the great intercession for quick and dead within the canon, the commemoration of the living being placed just before and the commemoration of the departed just after the words of institution; (b) the absence of an "Epiklesis" or invocation of the Holy Ghost upon the elements; (c) the position of the Pax or "Kiss of Peace after the consecration" and before the communion, whereas in other liturgies it occurs at a much earlier point in the service.

LITURGIES OF THE BRITISH ISLES

Period I. The Celtic Church.—Until recently almost nothing was known of the character of the liturgical service of the Celtic church which existed in these islands before the Anglo-Saxon conquest, and continued to exist in Ireland, Scotland, Wales and Cornwall for considerable though varying periods of time after that event. But in recent times a good deal of light has been thrown on the subject, partly by the publication or republication of the few genuine works of Patrick, Columba, Columbanus, Adamnan and other Celtic saints; partly by the discovery of liturgical remains in the Scottish Book of Deer and in the Irish Books of *Dimma* and *Mulling* and the *Stowe* Missal, etc.; partly by the publication of mediaeval Irish compilations, such as the Lebar Brecc, Liber Hymnorum, Martyrology of *Oengus,* etc., which contain ecclesiastical kalendars, legends, treatises, etc., of considerable but very varying antiquity. The evidence collected from these sources is sufficient to prove that the liturgy of the Celtic church was of the Gallican type. In central England the churches, with everything belonging to them, were destroyed by the heathen invaders at the close of the 5th century; but the Celtic church in the remoter parts of England, as well as in the neighbouring kingdoms of Scotland and Ireland, retained its independence for centuries afterwards.

An examination of its few extant service-books and fragments of service-books yields the following evidence of the Gallican origin and character of the Celtic liturgy: (a) the presence of collects and anthems which occur in the Gallican or Mozarabic but not in the Roman liturgy; (b) various formulae of thanksgiving after communion; (c) frequent biddings or addresses to the people in the form of Gallican Praefationes; (d) the Gallican form of consecration, being a prayer called Post-Sanctus leading up to the words of institution; (e) the complicated rite of "fraction" or "the breaking of bread," as described in the Irish treatise at the end of the *Stowe* Missal, finds its only counterpart in the elaborate ceremonial of the Mozarabic church; (f) the presence of the Gallican ceremonial of ***Pedilavium*** or "Washing of feet" in the earliest Irish baptismal office. (See F. E. Warren, Liturgy and Ritual of the Celtic Church, 1881.)

Period II. The Anglo-Saxon **Church.**—We find ourselves here on firmer ground, and can speak with certainty as to the nature of the liturgy of the English church after the beginning of the 7th century. Information is drawn from liturgical allusions in the extant canons of numerous councils, from the voluminous writings of Bede, Alcuin and many other ecclesiastical authors of the Anglo-Saxon period, and above all from a considerable number of service-books written in England before the Norman Conquest. Three of these books are missals of more or less completeness: (1) the Leofric Missal, a composite 10th- to 11th-century ms. presented to the cathedral of Exeter by Leofric, the first bishop of that see (1046–1072), now in the Bodleian library at Oxford; edited by F. E. Warren (Oxford, 1883); (2) the missal of Robert of Jumibges, archbishop of Canterbury (1051–1052), written probably at Winchester and presented by Archbishop Robert to his old monastery of Jumièges in the neighbourhood of Rouen, in the public library of which it now lies; edited by H. A. Wilson (1896); (3) the Red Book of Derby, a ms. missal of the second half of the 11th century, now in the library of Corpus Christi College, Cambridge.

The Anglo-Saxon church owed its foundation to a Roman pontiff, and to Roman missionaries, who brought, as we are told by Bede, their native liturgical codices with them (*Hist. Eccles.* lib. ii. cap. 28). Accordingly, when we speak of an Anglo-Saxon missal, we mean a Roman missal.

Period III. Anglo-Norman Church.—The influx of numerous foreigners, especially from Normandy and Lorraine, which preceded, accompanied and followed the Conquest, and the occupation by them of the highest posts in church as well as state had a distinct effect on the liturgy of the English church. These foreign ecclesiastics brought over with them a preference for and a habit of using certain features of the Gallican liturgy and ritual, which they succeeded in incorporating into the service-books of the church of England. One of the Norman prelates, Osmund, count of Séez, earl of Dorset, chancellor of England, and bishop of Salisbury (1078–1099), is credited with having undertaken the revision of the English service-books; and the missal which we know as the Sarum Missal, or the Missal according to the Use of Sarum, practically became the liturgy of the English church. It was not only received into use in the province of Canterbury, but was largely adopted beyond those limits—in Ireland in the 12th and in various Scottish dioceses in the 12th and 13th centuries.

Besides the famous and far-spreading Use of Sarum, other Uses, more local and less known, grew up in various English dioceses. In virtue of a recognized diocesan independence, bishops were able to regulate or alter their ritual, and to add special masses or commemorations for use within the limits of their jurisdiction. The better known and the more distinctive of these Uses were those of York and Hereford, but we also find traces of or allusions to the Uses of Bangor, Lichfield, Lincoln, Ripon, St. Asaph, St. Paul's, Wells and Winchester. The Eucharistic service was contained in the volume called the Missal (*q.v.*), as the ordinary choir offices were contained in the volume known as the Breviary (*q.v.*).

Period IV. The Reformed Church.—The Anglican liturgy of Reformation and post-Reformation times is described under the heading of COMMON PRAYER. BOOK OF, but a brief description may be added here of the liturgies of other reformed churches. The liturgy of the Scottish Episcopal Church in nearly its present form was compiled by Scottish bishops in 1636 and imposed—or, to speak more accurately, attempted to be imposed—upon the Scottish people by the royal authority of Charles I. in 1637. The prelates chiefly concerned in it were Spottiswood, bishop of Glasgow; Maxwell, bishop of Ross; Wedderburn, bishop of Dunblane; and Forbes, bishop of Edinburgh. Their work was approved and revised by certain members of the English episcopate, especially Laud, archbishop of Canterbury; Juxon, bishop of London; and Wren, bishop of Ely. This liturgy has met with varied fortune and has passed through several editions. The present Scottish office dates from 1764. It is nou used as an alternative form with the English communion office in the Scottish Episcopal Church. The general arrangement of its parts approximates more closely to that of the first book of Edward VI. than to the present Anglican Book of Common Prayer. (See Bishop J. Dowden, The Annotated Scottish *Communion Service,* 1884.)

American Liturgy.—The Prayer Book of "the Protestant Episcopal Church" in America was adopted by the general convention of the American church in 1789. It is substantially the same as the English Book of Common Prayer, but among important variations we may name the following: (a) The arrangement and wording of the order for Holy Communion rather resembles that of the Scottish than that of the English liturgy, especially in the position of the oblation and invocation immediately after the words of institution. (b) The Magnificat, Nunc dimittis and greater part of Benedictus were disused; but these were reinstated among the changes made in the Prayer Book in 1892, (c) Ten selections of Psalms are appointed for use as alternatives for the Psalms of the day. (d) Gloria *in excelsis* is allowed as a substitute for Gloria *Patri* at the end of the Psalms at morning and evening prayer. In addition to these there are many more both important and unimportant variations from the English Book of Common Prayer.

The Irish Prayer Book.—The Prayer Book in use in the Irish portion of the United Church of England and Ireland was the Anglican Book of Common Prayer, but after the disestablishment of the Irish church several changes were introduced into it by a synod held at Dublin in 1870. These changes included such important points as: (a) the excision of all lessons from the Apocrypha, (b) of the rubric ordering the recitation of the Athanasian Creed, (c) of the rubric ordering the vestments of the second year of Edward VI., (d) of the form of absolution in the office for the visitation of the sick, (e) the addition to the Catechism of a question and answer bringing out more clearly the spiritual character of the real presence.

The Presbyterian Church.— The Presbyterian churches of Scotland at present possess no liturgy properly so called. Certain general rules for the conduct of divine service are contained in the *Directory for the Public Worship of God* agreed upon by the assembly of divines at Westminster, with the assistance of commissioners from the Church of Scotland, approved and established by an act of the general assembly, and by an act of parliament, both in 1645. In 1554 John Knox had drawn up an order of liturgy closely modelled on the Genevan pattern ior the use of the English congregation to which he was then ministering at Frankfort. On his return to Scotland this form of liturgy was adopted by an act oi the general assembly in 1560 and became the established form of worship in the Presbyterian church until the year 1645, when the Directory oi Public Worship took its place. Herein regulations are laid down for the conduct of public worship, ior the reading of Scripture and for extempore prayer before and aiter the sermon, and in the administration of the sacrament of baptism and the Lord's Supper, for the solemnization of marriage, visitation of the sick and burial of the dead, ior the observance of days of public fasting and public thanksgiving, together with a form of ordination and a directory for family worship.

LITVINOV, MAKSIM MAKSIMOVICH (1876–1951), Russian politician, was born at Bielostok. When 17 he entered military service as a volunteer and while in the army became interested in Marxism. When his service was completed. he became a member of the Kiev committee of the Social Democratic party. One of the members of that committee proved to be a police agent and the committee was arrested. After a year and a half in prison Litvinov with 11 companions escaped, went abroad and took an active part in the *Iskra,* the Social Democratic newspaper. Litvinov joined the Bolshevik section of the party, returned to Russia illegally in 1903, and worked there as a member of the central committee until the revolution of 1905. He attended the London congress as a delegate from the Riga committee, and later took part with Maxim Gorky in founding *Novaya Zhizn (The New Life).*

After the failure of the attempted revolution of 1905 Litvinov lived abroad, and organized the sending of weapons to the revolutionaries in the Caucasus. After the Nov. 1917 revolution in Russia he was appointed diplomatic agent of the soviet government in England. He was subsequently arrested as a hostage for Bruce Lockhart, for whom he was exchanged. As assistant commissar for foreign affairs he took part in the initiation of peace negotiations with Estonia, in negotiations at Copenhagen with England, in the Genoa conference and, as president of the Russian delegation, in the subsequent conference at The Hague. Litvinov continued to take a leading part in disarmament conferences, both in Moscow and Geneva. From 1930 to 1939 he was people's commissar for foreign affairs. He died Dec. 31, 1951.

LIU-CHOU (Liuchow), a city in central northern Kwangsi Chuang Autonomous Region, China. Pop. (1953) 158,800. Until 1937 it was called Maping. An important U.S. advance airbase was located there during World War II. The city is located 300 mi. northwest of Canton on the Liu Chiang, which drains southeastern Kweichow, and is at the head of year-round junk navigation, and steam launch navigation in the summer. Liu-chou is an important transportation centre for roads and railroad lines leading north into Hunan, northwest into Kweichow, and south toward Vietnam. Coal is mined, and lumber produced, to the northwest. The city, in the early 1960s, was developing into a regional centre of light industry, with the beginnings of heavy industry, and was growing rapidly in population. (J. E. Sr.)

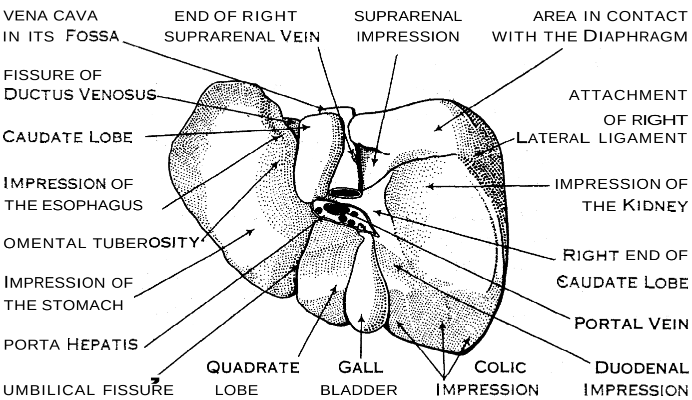
LIUDPRAND (Liutprand, Luitprand) (*c.* 922–*c.* 972), Italian chronicler, whose works are a major source for the history of Italy and Germany in the 10th century. Of noble Lombard family, he joined King Hugh's retinue as a page; after Hugh's fall (947) he entered the service of King Berengar who sent him on an embassy to Constantinople (949). Having quarreled with Berengar on his return, he found refuge at the court of Otto I, where he rose to a prominent position. Otto made him bishop of Cremona in about 961, and in the iollowing year he was present at Otto's imperial coronation. Having become one of the king's principal diplomatists, he went in 968 on another embassy to Constantinople, to'demand the hand of a Greek princess for the future Otto II. He died probably in 972.

A Lombard patriot and enemy of Berengar, Liudprand became a loyal adherent of Otto I; and his writings are coloured by his political enmities and loyalties, as well as by his personal prejudices, as for instance against the Greeks. While his *Antapodosis,* an account of events from 888 to 949, is directed against Berengar and Willa, his *Historia Ottonis* is meant to justify the emperor's ecclesiastical policy; and his *Relatio de legatione Constantinopolitana* may have been intended to serve as political propaganda for the resumption of the war against the Byzantines. But despite their strongly polemical and often biased character, his works are among the most valuable historical sources for the history of Italy and the empire during his time. Liudprand knew Greek and had a considerable knowledge of Roman literature; and his works constitute an important document of contemporary classical learning. The most recent edition of Liudprand's works is by J. Becker, in *Monumenta Germaniae Historica in usum scholarum,* 3rd ed. (1915) ; Eng. trans. by F. A. Wright (1930).

See W. Wattenbach-R. Holtzmann, *Deutschlands Geschichtsquellen im Mittelalter. Deutsche Kaisevceit, I,* 2 (1948) ; M. Lintzel, *Studien über Liutprand von Cremona* (1933). (N. R.)

LIU SHAO-CH'I (1898–), president of the People's Republic of China and a leading theoretician of the Chinese Communist party, was born of poor peasant parents in Ning-hsiang district, Hunan province, probably in 1898, though some sources give 1905. Liu attended middle school in Ch'ang-sha and studied in Shanghai and at the Peking university. He joined the Communist party in 1921 and became a labour organizer in Shanghai. In 1921 he was sent to the Far Eastern university in Moscow. The next year he returned as a labour organizer in coal-mining districts along the Kiangsi-Hunan border. In 1927 he was elected to the central committee of the Communist party. After a second sojourn in Moscow, he began organizational work in the Kiangsi Soviet and was later commissar of the New Fourth army. He was elected to the Politburo in 1942 and later served in other high offices. His theoretical essays became standard texts in Communist China. In 1949 Liu was made vice-chairman of the central government council in Peking. On April 27, 1959, he succeeded Mao Tse-tung as chairman (president) of the People's Republic of China. (R. C. N.)

LIVER (Hepar). The liver is a gland, the largest in the body. It is located in the upper right part of the abdominal cavity. It is rather soft, so that the surrounding organs push in its surface (as shown in fig. 1), but as soon as the living liver is taken out of its position, as during surgery, the depressions disappear. Its weight of approximately 1.5 kg. (3.3 lb.) presents about one-fiftieth of the total body weight. The liver has many different functions, each of which is based on its strategic location in the blood stream. It is a filter and clearing station that purifies blood; a storage place for food, particularly for sugar and vitamins; a producer of proteins of various kinds and of antibodies;



FROM CUNNINGHAM, "TEXT BOOK OF ANATOMY" (OXFORD MEDICAL PUBLICATIONS)

FIG. 1.—POSTERIOR SURFACE OF THE LIVER

and a gland that aids in digestion and acts as a remover of waste. All vertebrate animals and only vertebrate animals possess a liver.

Animal liver in man's diet is an important source of protein and fat and vitamins, especially of vitamins A, D, E and vitamin B complex. Because of its high content of iron, copper and particularly of vitamin B_{12} it is useful in the dietary control of certain kinds of anemia.

Functions.—The liver is a mass of cells through which the stream of venous blood flows as it returns from the intestine to the heart (fig. 2). As the blood passes through the wall of the gut, foodstuffs and occasionally poisonous substances are added to it. Laden with these materials, the blood passes immediately through the liver, which acts as a filter, removing noxious substances, destroying or inactivating poisons by chemical means and removing bacteria.

The liver also acts as a storehouse, taking nutritional material from the blood and storing it for future use. Among the stored

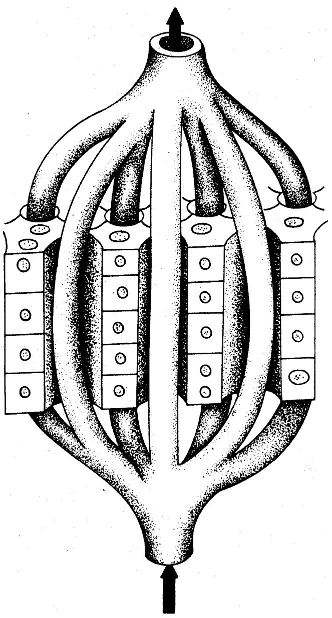


FIG. 2.—SCHEMATIC DRAWING OF THE LIVER AND ITS RELATIONSHIP TO THE GUT AND HEART

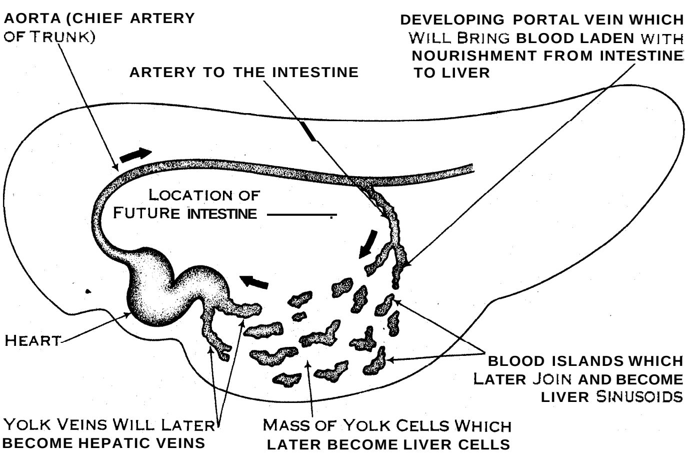
substances is sugar, which is taken from the blood under the influence of the hormone insulin (*q.v.*), produced in the pancreas. The sugar is converted into storable glycogen, which remains in the liver cells until it is needed for energy production, at which time it is reconverted into sugar under the influence of another pancreatic hormone, glucagon.

Fat, vitamins and other foodstuffs also are stored in the liver cells. Purification and storage are by no means the only functions of the liver. As the blood flows through it, the liver adds to the blood plasma proteins, among which albumin, fibrinogen, globulins, prothrombin and heparin are important. The liver also adds antibodies to the blood, which counteract disease-producing poisons (toxins) produced by bacteria. Thus it is a part of the defense system of the body.

Not only does the liver receive materials from the intestine via the blood stream, but it also is connected with the intestine by a system of tubes through which a stream of bile flows from the liver into the gut. Bile is a green liquid, secreted by the liver, that contains many different substances, among them bile acids: which aid in fat digestion, and bile salts, which help in the absorption of fat and fat soluble substances such as vitamins A, D, K and E. Many red blood cells are destroyed in the bone marrow, spleen and liver. Hemoglobin, which gives these blood cells their red colour, is thus released and flows freely in the blood. The liver picks up this dye and transforms it into bilirubin (a reddish pigment) and biliverdin (a greenish pigment), which flow with the bile into the intestine and are responsible for the brown colour of the feces. Waste products of the body activity, such as urea and uric acid, are excreted by the liver through the bile stream. Cholesterol also is eliminated from the liver through the bile, but most of it is rcabsorbed by the intestine and thus is not lost.

Embryological Development.—Developmentally, the liver is the successor of the yolk sac of lower vertebrates. Its development is best exemplified in the amphibians. The female frog produces eggs in her ovary. In these eggs, a great amount of nutritive material (fat, protein and sugar) called yolk is deposited.

The egg is laid in the water, and an embryo, then a young larva and later a tadpole develop from it. The yolk is activated and put at the disposal of the developing organism. Most of the cells that contain yolk are located in the belly of the embryo, just behind the newly formed heart (fig. 3). Hollow spaces develop in the mass of yolk cells. These spaces enlarge and become connected with each other and with the heart, and blood cells develop in them. Thus, through these primitive blood vessels in the yolk sac, the nourishing substances that are liberated from the stored yolk come into the blood and, by way of the heart, are pumped into all parts of the larva. Meanwhile, the intestine develops. Blood vessels grow from the main artery toward and around the intestine and from there toward the yolk sac. These blood vessels hook up with the network of blood vessels in the yolk sac.



(LARGE ARROWS INDICATE DIRECTION OF BLOOD FLOW)

FIG. 3.—YOLK SAC OF A FROG LARVA

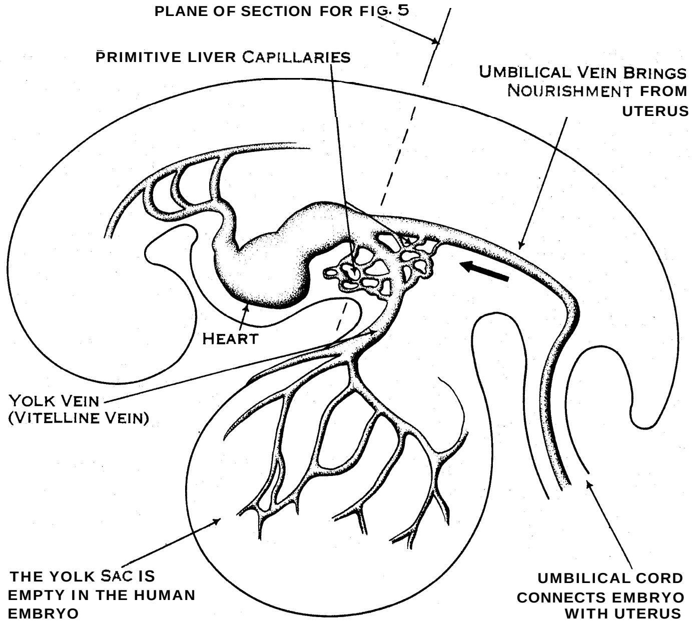


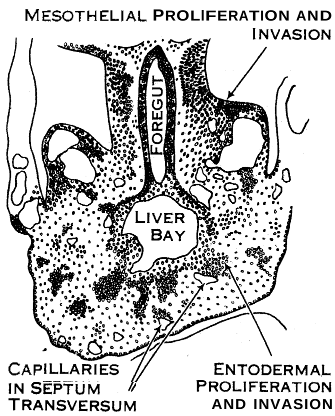
FIG. 4.—YOLK SAC OF THE HUMAN EMBRYO

Gradually, the cells in that region are depleted of yolk. At about the time the yolk has been used up, the mouth of the young tadpole opens, and it begins to eat. The food that it eats is digested in the gut, and through the wall of the gut penetrates into the blood vessels connected with the vessels in the former yolk sac. These vessels are surrounded by the cells that formerly contained the yolk. They are now empty and ready to store food again, but they are no longer yolk cells. They have become liver cells and can perform all the functions that liver cells must perform.

What were formerly yolk vessels are now called liver sinusoids. The yolk sac has become a liver. Since the liver produces bile, which must flow into the intestine, some liver cells arrange themselves so that they form the wall of a system of tubes, called bile ducts.

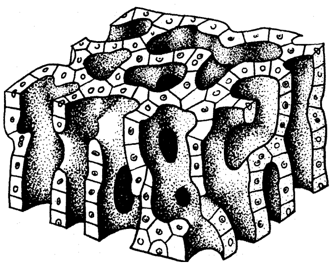
The main bile duct into which they all converge is termed the common bile duct. This common bile duct grows until it reaches the intestine and opens into it.

In man the development is quite different. The human embryo develops in the uterus, where it receives nourishment from the blood of the mother, and therefore the human egg contains almost no yolk. However, since man descended from lower verte-



FROM ELIAS, "LIVER MORPHOLOGY," BIOL. REV., 30, CAMBRIDGE UNIVERSITY PRESS (1955)

FIG. 5.—SECTION THROUGH A HUMAN EMBRYO, ABOUT 3 MM. LONG, SHOWING AN OUTPOCKETING OF THE FOREGUT, THE LIVER BAY



FROM ELIAS, "LIVER MORPHOLOGY," BIOL. REV., 30, CAMBRIDGE UNIVERSITY PRESS (1955)

FIG. 6.—A PORTION OF THE LIVER MURALIUM AND LABYRINTH

brates, the early human embryo has a yolk sac. This yolk sac is empty; yet, as if it were to remind us of our lower vertebrate ancestry, a dense net of blood vessels (the vitelline vessels) develops in its wall. A little later is developed a second system of blood vessels (the umbilical vessels.), which bring nourishment from the uterus. The vitelline and umbilical veins join just behind the heart and enter into the heart together. From the fork of their junction a network of blood capillaries grows into a mass of embryonic connective tissue (called septum transversum). (See fig. 4.) This capillary network has an outlet into the heart.

Many cells detach themselves from a ventral outpocketing of the wall of the primitive gut at its anterior junction with the yolk sac. Others detach themselves simultaneously from the lining (mesothelium) of the body cavity (fig. 5). These cells from both sources (entodermal and mesodermal) migrate into the spaces between the vitelline-umbilical capillaries in the septum transversum and surround the capillaries completely. They become liver cells.

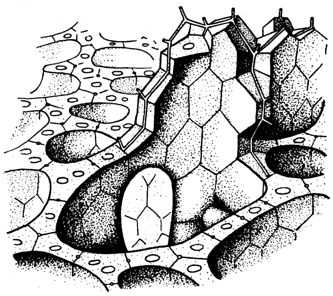
Immediately they assume the primary function of liver cells—that is, storage of food that is brought to them from the uterus through the umbilical veins. The bile ducts develop from liver cell; and join in the common bile duct, which in turn joins the intestine.

In the chick the liver arises from tubular extensions of the gut wall. Unfortunately this exceptional type of development has become the basis for standard descriptions of liver development in textbooks.

The liver of the embryo has the additional function of producing blood cells, a function that in the adult is carried on by the bone marrow.

Among vertebrate animals, 20 different modes of liver development have been found. But regardless of the method by which the liver develops, the end result is always the same. It is as if several houses were to be built according to the same floor plan and elevations, but with different building materials and methods of construction. At the end, each house is wallpapered inside and covered with stucco externally so that they all look alike, and no one except a construction expert can tell how each house was built.

This observation is contradictory to the biogenetic law of Johannes P. Müller and Ernst Haeckel and to the laws of embryogenesis of Karl Ernst von Baer, which tell us that the embryos of various species are alike, but that the adults differ. Although there is much truth in these "laws," the comparative



FROM ELIAS, "LIVER MORPHOLOGY," BIOL. REV, 30, CAMBRIDGE UNIVERSITY PRESS (1955)

FIG. 7.— MURALIUM OF LIVER CELLS WITH NETWORK OF BILE CANALICULI

embryology of the liver shows that they are by no means universal.

The livers of embryos of various species are extremely different, while the livers of adult vertebrates are in essence all alike.

Structure.— G. G. Simpson, in *The Meaning of Evolution,* has explained that if an organ shows great variations in adults from species to species, that organ must be adequate but it cannot be perfect. But if an organ is of equal construction throughout the entire range of its occurrence, then that organ must be perfect. Any divergent construction would be inadequate, and a better construction would be impossible. How, then, is this perfect liver built that can perform so many different tasks? Its construction is extremely simple, yet almost nothing was known about its microscopic structure prior to 1949 and almost nothing was known about its gross anatomy before 1952.

The liver of every vertebrate animal (including man) is a continuous mass of cells tunneled by a maze of connected cylindrical spaces (fig. 6) in which a network of specialized blood capillaries is suspended. One should imagine the liver to be a huge building with a maze of crooked hallways and long, narrow, crooked rooms.

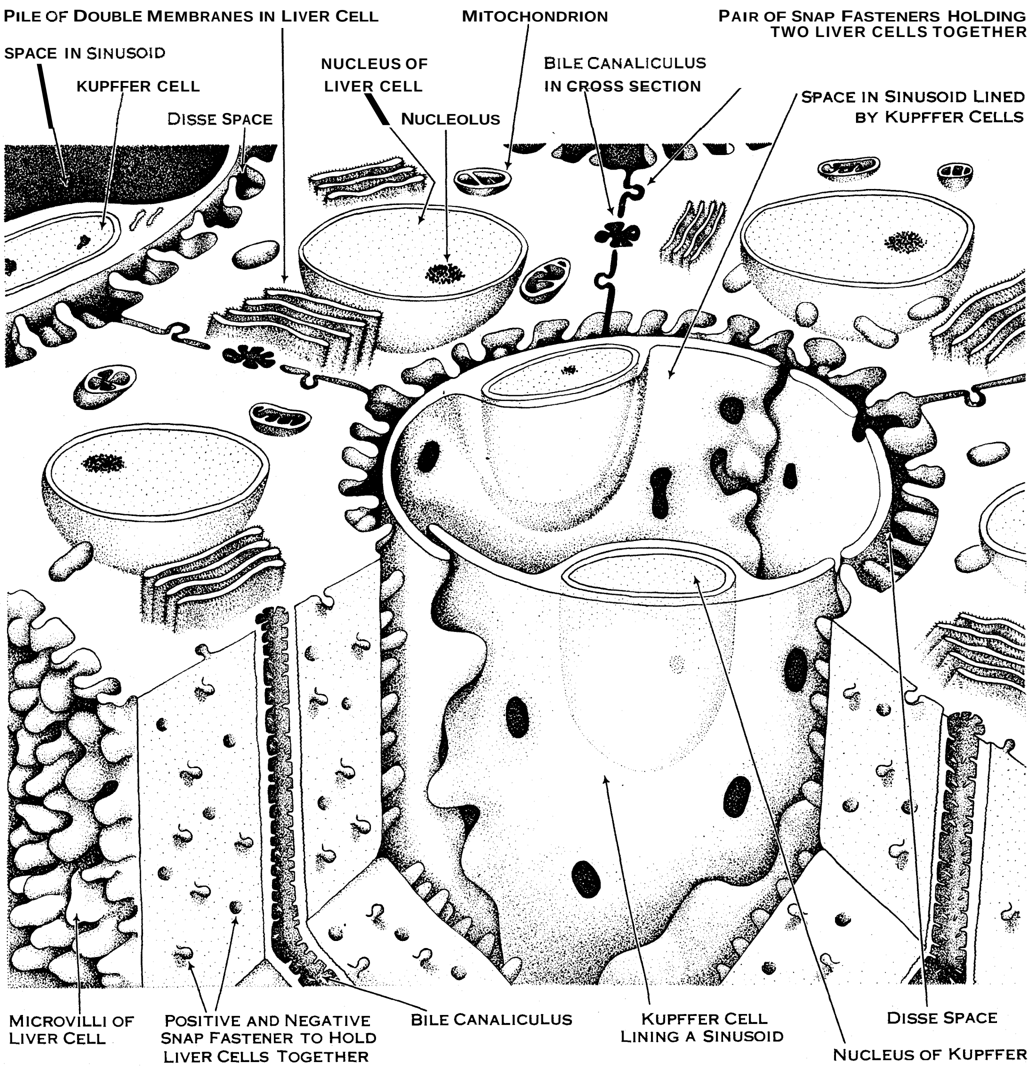


FIG. 8.—STEREOGRAM SHOWING THE SUBMICROSCOPIC STRUCTURE OF THE LIVER CELLS, KUPFFER CELLS AND BILE CANALICULI, AS REVEALED THROUGH ELECTRON MICROSCOPY BY FAWCETT, VOGEL AND RUTTNER

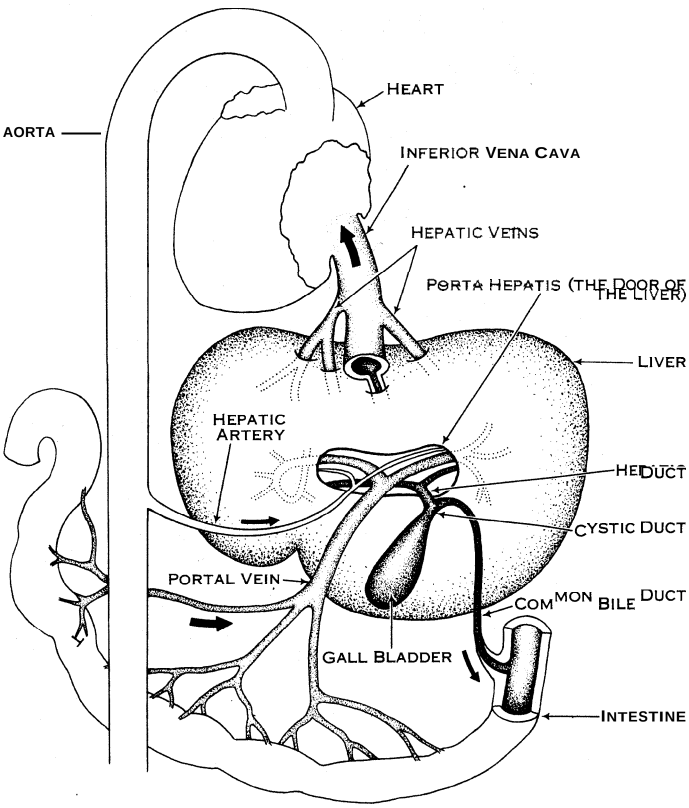


FIG. 9.—PORTA HEPATIS, THROUGH WHICH THE PORTAL VEIN AND HEPATIC ARTERY ENTER THE LIVER AND THROUGH WHICH THE BILE DUCTS LEAVE IT. PORTAL VENOUS BLOOD COMES FROM THE INTESTINE; HEPATIC ARTERIAL BLOOD COMES FROM THE MAIN ARTERY OF THE BODY, THE AORTA. BILE FLOWS THROUGH THE COMMON BILE DUCT INTO THE INTESTINE. THE BLOOD, AFTER PASSING THE LIVER, FLOWS THROUGH THE HEPATIC VEINS AND THE INFERIOR VENA CAVA BACK INTO THE HEART

Neighbouring rooms (the lacunae hepatis) are openly connected with each other, forming a three-dimensional labyrinth (the labyrinthus hepatis) (fig. 6). The walls between them are built not of stones but of liver (hepatic) cells (fig. 7). In lower vertebrates these walls (laminae hepatis) are two cells thick, while in songbirds and mammals, including man, they are only one cell thick. Such a system of connected walls is known as a muralium (from *murus*, "stone wall").

The liver of lower vertebrates, since its laminae are two cells thick, is a muralium duplex; that of higher vertebrates is a muralium simplex. The hepatic cells that compose the liver walls are connected, as the electron microscope shows, by little pegs that fit into depressions of neighbouring cells exactly in the manner of snap fasteners (fig. 8).

Between adjacent liver cells are minute tubes, the bile canaliculi, so small that they can rarely be seen in the light microscope (fig. 7). Electron microscopy shows that protoplasmic threads (microvilli) project into the bile canaliculi (fig. 8). The bile canaliculi together form networks of polygonal meshes, each surrounding an individual hepatic cell (fig. 7). Each liver cell possesses one, two or three spherical nuclei, each containing a nucleolus.

The size and number of the nuclei depends on the volume of each individual cell; this volume, in turn, depends on the location of the cell in the muralium, as shown in fig. 7. The hepatic cell also contains many mitochondria and piles of double membranes composed chiefly of ribonucleic acid. On the side toward the lacunae, the liver cells are studded with fingerlike and leaflike projections visible only by electron microscopy.

In the lacunae are suspended specialized capillaries, the successors of the yolk vessels, known as sinusoids. These sinusoids are lined by flat cells, called Kupffer cells after their discoverer, which have the ability to engulf and digest (phagocytize) particles of dirt, worn-out blood cells and bacteria. Until 1957 the Kupffer cells were believed to form an uninterrupted lining of the sinusoids. Electron microscopy, however, shows that there are spaces between them and pores in them through which liquid can pass directly from the blood stream to come into immediate contact with the myriads of submicroscopically small projections of the liver cells that pervade the narrow space (Disse space) between the solid part of the liver cells and the Kupffer cells.

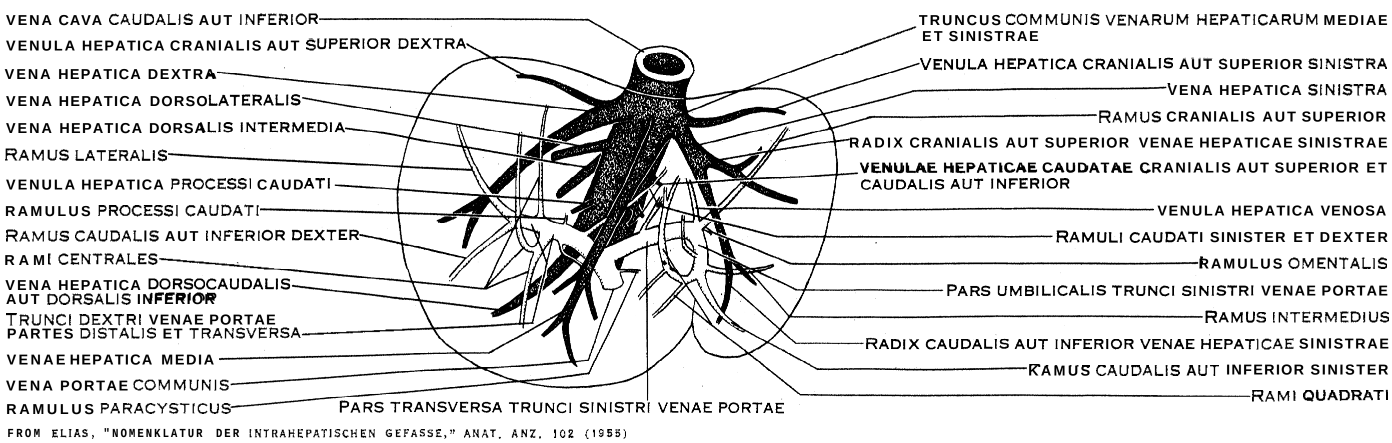
The numerous functions of the liver are all carried out by the Kupffer cells and the hepatic (liver) cells. Much is known about their structure, but it appears that the more details are learned, the less is understood about their astonishing variety of function.

Gross Anatomy.—The liver receives its chief blood supply from the intestinal capillaries that converge to form the mesenteric veins. These, together with a vein from the spleen and a few small veins from the stomach, converge into a short but thick vessel called the portal vein. This is so named because it enters the liver at its "door" (porta hepatis) (fig. 9). This door is a deep and broad depression in the postero-inferior (dorso-caudal) surface of the liver. The portal vein divides, in the porta hepatis, into a left and a right trunk, from which a number of branches (rami venae portae) arise. These branches were unknown to anatomists in 1952, although Francis Glisson had described them in all detail in 1654, but in 1952 an accident led to their rediscovery. They are shown and named in fig. 10.

The liver acts upon the portal venous blood, as noted above. But for all this work, the liver needs energy, which it must derive from the combination of carbon (contained in foodstuffs) with oxygen.

Oxygen is provided by a relatively small artery, the hepatic artery (fig. 9), the smaller branches of which accompany the rami venae portae. The branches of both the portal vein and the hepatic artery empty into the sinusoids.

Blood flows through the sinusoids into tributaries of the hepatic veins. The latter empty into the inferior vena cava, which returns



FROM ELIAS, "NOMENKLATUR DER INTRAHEPATISCHEN GEFASSE," ANAT. ANZ. 102 (1955)

FIG. 10.—POSTERIOR VIEW OF HUMAN LIVER. SHADED AREAS INDICATE HEPATIC VEINS: WHITE AREAS, PORTAL VEIN BRANCHES

the blood to the right atrium of the heart (figs. 9 and 10).

The porta hepatis is not only the entrance door for portal and arterial blood but also the exit for bile. The minute bile canaliculi converge inside the liver into ductules (little tubes), small ducts, large ducts, and then into ducts so thick that they can be seen with the naked eye. These ducts run along the portal vein branches. but the bile in them flows in the direction opposed to that of the blood flow. The bile ducts of ever-increasing calibre finally converge in the porta hepatis into the hepatic duct.

Outside the liver, the hepatic duct divides into two large branches. One of them, the cystic duct, ends in a large sac, the gall bladder. The internal lining of the gall bladder is thrown into many folds whereby its surface is increased. The cells lining it bear many tiny projections (microvilli). The gall bladder serves for short-term storage of bile, and at the same time it takes (through the microvilli) water out of the bile, making the bile more concentrated. If this concentration is carried to excess, gallstones consisting chiefly of cholesterol are formed. The other branch of the hepatic duct is the common bile duct. This duct leads into the upper part of the small intestine, the duodenum. At its exit, the common bile duct is guarded by a ring muscle, the sphincter of Oddi. Some animals, such as the horse. do not possess a gall bladder, a fact showing that the gall bladder is not necessary for life.

See also DIGESTION; GALL BLADDER; METABOLIC DISEASES; NUTRITION.

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LNERMORE, MARY ASHTON [RICE] (1821–1905), U.S. reformer, was born in Boston, Mass., on Dec. 19, 1821. She studied at the female seminary at Charlestown, Mass., and taught French and Latin there. She also taught in a plantation school in southern Virginia, and for three years conducted a school of her own in Duxbury, Mass. Upon returning from Virginia, she had joined the abolitionists, and she took an active part in the Washingtonian temperance movement. This movement was started in 1840 by habitués of a Baltimore, Md., tavern, who then founded the Washington Temperance society, named in honour of George Washington. The movement spread rapidly in 1841–43, but by the close of 1843 it had nearly spent its force. The members of the society made a pledge not to drink spirituous or malt liquors, wine or cider. Women organized Martha Washington societies as auxiliary organizations. In 1845 she married Daniel Parker Livermore (1819–99), a Universalist clergyman. During the Civil War, as an associate member of the U.S. sanitary commission, and as an agent of its northwestern branch, she organized many aid societies, contributed to the success of the Northwestern Sanitary fair in Chicago in 1863 and visited army posts and hospitals. After the war she devoted herself to the promotion of woman suffrage and to temperance reform, founding in Chicago in 1869 *The Agitator*, which in 1870 was merged into the *Woman's Journal* (Boston), of which she was an associate editor until 1872. She served as president of the Illinois, the Massachusetts and the American woman suffrage associations. She lectured in the United States, England and Scotland, and contributed to magazines. Her writings include *The Children's Army*, temperance stories (1844); *Thirty Years Too Late*, a temperance story (1848); *A Mental Transformation* (1848); *Pen Pictures*, short stories (1863); *What Shall We Do With Our Daughters? and Other Lectures* (1883); *My Story of the War* (1888); and *The Story of My Life* (1897). With Frances E. Willard she edited *A Woman of the Century: Biographical Sketches of Leading American Women* (1893). She died at Melrose, Mass., on May 23, 1905.

LIVERPOOL, EARLS OF. CHARLES JENKINSON, 1st earl of Liverpool (1729–1808), English statesman, was born at Winchester, April 26, 1729, eldest son of Col. Charles Jenkinson (d. 1750) who had commanded the Blues at Dettingen, and mas descended from Anthony Jenkinson (d. 1611), who in 1558 had been the first Englishman to penetrate into central Asia. Charles Jenkinson was educated at Charterhouse and at University college, Oxford, where he graduated M.A. in 1752. He entered parliament for Cockermouth in 1761 and joined the connection of Lord Bute. He soon secured the favour of George III; after Bute's retirement in 1765 he led the "king's friends" in the house of commons for many years, and was popularly supposed to enjoy the full confidence of the king. He held a series of minor offices: under-secretary of state, 1761–63; a secretary to the treasury, 1763–65; junior lord of the admiralty, 1766, and of the treasury, 1767–70; master of the mint, 1775–78. He also became a privy councillor in 1772 and bought the rich sinecure of clerk of the pells in Ireland in 1775. From 1778 to 1782 he was secretary-at-war, during the American Revolution. In 1786 he moved to the house of lords as Baron Hawkesbury and became president of the board of trade under William Pitt. holding that office with respectable efficiency for 1j years. He was created earl of Liverpool in 1796, and died in London. Dec. 17, 1808. His treatise on *Coins of the Realm* was authoritative enough to be reprinted by the Bank of England as late as 1880.

His son ROBERT BANKS JENKINSON, 2nd earl (1770–1828), prime minister for a longer consecutive period (1812–1827) than any other since Pitt, was born June 7, and educated at Charterhouse and at Christ Church, Oxford. where he made friends with George Canning. He witnessed the fall of the Bastille on July 14, 1789, and next year—before he came of age—was elected member of parliament for the pocket borough of Appleby. He spoke seldom, but strikingly; became a member of the India board in 1793, M.P. for Rye in 1796, and master of the mint in 1799; and as Henry Addington's foreign secretary negotiated the brief peace of Amiens in 1801. He was raised in 1803 (in his father's barony of Hawkesbury) to lead the house of lords. He was home secretary in Pitt's last administration (1804–06), and wisely refused to become prime minister when Pitt died (he accepted instead the lord wardenship of the Cinque Ports). In Lord Portland's government (1807–09) he was again home secretary, and was secretary of state for war and the colonies under Spencer Perceval (1809–12), effectively supporting Wellington's Peninsular campaigns. When Perceval was killed, Liverpool succeeded him as prime minister, and held that office continuously until crippled by paralysis early in 1827. He died at Kingston, Dec. 4, 1828.

The successful foreign policies of Castlereagh and Canning were carried through in close consultation with Liverpool, whose information on foreign affairs was as sound as his judgment was solid; eventually he and Canning worked in perfect unison. A severe home policy, which included the repressive measures of 1817–19 and support of George IV against Queen Caroline, has left him a bad reputation. Yet he was an excellent and conscientious administrator, and did much (*e g.*, by abolition of sinecures) to reform the public service and make it more fit to deal with the problems of the new industrial England. He also played a decisive role in stabilizing the currency. His relations with Huskisson were always cordial, and he warmly encouraged Huskisson's efforts at the board of trade to free commerce from the restrictions of the old economy (1823–27). His policy of keeping the question of Roman Catholic emancipation "open," and still more his own manifest integrity, held together the whole of Pitt's old connection, a party and a cabinet bitterly divided on the Catholic issue, for many years longer than they could have survived without him.

Though twice married, the 2nd earl had no children, and the earldom and barony became extinct when his half-brother died, leaving three daughters, in 1851. They were revived for the son of one of these daughters, CECIL GEORGE SAVILE FOLJAMBE (1846–1907), a Liberal politician who held court appointments under Victoria and Edward VII. His eldest son, ARTHUR WILLIAM DE BRITO SAVILE FOLJAMBE (1870–1941), 2nd earl of the second creation, was governor of New Zealand, 1912–17, and its first governor general, 1917–20.

See C. D. Yonge, *Life and Administration of the 2nd Earl of Liverpool*, 3 vol (London. 1868), and W. R Brock, *Lord Liverpool and Liberal Toryism, 1820 to 1827* (Cambridge, 1941), both based on the Liverpool papers now in the British Museum. (M. R. D. F)

LIVERPOOL, a city and county and parliamentary borough in Lancashire, Eng., the second largest seaport of Great Britain, 202 mi. N.W. of London by road, on the right bank of the estuary of the Mersey, the centre of the city being about 3 mi. from the open sea. On the north the city is partly bounded by the borough of Bootle, along the shore of which the line of docks is continued. Pop. (1961) 747,790. Area 42.7 sq.mi.

The form of the city is that of an irregular semicircle, the base line formed by the docks and quays extending about 9 mi. along the northeast bank of the estuary, the latter varying in breadth from 1 to 2 mi The city lies on a continuous slope of sandstone varying in gradient toward the river. The old borough, which lay betu een the pool, now filled in, and the river, was a mediaeval pattern of narrow alleys, and during the 16th and 17th centuries it was visited several times by plague. When the town expanded and spread up the slopes beyond the pool, conditions improved.

The irregular semicircular shape of the city is broadly zoned as follows: Lying along the river's edge are the docks and quays, together with the ancillary warehousing and other port facilities, as uell as a variety of industrial plants closely associated with the import and export of merchandise. The commercial and shopping area forms the centre of the semicircle and occupies broadly the site of mediaeval Liverpool. Around the city centre are the older suburban residential and industrial districts, formed around the original outlying villages which were absorbed by boundary extensions. Beyond these and up to the city boundary are the 20th-century private and municipal residential areas with generous parks and open spaces.

As one of the two most important ports in Great Britain, Liverpool was an important German target for aerial bombardment during World War II and sustained considerable damage, not only to commerce and industry but also in its residential areas; 6,500 dwellings were totally destroyed, and over 125,000 damaged.

History and Municipality.— During the 8th century colonies of Norsemen settled on both sides of the Mersey. After the Conquest the site of Liverpool formed part of the fief granted by the Conqueror to Roger de Poictou. Although Liverpool is not named in Domesday it is believed to have been one of the six berewicks, or subordinate manors: dependent on the manor of West Derby therein mentioned, and cultivated by 53 villeins. 62 bordarii or day labourers. 3 plowmen. 6 herdsmen. 1 horseman. 2 bondmen and 3 bondwomen. After various forfeituresand regrants from the crown, it was handed over by Henry II to his falconer Warine. In a deed executed about 1191 by John, earl of Morton, afterward King John, who was then lord of the Honour of Lancaster, in which he confirms Henry Fitzwarine in the possession of Liverpool, the name of the town first occurs. Probably its most plausible derivation is from the Norse *Hlithar-pollr,* "the pool of the slopes." Another possible derivation is from the Prov. E. lever, the yellow flag or rush. O.E. *laefer,* any rushlike or swordbladed plant. *(See* the *New English Dict., s.v.* "Levers.")

Besides his Honour of Lancaster. Prince John possessed also the lordship of Ireland, and he therefore needed a port where men and supplies could be shipped. Into the tidal waters of the Mersey a small stream ran forming a pool at its mouth. This pool could provide harbourage for the largest vessels of those days. and lay conveniently near to the castle of West Derby. After his accession to the throne. John repurchased the manor from Fitzwarine, giving him other lands in exchange. On Aug. 28. 1207, he issued letters patent granting Liverpool the same status as any other free borough upon the sea and invited his subjects to take up "burgages," or allotments, in the new town, which was built along the brow of the hill on which Castle street and the town hall are erected. The high cross stood near the present town hall, and there the main line of street was intersected by another line extending from the riverside to the Townsend bridge. which crossed the pool where the end of Dale street now is. Considerable use was made of Liverpool in the 13th century for shipping stores and reinforcements to Ireland and Wales. In 1229 a charter was granted by Henry III confirming in detail that previously granted by his father. making Liverpool a free borough forever, and authorizing the formation of a merchants' guild. Several charters were granted until the reign of William and Mary, whose charter was that under which the town was governed until the Municipal Reform act of 1835. In 1880, when the diocese of Liverpool was created. the borough was transformed into a city by royal charter, in 1888 it became a county borough, and in 1893 the style and dignity of lord mayor was conferred on its chief magistrate.

Liverpool sent no representatives to parliament in 1264, but in 1296 the borough sent two members, and again in 1307. The next time it sent members was in 1547. In 1588 the borough was represented by Francis Bacon.

Under the Municipal Reform act of 1835, the boundaries of the original borough were extended and there were several extensions afterward. In 1932 was added the township of Speke, where the municipal airport was established. Since 1951 Liverpool has returned nine members to parliament: for Edge Hill, Exchange, Garston, Kirkdale, Scotland, Toxteth Park, Walton-on-the-Hill, Wavertree and West Derby.

The crown revenues from rents and the royal customs were leased from time to time, sometimes to the corporation, at other times to private persons. The first lease was from Henry III in 1229, and in the same year the borough, with all its appurtenances, was bestowed with other lands on Ranulf, earl of Chester, from whom it passed to the earl of Derby, who seems to have built Liverpool castle between 1232 and 1237. The lands of his grandson. Robert de Ferrers, were confiscated in 1266 when Liverpool passed into the hands of Edmund, earl of Lancaster.

The corporation of Liverpool has possessed from a very early period considerable landed property, the first grant having been made by Thomas. earl of Lancaster, in 1309. This land was originally of value only as a source of supply of turf for firing, but in modern times it has become profitable building land. A large proportion of the southern district is held in freehold by the corporation and leased to tenants for terms of seventy-five years, renewable on a fixed scale of fines. Liverpool again became the property of the crown when Henry IV inherited it from his father John of Gaunt. In 1628 Charles I sold Liverpool to certain merchants of London, who, in 1635, reconveyed the crown rights, including the fee-farm rent of £14, 6s. 8d. to Sir Richard Molyneux, then Viscount Molyneux of Maryborough, for the sum of £450. In 1672 all these rights and interests were acquired by the corporation and in 1777 converted into a perpetuity. With the growth of commerce these dues enormously increased, and became a cause of great complaint by the shipping interest. In 1856, by act of parliament, the town dues were transferred to the Mersey Docks and Harbour board on payment of £1,500,000, which was applied in part to the liquidation of the bonded debt of the corporation amounting to £1,150,000.

During the Civil War the town was fortified and garrisoned by the parliament. It sustained three sieges and in 1644 fell to Prince Rupert.

Liverpool's trade developed slowly. From £10 per annum, in the beginning of the 13th century, the crown revenues had increased toward the end of the 14th century to 638; but then they underwent a decline. The black death, about 1360, carried off a large part of the population. The Wars of the Roses in the 15th century retarded progress for at least a century. during which period the crown revenues diminished from f38 and were finally leased at £14, 6s. 8*d*., at which they continued until the sale by Charles I. It is, however, not safe to conclude that the reduced fee-farm rent represents an equivalent decline in prosperity: the privileges conferred by the various leases differed widely and may account for much of the apparent discrepancy. The true rise of the commerce of Liverpool dates from the Restoration. Down to that period its population probably never exceeded about 1,000. Its trade was chiefly with Ireland, France and Spain, exporting fish and wool to the continent, and importing nines, iron and other commodities. The rise of the manufacturing industry of south Lancashire, and the opening of the American and West Indian trade, gave the first impulse to the progress which has continued. By the end of the 17th century the population had increased to 5.000. In 1699 the borough was constituted a parish distinct from Walton. In 1709, the small existing harbour was found insufficient to accommodate the shipping, so a met dock was constructed with floodgates impounding the water, so as to keep the vessels floating during the recess of the tide. The name of the engineer was Thomas Steers.

About now the Liverpool merchants entered on the slave trade, into which they were led by their connection with the West Indies. In 1700 the "Liverpool Merchant" carried 200 Negroes from Africa to Barbados; in 1730, encouraged by parliament, Liverpool went heartily into the new trade. In 1751, 53 ships sailed from Liverpool for Africa, of 5,334 tons in the aggregate. The ships sailed first to the west coast of Africa, where they shipped the slaves, and thence to the West Indies, where the slaves were sold and the proceeds brought home in cargoes of sugar and rum. By the end of the century five-sixths of the African trade centred in Liverpool. Just before its abolition in 1807 the number of Liverpool ships engaged in the traffic was 185, carrying 49,213 slaves in the year. Another branch of maritime enterprise which attracted the attention of the merchants of Liverpool was privateering, which, during the latter half of the 18th century, was a favourite investment.

The abolition of the slave trade did not bring to Liverpool the ruin which had been prophesied, and trade with the fast developing North American continent was further increased by the introduction of steam-driven ships in the early 19th century. The reformed town council, after a few years of acute political dissension, displayed a pioneering spirit in the field of public health, encouraged to do so, no doubt, by the problems arising from the mass immigration from Ireland after the famines of the 1840s. Liverpool appointed W. Duncan the first medical officer of health in 1846. As the town became more wealthy there was an increase of interest in cultural affairs. In 1849 the Philharmonic hall was opened and by the Act of 1852 Liverpool had one of the first libraries in the country. A museum was provided by Sir William Brown and an art gallery by Sir A. B. Walker. These buildings, together with the Picton reading room, form an impressive group opposite St. George's hall.

In the 20th century the opening of the Mersey tunnel had greatly increased the flow of traffic passing through Liverpool on a north-south axis and has brought residential and industrial areas of Cheshire and Staffordshire into closer touch with Liverpool and southwest Lancashire. Since World War II large blitzed areas in the centre of the city had to be cleared, but it was not until 1952 that the major tasks of central redevelopment could be commenced. Large suburban estates had also been developed at Norris Green. Dovecot, Speke. Kirkby and Croxteth.

The original supply of water was from wells in the Triassic sandstone. In 1847 an act was passed under which extensive works were constructed and extended later at Rivington, about 25 mi. distant. The vast increase of population led to further requirements, and in 1880 another act gave power to impound the waters of the Vyrnwy, a tributary of the Severn. These works were completed in 1892 and a second pipeline added in 1905. The capacity of the Vyrnwy reservoir is more than 13,000,000,000 gal. and the catchment area 23,150 ac. in extent. A third pipeline was opened in 1938 and work on a section of a fourth pipeline began in 1953.

Prior to 1699 Liverpool came within the parish of Walton-on-the-Hill, but in that year the chapel of ease of Our Lady and St. Nicholas at the pierhead separated from its parent to become the first parish church. A second church. that of St. Peter, erected by the corporation was founded and, together, these with a number of subsequent churches, served until the increasing population made the establishment of a see of Liverpool imperative. A public subscription was launched which realized £100,000 and as a result the see was formed in 1880 with the parish church of St. Peter serving as procathedral. The foundation stone of the new cathedral was laid in 1904 and the see is comprised of 223 parishes. Warrington is a bishopric suffragan.

The Roman Catholic archdiocese of Liverpool embraces the old hundreds of West Derby. Leyland and the Isle of Man. It was formed as a bishopric in 1850, raised to an archbishopric in 1911 and embraces 196 parishes. The parish church of St. Nicholas, Copperas hill, serves as procathedral. The foundation stone of the new cathedral was laid in 1933.

Architectural Features.—Although the city possesses many buildings of considerable architectural merit, the development of the commercial and shopping centre on the site of the mediaeval town has obliterated practically all traces of the earlier buildings. The town hall, opened in 1754 and designed by John Wood of Bath, is of particular merit. It is a rectangular building in the Corinthian style, surmounted by a dome which was added after a disastrous fire in 179j. The old Bluecoat hospital (built 1717), a Queen Anne group built around a courtyard off Church street, is a fine example of its period. It suffered considerable damage in World War II, but was later rehabilitated. Fine examples of 19th-century domestic architecture are to be found in Rodney street and in the Abercromby square area around the university. These dwellings were formerly the residences of Liverpool merchants. Outstanding among many buildings in the Classic Revival style is St. George's hall, designed by Harvey Lonsdale Elmes and completed in 1854. This imposing building, in addition to providing a large public hall, also houses the assize courts, and is surrounded by open spaces and gardens sufficiently extensive to enable its splendid classic proportions to be appreciated. After the death of Elmes in 1847, the building was completed by C. R. Cockerell, who also designed other important buildings in the city. Adjacent to St. George's hall is the impressive group of buildings in William Brown street. comprising the Technical college, the city museum, the Picton Reading room and the Walker Art gallery. The permanent collection in this gallery is regarded as one of the finest in the provinces.

Of the many modern buildings of architectural merit. the most famous are the three oyerlooking the river at the pierhead, which comprise the Royal Liver building, the Cunard building, and the offices of the Mersey Docks and Harbour board. The Philharmonic hall, replacing the old one that had been burned down, was opened in 1939. It is a finely proportioned concert hall with excellent acoustics for orchestral concerts and its own Philharmonic orchestra.

Of the two cathedrals being built in Liverpool in 1953, the Anglican cathedral was begun in 1904 when the foundation stone was laid by Edward VII. The architect, Sir Giles Gilbert Scott, has taken full advantage of the excellent site, and the cathedral is the most important 20th-century addition to the city's skyline. The building is designed in the Gothic style and is built of red sandstone with copper roof. The Lady chapel was consecrated in 1910, and the choir, east transepts and chapter house in 1924. The organ, dedicated in 1926, is the largest in the country (5 manuals, 10,925 pipes). The ultimate length of the cathedral will be 619 ft. The interior height is 116 ft.—14 ft. higher than Westminster abbey.

The construction of the Roman Catholic cathedral of Christ the King, to the design of Sir Edwin Lutyens, was begun in 1933. The original designs have been substantially modified (1955) and the size reduced by more than one-third. One of the outstanding features retained is the domed central space, 178 ft. in diameter.

Arts, Education and University.—The free library, museum and gallery of arts, established and managed by the city council, was originated in 1852. The first library building was erected by Sir William Brown. The Derby museum, containing the collections of Edward, the 13th earl: was presented by his son. The Mayer museum of historical antiquities and art was contributed by Joseph Mayer, F.S.A. (1803–86), who presented his collections to Liverpool in 1867. The museum contains an unrivalled collection of Wedgwood and Liverpool ware. Sir Andrew Walker (1824–93) erected in 1877 the art gallery which bears his name. Large additions mere made in 1884, the cost being again defrayed by Sir Andrew Walker. The permanent collection of paintings includes the William Roscoe collection of old masters and the bequest (1923 and 1927) of James Smith of Blundellsands of 28 pictures of G. F. Watts. 4 sculptures by Rodin, many etchings and engravings by Albrecht Diirer, Seymour Haden and James Whistler, together with a large number of modern works. British and foreign. The Picton circular reading room was built by the corporation and opened in 1879. Adjoining it is the Hornby library of fine art books, prints and bindings. There is a technical library, used by industrialists and scientists, and, in the business quarter of the city, an important commercial library. As well as two theatres and two variety palaces there is the Playhouse repertory theatre where many actors and actresses, later to become famous, have started their careers.

Sunday schools were founded in 1784 as the result of a town meeting and these were soon followed by private day schools. Of the semiprivate schools founded in the 19th century by public subscription the Liverpool institute (182 j) and Liverpool college (1840) still continue, the former as a day grammar school maintained by the local authority since 1903, the latter as an independent public school and local authority's grammar school since the division in 1907.

One-third of the 140,000 schoolchildren in Liverpool are Roman Catholic and these children are educated in schools provided by that denomination. A smaller proportion of schools is provided by the Church of England for children of that communion. and there is a Hebrew school for Jewish children. All these schools are maintained by the local authority or are administered as direct grant schools. There are many other educational institutions including separate colleges of technology, commerce, building and art and five teachers' training colleges. of which one is for physical training and one is for domestic science.

University college. Liverpool, founded by the citizens of Liverpool, received its charter of incorporation in 1881. Three years later it was accepted as a member of the federal Victoria university, and at the same time the Royal Infirmary Medical school, which had been established since 1844, became a member of the college. By 1900 there was a staff of 25 professors and 60 lecturers, and a student body of nearly 600.

On the dissolution of the Victoria university, a royal charter, granted in 1903, established the University of Liverpool. Degrees in engineering were instituted and, later, degrees in architecture; in 1904 the New Veterinary college of Edinburgh was transferred to Liverpool and a chair of veterinary medicine and surgery was founded.

After World War I development was rapid. Between 1920 and 1939 many new buildings and extensions were constructed. including the Jane Herdman Memorial Geology laboratories (1929), the Leverhulme building of the school of architecture (1933), an extension to the students' union (1935), the Harold Cohen library (1938) and Derby hall, a hall of residence for men students (1938). In 1942, a veterinary field station was opened at Willaston. Wirral. thus continuing the development of a science with which the university has always been prominently associated.

The extension of university education since World War II has brought an increase in staff, students and accommodation; the number of its chairs is 59 and the faculties of the university are those of arts (responsible for degrees in commerce, architecture and civic design, as well as for degrees in arts): science, including a department of oceanography, with the only chair in oceanography in the British Commonwealth, which works in close conjunction with the marine biological station maintained at Port Erin, and with the Liverpool Observatory and Tidal institute; medicine. including the school of dental surgery; law; engineering; and veterinary science. The Liverpool School of Tropical Medicine, though separately incorporated, is governed by a committee representative of the university and the merchants and shipowners of Liverpool; and its students take the university postgraduate diploma in tropical medicine and hygiene.

In 1948 a plan for the future development of the university was published, and the city council has reserved a site in its own redevelopment plan for the purpose, with Abercromby square as its approximate centre. The jubilee of the university was celebrated in May, 1953.

Docks and Railways. — The docks of the port of Liverpool on both sides of the Rlersey are owned and managed by the Mersey Docks and Harbour board. On the Liverpool side they extend along the estuary 6 mi., of which $1\frac{1}{4}$ mi. is in the borough of Bootle. The Garston docks. 6 mi. above Liverpool, are also within the city boundary. The Birkenhead docks have not such a frontage, but extend a long way backward. The water area of the Liverpool docks and basins is 460 ac. with a lineal quayage of nearly 28 mi. Birkenhead docks contain a water area of about $181\frac{1}{4}$ ac., with a lineal quayage of $9\frac{3}{4}$ mi. The system of enclosed docks was begun by the corporation in 1709. The Gladstone docks, opened 1927, are among the best equipped in the world. The sill is 20-ft. below datum level and the entrance is 130-ft. nide and the area with branch docks is nearly 54 ac. A fine graving dock is part of the system. Down to 1843 the docks were confined to the Liverpool side of the Mersey. In 1843 a scheme for docks in Birkenhead was carried through, proved unsuccessful. and was acquired in 1855 by Liverpool. The Birkenhead docks were for many years only partially used, but are now an important centre for corn milling, the importation of cattle, and export trade to the east.

The first portion of the great landing stage, known as the George's Landing stage, was constructed in 1847. This was 500-ft. long. In 1857 the Prince's Landing stage. 1,000 ft.-long, was built to the north of the George's stage and distant from it 500 ft. In 1874 the intervening space was filled up and the George's stage reconstructed but. being destroyed by fire, was reconstructed a second time. In 1896 it was extended farther north, and its length is now 2,534 ft. and its breadth 80 ft. It is supported on floating pontoons (about zoo) connected nith the river wall by 10 bridges. besides a floating bridge for heavy traffic 550 ft. in length and 35 ft. in width. The southern half is devoted to the traffic of the Mersey ferries, of which there are three — New Brighton, Seacombe and Birkenhead. The northern half is used by ocean-going steamers and their tenders. The warehouses for storing produce form a prominent feature in the commercial part of the city. In addition to general produce warehouses. grain warehouses have been constructed by the dock board at Liverpool and Birkenhead: with machinery for discharging, elevating, distributing, drying and delivering. Warehouses for the storage of tobacco and wool have also been built by the board. The Stanley tobacco warehouse is the largest of its kind in the world, the area of its fourteen floors being some 36 ac.

There are four terminal passenger stations in Liverpool. They are: Lime street, Exchange. Central and Riverside. Connection with Wirral is effected by the old Mersey tunnel (opened 1886), and by the new road tunnel completed in 1928. (See BIRKENHEAD; TUNNEL.) The Liverpool overhead electric railway running along the line of docks from Seaforth to Dingle was opened in 1893, and in 1905 a junction was made with the L.M.S. railway by which through passenger traffic between Southport and Dingle was established. In 1895 the Riverside station at the Prince's dock was completed by the Mersey Docks and Harbour board, giving direct access from the landing stage to the railway system.

Trade and Commerce. — The port is the traditional centre of business life in Liverpool and the adjoining districts that go to make up Merseyside. It is second only to London among British "general" ports, with extensive passenger interests to add to its handling of materials and goods of virtually every type. The total tonnage of these in an average year is of the order of 15,000,000, carried in some 32,000 sea-going vessels.

The commerce of Liverpool, channelled through its port. has a main emphasis on North and South America. West Africa. the Mediterranean countries, the Indian subcontinent and Australasia — a very large proportion of the trading world. The main imports are of raw materials and commodities (13,870,000 tons in 1952, excluding bulk oil), headed by grain and cereals to an extent of well over 1,000,000 tons annually (1,300,000 tons of flour and grain in 1951), together with a multitude of lesser cargoes, for use or manufacture in and around Liverpool or in the upcountry areas of industry which it serves. From these areas. principally of Lancashire, the midlands and west Yorkshire, come in return the chief exports of Liverpool — iron and steel, machinery, and manufactured goods of all types from the heaviest products to pottery. textiles and fine goods. compiling a list as long as the concerns of British overseas trade. The export tonnage in 1952 was 5,564,000.

The port is the hub of the wheel of Merseyside and in that hub are the ships, the building and fitting of ships, the manning, victualling, and servicing of ships that are known throughout the world. Packed around that hub are major facilities of banking and insurance, of warehousing and of every branch of commercial life and, packed equally, are industries to process imported materials as close as possible to the quays. For Merseyside has the largest flour-milling centre in Europe, its sugar and oil refineries are world-famous, oilseed crushing is a substantial industry and the same line of industrial thought is followed by biscuit, confectionery, rubber and soap factories, somewhat further from the main port area but well within local boundaries. In 1951, 951,000 tons of sugar and molasses were imported and 525,000 tons of oil.

In the late 1920s this picture, with some modifications, would have represented the sum of Liverpool's commerce and industry. But the trade recession which paralysed the world then had a particularly serious effect on Liverpool, dependant as it was on a maximum passage of the world's goods and, at the worst of the recession, some 100,000 of Liverpool's citizens were unemployed. To insure against a repetition of this, by spreading the risk over as wide and productive a field as possible, the Liverpool City corporation took special statutory powers (in 1936) which have since been imitated by many other authorities, both central and municipal—powers to bring work to the worker by means of special facilities, of finance, siting and construction, made available to manufacturing industry. The corporation's industrial estates at Speke, Kirkby and Aintree cover a total acreage of 2,741, and each is on a principal approach to the city from its inland areas of chief contact. The effect, when allied to the efforts of the state since World War II and of private enterprise throughout, has been to add a third partner, manufacture, to the older and better-known interests of Liverpool's life. There are now large factories for electrical and electronic apparatus, diesel engines, jet engines, tires and heavy chemicals. Other products include antibiotics, clocks, scientific instruments, pharmaceutics and matches. The social process involved, of converting a measurable part of a dock-side population, accustomed for many generations to casual labour, into an industrial population, working regularly, has been both interesting and successful.

As a result, Merseyside's registered working population of 580,000 has an infinitely greater industrial element than its grandfathers would have believed possible. The port and all to do with it remains the largest employer of that labour, followed by light engineering, chemicals and pharmaceuticals. food and foodstuffs, the services of commerce and inland transport and a very large number of smaller activities, each substantial in itself and completing the composition of an area which has at least taken definite steps in the direction of economic balance.

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LIVERSIDGE, ARCHIBALD (1847–1927), English chemist, was born on Nov. 17, 1847 in London, and studied at the Royal School of Mines and the Royal College of Chemistry, and entered Christ's college, Cambridge. In 1867 he became instructor in chemistry at the Royal School of Naval Architecture, and three years later university demonstrator in chemistry at Cambridge.

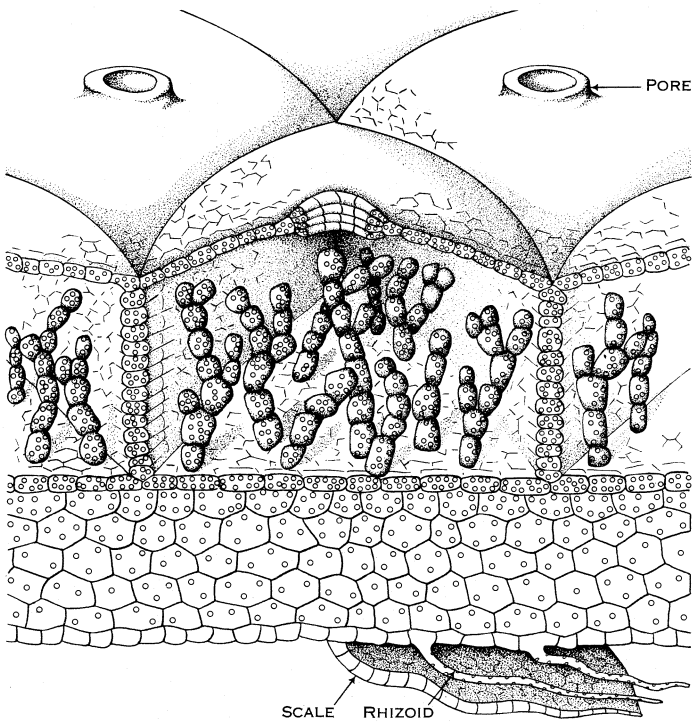
Liversidge was professor of chemistry at the University of Sydney from 1873 to 1908. In 1879 he founded the faculty of science at bydney university, and also the school of mines (1890). Liversidge gave an impetus to technical education in Australia. He founded the Australasian Association for the Advancement of Science in 1885. acted as secretary (1888–1909) and president (1888–90). In 1902 he founded the Sydney section of the Society of Chemical Industry and served as its first chairman (1903–05).

His researches were chiefly in mineralogy; he collected and analyzed meteorites. He also wrote papers on the origin of the gold nuggets in Australian alluvial deposits. His most important work is *The Minerals of New South Wales* (1888). but he was also the author of a *Report upon Technical Education and Museums* and of more than a hundred technical papers, most of which treated matters relating to chemistry and mineralogy.

Liversidge died in Surrey on Sept. 26. 1927.

LIVERWORTS, constitute a subdivision of the Bryophyta (*q.v.*), to which also belong the mosses. The liverworts differ from the mosses principally in the structure of the spore-bearing plants (sporophytes), described below. All mosses are leafy. but some of the liverworts lack leaves or, if leafy, are usually flatter than the majority of mosses. The leafless forms may be ribbonlike or otherwise flattened and ruffled, but most liverworts have leaflike appendages on the stems.

No liverwort has any important economic significance. although some (*Marchantia* and *Conocephaleum*) long ago were thought to have medicinal value for liver ailments in accordance with the Doctrine of signatures (*see* SIGNATURE). In nature they play a



REDRAWN FROM FULLER AND TIPPO'S 'REVISED COLLEGE BOTANY" (1954); REPRODUCED BY PERMISSION OF HENRY HOLT & CO., INC.

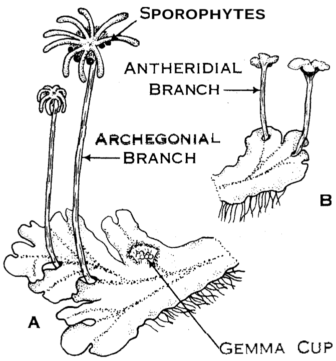
FIG. 1.—SECTION THROUGH MARCHANTIA THALLUS CONSISTING OF UPPER EPIDERMIS WITH PORES, AIR CHAMBERS WITH COLUMNS OF CELLS CONTAINING CHLOROPLASTS, REGION WITH FEW CHLOROPLASTS, AND LOWER EPIDERMIS BEARING SCALES AND RHIZOIDS

role as pioneers on newly exposed substrata in the reducing of rocks and woody materials to soil, in retarding soil erosion and in providing food and homes for small animals.

The liverworts may be divided into two groups: Hepaticae and Anthocerotae.

Hepaticae.—Sometimes called the hepatics. these liverworts may be divided into the leafy and the thalloid forms. the latter being flattened ribbons or rosettes without leaflike structures on the stems. The thalli vary in size from one-sixteenth to one inch in width.

The best-known thalloid species is *Marchantia polymorpha*, which appears like a green forking ribbon approximately one-half inch in width. It has an upper and lower epidermis nith scales along the middle of the latter. The portion between the upper and lower epidermis is filled with walled cavities. each with an opening through a fixed pore in the upper epidermis. The cavities

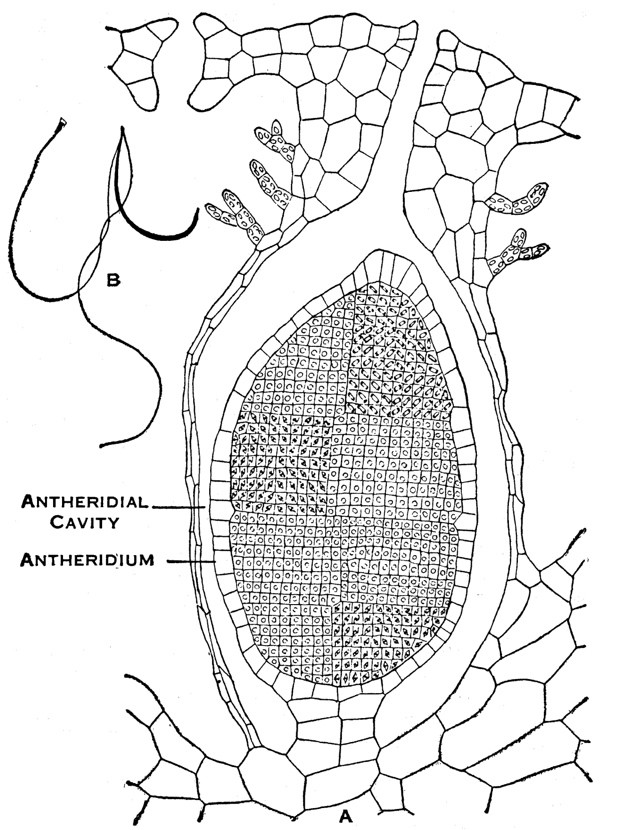


FROM WEATHERWAX, "PLANT BIOLOGY," (W. B. SAUNDERS COMPANY)

FIG. 2.—SOME COMMON LIVERWORTS. (A, B) MARCHANTIA. THE ANTHERIDIA ARE PRODUCED IN CAVITIES IN THE UPPER SURFACE OF THE DISC ON THE MALE PLANT; THE ARCHEGONIA ARE BORNE ON THE LOWER SIDES OF THE FINGERLIKE RAYS OF THE STAR-SHAPED STRUCTURE OF THE FEMALE PLANT

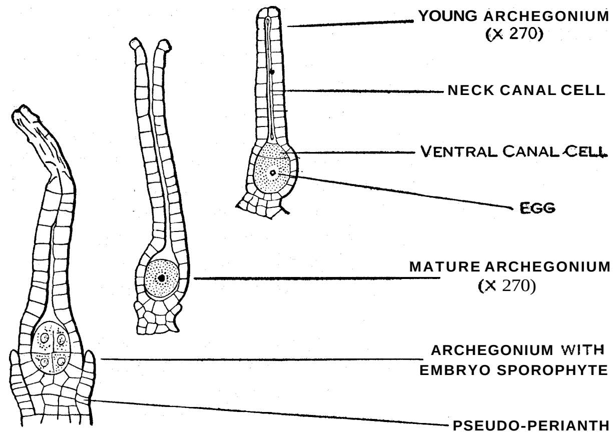
have short, green, cactoid filaments scattered in them.

These thalloid plants are haploid; *i.e.*, are gametophytes with a single set of chromosomes. They are unisexual, and eventually stalklike branches are formed. If female. the sexual branch somewhat resembles a palm tree or an umbrella without its fabric. The female sex organs (archegonia) are hung beneath the rays. The male branches terminate in a flattened, scalloped, screwhead-like structure with male sex organs (antheridia) buried in small-mouthed cavities in the upper surface. At maturity the male cells (sperms) may swim from the ruptured antheridia to the female plants and thence to the female cell (egg) contained in the enlarged. basal portion (venter) of the archegonium. The fertilized egg (zygote, formed by union of sperm and egg) by apical growth matures into a spore-bearing plant which is diploid; *i.e.*, a sporophyte with a double set of chromosomes. It consists of a foot embedded basally in the venter, a stalk (seta) which attaches the foot to the spheroidal spore-bearing capsule (sporangium). all of which develops within the archegonium. At maturity the cells of the seta rapidly elongate, bursting the archegonium and exposing the capsule. The capsules do not have a columella, and the spores are covered by a compact wall of one or two layers of cells. The spores are often mixed with slender. hygroscopic cells (elaters) which may effect spore dispersal when the capsule splits open or ruptures as a result of wall deterioration.



FROM SMITH, GILBERT, ET AL.. "A TEXTBOOK OF GENERAL BOTANY," (THE MACMILLAN COMPANY)

FIG. 3.— MARCHANTIA. (A) IMMATURE ANTHERIDIUM. WITH ADJOINING PARTS OF THE MALE DISC IN WHICH IT IS BORNE. (B) SPERM VERY MUCH ENLARGED



FROM STRASBURGER, 'TEXT-BOOK OF BOTANY'

FIG. 4.— MARCHANTIA POLYMORPHA, SHOWING THE ARCHEGONIUM. WHICH ENCLOSES THE OVUM OR EGG

The spore germinates on moist substrata and after a short (three or four cells) threadlike phase grows into the ribbonlike gametophyte.

The leafy members of the Hepaticae often resemble mosses but usually can be recognized by the fact that they have only two rows of leaves (also characteristic, however, of the moss genus, *Fissidens*) or two rows of large leaves and a third row of small leaves on the side of the stem toward the substrate. They vary from species microscopic in size to those in which single leaves may be easily seen without a lens.

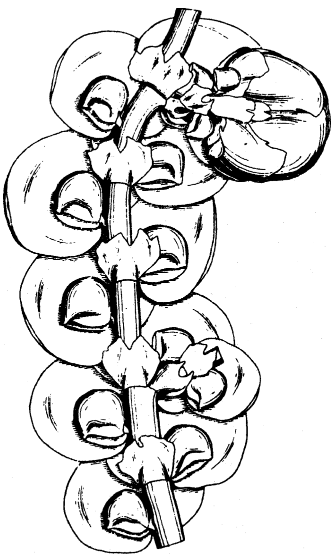
In Trichocolea, Ptilidium and others, the leaves are subdivided into hairlike segments. In *Frullania* and Jubula they have a small, pouchlike lobe bent up behind the main portion of the leaf. Some leaves have entire margins; others have long, marginal teeth. Some are smooth; others are rough with pimplelike projections (papillae).

The sexual life cycle of the leafy species is not essentially different from that of the thalloid forms. The antheridia are borne in the axils of leaves; the archegonia are usually terminal. The sporophyte usually has a longer seta than many of those in the thalloid species.

In addition to reproduction by sexual means, liverworts also produce vegetative reproductive bodies (gemmae) of various shapes and sizes. Some are formed on the surface or edges of leaves or thalli; others are borne in specialized structures in the form of cups or flasks. New plants are also formed by growth from fragments and by branching and subsequent death of the older portion.

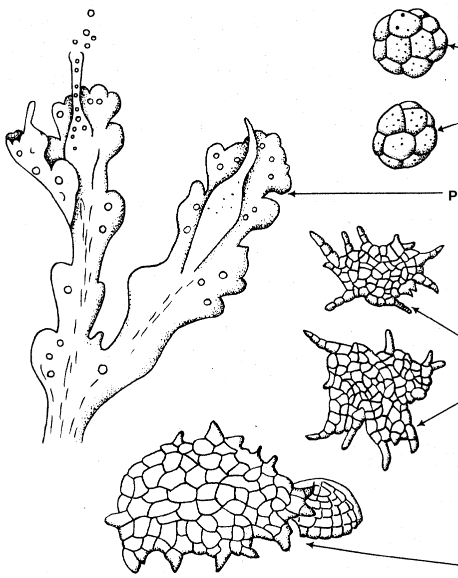
Anthocerotae.—These, often called hornworts, do not constitute a very large group of the liverworts. American genera include Anthoceros, Phneoceros and Notothylas. They differ from the hepatics in a number of characteristics, the most important of which is the indeterminate basal growth of the needle-shaped sporophyte. Thus, arises the unique situation in which mature spores may be falling from the top of the apically split sporophyte while new ones are being initiated at the base. Also. there is no seta and the foot is large and irregular.

The cells of the hornwort sporophyte have two large chloroplasts containing starch-producing bodies called pyrenoids;



FROM EVANS, "NORTH AMERICAN SPECIES OF FRULLANIA," (TRANSACTIONS OF CONNECTICUT ACADEMY OF ARTS AND SCIENCES, 1899)

FIG. 5.—FRULLANIA BRITTONIAE, WITH A PORTION OF EACH LATERAL LEAF FOLDED INTO A SAC



FROM THE STUDENT'S HANDBOOK OF BRITISH HEPATICS"

FIG. 6.— BLASIA PUSILLA, A LIVERWORT WHICH PRODUCES TWO TYPES OF GEMMAE. ONE OF WHICH GROWS INTO A NEW PLANT

cells of the hepatics have several to many small chloroplasts without pyrenoids

The sporophyte has a sterile central column (columella) and pores (stomata) in the epidermis; these structures are not present in the hepatics. The latter have unicellular elaters. if present; the hornworts usually have irregular multicellular elaters.

The gametophyte is not leafy but a thallus which has cavities, often opening by slits through the lower surface. containing symbiotic colonies of the blue-green alga *Nostoc*. The cells of the gametophyte each have a single. large chloroplast.

The sex organs (antheridia and archegonia) are somewhat similar to those of the hepatics but are sunk in the upper surface of the gametophyte, the antheridia occurring in cavities and the archegonia appearing as an integral part of the thallus.

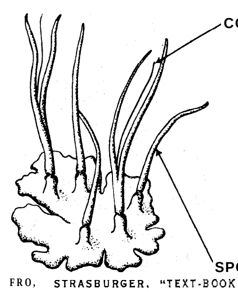
The sexual life cycle is similar to that of the hepatics except for the different shape of certain structures as described above. Vegetative reproduction may occur through natural division of the thallus.

The Xnthocerotae are interesting for several reasons. The large pyrenoid-containing chloroplasts appear primitive; in contrast, the basal indeterminate gron th of the sporophyte makes it appear related to more advanced plants. They are the lowest plants in the plant kingdom to exhibit stomata. These structures, plus the indeterminate growth of the sporophytes, have led some botanists to suggest that they represent a type ancestral to the ferns. However, in spite of certain primitive characters they are probably the most highly evolved of the liverworts and represent the current end of a line rather than an ancestral form.

The symbiotic relationship between the alga *Nostoc* and the thalli of the Xnthocerotae suggests that the host may receive nitrogen-containing compounds or other beneficial materials from the alga.

The Xnthocerotae are usually found in the moist, dim woodlands of tropical and warm temperate regions. In North America they are occasionally collected in southern Canada.

See also Moss.



FRO, STRASBURGER, "TEXT-BOOK OF BOTANY"

FIG. 7.— ANTHOCEROS LAEVIS, A DARK-GREEN LIVERWORT. ONE OF THE BEST-KNOWN MEMBERS OF THE GROUP ANTHOCEROTAE

BIBLIOGRAPHY.—H. C. Bold, *Morphology of Plants* (1957); D. H. Campbell, *Structure and Development of Mosses and Ferns* (1905); Evans, "Classification of the Hepaticae," *Bot. Rev.*, 5:49–96 (1939); Fulford, "Recent Interpretations of the Relationships of the Hepaticae," *Bot. Rev.*, 14:127–173 (1948); F. Verdoorn *et al.*, *Manual of Bryology* (1932). For identification of American species of Liverworts, *see* Conard, *How to Know the Mosses and Liverworts* (1956); *T.* Frye and L. Clark, *Hepaticae of North America* (1937); Macvicar, *The Student's Handbook of British Hepatics* (1926); Schuster, "Annotated Key to the Orders, Families and Genera of Hepaticae of America North of Mexico," *Bryologist*, 61:1–66 (1958); Schuster. "Boreal Hepaticae," *Amer. Midl. Nat.*, 49:253–684 (1953). (A. J. SH.)

LIVERY, originally the provision of food, clothing. etc.. to household servants. The word is an adaptation of the Anglo-French *livrée,* from *livrer,* "to deliver," in the special sense of distributing.

In the sense of a fixed allowance of provender for horses. it survives now only in "livery stable." *i.e.,* an establishment where horses and carriages are kept or let out for hire. From the meaning of provision of food and clothing the word is applied to a uniform worn by the retainers and servants of a household. In the 15th century in England a badge. collar or other insignia, the "livery," was worn by all those who pledged themselves to support one of the great barons in return for his promise of "maintenance," *i.e.,* of protection against enemies; thus arose the custom of "livery and maintenance." suppressed by Henry VII. The members of the London city companies *(see* LIVERY COMPANIES) wore a distinctive costume or "livery," whence the term "livery companies." In law, the term "livery" means "delivery," the legal handing of property into the possession of another; for "livery of seisin" see FEOFFMENT.

LIVERY COMPANIES, the name of a class of institutions in the city of London which at one time were universal in Europe. The gild (see GCILDS) in the 12th century "has many aspects, social. religious and economical, and it is unwise to look for any single origin for so complex an institution." The gilds assumed generally the character of corporations in the reign of Edward III.

Many of them had been chartered before: but their privileges, hitherto exercised only on sufferance and by payment of their terms, were now confirmed by letters patent. Edward III himself became a member of the fraternity of Linen Xrmourers, or Merchant Taylors, and other distinguished persons followed his example.

George VI was a freeman of the Grocers'. Drapers'. Fishmongers' and Merchant Taylors' companies, honorary freeman of the Needlemakers', Permanent Master of the Shipwrights'. and Admiral of the Master Mariners'. From Edward III's time they are called livery companies. The charters were regranted. generally in the original form, by successive sovereigns upon payment of a fine to the king's hanaper.

In 1684, on receipt of writs quo warranto, the companies surrendered their governance to the king—Charles 11—who granted a charter which abolished the right of election of wardens vested by earlier charters in the liverymen of the companies, increased the number of the courts of assistants and conferred membership for life upon the persons selected for these offices. James II. just before his departure to exile, restored the ancient privileges.

All proceedings were formally canceled by Act of Parliament 2, William and Mary session I, chapter 8. But even in cases where liverymen form an integral element in the administration of their companies' affairs; the system introduced by Charles II is followed in essentials.

The authority of the company extended to the general welfare, spiritual and temporal. of its members. In the regulation of trade they possessed extensive powers. They required everyone carrying on the trade to join the company, to prevent monopoly or enhancement of prices. There was no question of a monopoly until the degeneration of the craft gilds into limited corporations of capitalists. In the regulation of trade the goldsmiths had the assay of metals, the fishmongers the oversight of fish, the vintners of the tasting of wine, etc.

The companies enforced their regulations on their members by force and by fines. Many of their ordinances looked to the domestic affairs and private conduct of the members. The grocers ordain "that no man of the fraternite take his neyghbor's house yᵗ is of the same fraternite, or enhaunce the rent against the will of the foresaid neyghbor." The wearing of beards was forbidden. Football was prohibited. Attempts to restrict marriage to daughters of liverymen were made and failed. Members reduced to poverty by adventures on the sea, increased price of goods, borrowing and pledging, or any other misfortune, are to be assisted "out of the common money, according to his situation, if he could not do without."

From Gild to Charitable Trust.—But the companies gradually lost their industrial character. The richer members engrossed the power and the companies tended to become hereditary and exclusive. Persons became members who had nothing to do with the craft, and the rise of great capitalists and the development of competition in trade made the regulation of industry by means of companies no longer possible. The usurpation of power on the part of the richer members encountered, still encounters, opposition. In the Goldsmiths' company in 1529 the mode of electing officers, and the system of management generally, was challenged by three members who called themselves "artificers," poor men of the craft of goldsmiths. The dispute was carried into the court of chancery and the star chamber. The artificers accused the company of changing the constitution of the society, by persons who "were but merchant goldsmiths, and had but little knowledge in the science." In 1531 the three complainants were expelled from the company, and then the dispute seems to have ended. In most cases their regulative functions have disappeared. The Fishmongers company still carries out the supervision of certain Acts with vigour and success. The Goldsmiths carry out the assay of the Pyx. Throughout the companies have been owners of property and managers of charitable trusts.

The City and the Companies.—The ordinance of Edward II. required freemen of the city to be members of one or other of the companies. By the ordinance of 49 Edw. III. (1375), the trading companies were to nominate the members of common council, and the persons so nominated alone were to attend both at common councils and at elections. An ordinance in 7 Richard II. (1383) restored the elections of common councilmen to the wards, but corporate officers and representatives in parliament were elected by a convention summoned by the lord mayor from the nominees of the companies. An act of common council in 7 Edw. IV. (1467) appointed the election of mayor, sheriffs, etc. to be in the common council, together with the masters and wardens of the companies. By 15 Edw. IV. masters and wardens were ordered to associate with themselves the honest men of their mysteries,[1] and come in their best liveries to the elections; that is to say, the franchise was restricted to the "liverymen" of the companies. At this time the corporation exercised supreme control over the companies, and the companies were still genuine associations of the traders and householders of the city. The delegation of the franchise to the liverymen was thus, in point of fact, the selection of a superior class of householders to represent the rest. By 19 Henry VII. (1504) ordinances and by-laws were required to be submitted for approval to the chancellor, chief justices of either Bench or the Justices in eyre. This act still remains in force and by-laws or ordinances which have not been thus validated are devoid of authority. The corporation lost its control over the companies, and the members of the companies ceased to be traders and householders; the liverymen were no longer a representative class, and the Reform Acts of 1832 and 1867 reformed the representation in several particulars which was practically abolished by the Representation of the People Act of 1918. The liverymen of the companies, being freemen of the city, still elect the lord mayor, sheriffs, chamberlain and other corporate officers.

Taxing the Companies.—The wealth and organization of the companies made them a most appropriate instrument for the enforcement of taxation. The loan of £21,263 6s. 8d. to Henry VIII., for his wars in Scotland, in 1544 seems to be the first instance of a pecuniary grant to the crown. The confiscation of ecclesiastical property at the time of the Reformation affected many of the trusts of the companies; and they were compelled to make returns of their property devoted to religious uses, to pay over the rents to the crown and to purchase the trusts from their corporate funds. In course of time the taxation of the companies became "a regular source of supply to government," which when money was wanted for public works, informed the lord mayor, who apportioned the sums required among the various companies, and issued precepts for its payment. Contributions towards setting the poor to work, erecting the Royal Exchange, cleansing the city ditch, discovering new countries, furnishing military and naval armaments, for men, arms and ammunition for the defence of the city, are among the purposes thus served.

The livery companies in existence in 1940 were the following:

Apothecaries	Fishmongers	Musicians
Armourers and Brasiers	Fletchers	Needlemakers
Bakers	Founders	Painter Stainers
Barbers	Framework Knitters	Pattern Makers
Basket Makers	Fruiterers	Paviors
Blacksmiths	Gardeners	Pewterers
Bowyers	Girdlers	Plasterers
Brewers	Glass Sellers	Plumbers
Broderers	Glaziers	Poulters
Butchers	Glovers	Saddlers
Carmen	Gold and Silver Wyre-drawers	Salters
Carpenters	Goldsmiths	Scriveners
Clockmakers	Grocers	Shipwrights
Clothworkers	Gunmakers	Skinners
Coach and Coach-harness Makers	Haberdashers	Spectacle Makers
Cooks	Horners	Stationers and News-paper Makers
Coopers	Innholders	Tallow Chandlers
Cordwainers	Ironmongers	Tin Plate Workers
Curriers	Joiners	Turners
Cutlers	Leathersellers	Tylers and Brick-layers
Distillers	Loriners	Upholders
Drapers	Makers of Playing Cards	Vintners
Dyers	Masons	Wax Chandlers
Fanmakers	Master Mariners	Weavers
Farriers	Mercers	Wheelwrights
Feltmakers	Merchant Taylors	Woolmen

The Parish Clerks and the Watermen and Lightermen, though non-livery companies of the City of London, have sometimes been included.

In 1927 the Company of Master Mariners was constituted by Royal Charter and, in remembrance of the connection of the Mercer's Company, the first of all the companies, with the Merchant Adventurers and the maritime activities of earlier days, a loving cup was presented to the newly constituted company.

The following are the twelve great companies in order of civic precedence: Mercers, Grocers, Drapers, Fishmongers, Goldsmiths, Skinners, Merchant Taylors, Haberdashers, Salters, Ironmongers, Vintners, Clothworkers. The "Irish Society" was incorporated under James I. as "the governor and assistants of the new plantation in Ulster, within the realm of Ireland." The twelve companies contributed the sum of £60,000 for the scheme to settle a Protestant colony in the lands forfeited by the Irish rebels. The companies divided the settlements into twelve, under the paramount jurisdiction of the Irish Society. The charter of the society was revoked by the court of star chamber in the reign of Charles I., but a new one was granted by Charles II., under which the society still acts. The situation has been changed by the operation of the Land Purchase Act of 1903.

Livery Company Charities— Most of the companies administer charities of large value under schemes of the Charity Commissioners, the Board of Education, the Endowed School Commissioners and the Court of Chancery. Education in particular has benefited. The Mercers' Company administers St. Paul's school under Dean Colet's will, and in 1902 built a girls' school—now of the first rank. Mercers' school is one of the oldest schools in London. The Drapers administer Bancroft's school (1727) and Howell's school for girls, Denbigh. Queen Mary College (formerly the East London college), an important centre of university education in London, was built up by the company and has received from its

[1]Properly the word should be spelled, as it was originally, "mistery"; it comes through the O.Fr. ***mestier,*** modern ***métier,*** from Lat. ***ministerium,*** service, employment, and meant a trade or craft, and hence the plays acted by craftsmen and members of gilds were called "mystery plays" (*see* DRAMA). For the word meaning a hidden or secret rite, with which this has so often been confused, see **MYSTERY**.

corporate funds grants approximating £400,000. The Merchant Taylors' company maintains their school, removed in 1933, from the City to Sandy Lodge, Northwood, Middx., with admirable results. The Skinners' school at Tonbridge is of the first order. The City and Guilds of London Institute was developed from the initiative of the Cloth-workers company in 1875 by the joint action of the companies, and is now incorporated in the Imperial College.

Constitution of the Companies.—The constitution of the livery companies usually embraces (1) the court, which includes the master and wardens, and is the executive and administrative body (2) the livery or middle class, being the body from which the court is recruited; and (3) the general body of freemen, from which the livery is recruited. Some companies admit women as freemen. The freedom is obtained either by patrimony (by any person over 21 years of age born in lawful wedlock after the admission of his father to the freedom), by servitude (by *bona fide* apprenticeship to a freeman of the company) or by redemption which is in some cases wisely allowed only where an ancestor in the male line has had the freedom which his descendants have omitted to or been unable to acquire. Purchase is still regarded as rather disreputable. Admission to many of the companies is subject to the payment of considerable fees. Gift of the freedom is a recognized mode of expressing admiration for high public service. A royal commission was appointed in 1880 to inquire into all the livery companies, into the circumstances and dates of their foundation, the objects for which they were founded, and how far those objects were being carried into effect. A very valuable *Report and Appendix* (4 vols. 1884) was published, containing, *inter alia,* information on the constitution and powers of the governing bodies, the mode of admission of members of the companies, the mode of appointment, duties and salaries and other emoluments of the servants of the companies, the property of, or held in trust for the companies, its value, situation and description.

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LIVESTOCK FEEDS: *see* FEEDS, ANIMAL.

LIVESTOCK JUDGING is an art requiring the ability to select animals, on the basis of outward appearance, or phenotype (*see* HEREDITY: *Heredity of Quantitative Characters*), and for those characteristics associated with excellent productive performance. It attempts to correlate the appearance factors which will result in the reproduction of meat animals (beef cattle. sheep and swine) which will produce carcasses of high quality with a large proportion of edible cuts. It attempts to select dairy cows for milk production and horses for draft work or performance under the saddle or in harness. Although not a true science, it has served well throughout the world as a tool for livestock breeders to improve their herds and flocks (*see* ANIMAL BREEDING).

Increased emphasis is being placed in modern livestock judging of meat animals on rate of gain, feed efficiency and carcass quality, items that can be measured accurately, and eventually the grand champion or first prize animal will have to excel in both live appearance and carcass quality. Many times the best steer, lamb or hog on foot has not been the best in the carcass. Breeding animals (bulls, cows, rams, ewes, boars and sows) will be judged by rate of gain, feed efficiency, reproductive efficiency, milk production (dairy cows) and performance of progeny as well as on live appearance. Livestock judging will then become a combination of an art, based upon eye selection, and a science, based on performance records.

Whenever any characteristic of livestock ceases to be of productive value, it ceases to have a major place in livestock selection. Many times too much emphasis is placed on some minor fancy of a breeder, such as shade of hair colour; and thus the livestock breeder or judge loses sight of the fundamental basis for selection. Although many of these nonproductive characteristics have their place in contributing to the style and beauty of an animal, they should never be emphasized to the degree of masking the real purpose of livestock production; *i.e.,* the provision of meat, milk and wool. The accompanying sample judging card for beef cattle indicates the main points considered in livestock judging.

Beef Judging Card

Points to Consider	Placing			
	1st	2d	3d	4th
I. General appearance: straight top-line, deep, broad, uniform in width, low-set, compact, symmetrical stylish, standing squarely, trim middle . . .				
II. Form:				
1. Head—muzzle broad, nostrils large, eyes large and clear; face short, clean and slightly dished, forehead broad; ears medium size and fine texture; horns medium size and well shaped				
2. Neck—thick, short, blending smoothly into shoulders; throat clean				
3. shoulder—smooth, well-covered with flesh, compact on top; shoulder vein smooth and full				
4. Breast—wide, full; brisket neat and trim with little dewlap.				
5. Forelegs—short, strong; arm full, shank medium fine				
6. Chest—deep, wide, girth large, crops full .				
7. Back—wide, straight and thickly covered .				
8. Loin—wide, straight and deep-fleshed . .				
9. Ribs—well sprung and smoothly covered with firm flesh				
10. Flanks—full and low				
[illegible]				
[illegible] ..., level and free from patchiness				
13. Thighs—deep, broad, wide and full. . .				
14. Twist—full and deep				
15. Legs—straight, strong; shanks medium fine .				
III. Finish: deep, mellow, firm covering especially over back, ribs and loin; freedom from patchiness and rolls desired. (Finish is of great importance in fat classes, but is not so important in breeding classes as long as the ability to take on finish is indicated).				
IV. Quality: smooth in frame and finish; hair fine, soft; hide mellow; bone medium-size and clean . .				
V. Dressing percentage: well finished, not paunchy, medium weight hide. (Not considered in judging breeding cattle)				
VI. Breed and sex character: (Applies only to breeding classes)				

Certain characteristics should be developed for proficiency in judging livestock:

1. The desire to know livestock. An intrinsic interest in livestock and the desire to know their characteristics, habits and productive points is necessary in a good judge. Livestock judging requires the sacrifice of time and energy for the sake of studying and working with good livestock. A good judge or animal breeder must be livestock minded and be keenly aware of the perplexing problems that confront the breeder who is continuously selecting and culling to improve his livestock quality and performance. The imperfections as well as the perfections of the different breeds, classes and types of livestock must be recognized. Livestock judging and selection must become a real and living task rather than a means of attempting to correctly place a class or group of animals in the show ring or on a farm or ranch.

2. A mental image of ideal types. If only one animal is judged or appraised, it must be compared with some standard, namely the ideal of its kind. If two or more animals are judged, each animal must be compared with the ideal, and then with the others in the class. These ideal types can be learned by observing good individuals in both the live and picture form. Ideal types of livestock have been set up by a majority of the breed associations. Pictures are at best a poor substitute for the same type of live animals, but in cases where only common classes are available, pictures of other classes may be used to advantage. A judge must be constantly in contact with good animals and observe them keenly. Great value can be obtained from intelligently observing good representatives of the various breeds at leading livestock shows, sales, farms, and ranches in all parts of the world.

3. Keen power of observation. The ability to detect important differences in livestock quickly and accurately must be developed. This keen power of observation is the result of intense concentration on the outstandingly good and bad points of an animal.

Persistent practice in evaluating livestock in terms of an ideal is a sure way to develop a keen sense of differences. A herdsman knows his livestock well. As with human beings, each animal possesses a physical individuality which sets it apart. These individual differences become apparent to the herdsman through keen observation and habitual contact. The judge, too, must be among livestock and think about livestock to develop his power of observation.

4. Ability to make a logical analysis. Since judging is an art based on observation, it is impossible to appraise animals in the terms of exact percentages. While all parts of an animal do not have the same economic value, each part is interrelated and dependent on the other parts and in the last analysis, the animal must be considered as a whole. A score card is excellent for learning the parts of the animal if the supposed numerical value of the parts is disregarded. To be sure, the relative importance of various parts on the basis of anatomy and wholesale cuts should be mastered. but to assign definite percentage values to each part of an animal often leads to confusion. Judging is not a mathematical formula or an aggregation of percentages, but is an art requiring practice and sound judgment. A judge must be honest and open-minded in his search for facts. In market animals one must be able to appraise commercial values and still recognize the desirable balance in development that the breeders and producers prefer, even though some points such as constitution, feeding qualities, soundness and breed type may not much concern the packer. When one allows bias or prejudice to place a class of livestock, he is catering to his emotions and is disqualifying himself as a competent judge. If one observes the animals accurately, weighs the facts in a balanced manner, never follows hunches and concludes with a logical placing, his mistakes will be reduced to a minimum. Judging is applied, sound reasoning.

5. Independence of thought. Only in proportion to the extent that a judge exercises independence of thought is he able to improve his judging ability. A judge must be open-minded to just criticism from others and make his mistakes stepping stones instead of stumbling blocks, strengthening his ability to select animals correctly.

6. The ability to give effective reasons. This ability depends partly on natural talent but primarily on acquired knowledge and practice. Accuracy is of prime importance. Presenting a pleasant sounding and persuasive set of reasons without a high percentage of accuracy is worthless. A judge should give the reasons for his placing in a simple, straightforward manner and in suitable livestock terminology that serves to make his reasons clear, logical and to the point. (W. M. B.)

LIVIA DRUSILLA (c. 55 B.C.–A.D. 29), Roman empress, was originally the wife of Tiberius Claudius Nero, by whom she had two sons, Drusus and Tiberius (afterward emperor). In 38 Augustus compelled her husband to divorce her and married her himself, having first got rid of his own wife Scribonia. Her two sons were entrusted to the guardianship of Augustus, to whom she bore no children. Livia was suspected of committing various crimes to secure the throne for Tiberius. The premature deaths of Augustus' nephew Marcellus (whom he had at first fixed upon as his successor) and of his grandsons Gaius and Lucius Caesar, the banishment of his grandson Agrippa Postumus, and even his own death, were attributed to her. Augustus by his will declared her and Tiberius (whom he had adopted in A.D. 4) his heirs; Livia inherited a third of his property; she was adopted into the Julian gens, and henceforth assumed the name of Iulia Augusta. She had now reached the summit of her ambition, and at first acted as joint ruler with Tiberius. Tiberius, however, soon became tired of her control; his retirement to Capreae is said to have been caused by his desire to escape from her. Livia continued to live quietly at Rome, in the full enjoyment of authority, until her death at an advanced age.

LIVINGSTON, EDWARD (1764–1836), U.S. jurist and statesman, was born in Clermont, N.Y., on May 26, 1764. He graduated at Princeton in 1781, was admitted to the bar in 1785, and began to practise law in New York city, rapidly rising to distinction. He was a Republican representative in Congress, 1795–1801, where he was one of the leaders of the opposition to Jay's treaty, taking the ground that congress was not bound to appropriate money to carry out a treaty obligation. He opposed the alien and sedition laws, and introduced legislation on behalf of American seamen. In 1801 Livingston was appointed U.S. district attorney for the State of New York and while retaining that office was in August of the same year elected major of New York city. When, in 1803, the city was overtaken by an epidemic of yellow fever. Livingston helped to prevent the spread of the disease and relieve distress, and was himself attacked by the fever.

On his recovery he found himself indebted to the government for public funds which had been lost through the dishonesty of a confidential clerk, and for which he was responsible as district attorney. He at once surrendered all his property, resigned his two offices in 1803. and removed early in 1804 to Louisiana. He soon acquired a large law practice in New Orleans, and in 1826 repaid the government in full. including the interest.

In Louisiana. he was appointed by the legislature to prepare a provisional code of judicial procedure, which (in the form of an act passed in April 1805) was continued in force from 1805–25. During the war with England from 1812–15 Livingston was active in rousing the mixed population of New Orleans to resistance, and acted as adviser and volunteer aide-de-camp to Gen. Jackson. In 1821, by appointment of the legislature. of which he had become a member the preceding year. Livingston began the preparation of a new code of criminal law and procedure, afterward known in Europe and America as the "Livingston Code." Completed in 1824, it was accidentally burned, and reproduced in 1826, though not printed until 1833. It was never adopted by the state. It was at once reprinted in England, France and Germany, and studied all over the world, attaining wide influence. In referring to this code. Sir Henry Maine spoke of Livingston as "the first legal genius of modern times" (*Cambridge Essays,* 1856, p. 17). His code of reform and prison discipline was adopted by Guatemala. In 1823 he was appointed with Moreau Lislet to revise the civil code of Louisiana, which was substantially ratified.

Livingston was again a representative in congress during 1823–29, a senator in 1829–31, and for two years (1831–33) secretary of state under President Jackson. In this last position he was one of the most trusted advisers of the President, for whom he prepared a number of state papers, the most important being the famous anti-nullification proclamation of Dec. 1832. From 1833 to 1835 Livingston was minister plenipotentiary to France. He died May 23, 1836, at Montgomery place, Dutchess county, New York.

His works include: *Reports of the Plan of the Penal Code* (1822); *System of Penal Law for the State of Louisiana* (1826); *System of Penal Law for the United States* (1828); *Complete Works on Criminal Jurisprudence* (1873).

LIVINGSTON, ROBERT R. (1746–1813), U.S. statesman, son of Robert R. Livingston (1718–75), a justice of the New York supreme court after 1763, and brother of Edward Livingston (*q.v.*), was born in New York city on Nov. 27, 1746. He graduated at King's college, New York (now Columbia university), in 1765 and was admitted to the bar in 1773. He was a member of the second, third, and fourth provincial congresses of New York (1775–77), was a delegate from New York to the Continental Congress in 1775–77, and again in 1779–80, and was a member of the committee which drafted the Declaration of Independence. He was prevented from signing that document by his absence at the time to attend a meeting of the fourth New York provincial congress, which on July 10 became the convention of the representatives of the state of New York, and by which at Kingston in 1777 the first state constitution was adopted, Livingston having been a member of the committee that drafted this instrument. He was the first chancellor of the state, from 1777 to Feb. 1801, and is best known as "Chancellor" Livingston. In this capacity he administered the oath of office to Washington at his first inauguration to the presidency, in New York, on April 30, 1789.

In 1788 he had been a member of the New York convention, which ratified for that state the federal constitution. He became an anti-Federalist and in 1798 unsuccessfully opposed John Jay in the New York gubernatorial campaign. In 1801 he became minister to France on President Jefferson's appointment and in 1803, in association with James Monroe, effected on behalf of his government the purchase from France of what was then known as "Louisiana." In 1804 Livingston withdrew from public life and returned to New York, where he promoted various improvements in agriculture. He did much to introduce the use of gypsum as a fertilizer, and published an *Essay on Sheep* (1809). He was long interested in the problem of steam navigation; before he went to France he received from the state of New York a monopoly of steam navigation on the waters of the state and assisted in the experiments of his brother-in-law, John Stevens; in Paris he met Robert Fulton, and with him in 1802 made successful trials on the Seine of a paddle-wheel steamboat; in 1803 Livingston (jointly with Robert Fulton) received a renewal of his monopoly in New York, and the first successful steam-vessel, which operated on the Hudson in 1807, was named after Livingston's home, Clermont. He died at Clermont, N.Y., on Feb. 26, 1813.

See Frederick de Peyster, *Biographical Sketch of Robert R. Livingston* (1876); Robert K. Morton, "Robert R. Livingston: Beginnings of American Diplomacy," in *The John P. Branch Historical Papers of Randolph-Macon College*, i. 299–324 and ii. 34–46; and J. B. Moore, "Robert R. Livingston and the Louisiana Purchase," in *Columbia University Quarterly*, vi. 221–229 (1904); D. S. Alexander, "Robert R. Livingston," *N.Y. State Hist. Assoc. Proc.*, vol. vi., pp. 100–114 (Albany, 1906); and J. L. Delafield, *Chancellor Robert R. Livingston and His Family* (Albany, 1911).

LIVINGSTON, WILLIAM (1723–1790), American political leader, was born at Albany (N.Y.), probably on Nov. 30, 1723. He was the son of Philip Livingston (1686–1749), and grandson of Robert Livingston (1654–1725), an important figure in the early life of New York State.

William Livingston graduated at Yale college in 1741, studied law in the City of New York, was admitted to the bar in 1748, and served in the New York legislature (1759–60). However, his chief political influence was exerted through pamphlets and newspaper articles. Through the *Independent Reflector*, which he established in 1752, Livingston fought the attempt to bring the projected King's college (now Columbia university) under the control of the Church of England. Upon the suspension of the *Reflector* in 1753, he edited in the New York *Mercury* the "Watch Tower" section (1754–55), which became the organ of the Presbyterian faction.

In 1772 he removed to Elizabeth, New Jersey. He represented New Jersey in the first and second Continental Congresses (1774, 1775–76), but left Philadelphia in June 1776, probably to avoid voting on the question of adopting the Declaration of Independence, which he regarded as inexpedient. He was chosen first governor of the State of New Jersey in 1778, and was regularly re-elected until his death at Elizabeth (N.J.), on July 25, 1790. Livingston was a delegate to the Federal Constitutional Convention of 1787, and supported the New Jersey small State plan. In 1754 he joined with his brother, Philip, and others in founding what is now known as the Society Library of New York. With the help of William Smith (1728–93), the New York historian, William Livingston prepared a digest of the laws of New York for the period 1691–1756, which was published in two volumes (1752 and 1762).

His brother, PETER VAN BRUGH LIVINGSTON (1710–1792), was a merchant and a Whig political leader in New York, and one of the founders of the College of New Jersey (now Princeton university).

Another brother, PHILIP LIVINGSTON (1716–1778), was a member of the Continental Congress from 1774 until his death; he was a signer of the Declaration of Independence.

William's son, (HENRY) BROCKHOLST LIVINGSTON (1757–1823), was an officer in the American Revolution. From 1807 until his death he was an associate justice of the U.S. supreme court.

LIVINGSTONE, DAVID (1813–1873), Scottish missionary and explorer in Africa, was born on March 19, 1813, at the village of Blantyre Works, in Lanarkshire, Scotland. David was the second child of his parents, Neil Livingston (for so he spelled his name, as did his son for many years) and Agnes Hunter. At the age of ten David entered the neighbouring cotton-mill, and by strenuous efforts qualified himself at the age of twenty-three to undertake a college curriculum. He attended for two sessions the medical and the Greek classes in Anderson's College, Glasgow, and also a theological class. In September 1838 he went up to London, and was accepted by the London Missionary Society as a candidate. He took his medical degree in the Faculty of Physicians and Surgeons in Glasgow in November 1840. Livingstone had set his heart on China, and it was a great disappointment to him that the society finally decided to send him to Africa.

The Exploring Missionary.—Livingstone sailed from England on Dec. 8, 1840. From Algoa Bay he made direct for Kuruman, Bechuanaland, the mission station established by Robert Moffat twenty years before. The next two years Livingstone spent in travelling about the country to the northwards, in search of a suitable outpost for settlement. During these two years he became convinced that the success of the white missionary in a field like Africa was not to be reckoned by the tale of doubtful conversions he could send home each year—that the proper work for such men was that of pioneering, opening up and starting new ground, leaving native agents to work it out in detail. The whole of his subsequent career was a development of this idea. He selected the valley of Mabotsa, on one of the sources of the Limpopo river, 200 m. north-east of Kuruman, as his first station. Shortly after his settlement here he was attacked by a lion which crushed his left arm. The arm was imperfectly set, and it was a source of trouble to him at times throughout his life.

To a house, mainly built by himself at Mabotsa, Livingstone in 1844 brought home his wife, Mary Moffat, the daughter of Moffat of Kuruman. Here he laboured till 1846, when he removed to Chonuane, 40 m. farther north, the chief place of the Bakwain or Bakwena tribe under Sechele. In 1847 he again removed to Kolobeng, about 40 m. westwards, the whole tribe following their missionary. With two English sportsmen, William C. Oswell and Mungo Murray, he undertook a journey to Lake Ngami, which had never yet been seen by a white man. Crossing the Kalahari Desert, of which Livingstone gave the first detailed account, they reached the lake on Aug. 1, 1849. In April next year he made an attempt to reach Sebituane, who lived 200 m. beyond the lake, this time in company with his wife and children, but again got no farther than the lake, as the children were seized with fever. A year later, April 1851, Livingstone, again accompanied by his family and Oswell, set out, this time with the intention of settling among the Makololo for a period. At last he succeeded, and reached the Chobe (Kwando), a southern tributary of the Zambezi, and in the end of June reached the Zambezi itself at the town of Sesheke. Leaving the Chobe on Aug. 13, the party reached Cape Town in April 1852. Livingstone may now be said to have completed the first period of his career in Africa, the period in which the work of the missionary was predominant, but it must be remembered that he regarded himself to the last as a pioneer missionary, whose work was to open up the country to others.

Loanda and Victoria Falls.—Having seen his family off to England, Livingstone left Cape Town on June 8, 1852, and reached Linyante, the capital of the Makololo, on the Chobe on May 23, 1853, being cordially received by Sekeletu and his people. His first object was to find healthy high land for a station. Ascending the Zambezi, he found no place free from the tsetse fly, and therefore resolved to discover a route to the interior from either the west or east coast. He started, with 27 natives, from Linyante on Nov. 11, 1853, and, by ascending the Liba, Lake Dilolo was reached on Feb. 20, 1854. On May 31 the expedition reached Loanda, Livingstone, however, being all but dead from fever, semi-starvation and dysentery. From Loanda Livingstone sent his astronomical observations to Sir Thomas Maclear at the Cape, and an account of his journey to the Royal Geographical Society, which in May 1855 awarded him its patron's medal. Loanda was left on Sept. zo, 1854, but Livingstone lingered long about the Portuguese settlements. Making a slight détour to the north to Kabango, the party reached Lake Dilolo on June 13, 1855 Here Livingstone made a careful study of the hydrography of the country. He "now for the first time apprehended the true form of the river systems and the continent," and his conclusions have been essentially confirmed. The party returned to Linyante in the beginning of September.

For Livingstone's purposes the route to the west was unavailable, and he decided to follow the Zambezi to its mouth. With a numerous following, he left Linyante on Nov 8, 1855. A fortnight afterwards he discovered the famous "Victoria" falls of the Zambezi. Livingstone reached the Portuguese settlement of Tete on March z, 1856, in a very emaciated condition. Here he left his men and proceeded to Quilimane, where he arrived on May 20, thus having completed in two years and six months one of the most remarkable and fruitful journeys on record. The results in geography and in natural science in all its departments were abundant and accurate; his observations necessitated a reconstruction of the map of Central Africa. When Livingstone began his work in Africa the map was virtually a blank from Kuruman to Timbuktu, and nothing but envy or ignorance can throw any doubt on the originality of his discoveries.

The Zambezi Expedition. — On Dec. 12 he arrived in England, after an absence of sixteen years. He told his story in his *Missionary Travels and Researches in South Africa* (1857) with straightforward simplicity, and with no effort after literary style, and no apparent consciousness that he had done anything extraordinary. In 1857 he left the London Missionary Society, with which, however, he remained on the best of terms, and in February 1858 he accepted the appointment of "Her Majesty's consul at Quilimane for the eastern coast and the independent districts in the interior, and commander of an expedition for exploring eastern and central Africa." The Zambezi expedition, of which Livingstone thus became commander, sailed from Liverpool in H M S. "Pearl" on March 10, 1858, and reached the mouth of the Zambezi on May 14. The party, which included Dr. (afterwards Sir) John Kirk and Livingstone's brother Charles, ascended the river from the Kongone mouth in a steam launch, the "Ma-Robert"; reaching Tete on Sept. 8. Livingstone then explored the river above Tete, and especially the Kebrabasa rapids. The year 1859 was spent in exploring the river Shire and Lake Nyasa, which was discovered in September; and during a great part of the year 1860 Livingstone was engaged in repatriating such of the Makololo as cared to go home. In January of next year arrived Bishop C. F. Mackenzie and a party of missionaries sent out by the Universities Mission to establish a station on the upper Shiré.

After exploring the river Rovuma for 30 m. in his new vessel the "Pioneer," Livingstone and the missionaries proceeded up the Shiré to Chibisa's; there they found the slave trade rampant. On July 15 Livingstone, accompanied by several native carriers, started to show the bishop the country, and after seeing the missionary party settled in the highlands to the south of Lake Chilwa (Shirwa) Livingstone explored (Aug.–Nov.) Lake Nyasa. While the boat sailed up the west side of the lake to near the north end, the explorer marched along the shore. He returned more resolved than ever to rouse the civilized world to put down the desolating slave-trade. On Jan. 30, 1862, at the Zambezi mouth, Livingstone welcomed his wife and the ladies of the mission, with whom were the sections of the "Lady Nyassa," a river steamer which Livingstone had had built at his own expense. When the mission ladies reached the mouth of the Ruo tributary of the Shiré, they were stunned to hear of the death of the bishop and one of his companions. This was a blow to Livingstone, seerning to have rendered all his efforts to establish a mission futile. A still greater loss to him was that of his wife at Shupanga, on April 27, 1862.

The "Lady Nyassa" was taken to the Rovuma. Up this river Livingstone managed to steam 156 m., but farther progress was arrested by rocks. Returning to the Zambezi in the beginning of 1863, he found that the desolation caused by the slave trade was more horrible and widespread than ever. It was clear that the Portuguese officials were themselves at the bottom of the traffic. Kirk and Charles Livingstone being compelled to return to England on account of their health, the doctor resolved once more to visit the lake, and proceeded some distance up the west side and then north-west as far as the watershed that separates the Loangwa from the rivers that run into the lake. Meanwhile a letter was received from Earl Russell recalling the expedition by the end of the year. In the end of April 1864 Livingstone reached Zanzibar in the "Lady Nyassa." He reached England on July 23 The geographical results of this expedition, though not comparable in extent to those of his first and his final expeditions, were of high importance, as were those in various departments of science, and he had unknowingly laid the foundations of the British protectorate of Nyasaland Details will be found in his *Narrative of an Expedition to the Zambesi and its Tributaries* (1865).

The Slavers in **Lualaka.**—By Sir Roderick Murchison and his other staunch friends Livingstone was as warmly welcomed as ever. When Murchison proposed to him that he should go out again, although he seems to have had a desire to spend the remainder of his days at home, the prospect was too tempting to be rejected He was appointed British consul to Central Africa without a salary, aqd government contributed only £500 to the expedition. The chief help came from private friends. During the latter part of the expedition government granted him £1,000, but that, when he learned of it, was devoted to his great undertaking. The Geographical Society contributed £500. The two main objects of the expedition were the suppression of slavery by means of civilizing influences, and the ascertainment of the watershed in the region between Nyasa and Tanganyika. At first Livingstone thought the Nile problem had been all but solved by Speke, Baker and Burton, but the idea grew upon him that the Nile sources must be sought farther south, and his last journey became in the end a forlorn hope in search of the "fountains" of Herodotus.

Leaving England in the middle of August 1865, via Bombay, Livingstone arrived at Zanzibar on Jan. 20, 1866. He was landed at the mouth of the Rovuma on March 22, and started for the interior on April 4. His company consisted of thirteen sepoys, ten Johanna men, nine African boys from Nasik school, Bombay, and four boys from the Shiré region, besides camels, buffaloes, mules and donkeys. This imposing outfit soon melted away to four or five boys. Rounding the south end of Lake Nyasa, Livingstone struck in a north-northwest direction for the south end of Lake Tanganyika, over country much of which had not previously been explored. The Loangwa was crossed on Dec. 14, 1866. On Christmas day Livingstone lost his four goats, a loss which he felt very keenly, and the medicine chest was stolen in January 1867. Fever came upon him, and for a time was his almost constant companion; this, and other serious ailments, which he had no medicine to counteract, told on even his iron frame. The Zambezi was crossed on Jan. 28, and the south end of Tanganyika reached on March 31. Here, much to his vexation, he got into the company of Arab slave dealers (among them being Tippoo-Tib) by whom his movements were hampered; but he succeeded in reaching Lake Mweru (Nov. 1867). After visiting Lake Mofwa and the Lualaba, which he believed was the upper part of the Nile, he, on July 18, 1868, discovered Lake Bangweulu. Proceeding up the west coast of Tanganyika, he reached Ujiji on March 14, 1869, "a ruckle of bones."

Livingstone recrossed Tanganyika in July, and passed through the country of the Manyema, but baffled partly by the natives, partly by the slave hunters, and partly by his long illnesses it was not till March 29, 1871 that he succeeded in reaching the Lualaba, at the town of Nyangwe, where he stayed four months, vainly trying to get a canoe to take him across. It was here that a party of Arab slavers, without warning or provocation, assembled one day when the market was busiest and commenced shooting the women, hundreds being killed or drowned in trying to escape. Livingstone had "the impression that he was in hell," but was helpless, though his "first impulse was to pistol the murderers." The account of this scene which he sent home roused indignation in England to such a degree as to lead to determined and partially successful efforts to get the sultan of Zanzibar to suppress the trade. In sickened disgust the weary traveller made his way back to Ujiji, which he reached on Oct. 13.

Not long after his arrival in Ujiji he was inspired with new life by the timely arrival of H. M. Stanley, the richly laden almoner of Gordon Bennett, of the New York Herald. With Stanley, Livingstone explored the north end of Tanganyika, and proved conclusively that the Rusizi runs into and not out of it. In the end of the year the two started eastward for Unyamwezi. Stanley left on March 1S, 1872, and Livingstone, with a party of 57 men and boys, started on Aug. 15 for Lake Bangmeulu, proceeding along the east side of Tanganyika. His old enemy dysentery soon found him out, however, and in April 1873 he had to be carried in a litter. On April 29 Chitambo's village on the Lulimala, in Ilala, on the south shore of the lake, was reached. Early on the morning of May 1 he was found kneeling by the side of his bed. dead. His journals on these seven years' wanderings were published under the title of the Last *Journals* of David *Livingstone* ire Central Africa, in 1874, edited by Horace Waller. Many felt that no single African explorer had done so much for 'African geography as Livingstone during his 30 years' work. His travels covered one-third of the continent, extending from the Cape to near the equator, and from the Atlantic to the Indian Ocean. (J. S. K.; X.)

See, besides his own narratives, W. G. Blaikie, *Life of Livingstone* (1880); *H.* H. Johnston, *Livingstone* (1891, later ed., 1912); C. J. Finger, *David Livingstone, Explorer and Prophet* (1928); the *Proceedings* of the London Missionary Society, from 1840, the *Journal* and *Proceedings* ot the Royal Geographical Society; and H. M. Stanley, *How* I *found Livingstone* (1872) and *Autobiography* (1909).

LIVINGSTONE, a town of the Federation of Rhodesia and Nyasaland, Africa, situated 2,977 ft. above sea level, is the southern port of entry into Korthern Rhodesia. Pop. (1956) 13,660 (non-Africans and employed Africans). Named after the missionary explorer, David Livingstone, the town is a tourist and conference centre. The Victoria falls, the Zambezi river, the Wankie and Kafue Kational parks and the Kariba dam headwaters are aithin reach. There is a 673-ac. game park along the Zambezi. The Rhodes-Livingstone museum dominates Mainway and has a unique collection of ethnological, archaeological and historical exhibits, particularly those relating to Livingstone. Old Government house, now a national monument, contains the Southern provincial commissioner's offices. Barotse centre is the town park and there are sporting facilities on the Zambezi river. There are all grades of schools, European and African hospitals and places of worship for all denominations. The town is on the main railway system of southern Africa, has good road connections and an international airport 4 mi. N.W. Livingstone is a distributing centre for agricultural products and timber and its secondary industries include the Zambezi sawmills, blanket weaving and the making of furniture and steel river barges.

The first settlement was at the Old Drift ferry station, upriver on the Zambezi in the 1890s and the town was established on its present site in 1905 with the completion of the Falls bridge and the new railway line. It became the capital of Northern Rhodesia in 1907 and remained so until 1935 when the capital aas moved to Lusaka. It became the country's first municipality in 1927. (M. J. M.)

LIVIUS ANDRONICUS, LUCIUS (c. 284–*c.* 204 B.C.), the founder of Roman epic poetry and drama. His name shows that he was Greek and manumitted by a member of the Livian family; he may have been captured as a boy when Tarentum surrendered. He earned his living in Rome as a teacher of Greek and Latin, and it is probable that his main work, the *Odusia,* a translation of Homer's Odyssey, was intended as a schoolbook: Horace still read it at school. It was written in the rude Saturnian verse (a few hexametrical fragments belong to a later reworking in that metre) and, to judge from less than 50 surviving lines and the comments of Cicero and Horace, had little poetic merit. But it was both the first major poem in Latin and the first example of artistic translation, and the subject matter was happily chosen for the purpose of introducing Roman youth to the Greek world.

In 240 B.C. Andronicus produced at the ludi *Romani* a translation of a Greek play, probably a tragedy. and perhaps also a comedy. After this, the first dramatic performance ever given in Rome. he continued to write and stage both tragedies and comedies. from 235 onward in rivalry with Naevius. Only three titles of his comedies are known, each represented by one fragment. The titles of his tragedies (Achilles, *Aegisthus,* Aiax, Andromeda, *Danae, Equos Troianus, Hermiona*, Ino, Tereus) show that he translated mainly the three great tragedians, Aeschylus, Sophocles and Euripides. Fewer than 40 lines have survived. The skillful adaptation of the Greek iambic and trochee metres, long considered his personal achievement, is rather the result of popular borrowing before his time.

Livius is reported to have taken part in his plays and, when his voice failed, to have had the arias sung by a boy behind the stage, while he himself acted a dumb show. In 207 to ward off menacing omens, he was commissioned to compose an intercessory hymn to Aventine Juno, to be sung by a procession of 27 maidens. It is related that, as a reward to him for the success of this intervention, the guild of poets and actors was granted a place of meeting in the temple of Minerva on the Aventine.

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LIVONIA, a former province of Russia, now partly in Latvia (q v.) and partly in Estonia (*q.v.*).

History. — Coins of the time of Alexander the Great, found in Oesel, show that the coasts of the Baltic were at an early period in commercial relation with the civilized world. The chronicle of Nestor mentions as inhabitants of the Baltic coast the Chudes, the Livs, the Narova, Letgola, Semigallians and Korś. It was probably about the 9th century that the Chudes became tributary to the Varangian-Russian states. As they reacquired their independence, Yaroslav I. undertook in 1030 a campaign against them, and founded Yuriev (Dorpat). The Germans first penetrated into Livonia in the 11th century. In 1186 the emissaries of the archbishop of Bremen began to preach Christianity among the Ehsts and Letts, and in 1201 the bishop of Livonia established his residence at Riga. In 1202 or 1204 Innocent III. recognized the order of Brothers of the Sword, the residence of its grand master being at Wenden; and the order, spreading the Christian religion by the sword among the natives, carried on from that time a series of uninterrupted wars against the Russian republics and Lithuania. The first active interference of Lithuania in the affairs of Livonia took place immediately after the great outbreak of the peasants on Oesel; Olgierd then devastated all southern Livonia. The war of the order with Ivan IV. of Russia in 1558 led to a division of Livonia, its northern part, Dorpat included, being taken by Russia. and the southern part falling under the dominion of Poland. From that time (1561) Livonia formed a subject of dispute between Poland and Russia, the latter only formally abdicating its rights to the country in 1582. In 1621 it was the theatre of a war between Poland and Sweden, and being conquered by Sweden enjoyed twenty-five years of milder rule. In 1654, and again at the beginning of the 18th century, it was the scene of nar between Poland, Russia and Sweden. It aas finally conquered by Russia, the official concession being confirmed by the treaty of Kystad in 1721. From this time Livonia formed, with Courland and Estonia, the Baltic provinces, a part of the old Russian Empire. On the conclusion of World War I a German army occupied these provinces and did not withdraw until Dec. 1919. Livonia lost its individuality in the formation (1918) of Latvia and Estonia.

LIVY (TITUS LIVIUS) (59 B.C.–A.D. 17), most famous of Roman historians, was born at Patavium (Padua), Italy. Considering how celebrated he was in his day, remarkably little is knoan about his life. Even the date of his birth is not certain, since Jerome, in his history dealing with the year 59 B.C., links it with that of Messalla Corvinus, who was in fact born in 64 B.C. According to Quintilian, Livy had a son, who may have been the geographer cited by Pliny, and Seneca states that he had a daughter, who married a rhetorician L. Magius. If the T. Livius of a Paduan inscription of this period is the historian, he had two sons. He soon made his mark in literary circles at Rome, and it is known that Augustus was interested in his work, certainly in the early part of it. It may be assumed that he remained in favour despite his praise of Pompey and his doubts concerning Caesar, quoted respectively by Tacitus and Seneca, for he was able to encourage the later emperor Claudius in his youthful historical studies. Livy's fame throughout the empire is illustrated by the story of the man from Gades in Spain, who journeyed to Rome solely to see him. He presumably traveled; yet most of his time must have been spent at his desk in Rome or Padua. His work brought glory to Padua as can be judged from Martial's words Censetur Apona Livio *suo tellus* ("The Aponian land is celebrated for its son Livy"). His portrait may survive in a 3rd-century mosaic at Trier.

There is evidence for Livy's studies in rhetoric, and it is relevant to his historical methods. As a rhetorician he stood in the tradition of Cicero. "Read Demosthenes and Cicero," he wrote in a letter to his son, "then others as each is most like to Demosthenes and Cicero." He opposed Sallust and those who attempted a severe style by writing obscurely — orationis *obscuritatem* severitatem putant — and he condemned verba *antiqua* et sordida ("archaic and vulgar words"). Quintilian makes it clear that in the literary controversies of his day he carried on the campaign which Cicero had waged for a pure Latinity, without archaism or vulgarity. His position is not affected by Asinius Pollio's charge of Patavinitas which suggests a certain "provincialism" (rusticitas) by the standards of the Roman capital (urbanitas). In a literary sense the charge — for what it is worth — reflects upon his actual writing, not upon his theoretical views; but Pollio may have directed it originally against what he regarded at Livy's naïve treatment of Roman history. According to Seneca, Livy extended his interests to the composition of philosophical dialogues, including dialogues that were historical in character. Here again the influence of Cicero may be seen, particularly of his De *republica.* But Livy's great achievement lay in the application of his historical feeling and literary art to the writing of a full-dress history of Rome.

THE HISTORY OF ROME

Subject.——Livy's History of Rome (Ab urbe condita libri) was in 142 books and covered Roman history from the arrival of Aeneas in Italy to the death of Drusus, brother of the emperor Tiberius, in 9 B.C. After a formal preface, book i treated the origins of Rome and the regal period; books ii–v, the history of the republic to the sack of Rome by the Gauls (390 B.C.); books vi–xv, the conquest of Italy; books xvi–xx, the first Punic War; books xxi–xxx, the second Punic War; books xxxi–xl, the conquest of the east to the death of Philip V of Macedon; books xli–xlv, the third Macedonian War. So far Livy had composed his work in groups of five or ten books, and in a preface to book xxxi he refers to the two previous groups of 15 books; later the subject matter makes this arrangement impossible. Livy treated the third Punic War and destruction of Corinth (146 B.C.) in books xlix–lii; the Gracchan period in books lviii–lxi; Marcus Livius Drusus and the Social War, with events to the death of Marius, in books lxxi–lxxx; and reached the death of Sulla in book xc. After the rise of Pompey and Crassus, Caesar's consulship and the first triumvirate are dealt with in book ciii. Books cix–cxvi on the civil war constituted a group that was called Belli *civilis* libri i–viii, closing with the assassination of Caesar (44 B.C.). Books cxviii–cxxxiii continued the work to Actium, and books cxxxiv–cxlii carried the history of Augustus' reign to the death of Nero Claudius Drusus (9 B.C.). The division of the whole work into decades is not attested before the 5th century A.D., although it may have been done by the book publishers of the 4th century.

There are some indications of the dating of publication. When Livy in the preface charges Rome with enduring neither vices nor their remedies, this may reflect the situation following Augustus' attempt at moral reform in 28 B.C. In i, 19, 3. he refers to the closing of the temple of Janus in 29 B.C. but not to its next closing in 25 B.C., and uses the name Augustus, which was conferred on Octavian in Jan. 27 B.C. The beginning of publication may therefore be dated in 27–26 B.C. Livy's silence at ix, 18, 9 about any return of Roman standards by the Parthians indicates that book ix appeared before 20 B.C. On the other hand, if xxviii, 12, 12 presupposes Agrippa's Spanish campaign, it cannot be dated earlier than 19 B.C. Book lix mentions Augustus' recital in 18 B.C. of Metellus' famous speech on marriage. If book cxxi appeared after Augustus' death, this leaves Livy publishing the large number of 21 books between A.D. 14 and 17; but he may have been ahead with his writing. In any event it may be supposed that he died with pen in hand.

Of Livy's immense work only 35 books survive: books i–x, xxi–xlv (some lacunae in xli–xlv); with a long fragment from book xci (in a Vatican palimpsest). Some quotations were given by later authors, notably two passages about Cicero quoted in Seneca's Suasoriae. For the rest information can be derived only from material already reduced to epitome scale., An epitome of Livy had already appeared in the 1st century A.D. of which Martial wrote *pellibus exiguis* artatur Livius *ingens* ("in tight skins huge Livy is constricted"). It has perished, and the lost books (excepting cxxxvi–cxxxvii) are now represented only by the Periochae, or summaries of contents (probably of the 4th century); the Oxyrhynchus papyrus epitome of books xxxvii–xl, xliii–lv (written c. A.D. 300) may be noted. The Prodigiorum Liber of Julius Obsequens preserves a list of prodigies from the years 190–12 B.C., and the Chronica of Cassiodorus a list of republican consuls. Some information can also be verified from such writers as Orosius, Florus, Eutropius and Rufius Festus.

Sources and Composition. — In studying the history of Livy it is necessary to refer again to Cicero, whose work gave guidance to Livy in the theory and practice of historical composition. Both men believed that history as *magistra* vitae ("guide to life") had a moral purpose, which could only be achieved by rhetorical presentation: opus *unum hoc* oratorium *maxime.* The first law of history was to tell the truth, and the whole truth; but this established merely the jundamenta. One must build up the historical narrative (exaedificatio), wrote Cicero, and embellish it in literary style (exornatio), so that history should take on a form befitting its dignity; previous writers had been no more than chroniclers. In Cicero's view Rome lacked a history worthy of its greatness: abest enim *historia litteris* nostris he said in the De legibus. Such was the challenge and Livy took it up.

Yet Livy was also the heir of the Roman annalistic tradition, which, if it is judged by broader principles than those of Cicero's rhetoric, had already developed a powerful and impressive character. At the outset Roman folklore and Greek mythography combined to enlarge upon the foundation legends of Rome. Naevius and Ennius gave the traditions a strong epic flavour, and Ennius, working through the annalists, influenced the first books of Livy. The senatorial historians from Fabius Pictor to Acilius also provided material about early Rome and, again, about their own period; and Fabius and Acilius were used by later annalists, thus in their turn reaching Livy. After Cato the antiquarian history of Calpurnius Piso gained special authority. In the Gracchan period two important developments occurred: first, the *Annales Maximi* made more archival material available under a yearly or "annalistic" arrangement that preserved its official appearance; secondly, the adoption of rhetorical methods of composition allowed the annalists to elaborate this material within its ceremonial framework. By the time of Sulla the annalists had established their genre of Roman historiography as it is found in Livy — traditional in content, form and expression, yet contemporary in its appeal. Claudius Quadrigarius may be noted in archaic style and Valerius Antias with conscious rhetoric, followed by Licinius Macer and Aelius Tubero, who submitted the traditions to fresh treatment.

Among these annalists Livy found his historical material already arranged in a form which provided both a chronological order and a traditional setting. In books i–iv he used Valerius Antias, Licinius Macer and Aelius Tubero, and in book v also included Claudius Quadrigarius who had begun his history with the Gallic sack of Rome. He continued with these sources in books vi–x and (presumably) in the lost second decade. The second Punic War allowed wider scope. In books xxi–xxx Livy kept Valerius Antias and Claudius Quadrigarius, dropping Macer and Tubero, and added fully descriptive material from Coelius Antipater's historical monograph on the war and from Polybius' "universal history" of the period 220–146 B.C. In books xxxi–xlv he used Valerius Antias and Claudius Quadrigarius, supplemented elaborately for events in the east from Polybius. He continued to the Sullan period with Antias and Claudius Quadrigarius, adding other sources, *e.g.*, possibly Posidonius who cannot be identified from the Periochae; and later he may have used, among others, Sulpicius Galba, Sisenna, and Caesar. Livy does not seem to have used the older annalists directly, and his references to Fabius Pictor, Cato and Calpurnius Piso as well as to Silenus on Hannibal, were most probably at second hand. At special points, *e.g.*, on the trial and death of Scipio Africanus, he might consult other authorities; but this is a rare occurrence in the extant books.

Method.—Livy did not claim to have studied his sources thoroughly. He recognizes the legendary character of the earliest stories and expresses doubts about the traditions before 390 B.C.: "I should be satisfied to take as true what appears to be true" he writes. In some passages he may prefer the oldest historian, *e.g.*, Fabius Pictor; in others the most authoritative, *e.g.*, Polybius; and he cites Valerius Antias' casualty figures sceptically throughout; sometimes he may even reject all the authorities. Yet for the most part he either judges on superficial grounds of probability in each instance or refrains from judgment entirely; for his comparison of variant details at the end of each section is conventional. In fact, despite his show of criticism, his method is basically uncritical. He did not inspect official documents; nor did he examine the inscription on the breastplate of A. Cornelius Cossus when Augustus raised the question of Cossus' *spolia* opima (spoils offered by a general who had killed an enemy leader in single combat), or the *libri* lintei (ancient records written on linen) when Macer and Tubero cited them differently. The set form of his annalistic sources enabled him to compose his work by the simple expedient of switching from one to another, as each offered the most immediately attractive material, and he incorporated episodes from other authors directly into his annalistic framework. He rendered all this subject matter, normally from one source at a time, without reconciling it with his previous narrative. As a result his history is disfigured everywhere by a multitude of inconsistencies, which fall in a pattern of change between sources from section to section.

The chief examples of this method must suffice. In dating events by years ab urbe condita Livy gives three systems; even in dating by consuls his use of different annalists, especially Licinius Macer, has involved him in confusion. His description of the Roman disaster at the Caudine Forks (321 B.C.) represents the most tendentious tradition and is insufficiently corrected by his notes of variants. At the opening of the second Punic War, as he admits, he is unable to clarify his chronology; and in following Coelius for Hannibal's crossing of the Alps—in agreement with Polybius, since both Coelius and Polybius drew upon Silenus—he inserts a passage in book xxi from another source which temporarily makes nonsense of the itinerary. In recording Spanish events in books xxxi–xlv he regularly refers to the governors—they were praetors with proconsular command—as both praetor (or propraetor) and proconsul, because the annalists differed in their titulature. When he incorporates Polybius on the Roman campaigns in the east, which Polybius reported under Olympiad years (autumn to autumn), he sets these sections under the Roman year (spring to spring) without any adjustment, and it is only the fact that very little happened during the winter that eases chronological difficulties. As regards his notorious "doublets," or repetition of reports of the same event, these arise from the mechanical combination of his sources, where he moves from one to another without noticing the order in which they have arranged the respective parts of their narrative.

In writing up his subject matter Livy followed the rhetorical principles which Cicero had laid down in the De *oratore* for the composition of full-dress history. The historian must define the time and place of the action, show how it was conceived and executed, and explain its results, with attention to the character of the men in command. This kind of narration will be clear, since it is systematic, and—being circumstantial—it will produce a realistic impression in the mind of the reader. The effect may be increased by set descriptions of topography or battle scenes and the composition of speeches. In addition to this technique, as Cicero mentions in writing to Lucceius, there was a "tragical" style of writing, in which the historian developed episodes as dramatic scenes, with vivid affecting detail, in order to inspire the reader, as if he were a spectator, with feelings of horror and pity. These methods had been practised in Hellenistic historiography, as is known from Polybius, who criticizes both the rhetorical procedure and Phylarchus' use of "tragical" effects. It is worth noting that one treatment does not necessarily exclude the other in a writer who is the master of his presentation. Livy began with the ceremonial appeal of the annalistic material to the Roman reader and elaborated his episodes in the rhetorical manner, heightened by dramatic touches, without ceasing to interpret the course of events in the light of his own conception of history.

The results of this treatment can be seen throughout Livy's narrative, but it may best be illustrated where he has rendered extant parts of Polybius. In describing the siege of Ambracia (xxxviii, 3–7; Polyb. xxi, 25–28) Livy enlarges on the topographical setting; at Cynoscephalae (xxxiii, 5–11; Polyb. xviii, 18–33) he stresses the influence of terrain and weather on the battle; at the conference of Nicaea between Philip V of Macedon and Flamininus and his allies (xxxii, 32–37; Polyb. xviii, 1–12) he describes the scene, with its lively incidents, before proceeding to a sober account of the negotiations. His feeling for a dramatic occasion is apparent where he shows Flamininus proclaiming "the freedom of Greece" (xxxiii, 32–33; Polyb. xviii, 46), and his sense of dramatic irony, where he recounts how the Aetolians failed to realize that surrender in *fidem populi Romani* was unconditional surrender (xxxvi, 27–29; Polyb. xx, 9–11). The literary conventions of the rhetorical method appear when he presents the appeal of Antiochus the Great to Prusias of Bithynia (xxxvii, 25; Polyb. xxxi, 11) in the fictitious form of a letter, which balances a letter from the Romans. Rhetorical argument, too, has its place. The Pergamene prince Attalus was in danger of being won over to Roman interests, and Stratius appeals to his loyalty (xlv, 19; Polyb. xxx, 1–3) on grounds of honour and expediency: these are the rhetorical themes of *honestas* and utilitas, indicated by Polybius but more definitely formulated by Livy.

Such literary methods may be necessary, if only for the sake of the reader, but they should be based upon full knowledge of the evidence. The "armchair" writer, as Polybius points out, may sacrifice historical accuracy in elaborating material without knowledge of the local conditions. Livy is conscientious, systematic and vivid; but he may misrepresent the original account by trying to clarify it, especially where he is dealing with Hellenistic institutions or topography. It is bad to take an Aetolian meeting at Thermum for an Amphictyonic meeting at Thermopylae (Polyb. xviii, 48, 5; Livy xxxiii, 35, 8); it is worse to turn a disorderly engagement at Cynoscephalae (Polyb. xviii, 18–33) into a set battle piece (Livy xxxiii, 5–11); but what would Polybius have said of a historian who—misunderstanding his technical term for "laying" spears to the charge position—made the Macedonian phalanx "lay down" its spears because of their unwieldy length ("longitudo *impedimento erat*") and fight with swords? However, this is an extreme example, and for the most part, and especially where he was dealing with more familiar Roman conditions, Livy faithfully passes on his subject matter little affected by the rendering into more readable Latin.

Style.—According to Cicero, again, in the De *oratore,* the style of historical writing should be comprehensive and smoothly flowing, that is, a "periodic" style; which would allow the historian to present a complex account with logic and force, relating its elements to one another syntactically so as to keep the main action moving forward. Livy followed this principle, so important for a long history. Quintilian praises him for elevated but natural writing, mentioning his "flowing style" (*lactea ubertas)* and "brilliant lucidity" (*clarissimus* candor), words which define the chief virtues of the "periodic" style. It should be noted that Livy wrote with force as well as fullness. He uses elaborate sentences to set out the circumstances and preparation of the main action, which he then describes in rapid, short sentences, adapting his composition to the rhythm of the events. Almost any page will provide illustrations; but his vigorous story about Hercules and Cacus (i, *7)* in contrast to the leisurely account of Dionysius of Halicarnassus (Rom. *Ant. I*, 39), who was in the same rhetorical tradition, may be particularly noted. Livy handles with equal facility the plain reporting of official matters, the vivid description of dramatic episodes, and the oratory of his speeches. Where he falls into difficulty through overconcentration in his sentences, this is usually due to the pressure of the forward movement of his narrative. Further, the freedom with which literary convention allowed a historian to draw upon all the resources of the Latin language for colour and warmth enabled him to present the "epic" story of early Rome in "poetical" style; this is seen in the story of Hercules and Cacus and in his rendering in book vii of Claudius Quadrigarius' account of the combat of Manlius Torquatus and a Gaul. He also developed ceremonial and ritualistic expression, in the annalistic tradition, for emotional appeal; *e.g.,* in describing in book vii the combat of Valerius Corvinus and a Gaul. That he would always raise his style in this way is proved by his impressive account of the siege of Abydus (xxxi, *17–18),* based on the prosaic Polybius (xvi, 30–34).

Conclusion.—When Livy's work has been considered in terms of subject matter, historical setting and literary influences, there still remains the quality of his achievement, which transcends the technical and the contemporary. That he was uncritical by modern standards is undoubtedly true; yet he has passed on the traditions of Rome as they came to him, and uncritical transmission may be preferred to unsystematic rationalization. His material, then, is worth having, and where his work is lost the historian labours under a serious disadvantage. Even allowing for his idealization of the past, he preserves the standards of public conduct which had raised Rome to greatness and which Augustus, relying on Italian sentiment, hoped to recall. As the republic fell into civil strife, he could lift his history above the bitterness of party feuds—"Pompeian" though he was—to a level of national interest and present it in the light of Rome's destiny. Lacking cynicism he wrote to inspire patriotism.

Yet Livy's history has more than a Roman appeal—or rather, where he is thinking of the men and events of Rome, he portrays Rome in the light of men and events, which he describes and interprets in universal terms. It is no coincidence that he treats the Greeks struggling under the shadow of Rome as carefully as he treats the Romans. There is a quality of sympathy in his work that arises from his understanding of human nature, and—though he may fail in the finer distinctions—he succeeds in his main purpose, especially where he depicts not only individuals but groups acting under the stress of emotion. Herein lies the true greatness of Livy's history. His imagination fuses and fires his rhetorical technique and stylistic skill, giving spontaneity to his composition, so that he stirs the mind and moves the heart. The Romans of his day felt his power; Romans of the later empire looked to him to revivify their pagan traditions; and men of the Renaissance—such men as Petrarch and Machiavelli—took his instruction into their own experience. Since modem criticism has done its work on his subject matter, it is permissible to return to his historical conception and the artistry with which he has presented it.

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LI YUAN-HUNG (1864–1928), president of the Chinese republic, was born in the province of Hupeh, and educated at the Pei-yang naval college at Tientsin. He served in a cruiser during the war with Japan, and later was in charge of fortifications at Nanking. He accompanied the Viceroy Chang Chih-tung to Wuchang, and twice visited Japan to study its educational system and army organization. In 1911 he had risen to the rank of divisional commander and was among the first military officials to realize the force of the revolutionary movement. In consequence he was empowered to negotiate peace at Shanghai, and upon the foundation of the republic became its first vice-president.

Upon the death of Yuan Shi-kai he succeeded as president and held office until the temporary restoration of the boy emperor in July 1917, when he resigned, remaining for the next five years in Tientsin. In 1922 he was prevailed upon to resume the presidency, but in September of the following year he was compelled to resign in favour of Tsao Kun. Li Yuan-hung at an early date opposed "Tuchunism"; *i.e.,* the system of military governorships, and advocated divesting the tuchuns of administrative duties; he worked for the reunification of the country by negotiation instead of by force but was unsuccessful. He died in retirement in Tientsin on June 5, 1928.

LIZARD. Lizards and their close relatives snakes are the dominant reptiles of the present day. The order Squamata, to which both belong, probably originated in Triassic times (about 200,000,000 years ago) from a group of extinct forms, the Eosuchia, that had earlier given rise to another stock of which there is a single surviving species, the tuatara. The Squamata differ from the tuatara and from crocodiles and alligators in many anatomical features of which the most significant, as an indicator of relationship, is the presence of not more than one bony arch across the temple instead of two. Lizards are usually distinguishable from snakes by the presence of limbs; but many lizards are limbless and, so closely are the two groups allied, that in these instances there is no single external character which will easily differentiate them.

Like all other cold-blooded animals, lizards flourish most abundantly in tropical and subtropical regions, the numbers of individuals and species diminishing toward the northern and southern borders of the temperate zones; only a few species penetrate to the Arctic circle or slightly beyond it, the limit being set by the presence of permanently frozen subsoil, which prevents hibernation out of reach of frost.

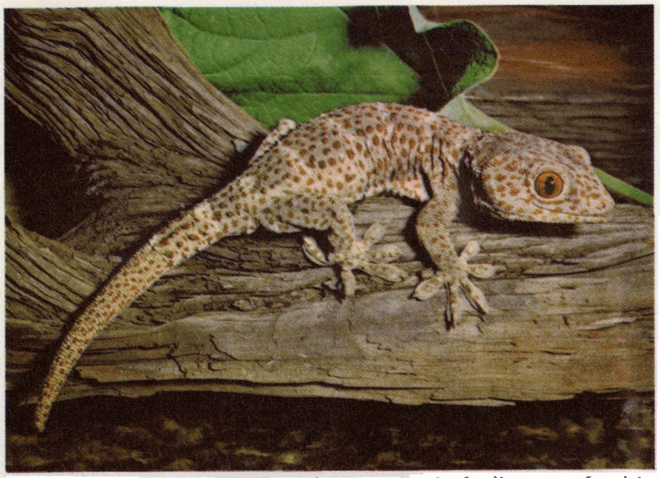
None of the present day lizards is thoroughly aquatic (some extinct forms were), and none is an efficient flier; but lizards are adapted to almost every other environment and mode of life, showing a correspondingly great diversity of size, shape and structure. As in almost all reptiles the skin has a protective layer of ceratinous scales that is periodically renewed from beneath, the old layer being sloughed away. The shape and size of the scales vary in the different families and with the mode of life; in active, noncryptozoic forms maximum flexibility of the skin is achieved by reduction of the scales to small, nonoverlapping

HARDUN, OR STARRED LIZARD

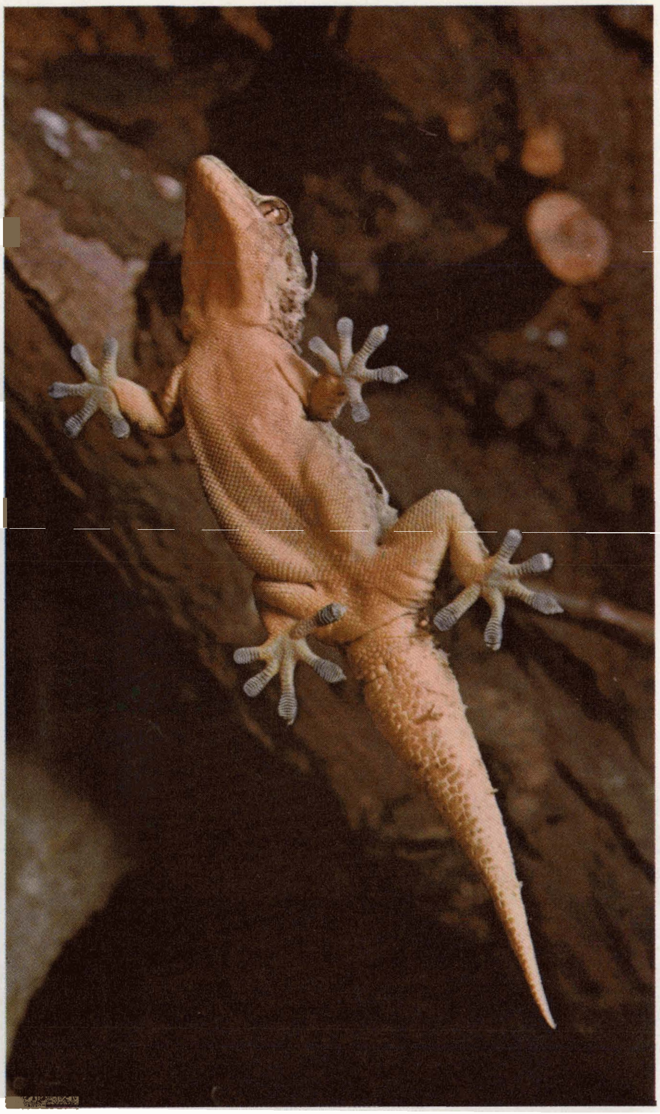
Agama stellio, a north African agamid that prefers a climate of extremely high temperatures

PHOTOGRAPH, JOHN MARKHAM

LIZARD



Tokay (*Gekko gecko*), largest member of the gecko family. It is found in Indo-Malaya, usually in or near areas of human habitation



Underside of a Moorish or wall gecko (*Tarentola mauritanica*) showing the pads on the feet, an adaptation that permits this lizard to climb any kind of surface. It is found chiefly in north Africa, Spain and Yugoslavia

Australian bearded lizard or bearded dragon (*Amphibolurus barbatus*), an agamid, in an attitude of defense with its throat puffed out and its mouth open

Meller's chameleon (*Chamaeleo melleri*), a large species found in Africa. True chameleons are found only in the eastern hemisphere

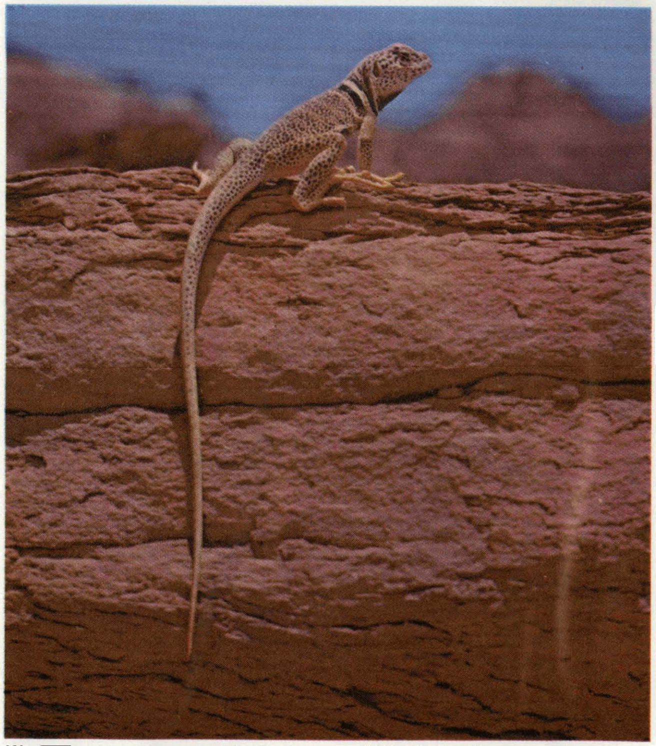
South African chameleon (*Chamaeleo pumila*), an arboreal species with a prehensile tail

AGAMIDS, GECKOS AND TRUE CHAMELEONS

PHOTOGRAPHS, (TOP LEFT) JOHN H. GERARD, (TOP RIGHT) JOHN MARKHAM, (CENTRE LEFT) JOHN WARHAM, (BOTTOM LEFT) CY LA TOUR AND THE DETROIT ZOO, (BOTTOM RIGHT) EDWARD VAN BAERLE

Southern prairie lizard (***Sceloporus undulatus consobrinus***), a spiny lizard of Texas and northern Mexico

Texas horned lizard (***Phrynosoma cornutum***), of southwestern U.S., the so-called "horned toad" sold in pet stores



Western collared lizard (***Crotaphytus collaris baileyi***), one of the lizards that runs on its two hind feet with its body upright. Found in western U.S.

Common or green iguana (***Iguana iguana***), whioh may grow to a length of more than six feet (including the tail). Found in tropical Central a d South America

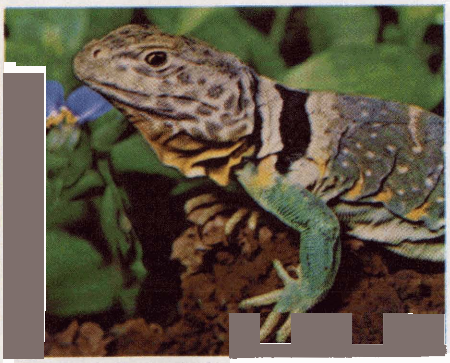
Close-up of the head of a male northern fence lizard (*Sceloporus undulatus hyacinthus*) showing the brilliant blue marking of the throat and side of belly. Ranges over east and south central US.

IGUANIDS

PHOTOGRAPHS, (TOP LEFT, CENTRE LEFT, BOTTOM RIGHT) JOHN H. GERARD, (TOP RIGHT, BOTTOM LEFT) WILLIS PETERSON

Brown colour phase of the green anole (*Anolis carolinensis*), also known as the American "chameleon." Ranges over southeastern U.S.

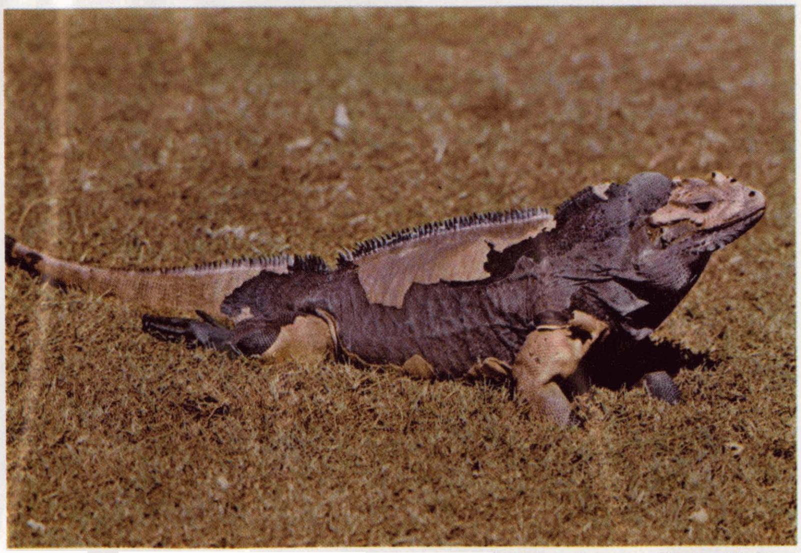
Cuban ground iguana (*Cyclura macleayi*), one of the most primitive types of iguanas. Found on a few islands of the West Indies and Caribbean area



Close-up of the head of an eastern collared lizard (*Crotaphytus collaris* collaris). Found in central southern U.S.

Marine iguana (*Amblyrhynchus cristatus venustissimus*) shown in its native habitat, the rocky shore of Hood Island, one of the Galapagos group

Desert iguana (*Dipsosaurus dorsalis*) of southwestern U.S. a herbivorous species. Like several other iguanids, this species employs bipedal locomotion



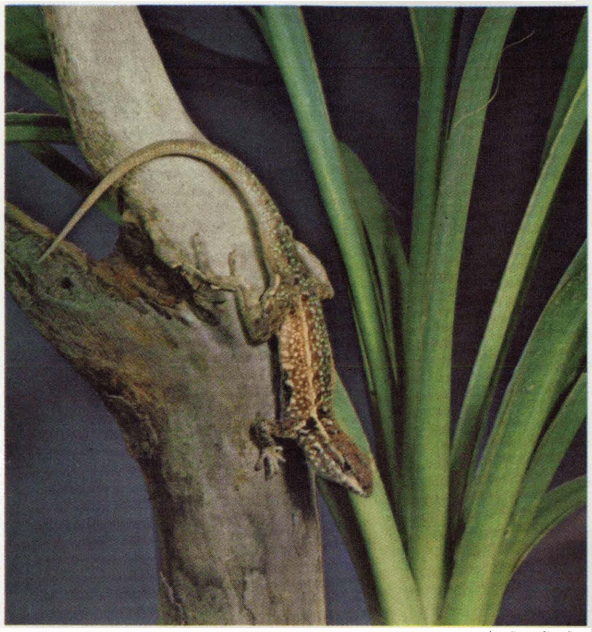
Rhinocerous iguana (*Cyclura* cornuta), one of the largest ground iguanas. The mottled appearance of this specimen is due to sloughing or shedding of the skin, a phenomenon usually associated with periods of growth in reptiles. Occurs on a few islands of the West Indies

IGUANIDS

PHOTOGRAPHS, (TOP LEFT) AMERICAN MUSEUM OF NATURAL HISTORY, PHOTO BY R. G. ZWEIFEL, (TOP RIGHT) EDWARD VAN BAERLE © ENCYCLOPÆDIA BRITANNICA, (CENTRE LEFT) JOHN H. GERARD, (CENTRE RIGHT) I. EIBL-EIBESFELDT, (BOTTOM LEFT) WILLIS PETERSON, (BOTTOM RIGHT) CY LA TOUR AND THE SAN DIEGO ZOO

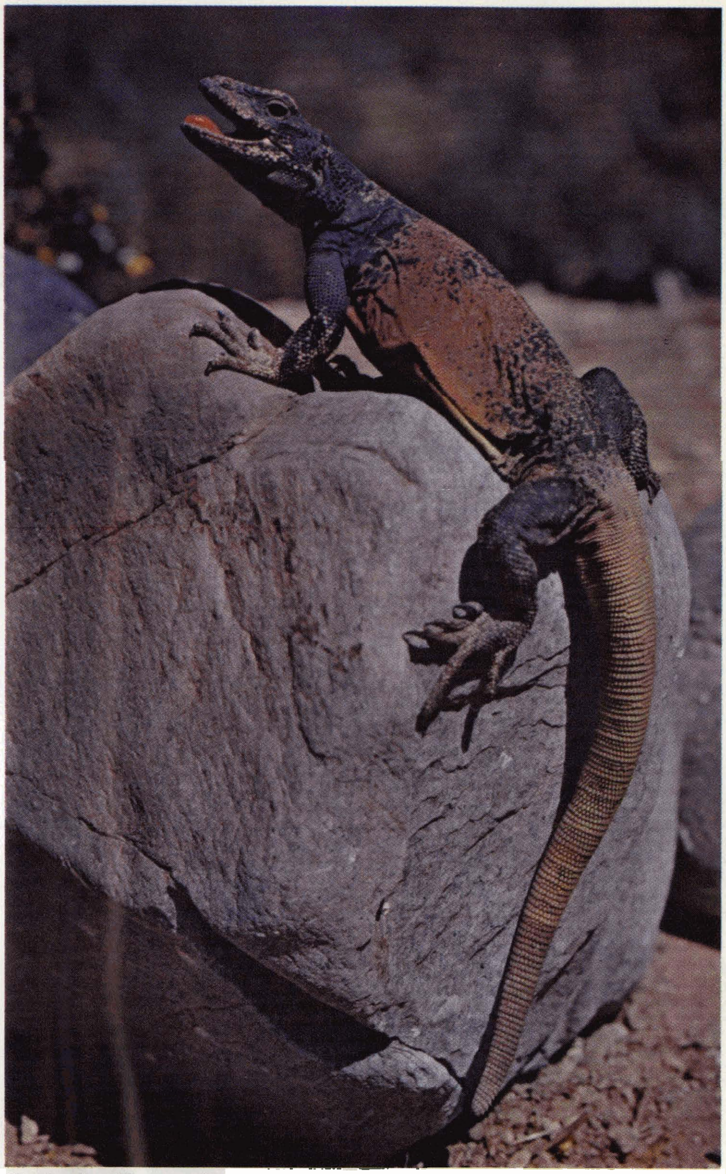
LIZARD

Northern earless lizard (*Holbrookia maculata maculata*), a burrowing iguanid found from South Dakota to northern Texas



Side-blotched lizard (*Uta stansburiana*) of southwestern U.S. Scales in its tail, which catch into bark, adapt this iguanid for climbing trees, its usual habitat

Fringe-toed lizard (*Uma notata*), another burrowing iguanid found in the desert. When alarmed it buries itself completely in the sand



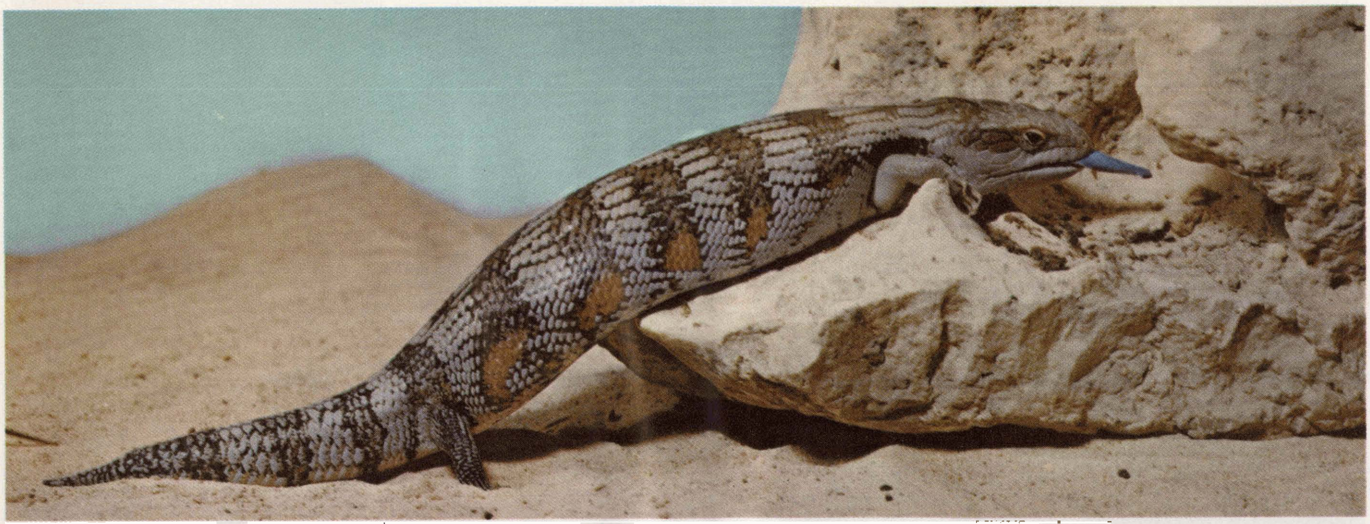
Chuckwalla (*Sauromalus obesus*), found in rocky, arid regions of southwestern U.S. and northern Mexico. When frightened the chuckwalla hides among the rocks where it inflates its lungs to wedge itself tightly within a crevice

Head of the common or green iguana (*Iguana iguana*) showing pattern of scales and detail of the sense organs and foreclaw

IGUANIDS

PHOTOGRAPHS, (TOP LEFT, CENTRE LEFT, BOTTOM RIGHT) JOHN H. GERARD, (TOP RIGHT, BOTTOM LEFT) WILLIS PETERSON

LIZARD



Blue-tongued skink (*Tiliqua scincoides*) of Australia, among the largest of the family, with a length up to about two feet

Western skink (*Eumeces skiltonianus*), which ranges from Canada to Baja California. The brilliant blue tail is common among young skinks of several genera

Trachysaurus rugosa, commonly known as the stump-tailed or shingle-back skink. The scales overlap like those of a pine cone. Australian

Broad-headed skink (*Eumeces laticeps*), an arboreal, woodland species found in most of the south central and southeastern US.

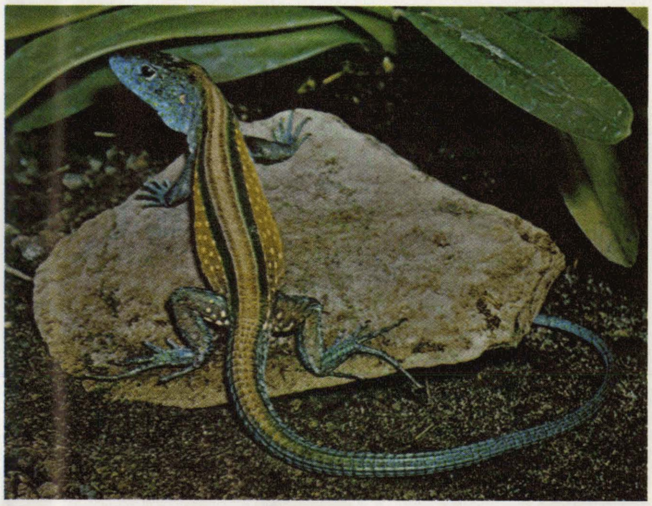
African skink (*Mabuya perrotetii*). Other *Mabuya* species are widely distributed in tropical regions of both hemispheres

SKINKS

Red worm lizard (*Amphisbaena alba*) of South America. Reaching a length of about 1½ ft., this lizard is only occasionally teen above ground

Scheltopusik or glass lizard (*Ophisaurus apodus*), largest of the snakelike anguid lizards, will grow to a length of almost four feet. Found in south-eastern Europe and southwestern Asia

Six-lined race runner (*Cnemidophorus sexlineatus*), found in southeastern and south central U.S., is, like all race runners (or whiptails), noted for its speed



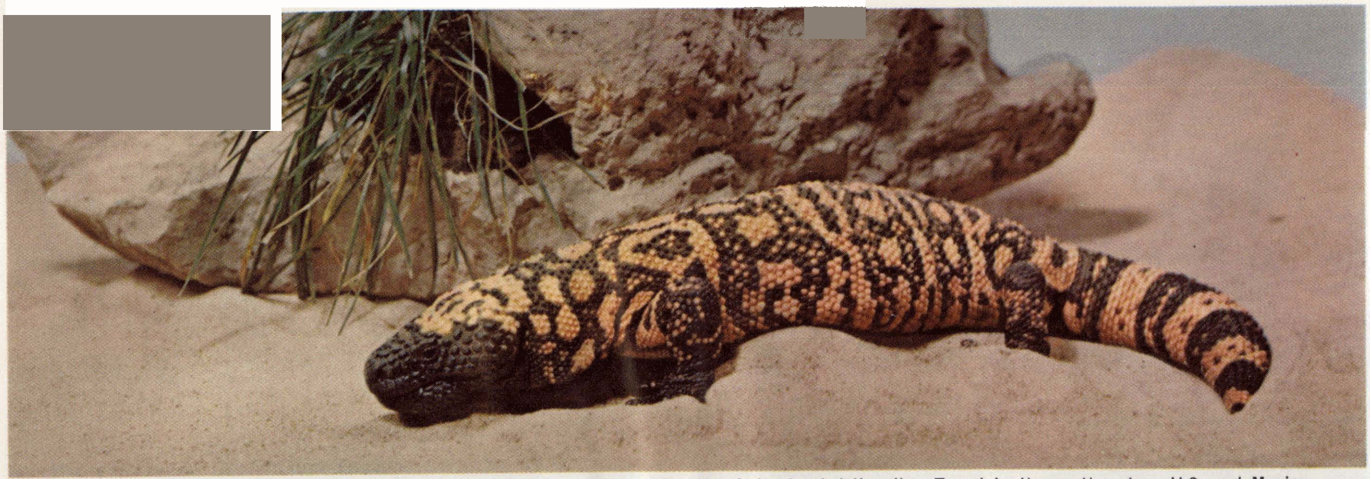
Cnemidophorus lemniscatus, the strand race runner, of South America, uses bipedal locomotion when running at top speed

Golden or northern tegu (*Tupinambis nigropunctatus*), me of the largest of tho telld family. Found in South America

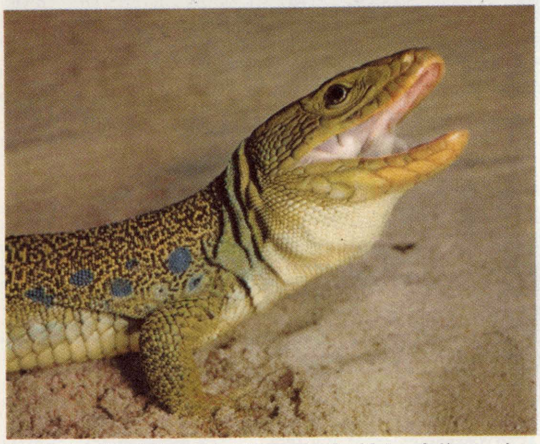
WORMLIKE LIZARDS AND TEIIDS

PHOTOGRAPHS, (TOP LEFT) JOHN MARKHAM, (TOP RIGHT) © ROY PINNEY, (CENTRE LEFT, BOTTOM) JOHN H. GERARD, (CENTRE RIGHT) HANS ROSENBERG

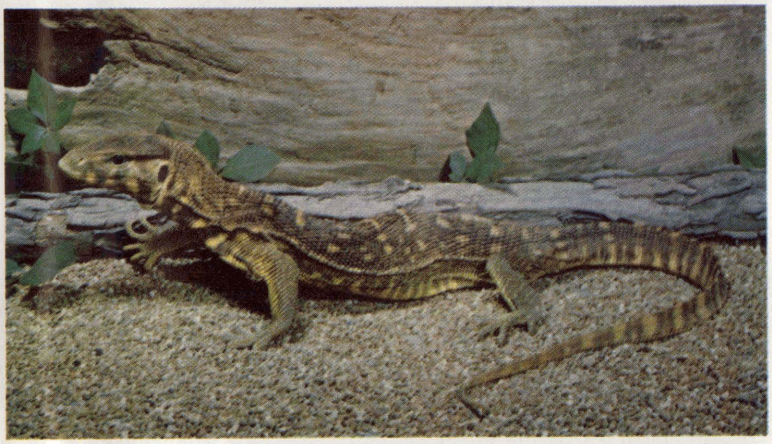
LIZARD



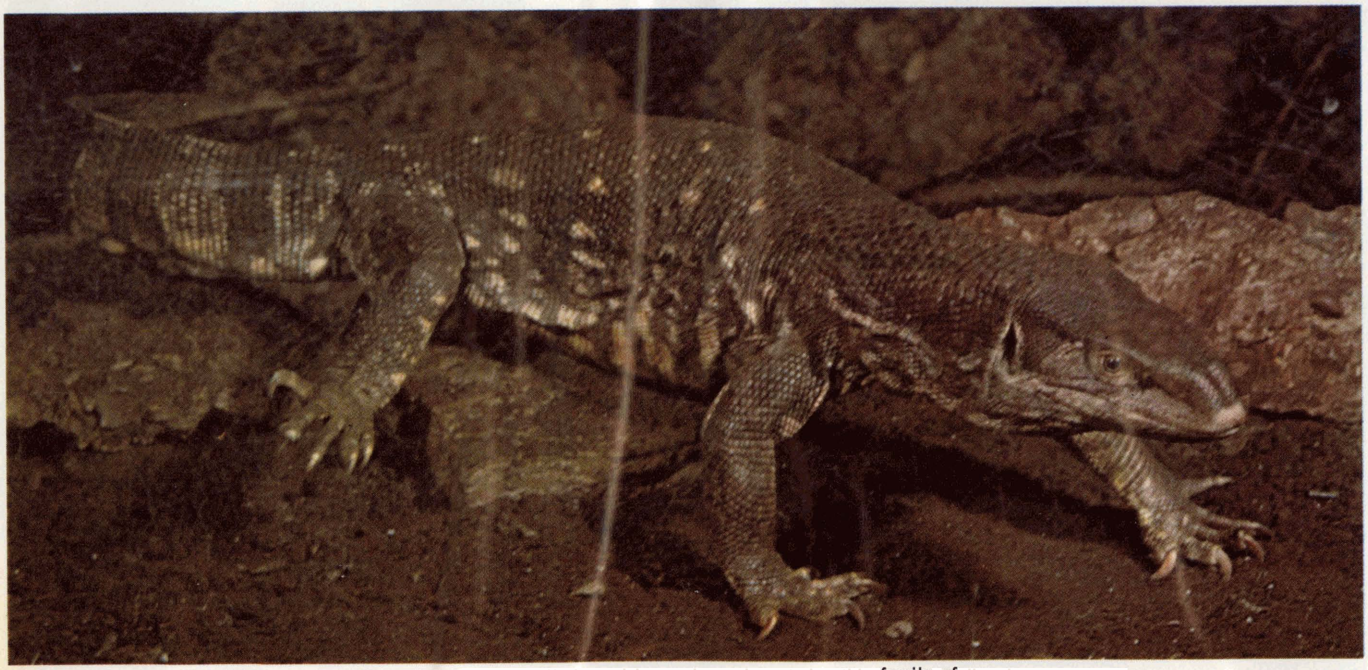
Gila monster (*Heloderma suspectum*), one of two venomous lizards known (the other is the beaded lizard). Found in the southwestern U.S. and Mexico



Head of a jeweled lacerta (*Lacerta lepida*), of the western Mediterranean area, largest member of a family found throughout Europe and Africa



Indian yellow monitor (*Varanus flavescens*). Monitors constitute a family of large, carnivorous lizards widely distributed in Africa, the middle east, southern Asia and Australia



African savanna monitor (*Varanus exanthematicus*). Strong limbs and large claws characterize this family of lizards

MONITORS, LACERTIDS AND THE GILA MONSTER

granules; among desert dwellers there is a tendency for some of them, particularly on the head and tail, to be enlarged to form spines; burrowing and cryptozoic forms achieve a slippery surface by the development of smooth, highly polished overlapping scales. The skin is often re-inforced by bony plates, which lie beneath the superficial scales (though corresponding with them in size and shape), and these may form a continuous protective armour. Other defensive, or sometimes offensive, devices associated with the skin and scales are the occasional development of horns, fringing folds that break up the animal's outline and colouring. The colour pattern may be fixed and of any protective type or there may be a highly developed mechanism for rapid colour change. This mechanism consists of numerous star-shaped cells (chromatophores) each containing granules of pigment or a highly refractive substance, guanine. The granules are capable of movement within the cell and the cells themselves are capable of limited movement toward or away from the surface of the skin. Movement of a cell toward the surface and dispersal of its granules displays its particular colour to the maximum. Changes may result from the direct stimulation of the chromatophores by light or heat but the cells are under the control of the central nervous system. In consequence stimuli received through any of the sense organs may induce reactions and these will not be automatic and stereotyped but modified by such factors as associated memories and the individual's physiological condition.

The sense organs exhibit some modifications found also in other vertebrate groups, but a few are peculiar to the lizards or shared only with the snakes. Replacement of movable eyelids by a fixed, transparent, protective covering of the cornea is a characteristic of snakes found also in many lizards, but in the latter group a peculiar condition is sometimes found in which eyelids are normally movable but a transparent window is developed in the lower one. The median eye of primitive vertebrates persists in some lizards in a more complete form than in any other living animals except the tuatara. This, the parapineal organ, consisting of cornea, lens, retina and' nerve connection to the brain, lies beneath a transparent or translucent scale on the top of the head; it is clearly an organ of vision but not an efficient one. Another sense organ modification shared with snakes concerns Jacobson's organ, which in other vertebrates is part of, and continuous with, the olfactory system and functions by smelling the food that is in the mouth. In the Squamata Jacobson's organ is completely separated from the other nasal structures and appears as two separate pouches opening on the roof of the mouth. Into these pouches the tips of the bifid tongue are thrust after they have collected particles from external objects that are being investigated, or even from the air.

Though the majority of lizards are creepers (reptile from the Latin *repere,* "to creep") they exhibit many modifications for locomotion in different environments. For scampering over loose, shifting sand the area of the feet is increased by the development of lateral fringes on the digits. For climbing either among rocks or in trees the scales beneath the hands and feet may be spinose to provide the equivalents of additional claws, or there may be adhesive discs; for arboreal life the chameleons have the extreme specialization of the digits bound together into opposable bundles like tongs, and a prehensile tail. The larger and more active terrestrial forms, such as the monitors, are no longer restricted to creeping but can run with the body held clear of the ground and some iguanas and agamas when alarmed can rise and run on the hind limbs only. Reduction of digits and limbs in connection with burrowing habits or life among dense, tangled vegetation has occurred many times but only in those families in which the essential muscle (rectus *superficialis*) is present for the production of the sinuous lateral undulations that are the basis of serpentiform movement. Other modifications associated with burrowing habits are elongation and slimming of the body, elimination of a distinct neck, reduction of eyes, reduction of the outer and middle ear and the development of a smaller but more compact and stronger skull. In the truly subterranean burrowers the tail is short and blunt, but the trend of those living in dense herbage is in the opposite direction, the tail being sometimes more than four times as long as the head and body. Gliding flight has been achieved by a few oriental species comprising the genus Draco. As in the gliding mammals (flying squirrels and flying lemurs) the wings are extensions of the skin on the flanks but in the lizards this patagium is supported by five or six enormously elongate ribs. Flipperlike limbs for swimming were possessed by the extinct, marine mosasaurs but no modern lizards are aquatic to the same extent though many live in close association with fresh water, and one (Amblyrhynchus) with the ocean. These swim readily by means of their laterally compressed tails whose area is increased by crests of enlarged bladelike scales.

The great majority of lizards are insectivorous and consequently there is relatively little diversification of the teeth, which are mostly simple and peglike. Even among the insectivorous forms, however, there may be some differentiation into incisors, canines and molars (though these are not homologous with the similarly named teeth of mammals) and the molars may be elaborated by the development of additional cusps even to the extent of being serrated. Some of the larger forms tend to be omnivorous scavengers and in them teeth are enlarged and strengthened. Others again, notably among the iguanas and agamas are herbivorous and sometimes the anterior teeth may be fused together to form a long, cutting edge for grazing. Two major specializations for the capture of prey are found, one being the extraordinary tongue of the chameleons (*q.v.*) and the other the venom apparatus of the Gila monsters (see Helodermatidae below).

As in all reptiles fertilization is internal and the developing embryo is provided with an amnion and allantois. Secondary sex characters associated with courtship are of widespread occurrence in the different families. Frequently the males are brilliantly coloured during the mating season and there is usually a simple display pattern by this sex. This may consist in no more than some bobbing of the head, but there is often inflation of the body, and more particularly the throat, which may be equipped with a specially dilatable and brilliantly coloured dewlap. Hedonic glands, opening by a series of pores on the hinder side of the thighs or on the preanal region, are of common occurrence in males.

The majority of lizards lay eggs with a tough parchmentlike shell; these are usually buried in the ground and incubation is effected by the sun's heat. There are, however, many forms in which the eggs are retained in the female's oviducts for a longer period, in some instances until the eggs are on the point of hatching. In these ovoviviparous forms the normal thick protective eggshell is reduced to a thin transparent membrane. which is ruptured by the young lizard at the moment the egg is laid. Rupture of the eggshell, whether there is external incubation or not, is facilitated by a special forwardly directed tooth on the middle of the upper jaw, the egg tooth, which is shed after it has served its purpose. In both the oviparous and ovoviviparous types the whole of the food material for the development of the embryo is provided by the egg yolk, but in two families, the Scincidae and Gekkonidae, there is true viviparity of a simple type. In these lizards, although the eggs contain much yolk, the embryo is supplied additionally through a primitive type of placenta (*q.v.*).

The number of species of lizards extant today is of the order of 2,500. They are grouped into 18 families based on anatomical features which are discussed in the general article on reptiles.

1. *Gekkonidae.*—Geckoes (*q.v.*). Most geckoes have a soft, granular skin though it is often beset with conical or trihedral tubercles, and the vast majority lack movable eyelids. The family has a world-wide tropical and subtropical distribution and shows considerable tolerance of climatic and environmental conditions. Most species are climbers and have adhesive pads on the fingers and toes, and one genus, the African Lygodactylus also has a similar adhesive pad on the tip of the tail. This organ is extremely fragile in most geckoes and is also more variable in shape in this group than in any other family. (A regenerated tail may be quite different in shape from the original one, and always has simpler and more uniform scales.) Many geckoes have a true voice as distinct from the hissing noises, which are all that most

lizards are capable of. None of the group has adopted burrowing habits or suffered limb degeneration. Several species have folds of skin fringing the flanks. tail and sides of the limbs and it has been claimed that these membranes enable the oriental Ptychozoon to parachute or glide from one branch ta another. Whether this is true or not, there is no doubt that similar fringes in other forms are effective aids to concealment. The classical example is the Madagascar *Uroplates,* which is almost invisible when at rest on a tree trunk or branch; in it the edges of the folds are irregular so that the outline of the animal is obscured and its cryptic colouring, resembling a patch of lichen, merges smoothly into that of the background. Although two genera, both confined to New Zealand, are viviparous, with a simple type of placenta, most other geckoes lay eggs with a hard, calcareous shell. Perhaps it is this hard eggshell that accounts for another unique feature of geckoes, a double egg tooth; in other lizards there are germs of two egg teeth, but only one develops. The largest member of the family is the Indo-Malayan Gekko gecko (vernacular names tokay, tuk-kaa or tuck-too, in imitation of the call note), which is less than 18 in. over-all. The smallest is one of the tropical American species of Sphaerodactylus (wood slaves in the West Indies). These creatures, some less than 1½ in. in length when fully adult, live among the dead leaves of the forest floor and possess a unique development of the claws, which are disposed in a plane at right angles to the normal and can be retracted horizontally into a large sheath. Geckoes are often to be found in and about human dwellings; where sanitary arrangements are defective they may be carriers of pathogenic organisms such as *Salmonella.*

2. *Pygopodidae.*—A small assemblage of lizards confined to Australia and New Guinea which have some anatomical features in common with the geckoes, but which are all snakelike and without functional limbs. None has movable eyelids nor any external traces of fore limbs, though there are vestiges of a shoulder-girdle; the hind limbs are present as a small scaly flap on each side of the vent. They are semiburrowers, to be found in grass or among tangled scrub herbage or in loose soil. In the grass-dwelling forms such as Lialis and *Pygopus* the tail is inordinately long, up to twice as long as the body, and fragile.

3. *Iguanidae.*—(*See* IGUANA.) An ancient and generalized family confined in modem times to the new world and Madagascar, with a single form (Brachylophus) in the Fiji and Tonga islands. Presumably the family at one time had a world-wide distribution; one fossil genus has been found in Europe.

4. *Agamidae.*—This family is the old-world analogue of the Iguanidae. The two groups are mutually exclusive in their territorial ranges, the agamas being confined to Europe, Africa, Asia and Australia. Each group has invaded the same kinds of environment within its own territory with many strikingly similar evolutions of form. The agamids are mostly insectivores, and these have the teeth differentiated into simple incisors, enlarged canines and laterally compressed more or less tricuspid molars. Scales are relatively small (though they may form spines), there are no enlarged plates on the head (except for the scale under which lies the pineal eye), and there are no bony plates under the scales. Movable eyelids and limbs are always well developed and the tail is not autotomous. The shape of the body varies considerably, ground-dwelling forms tending to be horizontally flattened and arboreal species to be compressed from side to side. The genus Agama, with more than 40 species, is a generalized, ground-dwelling type common throughout Africa, the near east and southeast Europe; most of them are cryptically coloured in shades of brown, but the males often develop brilliant red or blue heads and throats, the latter being distended and pulsated in courtship. Dilatation of the throat, and special structures developed in association with it, is a common habit throughout the family, the gesture being either part of a courtship display or a threat. In the Australian frilled lizard (Chlamydosaurus) the neck has an erectile collar, consisting of a fold of skin which when not in use hangs like a cape about the shoulders. When the lizard is angered or frightened this cape is erected so that it stands out like an enormous ruff and at the same time the mouth is widely opened, displaying its saffron-yellow interior. The gesture is impressive but is mostly bluff and if further molested the animal usually flees, running swiftly on the hind limbs only. This habit of running on the hind legs is shared by other members of the family, including Physignathus, found from Australia to Tonkin, some of whose species are semiaquatic, living on the banks of streams and taking to the water readily when disturbed. Bipedal running is also frequent among iguanid lizards. It is in the Indo-Malayan region that the greatest diversity and the most bizarre developments are to be found. The extreme among the inexplicable modifications is probably in *Lophura amboinensis* found in the Philippines, Java, Celebes and the Moluccas. This animal reaches 3 to 4 ft. in length, of which the tail accounts for 2½ ft. or more and has a high saillike crest supported by enormously developed spines from the vertebrae. Like the iguanid *Basiliscus,* it has fringed toes, which enable it to run across water. Horns on the tip of the snout, similar to those of chameleons, are found in genera such as Ceratophora of Ceylon and *Harpesaurus* of Java. Parallelism with chameleons extends also to the development of a prehensile tail (*Cophotis* of Ceylon, Sumatra and Java), to bony ridges above the eyes in Lyriocephalus (which also has a globular excrescence on the tip of the snout) and to remarkable powers of colour change in genera such as Calotes, which, like the American anoles (family Iguanidae), are sometimes erroneously known as chameleons. This phenomenon is associated more with emotional changes and physical conditions than with colour of the background and is most marked at the breeding season either during courtship or when males are in combat. Calotes *versicolor,* known in some parts of its range as the bloodsucker, is extremely pugnacious during this period when the males develop a brilliant scarlet or crimson colour that may be restricted to the head and shoulders or may involve almost the whole of the body. The acme of specialization in the family is in the arboreal flying lizards (Draco) of the Malayan region.

Most of the forms hitherto mentioned are either insectivorous or have a mixed diet and it is surprising that the most exclusively herbivorous members of the group live in the Saharo-Sindian desert belt. They are the mastigures (Uromastix), heavily built lizards with short limbs and a short but heavy tail armed with whorls of strong spines. Spinosity, also associated with desert life, reaches its maximum in the Australian thorny devil (Moloch) ; this is a small, squat. short-tailed creature, which is liberally beset all over with spines, the largest being on the snout and above the eyes.

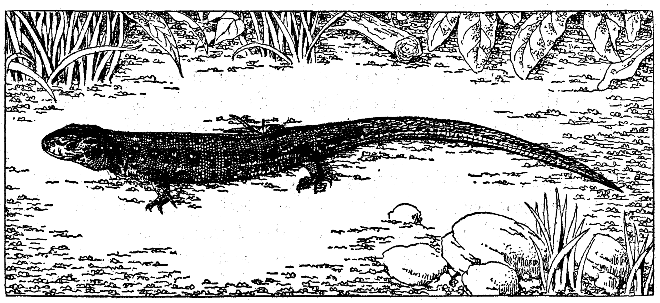
5. *Chamaeleontidae.*—Chameleons (*q.v.*). Arboreal lizards with many unique specializations including the grouping of the fingers and toes to form opposable bundles for grasping twigs and branches and an enormously protractile tongue for catching insect prey.

6. *Xantusiidae.*—A small Central and western American group of lizards with geckolike eyes lacking movable eyelids. The body is covered with small granular scales, with or without some scattered enlarged tubercles on its upper surface, but the lower surfaces and the top of the head have larger, platelike scales; there is no bony armour under the scales. Xantusia is found in the arid regions of the southwest of the United States, Lepidophyma in Central America and Cricosaura in Cuba.

7. *Scincidae.*—The largest lizard family with a cosmopolitan distribution. All members of the group have relatively large overlapping, platelike scales underlain by bony plates, which form a complete armour. Compared with such families as the Iguanidae and Agamidae the skinks show relatively little diversity of form and scale modifications, nor have they powers of rapid colour change though the colours are often brilliant. A widespread colour feature in the group is a sky-blue or turquoise tail, particularly in young individuals. In the vast majority, the scales are uniform in size and smoothly polished, but sometimes they have one or more raised longitudinal ridges (keels) that continue beyond their edges to form spines. In the Australian stump-tails (*Trachysaurus*), for example, the keels are wide and blunt and each scale resembles that of a pine cone; in other Australian forms of the genus Egernia the keels are enlarged and prolonged to form effective, thornlike spines, particularly on the broad tail. The

family is noteworthy for the extent to which there is limb degeneration in association with cryptozoic or burrowing habits. There is every gradation between well-developed limbs, each with five digits, and complete absence of any external traces of limbs; in the intermediate stages it may be the fore limb that shows greater reduction and loss of digits than the hind limb or the reverse may be the case, and it seems certain that limb reduction has taken place many times within the family. One such evolutionary line in Africa culminates in a group of blind, limbless burrowers that is sometimes given family status under the name Feyliniidae and the American genus Anelytropsis which resembles the Feyliniids is probably a parallel development. Another modification of which gradational stages can be traced is the development of a fixed transparent covering over the eye similar to that found in some other families and in all snakes. This modification may be associated with burrowing habits but is also found in nonburrowers. In the most primitive condition the Iower eyelid is still movable but a few scales in the centre of it are enlarged and transparent; in more advanced stages, as for instance in the genera Leiolopisma and Emoia almost the whole of the lower lid has lost its scaly character and is transparent; the most advanced stages in genera such as Panaspis, Ablepharus and Ophiseps, have the lower lid immovable in the "closed" position and also more or less fused along its edge with the upper lid. Most skinks lay eggs but a few species of Leiolopisma, Hinulia and Chalcides are truly viviparous, the later stages of foetal development being nourished through a simple placenta; this phenomenon is also reported for certain snakes (Denisonia) and for two New Zealand geckoes but is not known to occur in any other recent reptile. The skink, the species that has given its name to the whole family, is a small desert-dwelling lizard of the Sahara and Arabian deserts that when dried, pondered and swallowed was formerly regarded as a panacea for many ills, and as an aphrodisiac, and is still esteemed by primitive tribes both as a food and a drug. It shares with a few close relatives from the same region the ability to "swim" through loose sand by modifications similar to the moles among mammals; it has a pointed, wedge-shaped snout, tiny eyes and short, broad, paddlelike limbs, with broadly fringed fingers and toes.

8. *Dibamidae.*—A single genus (*Dibamus*) of degraded, blind, burrowing lizards of unknown ancestry found from New Guinea to Annam and the Nicobar Islands. In females the fore limbs are absent and the hind limbs, also; in males the latter are represented by a pair of small scaly flaps. The general appearance is wormlike. both head and tail being of the same diameter as the elongate body and there being no recognizable neck. The snout is covered



BY COURTESY OF THE AMERICAN MUSEUM OF NATURAL HISTORY
THE SAND LIZARD OF ENGLAND AND THE CONTINENT. A SPOTTED SPECIES. NEVER ATTAINING TO A LENGTH OF MORE THAN NINE INCHES

with a thickened shield and the eyes are minute and concealed beneath the skin. The body is covered with smooth overlapping scales and there is no bony armour beneath them. Reproduction is by eggs which, like those of the geckoes, have a brittle calcareous shell.

9. *Lacertidae.*—These are the true lizards of the old world exclusive of Madagascar and Australasia; their northern limits coincide approximately with the southern edge of the permafrost zone (*i.e.,* where the subsoil remains frozen even through the summer) and they are the dominant lizards of Europe. All are terrestrial and the family shows relatively little diversity of form and no tendencies toward limb degeneration. The head is covered by enlarged, symmetrically disposed plates each with a corresponding bony plate beneath it; the body scales lack any such bones and are generally small and granular on the back, but enlarged to form rectangular plates on the under surfaces; the tail is almost always long and slender and fragile. Two species, both of the genus Lacerta, occur in Great Britain. The common or viviparous lizard (L. vivipara), which also occurs over a large area of northern Europe is plentiful throughout Great Britain and ako occurs in Ireland, though scattered there. The scientific name is slightly misleading since the species is really ovoviviparous and not viviparous; *i.e.,* the eggs are retained within the mother's body until they hatch but the embryos obtain their nutriment solely from the yolk material in the egg; in the Pyrenees it has been reported that eggs may be laid before the young are ready to emerge. The other British Lacerta, the sand lizard, always lays eggs and despite its scientific name, L. agilis, is a more heavily built and less nimble species. Though common enough in north central Europe this species is relatively rare in Britain and is restricted to a few areas of sand dunes or sandy subsoil. Females of the species are inconspicuously coloured, being gray-brown with longitudinal rows of large darker blotches enclosing white spots. Males, however, are a beautiful dark emerald green with a row of conspicuous black-bordered white circles on the sides of the neck and the flanks, and their colour sometimes leads to erroneous records of another species, the true green lizard (L. viridis) which is a much larger species common throughout western and southern Europe. It is there and especially in the Mediterranean region, that the genus Lacerta is dominant. Everywhere wall lizards are to be found and they show great variability particularly in colour and pattern. Almost every small island has a recognizably different form and on the mainland, too, there are almost endless variations from place to place with or without intergradation from one to the next. Some of the colour forms are associated with special environmental conditions and may be caused by them; for instance on small barren rocky islands where there is little or no vegetational cover the lizards are almost always black or nearly so. But in most cases there is no obvious cause and effect relationship and it seems that here is an instance of one kind of evolutionary development in progress—the formation of local races as precursors of distinct species. Circular sky-blue spots on the flanks are of common occurrence in the family and the handsomest of the European lizards is the eyed lizard, which has rows of spots, each one black bordered, on a green ground colour. In Africa and the near east the lacertids show great tolerance of arid climatic conditions. Acanthodactylus has the area of the fingers and toes increased by fringes of elongate scales and is thereby enabled to run over soft sand. Probably in connection with life in desert and semidesert conditions the eyelids of lacertids have undergone the same modifications as those of other families, viz., the development of a transparent window in the lower lid and, where the window is perfect, fusion of the lower lid with the upper so that the delicate cornea is never exposed. This condition is found in the Indian *Cabrita* and in Ophiops, a genus that ranges from Algeria to Madras, India.

10. *Cordylidae.*—The plated lizards and Zonures from southern Africa and Madagascar with resemblances to the Scincidae and Lacertidae. The head is covered with enlarged scales with bony plates beneath them and both back and belly have relatively large, almost rectangular scales, which form linear series longitudinally and transversely; beneath them is a bony armour. The result is a somewhat rigid shield on the back and a similar one covering the belly. Flexibility is provided in several of the genera by an inverted box pleat along each flank; this inturned fold of skin is covered with small granules and is devoid of bony plates. Most of the group have well-developed limbs but Chamaesaura and Tetradactylus of South Africa, show various stages in limb reduction, the most degenerate species being snakelike with limbs represented by mere stumps devoid of recognizable digits. Chamaesaura is a dweller among dense herbage and possesses to a marked degree the elongate tail often found in association with that environment; the tail is four times as long as the rest of the animal. Cordylus (*Zonurus*), on the other hand, is a rock dweller and has a short

tail with enlarged scales forming whorls of large spikes. These must surely deter would-be predators trying to extract it from crannies in which it has taken refuge.

11. *Teiidae.*—An American family whose typical members superficially resemble the Lacertidae of the old world, the head being covered with large symmetrical plates, the back usually with small granules and the belly with rectangular plates in regular transverse series. Genera such as Kentropyx, Ameiva, and *Cnemidophorus* (race runners in the U.S.) found from the south and west of the U.S. and the West Indies to Patagonia, resemble the old-world genus *Lacerta* not only in general appearance but in the multiplicity of local races or subspecies. The family as a whole, however, shows a much greater range of form and adaptability than the Lacertids. The teyous (*Tupinambis*), found from the Guianas to tropical Argentina resemble the monitors (see *Varanidae* below) in size (up to 4 ft. or more), form and habits; they are general predators and scavengers. *Crocodilurus* of the Amazon basin is probably semiaquatic and has a flattened tail with a double crest, like that of a crocodile. *Dracaena,* another large species of the same region, has large oval crushing teeth in connection with its molluscivorous diet. In the smaller forms there is progressive reduction of the limbs and development of a window in the lower eyelid; *Alopoglossus* of Ecuador and Peru has a few enlarged semitransparent scales on the lower eyelid; Pantodactylus of southern Brazil and northern Argentina is a rather elongate form with an undivided transparent disc, and *Gymnophthalmus* and Micrablepharus have, like some skinks and lacertids, the transparent lower eyelid fused with the upper. *Anadia* of Central America and Ecuador is elongate but with the limbs pentadactyle; *Scolecosaurus* is serpentiform with three or four clawed fingers and toes and burrows in humus and rotten wood, feeding principally on termites. Bachia and *Iphisa* of northern South America exhibit the greatest degree of degeneration in the family; the body is elongate and serpentiform, the eye minute but still equipped with functional eyelids, the scales no longer granular or overlapping but squarish and arranged in regular longitudinal and transverse rows like those of the amphisbaenids, the fingers reduced to clawless tubercles or quite absent and the hind limbs having perhaps a single toe. One of the most remarkable modifications is in the Trinidad species *Proctoporus shrevei* which lives in the half light of caves on Mt. Aripo. The males have a series of white spots along their flanks, each being a transparent area of thickened skin. These appear to be crude lenses, for it is reported that if a beam of light strikes the animal each spot reflects it like a cat's eye on the highway in the light of an automobile headlamp.

12. *Amphisbaenidae.*—A family highly specialized for subterranean life. All are wormlike in appearance and only one genus, Chirotes of western Mexico and lower California, has any external trace of limbs; in it the fore limb alone persists and, though short, it has five, four or three digits. The head of all amphisbaenas is small, no wider than the body, and the bones of the skull are much stouter than in other lizards. Eyes are minute and completely covered by the skin though they may be visible through the scales. The conducting apparatus of the ear, instead of being connected to an ear drum to pick up sound waves, is connected with the lower jaw and chin to transmit soil vibrations. The head is covered by a few enlarged plates but the outer covering of both head and body, though of the same horny material as normal reptilian scales is a thin sheet. The skin on the body and tail is divided into small rectangular segments, which form regular annuli, and carries no pigment except, sometimes, black; in consequence the animals are always somewhat pink owing to the blood colour showing through. The name, derived from Greek words meaning "both go," arises from the ability to progress either backward or forward and the fact that the tail is so short and blunt that it is scarcely distinguishable at a glance from the head. All the species are completely subterranean in habits and are predators on burrowing invertebrates, particularly ants and termites. They are found in the Iberian peninsula, from Asia Minor southward throughout Africa and from the southern U.S. southward to Argentina.

13. *Helodermatidae.*—Lizards with small, tuberclelike scales and with recurved, grooved teeth. This family contains the only known poisonous lizards, the Gila monster (Heloderma *suspectum*) of Arizona, New Mexico and Utah, and the Escorpión (Heloderma horridum) of Mexico. These are sluggish, heavy-bodied creatures with weak limbs, short stumpy tails and a warning coloration of alternating rings of blackish-brown and yellow or pinkish-orange. The poison apparatus consists of a row of glands along the inside of the lower lip whose openings lie near the bases of the grooved teeth. When the animals bite they deliberately chew the object and in this way a considerable amount of venom is worked into the wounds through the channels of the teeth. The food consists chiefly of small lizards on which the poison acts fairly rapidly, but the bite is not as a rule fatal to man.

14. *Lanthanotidae.*—The rare Bornean lizard Lanthanotus was for a long time regarded as a close relative of the Gila monster. Recently, however, it has been shown to he allied to the monitors and even more closely to some of their extinct relatives the mosasaurs and dolichosaurs. Although it is by no means snakelike in general appearance it possesses many of the structural features to be expected in an ancestor of the snakes, a fact which supports the hypothesis that the snakes are derived from some platynotan (monitorlike) lizard.

15. *Anguidae.*—A small family, chiefly American, but with a few species in Europe and the Indian region; all the species have large, overlapping scales with osteoderms beneath them. *Gerrhonotus* of North and Central America and Celestus of the West Indies, Central and South America are genera with well-developed, pentadactyle limbs; *Ophisaurus* has the limbs reduced to a pair of small stylets on each side of the vent and has a peculiar distribution, three species occurring in the United States, one in Mexico, another in India and Burma, and still another in southern Europe and Morocco. The European species (O. apus) is the "Scheltopusik" or glass snake, the latter name bestowed on account of the extreme fragility of its tail, which, if the creature is roughly handled, breaks into several fragments. The American species have similar habits and the same vernacular name.

Anguis, another genus, has no external rudiments of limbs; its sole species, A. *fragilis,* known in England as the slowworm or blindworm, is a snakelike creature, frequenting grassy banks and ditches and is one of the few animals that preys largely on slugs.

16. *Xenosauridae.*—Two montane lizard genera, one Mexican (Xenosaurus) and one Chinese (Shinisaurus), resemble the Anguidae in many features but have some differences in common, including reduction of the osteodermal armour; on the head the osteoderms are consolidated with the underlying bones but elsewhere they are reduced to small isolated nodules. *Shinisaurus* looks like a miniature, foot-long, crocodile and is semiaquatic. It frequents the banks of streams into which it plunges when disturbed, seeking refuge at the bottom under rocks and stones.

17. *Anniellidae.*—A single genus (Anniella) of elongate and limbless, burrowing lizards from California related to the Anguidae in much the same way as the Dibamidae are to the Scincidae. They are wormlike, with no external vestiges of limbs and minute eyes covered by scales. The scales are soft and without bony plates. The colour is silvery, each scale edged with brown and with a narrow dark line down the middle of the back.

18. *Varanidae.*—Monitors. An old-world family of large lizards which, despite the fact that its members are successful in many different habitats shows little diversity of form. All are typically lizardlike in general appearance with heavy bodies, slender tails, which are not fragile, and with well-developed pentadactyle limbs armed with powerful claws. The neck is longer and more flexible than in most other lizards and the tongue is snakelike, forked and protrusible. The head and body are covered with small granular scales and there is either no bony armour or the osteoderms are small and widely separated. The family is an old one, fossils as old as the Cretaceous being known, and it is closely allied to the extinct semiaquatic dolichosaurs and marine mosasaurs. The living varanids are found in Africa, Arabia, southern Asia and Australia. Some, such as the Nile monitor (Varanus *niloticus*)

and the Indo-Malayan water monitor (*V. salvator*) frequent the vicinity of rivers and streams and take readily to the water, swimming by lateral undulations of their vertically flattened tails, the limbs being held close to the sides; others such as the desert monitor (V. *griseus*) which ranges from North Africa to the Caspian sea and northwestern India are restricted to arid country, and others again are semiarboreal. But most of the species are adaptable and are not inseparably associated with any restricted environment. All the species are carnivorous, most of them indiscriminately so with no objection to carrion, and are active predators; some will eat fruits such as melons and cucumbers, several regularly prey on the eggs of crocodiles and turtles, digging out the nests, and the semiaquatic forms often feed on mussels.

Monitors are the largest lizards of the present time and the largest species is the Komodo dragon (V. *komodoensis*), which is found on the two small East Indian islands of Rincha and Komodo and on the adjacent part of Flores. Exaggerated and sensational stories accumulated around this creature, until it was studied in the field by E. R. Dunn in 1926. It has the heaviest build of any of the monitors but it also has a relatively short tail so that a specimen 9-ft. long has a body three or four times as heavy and bulky as that of, say, a water monitor of the same overall length. This led, by inapplicable arithmetic, to stories of go-ft. specimens; the maximum size is probably about 10 ft. It is a diurnal animal that preys mainly on small wild pigs.

The largest number of forms is to be found in Australia where the rare Queensland species, *V. giganteus* is a close rival to the Komodo dragon in size. Monitors can all run at a considerable speed though this, again, is often exaggerated and probably does not exceed 10 m.p.h. and that for only a short distance. When angered they inflate themselves, hissing violently, lashing the tail and threatening with widely opened mouth. The threat may be no idle one since both bite and tail slap can be effective, but it may be no more than bluff; the African *V. exanthematicus,* will sometimes, after threatening, sham dead, rolling over on its back and remaining inert until the danger is past. All the species lay large oval, soft-shelled eggs, which are deposited in holes in the ground or in termite nests. (H. W. P.)

LIZARD PENINSULA, or THE LIZARD, terminates in Lizard point, Cornwall, Eng., the southernmost point of Great Britain, in 49° 56' 30" N., j° 12' W. The beam from the Lizard lighthouse is visible for 21 mi. The cliff scenery is magnificent; the coast is fretted into small bays, caves pierce the cliffs and bold isolated rocks fringe the shore; Kynance and Mullion coves are particularly beautiful. The dark green and purple colouring of the serpentine rock, of which most of the peninsula is formed, is remarkable; it is used for building and worked into ornaments. Most of the peninsula is 200–300 ft. above sea level and on the thin soil Cornish heath is a characteristic plant. Lizard Town, at the southernmost extremity, is a straggling village. The nearest town of importance is Helston (*q.v.*), 11 mi. N. by road from Lizard point. At Poldhu, 2 mi. N. of Mullion, a monument marks the spot where' Marchese Guglielmo Marconi sent and received the first trans-Atlantic radio messages in 1901. There are remains of ancient settlements. The name (Lis-ard) means "high court."

LJUBLJANA, a city of Slovenia, Yugos., on the Ljubljana river. Pop. (1961) 133,386. It is a Roman Catholic see, founded in 1461, with a Renaissance cathedral, lavishly frescoed, and several beautiful churches. There are various educational institutions including a university and societies for the promotion of science and literature. While under Austrian rule it was the centre of the Slovene national movement, the first Slovene newspaper having been published there in 1797, while the Prince Bishop was one of the chief promoters of the Yugoslav movement.

Ljubljana became an important transportation centre and is a busy industrial city with a number of suburbs. Industries developed there include cotton, woollen, porcelain, paper, furniture, boot, tobacco, soap, pottery, firehose, match and chemical manufacturing, and a foundry work, breweries, distilleries, leather tanneries and brickfields. After the draining of the surrounding plain, the city became a beautiful spot, and a favourite summer resort and tourist centre.

It is dominated by the mediaeval fortress on the height of the Schlossberg, from which a magnificent view is obtained.

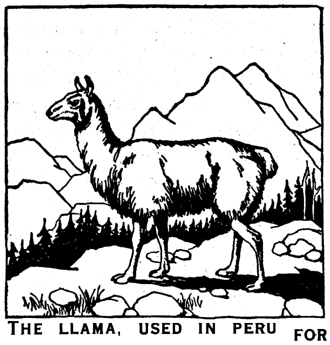
Ljubljana lies on the trade route from east to west, and legend says that it was founded by Jason. It is supposed to occupy the site of the ancient Emona or Aemona, founded by the emperor Augustus in 34 B.C. It was besieged by Alaric in 400 and desolated by the Huns in 451. In 900 it suffered much from the Magyars, who were, however, defeated there in 914. In the 12th century the city passed into the hands of the dukes of Carinthia; in 1270 it was taken by Ottokar of Bohemia; and in 1277 it came under the Habsburgs.

In 1809 the city was twice taken by the French, and from 1809 to 1813 it became the seat of their general government of the Illyrian provinces. From 1816–49 Ljubljana was the capital of the kingdom of Illyria. It is historically known from the congress of Laibach. In 1895 it suffered severely from an earthquake. In 1941 Ljubljana became the capital of the part of Slovenia annexed by Italy, and the centre of resistance to Italian occupation. It was occupied by Germany from 1943 to 1945. From 1949 the city was the capital of Slovenia and Ljubljana oblast.

LJUNGGREN, GUSTAF HAKAN JORDAN (1823–1905), Swedish man of letters, born at Lund on March 6, 1823, was educated at Lund university, where he was professor of German (1850–1859), of aesthetics (1859–1889) and rector (1875–1885). He had been a member of the Swedish academy for 20 years at the time of his death in September 1905. His most important work, *Svenska vitterhetens hafder efter Gustav III's död* (j vol., Lund, 1873–1895), is a comprehensive study of Swedish literature in the 19th century.

His other works include: *Framställning af de förnämste estetiska systemerna* (an exposition of the principal system of aesthetics; 2 vol., 1856–60); *Svenska dramat intill slutet af 17 århundradet* (a history of the Swedish drama down to the end of the 17th century, Lund, 1864); an edition (1864) of the *Epistlar* of Bellman and Fredman, and a history of the Swedish academy in the year of its centenary (1886). His scattered writings were collected as *Smarre Skrifter,* 3 vol. (1872–81).

LLAMA, the larger of the two domesticated members of the camel-tribe indigenous to South America. The llama *(Lama guanicoe glama)* is a domesticated derivative of the wild guanaco, which has been bred from time immemorial as a beast of burden, its sure-footedness and endurance rendering it almost the equal of the mule. Chiefly found in southern Peru, it attains a larger size than the guanaco and is usually white, spotted with brown or black, or sometimes altogether black. The following account was given by Augustin de Zarate in 1544:



THE LLAMA, USED IN PERU FOR CENTURIES AS A BEAST OF BURDEN

"These sheep of Peru are large enough to serve as beasts of burden. They can carry about 100 lb. or more, and the Spaniards used to ride them, and they would go four or five leagues a day. When there is a man on one of them, if the beast is tired and urged to go on, he turns his head round and discharges his saliva, which has an unpleasant odour, into the rider's face. These animals are of great use and profit to their masters, for their wool is very good and fine, particularly that of the species called pacas; and the expense of their food is trifling, as a handful of maize suffices them, and they can go four or five days' without water. Their flesh is as good as that of the fat sheep of Castile."

The disagreeable habit of spitting is common to all the group.

In a wide sense the term llama is used to designate all the South American Camelidae. *(See* TYLOPODA.)

LLANBERIS, a small town of Caernarvonshire, Wales, $7\frac{1}{2}$ mi. E.S.E. of Caernarvon by road. Pop. of civil parish (1951) 2,333.

It is a favourite tourist centre, being situated between two lakes, Llyn Padarn and Llyn Peris, the latter of which lies at the foot of the fine Llanberis pass (1,169 ft.), and being also the starting point for the easiest ascent of Snowdon, which rises to the south-east. At Llanberis is the station of the Snoudon railway. Nant Peris, the old village. is about 2 mi. S. at the foot of the pass. Near Llyn Peris are the ruins of the 13th-century Dolbadarn castle. Although picturesquely situated, slate quarrying has spoiled the appearance of Llanberis, but the great Dinorwic quarries export fine slate to all parts of the world. A road over Llanberis pass leads through Nant Gwynant to Beddgelert.

LLANDAFF, a ward (since 1922) in the county borough of Cardiff, Wales, 2 mi. N.W. of Cardiff. Pop. (1951) 19,859. It stands on high ground sloping toward the southern bank of the Taff. Of Llandaff's first two bishops, St. Teilo flourished in the latter half of the 6th century and St. Dubricius died in 612. Geoffrey of Monmouth died and was buried at Llandaff (1154). By the 12th century the see had acquired great wealth (as may be seen from the Book of *Llandaff,* a mediaeval inventory of its land), but after the reign of Henry VIII it became impoverished, and its Early English cathedral was left to decay. In the 18th century a new church, in debased Italian style, was built amid the ruins. This was demolished and the old cathedral restored in the mid-19th century, the chancel arch of Bishop Urban's building, erected in 1120 being incorporated. The restored cathedral was, however, badly damaged in an air raid on Cardiff in 1941, when St. Michael's Theological college, removed to Llandaff from Aberdare in 1907, also suffered. The palace or castle built by Urban was destroyed about 1402, after which Mathern near Chepstow became the episcopal residence until about 1690, when it fell into decay. leaving the diocese without a residence until Llandaff court was acquired during Bishop Alfred Ollivant's time (1849–82). Of the old palace only the gatehouse remains. Money bequeathed by Thomas Howell, a merchant, who died in Spain in 1540, maintains an intermediate school for girls, managed by the Drapers' company, Howell's trustees. Llandaff diocese, one of the six dioceses of the church in Wales, embraces a substantial portion of Glamorgan.

LLANDOVERY, a market town and municipal borough in the Carmarthen parliamentary division of Carmarthenshire, Wales, 27 mi. E.N.E. of Carmarthen by road. Pop. (1951) 1,857. Area 1.9 sq.mi. The place probably owes its Welsh name of *Llan-ym-*ddyfri (ddyveri), "the church amid the waters," to the proximity of Llandingat parish church to the streams of the Towy, Bran and Gwydderig. Llandovery stands on the site of a Roman fort, probably called Alabum. Being at the head of the fertile vale of Towy, it was a strategic site in the middle ages. The 12th-century castle frequently changed hands and was partly burned by Gmffydd ap Rhys (d. 1137). In 1485 Llandovery was incorporated by a charter from Richard III, a privilege confirmed by Henry VIII and by Elizabeth I whose charter is still held by the corporation. In the 17th century the vicarage of Llandingat was held by the celebrated Vicar Rhys Prichard (1579–1644), whose book *Canwyll* y Cymry *(The* Welshman's Candle), a collection of religious poems written in colloquial Welsh, was the most famous book produced during the Renaissance in Wales. In the early 19th century Llandovery was known for its printing press, which has published many books on Wales. Thomas Phillips founded Llandovery college in 1848, and there Welsh boys are able to study their native language and literature. Llandovery is a market, fair and cattle mart centre.

LLANDRINDOD WELLS, an urban district in the Brecon and Radnor parliamentary division of Radnorshire, Wales, 21 mi. N.W. of Hereford by road. Pop. (1951) 3,212. Area 2.4 sq.mi. It is the seat of county administration. Situated in a lovely setting to the east of the Wye river, about 700-ft. above sea level, it is a health and holiday resort with trout, salmon and other fishing, and a golf course. As early as 1696 it became known for its mineral springs, and is affiliated to the British Spas federation. About 2 mi. N. is the Roman fort of Castell Collen.

LLANDUDNO, a seaside town and urban district in the Conway parliamentary division of Caernarvonshire, Wales, 47 mi. W.N.W. of Chester by road. Pop. (1951) 16,715. Area 7.7 sq.mi. It lies between the limestone headlands of Great Orme (northwest) and Little Orme (east), on a peninsula formed by the Irish sea and the Conway river, and has two sandy shores. On Great Orme are prehistoric sites, including a camp and a burial chamber; copper mines, now disused, that were worked by the Romans; and the old parish church of St. Tudno, believed to occupy the site of an oratory erected by its patron saint in the 7th century. Llandudno has grown from a village into a health and holiday town with two golf courses, Alpine displays in the Happy valley, magnificent views from a marine drive encircling the Orme, and steamers operating from Llandudno pier to Liverpool, the Isle of Man and Anglesey in the summer.

Lewis Carroll frequently visited Dean Liddell and his daughter Alice at their residence in the town and a memorial to him stands on the west shore.

LLANELLY, a seaport and municipal borough in the Llanelly parliamentary division of Carmarthenshire, Wales, on the Lliedi, 19 mi. S.S.E. of Carmarthen by road. Pop. (1951) 34,476. Area 3.2 sq.mi. The town derives its name from the dedication of the parish church to the Celtic saint Elliw or Elli. With the beginning of the Industrial Revolution Llanelly became important for its lead smelting works, shipbuilding and flannel industries. In 1804 copper works were established but gradually the old industries were superseded by the manufacture of tinplate. The first tinworks opened in 1847 and others followed in 1852–53, until, in 1888, 92 mills were in operation. This industry declined when the Ebbw Vale strip mill was set up, and the town became a colliery centre and collecting ground for the anthracite from the Gwendraeth valley. Secondary industries, including potteries, iron foundries and chemical works, also grew up. The tinplate industry was revived in the mid-20th century by the opening of a cold reduction plant at Trostre, on the outskirts of Llanelly, to work with the huge Margam strip mills in Glamorgan. Other steelworks have also been built. In 1955 the Towy water scheme was opened. The port, which exported many tons of coal in the 19th century, ceased operating for trading purposes in 1951, but the north dock was let to the admiralty for the laying up of reserve fleet vessels.

Llanelly was a borough by prescription in the old lordship of Kidwelly; by royal charter granted by George V, it was incorporated in 1913. In the same year its first mayor presented Parc Howard to the town, the grounds of uhich are used for recreation and the house for a museum, art gallery and tearooms. The town also has a mining and technical institute, a junior technical school and a school of art. There are two miles of sands along the shore.

LLANGOLLEN, a market town and urban district in the Denbigh parliamentary division of Denbighshire, Wales, 23 mi. S.W. of Chester by road. Pop. (1951) 3,274. Area 4.9 sq.mi. Lying in the green Vale of Llangollen, on the Welsh Dee, there crossed by a 14th-century bridge, the town is much visited in the summer. Coracles are still used on the river, which contains trout and salmon. The scanty remains of Castell Dinas Bran, built early in the 13th century, stand on a hill about 1,000-ft. above sea level. At Plas Newydd, a black and white house now owned by the council, lived the "Ladies of Llangollen," Lady Eleanor Butler (d. 1829) and Sarah Ponsonby (d. 1831), eccentric Irishwomen who entertained Thomas de Quincey, Sir Walter Scott and William Wordsworth. The Llangollen International Musical Eisteddfod, instituted in 1947, is annually held in July. The ruins of the Cistercian abbey of Valle Crucis, founded c. 1200, lie 1½ mi. N.W. There are brewers, tanners and sheet-metal workers in the town.

LLANIDLOES, a market town and municipal borough in the Montgomery parliamentary division of Montgomeryshire, Wales, in the Severn valley, 30 mi. E. of Aberystwyth by road. Pop. (1951) 2,341. Area 1 sq.mi. The parish church of St. Idloes (a 7th-century saint) has a 14th-century tower capped with a wooden belfry of Welsh border type, and a fine early 13th-century arcade, transferred from Cwmhir abbey (Radnorshire] in 1542. The town grew up under the protection of its motte and bailey castle, and in 1280 Owen of Arwystli, prince of Powys, obtained a charter establishing the fairs and Saturday markets of Llanidloes.

Full civic privileges, granted about 1300, are still retained. The half-timbered market hall, standing on oaken legs at the town centre, is the only surviving example in Wales. It still possesses its ancient curfew bell. From 1933 it has housed a museum of local history and industry. Flannel weaving and lead mining flourished in the 19th century but after 1918 both industries declined and are now extinct. The present interests of the town are mainly agricultural but there is a foundry (established 1850), and a tannery for sheep and goatskin leathers (1908). There is a weekly market and a monthly fair. A new cattle market was opened in 1955. Llanidloes was an active centre of Chartism, and for five days was in the hands of the rebels when the weavers rose in arms in 1839. The eastern slopes of Plynlimon, 10 mi. E., are now part of the vast Hafren forest, covering several thousand acres.

LLANO ESTACADO (STAKED PLAINS), a portion of the high plains of the United States covering an area of approximately 30,000 sq.mi. in western Texas and eastern New Mexico; the northern half is known as the Panhandle. The "break of the plains" bounds the area on the east; the Mescalero ridge overlooking the Pecos valley is the western margin; the Canadian river valley is at the northern edge; while in the south the region grades imperceptibly into the Edwards plateau. The present surface is composed of a mantle of silts, sands and gravels. Porosity of surface materials, levelness of terrain and semiaridity have combined to eliminate nearly all water erosion. The flatness of the surface is striking. Locally, small saucerlike depressions, varying in diameter from a few feet to almost a mile, and in depth from a few inches to several tens of feet, partially break the surface monotony. These hollows retain water for a short time after rains and a few contain permanent though varying amounts of water.

Soils of high inherent fertility have evolved in the region, but their usefulness is restricted by meagre rainfall, high evaporation rates and periodic droughts. Blistering summers are succeeded by cool uinters, strong winds are omnipresent, and weather extremes are commonplace. "Short grass," largely grama and buffalo grass, cloaks the uncultivated portions of the region.

Extensive grazing, dry-land farming of wheat and grain sorghums, localized irrigated cotton production, and the pumping of natural gas and petroleum are the principal economic pursuits of the area. Lubbock and Amarillo, Tex. (*qq.v.*), are the most important cities of the region, but a less than salubrious climate, monotonous landscape and isolation combine to restrict population densities.

See also TEXAS: Physical Features; UNITED STATES (OF AMERICA): *Physiography*: Interior Plains. (A. H. DR.)

LLANOS, Spanish American name for the vast plains or prairies of northern South America, extending from the Atlantic ocean to the Andes, and bounded by the coastal ranges in the north and by the Orinoco river (*q.v.*) and its Guaviare tributary on the south. The region which covers about 125,000 sq.mi. in Venezuela and 100,000 sq.mi. in eastern Colombia, has a hot climate, supports little wild life and is sparsely populated.

The plains slope gently from a few hundred feet elevation at the base of the mountains toward the Orinoco and are broken here and there by low mesas. Many tributaries of the Orinoco drain the plains and flow in relatively straight courses. The largest of these are the Apure river (*q.v.*), the Arauca and the Meta, which rise in the far western part of the llanos.

The llanos are alternately flooded and dry in response to conditions of weather and terrain. The rainy season begins in May and reaches a peak between June and October when much of the area becomes flooded. The swollen rivers slowly recede during the dry season (December–March) and the land becomes parched and baked, the grass becoming brown and brittle for lack of moisture. Dense forests are confined to the stream courses and near the base of the mountains. The typical vegetation is tall, coarse grass with some dry, scrubby forests and scattered palms. Soils are chiefly infertile laterites, though fertile alluvial soils are fairly extensive.

Cattle were introduced into the llanos in 1548 and have been the mainstay since colonial days. The plains are Venezuela's most important stockbreeding region, accounting for two-thirds of the nation's cattle. Although plagues of insects make life difficult and herds must be driven to higher land during flood, several million head range widely in a region where fences are rare. Because of distance, much of the beef is shipped by air from such centres as San Fernando de Apure, the largest town in the central llanos, to Caracas. Irrigated agriculture has been developed in several places in the upper llanos since the eradication of malaria and the construction of large dams.

The *llanero*, the tough, hard-riding herdsmen and skilled horseman of the plains, played an important role during the Venezuelan war of independence and has been an ardent supporter of successive revolutionary caudillos. See also VENEZUELA and COLOMBIA. (D. R. D.)

LLANQUIHUE, province of southern Chile bordering the northern shores of Ancud gulf, bounded on the north by Osorno province, and extending from the Pacific to Argentina. Area 7,107 sq.mi. Pop. (1952) 139,986. The western half of Llanquihue is a rolling country of forests and pastoral and farm land; the east is a rough, volcano-studded, cordilleran landscape of deep glaciated valleys, lakes and virgin forest. It is noted for sports fishing. Chile's largest lake, Llanquihue (marginal to the mountains) and Lake Todos los Santos mark a scenic trans-Andean route to Argentina which draws sizable summer tourist traffic to Puerto Varas, Ensenada, Petrohué and Peulla. The provincial capital, Puerto Montt (*q.v.*) pop. (1952) 28,944, affords road access to the scenic southern coast line of the province and air and water service to island and mainland points extending from the Gulf of Ancud to Punta Arenas (*q.v.*). Rail, air, road and sea communications are available to Santiago-Valparaiso. Summers are comfortable; winters are cool and very wet.

The province was formed in 1937 by dismembering Chiloé province. Less than 15% of its area is considered arable but about 50% of its gainfully employed people are in agriculture. Beef, dairy products, potatoes, wheat, fruit and wool are important. The increasing significance of sugar beets results from the construction of a beet sugar factory at Llanquihue in 1958. Lumbering, farm product processing, tourism, shipbuilding, fishing and the canning of seafood support large segments of the population. Since 1853 German pioneers and their descendants have played an important economic role. (J. T.)

LLANTWIT MAJOR (Welsh, *Llanilltyd Fawr*), a small town in the Cowbridge rural district of Glamorganshire, Wales, 1 mi. from the coast and 19 mi. W.S.W. of Cardiff by road. Pop. of civil parish (1951) 2,892. Weapons and implements of the Bronze Age were discovered in a tumulus in the town. Castle Ditches, a triple line of earthworks, commands the entrance to the creek of Colhugh, once the port of Llantwit. At Caermead (1 mi. N.N.W.) there were discovered in 1888 the remains of a large Roman villa. Llantwit Major castle, now a ruin, was scheduled as an ancient monument.

The town derives its name from St. Illtyd or Iltutus (c. 520), a native of Brittany who, having come under the influence of St. Cadoc, abbot of Llancarfan (6 mi. E.N.E.), established at Llantwit a monastic college which became a famous seat of learning and was associated with the Celtic saint movement in Wales. SS. Samson, Paul Aurelian and Gildas, the historian, are said to have been educated there. The monastery later became a cell of Tewkesbury abbey and was finally destroyed at the Dissolution, the only remains being the gatehouse and the dovehouse. The present church of St. Illtyd is the result of a sequence of buildings dating from the time of its foundation in the 12th century until the 15th century. It is now divided into the Old church and the New church; the old (western) part, thought to have been the parish church, contains a collection of Celtic crosses, effigies, etc., and the New, probably the monks' chapel, has a Jesse rod niche and is used as the parish church. The ruined chantry was finally destroyed by German action in 1940. The toun hall is Tudor. Llantwit lies in a fertile district and its people depend to some extent upon agriculture, but the greater proportion is employed at nearby royal air force stations.

About 2½ mi. W. is St. Donats castle, which has been inhabited continuously since the early 13th century.

LLEWELYN, the name of two Welsh princes.

LLEWELYN I, AP IORWERTH (d. 1240), prince of north Wales, was born after the expulsion of his father, Ionverth, from the principality. In 1194, Llewelyn recovered the paternal inheritance and by 1201 was the greatest prince in Wales. At first he was a friend of King John, whose illegitimate daughter, Joanna, he married (1201); but the alliance soon fell through, and in 1211 John reduced Llewelyn to submission. In the next year Llewelyn recovered all his losses in north Wales. In 1215 he took Shrewsbury. His rising had been encouraged by the pope, by France and by the English barons. His rights were secured by special clauses in the Magna Carta. But he never desisted from his wars with the Marchers of south Wales, and in the early years of Henry III he was several times attacked by English armies. In 1234, however, a truce was concluded at Middle. In 1239 Llewelyn retired into a Cistercian monastery.

LLEWELYN II, AP GRUFFYDD (d. 1282), prince of north Wales, succeeded his uncle David in 1246, but was compelled by Henry III to confine himself to Snowdon and Anglesey. In 1254 Henry granted Prince Edward the royal lands in Wales. The steady encroachment of royal officers on Llewelyn's land began immediately, and in 1256 Llewelyn declared war. The Baron's War engaged all the forces of England, and he was able to make himself lord of south and north Wales. Llewelyn also assisted the barons. By the treaty of Shrewsbury (or Montgomery; 1267) he was recognized as overlord of Wales; and in return Simon de Montfort was supplied with Welsh troops for his last campaign. Llewelyn refused to do homage to Edward I, who therefore attacked him in 1277. He was besieged in the Snowdon mountains until hunger made him surrender and conclude the humiliating treaty of Conway (1277). He was released, but in 1282 he revolted again, and was killed in a skirmish with the Mortimers, near Builth in central Wales.

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LLOYD, MARIE (1870–1922), English music-hall artist, who may be said without exaggeration to have been the incarnation of the London or cockney genius for low comedy, which grew to its height in the 19th century. She was born in Feb. 12, 1870. the daughter of John and Matilda Wood. She first appeared at the Eagle music hall in 1885 under the stage name of Bella Delmore. Six weeks later she adopted the stage name of Marie Lloyd, which she retained. She was responsible for a series of music-hall entertainments, songs, sketches, etc., which placed her in the front rank among artistes of her day. She introduced to the British public a series of studies in cockney humour, *e.g.,* "Everything in the garden's lovely," "Oh, Mr. Porter, whatever shall I do" and "One of the Ruins that Cromwell knocked about a bit." She was married (1) to Percy Courtney, (2) to Alec Hurley, a singer of coster songs (d. 1913), and (3) to Bernard Dillon, a jockey. She died on Oct. 7, 1922. (E. I. J.)

.**LLOYD, WILLIAM** (1627–1717), English clergyman, successively bishop of St. Asaph (1680), of Lichfield and Coventry (1692), and of Worcester (1699), was born at Tilehurst, Berks., and was educated at Oriel and Jesus colleges, Oxford. Lloyd was an indefatigable opponent of the Roman Catholic tendencies of James II, and was one of the seven bishops who were arrested and tried for refusing to have the Declaration of Indulgence read in their dioceses. Lloyd was a stanch supporter of the revolution. His chief publication was *An Historical Account of Church Government as it was in Great Britain and Ireland when they first received the Christian Religion* (London, 1684, reprinted Oxford, 1842). He died at Hartlebury castle on Aug. 30, 1717.

LLOYD GEORGE OF DWYFOR, DAVID LLOYD GEORGE, 1ST EARL (1863–1945), British statesman who led his country to victory in World War I, was born at Manchester on Jan. 17, 1863. His father, William George, died about two years after David's birth, leaving the family in poor circumstances. Mrs. George's brother, Richard Lloyd, a shoemaker at Llanystumdwy, and pastor of the Campbellite Baptists there, became their chief support; it was from him that young David obtained his earliest views of practical and political life, and also the means of starting, at the age of 14, on the career of a solicitor.

Having passed his law preliminary, he was articled to a firm in Portmadoc, and in 1884 obtained his final qualifications. In 1888 he married Margaret, daughter of Richard Owen of Criccieth. From the first he managed to combine his solicitor's work with politics, becoming secretary of the South Caernarvonshire Anti-tithe league; and his local reputation was made by a successful fight, carried to the high court, in defense of the right of Nonconformists to burial in the parish churchyard. In the first county council elections for Caernarvonshire he played a strenuous part on the Radical side, and was chosen an alderman; and in 1890, at a by-election for Caernarvon Boroughs, he was returned to parliament by a majority of 18 over a strong Conservative opponent. He held his seat successfully at the contests in 1892 and 1895, his reputation as a champion of Welsh nationalism, Welsh nonconformity and extreme radicalism becoming thoroughly established. In the house of commons he was a prominent guerrilla fighter, conspicuous for his audacity and pungency of utterance, and his capacity for obstruction while the Conservatives were in office. During the South African War he was specially vehement in opposition to Joseph Chamberlain, and took the "pro-Boer" side so fiercely that he was mobbed in Birmingham at the end of 1901 when he attempted to address a meeting at the town hall. But he had already been again returned for Caernarvon Boroughs in the election of 1900 and in the ensuing parliament he came still more to the front by his resistance to the Education act of 1902.

As the leader of the Welsh party, and one of the most dashing parliamentarians on the Radical side, his appointment to office when Sir Henry Campbell-Bannerman became premier at the end of 1905 was generally expected; but his elevation direct to the cabinet as president of the board of trade was somewhat of a surprise. His settlement of the railway dispute in 1906 was universally applauded; and the bills he introduced and passed for reorganizing the port of London, dealing with merchant shipping, and enforcing the working in England of patents granted there, and so increasing the employment of British labour, were greeted with satisfaction by the tariff reformers, who congratulated themselves that a Radical free trader should thus throw over the policy of *laissez faire.* The president of the board of trade was the chief success of the ministry, and when H. H. Asquith became premier in 1908 and promoted Lloyd George to the chancellorship of the exchequer, the appointment was well received even in the City of London. For that year the budget was already settled, and it was introduced by Asquith himself, the ex-chancellor; but the provision of the finance for old-age pensions was left to Lloyd George. The money was raised by the new taxation provided for in the budget of 1909–10.

Chancellor of the Exchequer. *The Budget Struggle, 1909–1910.*—For 1909–1910 a considerable deficit, of about £16,000,000, was in prospect. Lloyd George and Winston Churchill were conspicuously in alliance in advocating the use of the budget for introducing drastic reforms in regard to licensing and land, which the resistance of the house of lords prevented the Radical party from effectingby ordinary legislation. When Lloyd George, on April 29, introduced his budget, its trenchant character, however, created widespread dismay in the City and among the propertied classes. In a lengthy speech, which had to be interrupted for half an hour while he recovered his voice, he ended by describing it as a "war budget" against poverty, which he hoped, in the result, would become "as remote to the people of this country as the wolves which once infested its forests." The excitement over the budget entirely monopolized public attention for the year, and while the measure was defended by Lloyd George in parliament with much suavity and by Asquith, Sir Edward Grey and R. B. Haldane outside the house of commons with tact and moderation, the feelings of its opponents were exasperated by a series of denunciatory public speeches at Limehouse and elsewhere from the chancellor of the exchequer, who kindled the passions of the working classes against the landed classes and the peers. When the Finance bill went up to the house of lords, Lord Lansdowne gave notice that on the second reading he would move "that this House is not justified in giving its consent to this bill until it has been submitted to the judgment of the country," and on Nov. 30 this motion was carried by an overwhelming majority of peers. The government passed a solemn resolution of protest in the house of commons and appealed to the country; and the general election of Jan. 1910 took place amid unexampled excitement. The Unionists gained 100 seats over their previous numbers, but the constitutional issue undoubtedly helped the government to victory, won indeed the votes of the labour members and Irish nationalists.

Events had now made Lloyd George and his financial policy the centre of the Liberal party program, but party tactics for the moment prevented the ministry, which remained in office, from simply sending the budget up again to the lords and allowing them to pass it. There was no majority in the commons for the budget as such, since the Irish nationalists only supported it as an engine for destroying the veto of the lords and thus preparing the way for Irish Home Rule. Instead, therefore. of proceeding with the budget, the government allowed the financial year to end without one, and brought forward resolutions for curtailing the powers of the lords, on which, if rejected by them, another appeal could be made to the people. (See PARLIAMENT.) Hardly, however, had the battle been arrayed when the king's death in May upset all calculations. A conference was arranged between four leaders from each side—Lloyd George being one—to consider whether compromise on the constitutional question was not feasible. The budget for 1909–10 went quietly through, and the chancellor introduced his budget for 1910–11 which left matters precisely as they were.

The 1910 conference of British party leaders lasted from June until November. The conferring leaders nearly arrived at a comprehensive and far-reaching scheme of agreement, affecting all the disputed issues—the house of lords, Home Rule, tariffs and conscription. But the six months of secrecy ended in detaching the leaders from their followers. While the leaders had passed into a mood of conciliation, the followers were still living in an atmosphere of party warfare. On both sides the proposals put forward were regarded as surrenders. Lloyd George was ready to come to bold settlements if they would save the country from civil strife. He and A. J. Balfour agreed in this attitude, but party tides still ran too strong.

National Insurance.—In Dec. there took place the second of the two 1910 general elections. The Liberal government had refused to go to the polls until they obtained the promise of the king that, if they were successful, he would consent to employ his prerogative of peer making in order to carry the parliament bill. That promise was reluctantly given by King George V. Lloyd George was returned for Caernarvon Boroughs for the seventh time with an enhanced majority (1,208). But a second national campaign within one year proved too much for his strength, and he was stricken by serious throat trouble for some months. During this compulsory retirement he prepared the National Insurance bill of 1911. This was the first of a series of measures for improving the condition of the British working class by the method of social insurance. The idea was first applied by Otto Bismarck, and Lloyd George had made a study of the German insurance system during a holiday visit to central Europe in autumn, 1908. Old-age pensions had been already passed into law; and thus it was that the British system of old-age pensions originally took a noncontributory form.

Lloyd George applied the contributory insurance principle first to invalids and the sick, and the proposal produced a formidable social and political crisis in the autumn of 1911. Lloyd George was proposing a new habit to the British people, and at the first shock it was profoundly unpopular. All classes rose against it. There followed a succession of political revolts; and it seemed as if the combination of forces—of the Conservatives, the press and the public—opposed to the bill would be sufficient to swamp it. By-election after by-election was lost by the Liberal government. The party managers were in favour of postponement; but Lloyd George held on. He eased the passage of the bill by a series of conferences with all the disturbed parties, and achieved its third reading early in Dec. 1911. He followed it with an Unemployment Insurance bill which was extended in subsequent years over the whole working class.

Land Reform.—In 1912 Lloyd George approached the reform of the English land system by way of a land committee. He sketched the main lines of his policy in a series of speeches throughout 1912 and 1913. But just as he approached this venture his way was barred by two events—one personal and the other national. The first was known as the "Marconi affair," which produced a grave crisis in Lloyd George's career. He had been persuaded by his friend Sir Rufus Isaacs (later Lord Reading) to take £2,000 worth of shares in the American branch of the great Marconi company at a moment when the British post office was discussing the terms of a contract with the British company. The two companies were legally separate, but their fortunes were closely linked. Such a speculation on the part of a chancellor of the exchequer was at best highly imprudent, and the affair became the subject of an inquiry by a committee of the house of commons. Lloyd George and Isaacs were acquitted of all blame by the Liberal majority but censured by the Conservative minority. The majority report was accepted by the house but the episode undoubtedly damaged Lloyd George's prestige for the time being.

Already overshadowed by these events, the land proposals were now effectively blocked by the far greater crisis of Irish civil war. Ulster, organized by Sir Edward Carson (later Lord Carson), threatened an alarmed defiance of the government. This defiance had its first effect in the revolt of the officers at the Curragh against the orders issued for carrying out the prospective Home Rule policy. Faced with the possibility of a military revolt both at the Curragh and at Aldershot, Lloyd George devoted all his energies to preserving civil peace. But at this moment, at the heart of this Irish crisis, there came the vaster and more momentous challenge of World War I.

The Outbreak of War.—Lord Grey of Fallodon in his memoir, Twenty-Five Years, *1892–1916* (1925), gives a vivid account of the state of division that prevailed in the Liberal cabinet in the fortnight before the outbreak of war. During that period the attitude of Lloyd George was deeply affected by his position as chancellor of the exchequer. On Aug. 1, 1914, the governor of the Bank of England headed a deputation to No. 11 Downing street, urging the policy of neutrality upon the government. On Monday, Aug. 3, when the Germans invaded Belgium, he telephoned to Downing street withdrawing the opposition of the City, and declaring that they were now in favour of war. This change of opinion in the City was highly dramatic, but it reflected the attitude of the chancellor of the exchequer. Lloyd George at first was not in favour of Great Britain's being drawn into a contest between the two great warring groups of Europe unless some British interest or some British obligation were clearly involved. Accordingly during the previous week he did not take up the decisive attitude against Germany which he had adopted in 1911, when he held the view that the claim of Germany to go to war with France over Morocco clearly involved a British guarantee (under the Entente). Once Belgium was invaded, however, and the neutrality treaty of 1839 defied, all hesitation left him. Thus it was that Lloyd George entered upon a new phase of his career—that of war statesman.

The first great civilian duty of the war fell on Lloyd George. As chancellor of the exchequer, he had to secure the finances of the country. He called together the governors of the leading banks and arranged a moratorium which prevented a panic. All the gloomy forecasts of the breakdown of finance by the opponents of the war were dissolved into thin air. During the first ten months of the war he remained chancellor of the exchequer; and thus on him fell the main financial responsibility. All parties were agreed that he placed British finance on an impregnable foundation.

Minister of **Munitions.**—The insufficient supply of shells and guns at the front was exposing British armies to an intolerable inequality of loss. This fact, together with a major crisis in the admiralty broke up the Liberal government, May 19, 1915, and substituted for it the first coalition administration, of Asquith and Bonar Law. The government was entirely reconstituted. Perhaps the most important change was the creation of a ministry of munitions—offered to and accepted by Lloyd George. This ministry was boldly entrusted with the whole function of providing war armaments, hitherto part and parcel of the duties of the war office. The new enterprise was rather a national movement than an ordinary office of state. The government workshops at Woolwich and elsewhere had been modelled to supply arms for a small peace army. Now that Lord Kitchener was calling forth from the nation an army of 2,000,000 there had to be a corresponding effort to supply them with weapons. In order to achieve this, Lloyd George put forth all his powers as a stimulating orator and organizer. He first called on the private armament firms to make a new and gigantic combined effort. But this was not enough. He was compelled to create a vast network of new factories and workshops, and to rally a huge army of workers, both men and women.

It was one thing to raise so gigantic an army. It was another thing to apply it to its full use and value. On all these questions Lloyd George in 1915–16 held vigorous views. He was not content to confine himself to the function of creating guns and shells. In the beginning of 1915 he began to pour out to the cabinet a succession of memoranda, in which he endeavoured to put before them the full seriousness of the military situation following upon the collapse of the Russian attack in the spring and summer of 1915.

The policy and strategy laid before the cabinet in the Lloyd George memoranda in the year 1915 were never fully adopted. In the language of the time, the cabinet was divided between westerners and easterners—those who looked for a decision only on the western front, and those who believed that victory could be quickened by transferring part of the British effort to the near east. The division ended in a compromise which resulted in the expedition to Salonika. But Lloyd George aimed at something far larger—nothing less than a considerable diversion of armies from the west to the east of Europe. He proposed and contemplated the diversion of an army of at least 1,000,000 from the western to the eastern front. With the development of the German submarine warfare Lloyd George's eastern idea became less and less practicable; and with the increase of the German armies the danger of a German breakthrough in the west finally held the Eritish armies to their task. But in early 1915 these facts had not been fully disclosed.

War Office.—As 1915 advanced, Lloyd George's general discontent with the conduct of the war grew stronger. It extended to home as well as foreign policy. The war required a continual supply of vast armies. Such armies, Lloyd George now began to perceive, could not be secured by the voluntary principle alone. He became a vehement advocate of conscription in the autumn of 1915. But Liberal sentiment was against it, and Asquith hesitated. At last Lloyd George swung the cabinet into conscription; and only one minister—Sir John Simon—resigned. Everything possible had now been done to supply the generals both with men and with munitions. But the question of policy remained, and there Lloyd George's discontent continued to grow. The tragic death of Kitchener by the sinking of the cruiser H.M.S. "Hampshire" on June 5, 1916, created a vacancy at the war office to which Asquith, not without some misgivings, decided to appoint Lloyd George. In this new position of power he obtained a firmer grip on the military machine at the front, and in particular he carried out a drastic reform of communications in France.

From these lesser tasks his mind mas diverted to the main issue of victory or defeat by the tremendous tragedy that befell the Allied cause in the autumn of 1916. Rumania, tempted by Russia into the war on the side of the Allies at an unseasonable moment, was violently attacked by Gen. A. von Mackensen and dramatically crushed before the eyes of the distant and helpless Allies. In vain Lloyd George appealed to the cabinet to make some effort to save Rumania. Italy had entered the war in the previous year, and the Russian armies were still in being—could nothing be done? Nothing was done; and for the moment Rumania was blotted out. But the event had a profound effect on the mind of Lloyd George. He was convinced that the war was being mishandled and on Dec. 1, 1916, he formally put his views before Asquith.

Collapse of the Asquith Government.—His main contention was that so large a war committee as then existed could not conduct the war to victory. He proposed a smaller and more efficient body of three or four men, solely devoted to this one object of winning the war. What was wanted was unified and unsleeping control. But he proposed—and here was the crux of the political situation—that the existing prime minister should not be chairman of the committee. That was where the dividing line came. For frankly and definitely Lloyd George had ceased to believe in Asquith as war leader. Asquith's pride was touched to the quick; and it was quite clear that he profoundly resented the proposal, although he himself had first named Lloyd George as chairman of the new war committee. On Dec. 2, Lloyd George was under the impression this his proposal had been accepted. But friends intervened on both sides: the Northcliffe press in favour of Lloyd George, and Asquith's friends in favour of a chief whose loyalty had always commanded a fit return of personal devotion. On Dec. 4, 1916 the Times published a leading article displaying exultation over Asquith's defeat, and immediately Asquith wrote to Lloyd George breaking off the agreement. In the afternoon of that day Asquith resigned office. He received authority from the king to form a new ministry. He wrote to Lloyd George asking him to join on condition that he—Asquith—as prime minister should be chairman of the new war committee. Lloyd George refused that condition and placed his office at Asquith's disposal.

Already, on Dec. 3, the Conservative rank and file had met. They had decided at first against following Lloyd George, whereupon Bonar Law had emphatically said that, in that case, they could not count on his leadership. He and his friends refused to join the new ministry and so Asquith's efforts to reform his coalition without Lloyd George broke down. The king then sent for Bonar Law. But as some of the Liberals and the Labour party refused to support him, he too failed to form a government, although Lloyd George offered to serve under him. The king then called a conference at Buckingham palace and tried to form a new coalition ministry under Bonar Law, with the offer of the woolsack to Asquith. Asquith refused. Thereupon the king sent for Lloyd George, as he was clearly the only possible premier.

PRIME MINISTER

The **New War** Policy.—Lloyd George attempted to rally all parties behind him. He succeeded with the Conservatives and the Labour party, and a certain number of Liberals. But the bulk of the Liberal ex-ministers stood aside and began to form a group known as the Independent Liberal party. Lloyd George was now in sole command of his own war policy. The small war cabinet which he instantly appointed fully carried out the hopes of its founders. It sat from day to day, and often twice a day. Records were kept of its meetings, and Lloyd George formed a small Downing street secretariat in order to keep in close touch with the various ministries. The result was a general quickening up of war decisions and a more decisive control of the whole machine of government.

During 1917 Lloyd George pressed forward his idea of unified command of the Allied armies. He was now completely convinced that the war could only be won if fhe Allies were to face Germany with the same concentrated authority that Germany had established over its own partners. He was faced, ho ever, with a steady resistance from the high military command, whose leading figures, Sir Douglas Haig and Sir William Robertson, he profoundly mistrusted.

On Oct. 24, 1917, an event finally decided him to force the matter of unified control to a decision. On that day the Austro-German armies under Karl von Bulow broke through the lines of the Italian armies and drove them back to the line of the Tagliamento with the loss of 300,000 men and 2,000 guns. Italy stood for the moment in peril of a defeat equal to that of Serbia and Rumania in the preceding years. Lloyd George was determined that this defeat should not take place. He compelled the western commands to send an army of infantry and artillery, English and French, under Gen. H. C. Plumer through the Mont Cenis tunnel to northern Italy, which arrived in the nick of time.

The End of the War.—Having achieved this task, Lloyd George, with characteristic swiftness, determined to press on with the matter of unified control. On his journey back to England he stopped in Paris on Nov. 12, 1917, to make a speech in which he plainly announced that divided control meant defeat. In Feb. 1918 Lloyd George dismissed Robertson, who as chief of the imperial general staff had steadily resisted his plans, and replaced him with Sir Henry Wilson. During the winter the Germans brought across Europe a fresh army of 2,000,000 men released by the collapse of Russia after the Bolshevik revolution of Nov. 1917, and the first blow fell on March 21, when 40 German divisions attacked and broke through the British line west of St. Quentin. On rhe following days the British line withdrew 15 mi., and the military struggle that followed lasted five months. Lloyd George was indomitable in this supreme crisis and met it by two principal steps. One was the assertion of full unity of control, and the other was the bringing over of the U.S. armies.

Pres. Woodrow Wilson had not contemplated sending his armies to Europe until they were fully trained. In that case the U.S. armies would be too late. Lloyd George therefore made a definite appeal to President Wilson to send all he could immediately. No fewer than 2,000,000 U.S. soldiers were carried across the Atlantic, in spite of the submarines. during April and May 1918. But mere numbers were still useless without unity. Visiting France in the first week of May 1918, Lloyd George held a decisive combined meeting of the military and civil powers, in which, supported by Lord Milner and Georges Clemenceau, he was at last able to persuade the British generals to accept the supreme command of Marshal Ferdinand Foch. Lloyd George was, however, confronted with one more political crisis. In May Gen. F. B. Maurice, recently dismissed from an important post in the war office, challenged the veracity of certain government statements about manpower on the western front. Underlying this challenge was the old struggle between the westerners and the easterners, and Lloyd George insisted on making the ensuing debate an issue of confidence. He won easily but Asquith and about 100 Liberals voted against him. The tide of battle at last turned on Aug. 8, 1918. Seven great battles were fought after this event, but from August until November the German armies were steadily driven back. Finally, on Nov. 11, came the collapse of the German resistance and the acceptance of armistice terms of defeat by the new German government. "Germany is doomed,)' cried Lloyd George, speaking at the Mansion house on Nov. 9, 1918, and he proved a true prophet. The Allies had won the war.

Victory having been achieved, it now remained to make peace. There were inevitable delays. Lloyd George deemed it necessary first to strengthen his position by an appeal to the country. The effect was an overwhelming victory for Lloyd George, he being returned to power by a majority of 249 over all the independent groups. Nevertheless his political position was precarious. The Liberal party was divided; Asquith and all those who had voted against Lloyd George at the Maurice debate were denied the so-called "Coupon"—the joint letter from Lloyd George and Bonar Law endorsing their support of coalition candidates. Great though Lloyd George's prestige was, he had in reality become the prisoner of the Conservative party which constituted three-quarters of his support in the house.

The first meeting of the Peace conference took place on Jan. 18, 1919, at the Palace of Versailles, and it proved an impressive gathering of the representatives of all the 30 countries which had taken part in the defeat of the central powers. The whole British empire was represented at Paris among the colleagues of Lloyd George.

It soon became obvious that so big an assembly could not really arrive at peace. The Allied negotiators gradually narrowed to an inner council of ten, which was soon reduced to three—Lloyd George, Wilson and Clemenceau. Roughly, the position behind the scenes was that Lloyd George and Wilson worked for a peace of conciliation, while Clemenceau worked for a peace of victory. The French started with a claim to extend their frontier up to the left bank of the Rhine. Wilson and Lloyd George together succeeded in moderating this claim. But they were compelled to hand over the Saar valley for 15 years as part of the compromise. Other compromises took place in regard to Silesia and the Polish corridor. Wilson's contribution to the settlement was the League of Nations covenant. When the crisis came and President Wilson threatened to leave the conference unless the covenant was placed first in the treaty, Lloyd George supported Wilson.

The Treaty of Versailles.—Lloyd George's freedom was much hampered by press attacks from home, and at one moment Lord Northcliffe organized a mandatory telegram from over zoo members of parliament rebuking him for a tendency to weaken on the demands to Germany. Lloyd George returned to London to face his critics in parliament and secured a huge majority. There can be no doubt, however, that these symptoms of discontent at home diminished his authority and weakened his resistance to the military policy of France. At this point, for instance, he agreed (as he found Wilson had already done) to the French claim to occupy the left bank of the Rhine for 15 years, which he had hitherto attempted to limit to a much shorter period. On May 6 a draft of the treaty was completed, and was presented to the German foreign minister. Count Ulrich Brockdorff-Rantzau, on the following day. Germany instantly pleaded for various important modifications. During the six weeks of parley that followed Lloyd George played the part of conciliator. Wilson hardened against Germany, and took the view that he was pledged to the treaty as it stood. On June 22 the national assembly authorized the signing of the treaty, and on June 28 it was signed at Versailles by the German envoys. Lloyd George returned to England and defended the treaty before parliament, which unanimously ratified it on July 3 Shortly after he was awarded the Order of Merit.

Domestic Discontents.—Having made peace abroad, Lloyd George returned to restore peace at home, which was just as much in peril. The long strain of the World War and the terrible losses of men and material had left Great Britain gravely wounded and weakened. A series of industrial struggles began with the London railway strike in Feb. 1919, followed a few weeks later by the first of the coal crises. Lloyd George averted a strike on the coal fields by appointing a royal commission, with Mr. Justice Sankey as chairman which recommended a two-shillings' increase in wage and an immediate adoption of the seven-hours' day. The concessions were granted and a strike was averted. But when the majority of the commission went on to recommend nationalization of the mines, Lloyd George refused to adopt the suggestion. In Oct. 1919 the railwaymen precipitated a national strike; and once more Lloyd George had to play the part of national conciliator. He brought the strike to an end by a compromise settlement fixing wages according to the scale of living.

During the next two years the Lloyd George coalition government passed a series of agreed measures on housing, suffrage and land. But as time went on it became clear that the country was financially more exhausted than had been supposed. The first postwar boom gradually passed into a slump, and there arose from the whole country a cry for economy which expressed itself in an antiwaste campaign of the utmost vigour. By-election after by-election was lost to the government, and the country was swept by financial panic. Lloyd George met it by a drastic measure. He appointed a small committee, with Sir Eric Geddes as chairman, to revise the whole of Britain's national finance. As a result of its sweeping report—the "Geddes axe"—widespread economies were effected in all departments.

Fall of the Ministry.—These measures weakened Lloyd George's Radical support. More serious, a number of factors began to diminish his hold upon the Conservatives. In March 1921 his friend and wartime partner, Bonar Law, resigned on grounds of health. His successor as Conservative leader, Austen Chamberlain, was not so closely in touch with the rank and file of the party, and lacked his predecessor's gift of stating unpalatable truths to the prime minister. Conservative loyalty was strained to the utmost by events in Ireland, where civil war had broken out between the Sinn Fein party and the government, and both sides were responsible for brutal outrages. In June 1921 the government decided to open peace negotiations. and after many months of discussion the famous Irish treaty was signed at midnight on Dec. 6. It conceded dominion status to south Ireland and left Ulster a separate province governed under the provisions of the Government of Ireland act of 1920. Lloyd George was fully supported by his Conservative colleagues in the cabinet, but the majority of the party disliked the settlement, and from then onward a diehard group began to campaign openly for the breakup of the coalition. In the summer of 1922 their discontent was increased by the so-called honours scandal—allegations that Lloyd George had been trafficking in the sale of honours in return for contributions to his own party fund. The truth about these transactions remains obscure, but Lloyd George's reputation suffered permanently. In the autumn of 1922 a grave crisis in foreign policy arose, and the government's well-justified determination to resist a Turkish invasion of Europe (the "Chanak Incident," Sept. 1922) frightened the Conservative party with the danger of renewed war. On Oct. 19, 1922, a meeting of the party at the Carlton club to decide whether to fight the next election as part of a coalition. Bonar Law, emerging from retirement, spoke against the coalition, and was supported by a majority of 261. Lloyd George at once resigned, being succeeded by Bonar Law who gained a conclusive victory over all other parties in the election which followed.

OPPOSITION LEADER

Throughout the vicissitudes of the general elections which followed in the autumns of the following years (1923 and 1924) Lloyd George remained a leader of opposition. He reunited his followers with the independent Liberals after the election of 1922, and devoted his energies to identifying the Liberal party with a policy of economic reconstruction. In 1924 he published *Coal and Power,* which outlined a comprehensive scheme for the more efficient utilization of the natural resources of the country. Nevertheless the reunited Liberal party failed to gain strength and in the general election of 1924 its numbers in the house of commons, controlled by Asquith and Lloyd George, sank to 40 members. Lloyd George continued his active efforts to rouse the country to the need of further domestic reform to meet the home crisis: and in the early autumn of 1925 he issued a big land program which he proceeded to advocate throughout the country.

By the elevation of Asquith to the peerage as the Earl of Oxford and Asquith (1925) Lloyd George succeeded to the Liberal leadership in the house of commons. In Feb. 1926 he carried his land proposals, with few modifications. through a Liberal convention. But the Liberal party still showed no signs of revival in the country. His national and parliamentary position was in strange contrast to the size of his following; and that created a strange diversity of opinion in the forecasts of his future. In May, during the general strike, Lloyd George expressed opinions not in accord with those of Lord Oxford and the other Liberal leaders. His idea was that the government should negotiate with the strike leaders without delay, instead of declining to do so until the strike had been called off. He ridiculed the view that the general strike was aimed at the constitution. A somewhat acrimonious correspondence between him and Lord Oxford followed, and the party, both in and out of the house of commons, was acutely divided upon the question. At last in Oct. 1926, Lord Oxford resigned the Liberal leadership. For a time worse dissensions followed. Lord Grey's small but weighty group reprobated Lloyd George. The latter, however, was soon recognized by almost the whole of Liberalism as the indispensable man and he secured its enthusiastic allegiance. He provided a fighting fund out of the large resources placed under his personal trusteeship by his supporters when prime minister. From the spring of 1927 onward he threw himself with ceaseless energy into the task of stirring up his party throughout the country. An important committee working in the same spirit proposed in the "Yellow Book" an elaborate industrial policy. For some time the by-elections seemed to show signs of a real "Liberal Revival," but at length the Labour party resumed its old rate of progress chiefly at Liberal expense. The position of Lloyd George in the late autumn of 1928 was unprecedented and enigmatical. In the general election of 1929 the Liberal party (*q.v.*) under his leadership returned 59 members.

After the formation of the national government, and the general election of 1931, Lloyd George remained in opposition. but held aloof from party politics. His *War Memoirs* were published in six volumes (1933–36). On Dec. 31, 1944, he was elevated to the peerage as Earl Lloyd George of Dwyfor. He died on March 26, 1945.

Lloyd George's first wife died in 1941 and in 1943 he married Frances Louise Stevenson, who had been his private secretary since 1913. Of the four children of his first marriage, two entered politics. Gwilym (1894–   ) entered parliament as a Liberal in 1922 and as Liberal and Conservative member for Newcastle on Tyne, became home secretary and minister for Welsh affairs in 1954. Megan (1902–   ) was a Liberal member of parliament from 1929 to 1951 and deputy leader of the party, 1949–51, but subsequently joined the Labour party.

CHARACTER AND ACHIEVEMENTS

"What is this glittering whirl at the centre of our public life?" asked one of Lloyd George's many critics. It is not an easy question to answer. His personality is something of an enigma to the historian. It is easy to list his qualities: his eloquence; his extraordinary charm and persuasiveness; his sense of wit and fun; his capacity to see to the heart of problems whose complexity baffled lesser men; his profound sympathy with oppressed classes and races; his genuine hatred of those who abused power, whether that power was based on uealth or caste or military might. But there mas an obverse side to these virtues: his love of devious methods; his remarkable, albeit temporary, gullibility in the face of Hitler and the nazis; the carelessness and want of discretion—some would use severer words—over appointments and honours; the defeatism in World War II, which contrasted so sadly with his earlier courage.

The truth is that Lloyd George, for all his greatness, aroused in many people a profound sense of mistrust. "England, a country subject to fogs and possessing a powerful middle class. needs grave statesmen." wrote Disraeli. Lloyd George, like Disraeli himself, was never a grave statesman. Like Disraeli too he was not even English, and it was in the English middle class, represented in politics by Stanley Baldwin and Neville Chamberlain, that he inspired the acutest misgivings. They were both determined to exclude him from office, and it would be wrong to ascribe his long years in the political wilderness solely to the declining fortunes of the Liberal party. It is perhaps significant of his defects that Lloyd George. though possessing a host of acquaintances and a number of sycophants, never had a really intimate friend. Winston Churchill was the only political personage who habitually addressed him in letters as "My dear David." There was in him a streak of ruthlessness which left little room for the cultivation of personal friendship. Lord Beaverbrook, who knew him well, wrote: "Once he is estranged there is none of that lingering afterglow which makes us still cherish memory and hesitate to strike the sometime companion."

For these and other reasons he was never able to recover the position he had lost in 1922. It was one of the tragedies of the interwar years that in an era not notable for political talent the one man of genius in politics, who might have found some solution for Britain's economic malaise, should have been condemned to remain an impotent spectator on the sidelines. But his earlier achievements make his place in history secure. He laid the foundations of the welfare state. He led Britain to victory in what seemed then the greatest of all wars. For 16 years from 1906 to 1922 he dominated the political scene. In the words of Churchill addressing the house of commons after Lloyd George's death: "When the English history of the first quarter of the twentieth century is written it will be found that the greater part of our fortunes in peace and in war were shaped by this one man." (See also LIBERAL PARTY.)

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LLOYD OF DOLOBRAN, GEORGE AMBROSE LLOYD, 1ST BARON, created 1925 (1879–1941), British politician and administrator, was born on Sept. 19, 1879, at Dolobran, Montgomeryshire, and was educated at Eton and Cambridge. He travelled aidely in Burma, India, Little Tibet, the Himalayas, Egypt, Morocco and Asia Minor. In 1905 he was appointed attaché to the British embassy at Constantinople. During World War I he saw service in Egypt, Gallipoli. Russia, Mesopotamia and with the sherif of Mecca's forces in the Hejaz. gaining the D.S.O. in 1917. He was Conservative M.P. for West Staffordshire from 1910 until 1918, governor of Bombay from 1918 until 1923, and M P. for Eastbourne from 1924 to 1925. From May 192j until 1929 he was high commissioner of Egypt and the Sudan. He was created G.C I.E. in 1918 and G.C.S.I. in 1924. In 1940 he entered the Churchill cabinet as colonial secretary. He was appointed leader of the house of lords shortly before his death Feb. 4, 1941.

LLOYD'S. The corporation of Lloyd's is an old London institution in which all forms of insurance except long-term life and financial guarantee can be effected. Its constitution and methods are unique because the corporation as such does not subscribe policies, the risks being accepted by individuals each signing for a specified sum for which he alone is responsible. Policies can be subscribed only by underwriting members, each of whom has before election to place with the corporation securities to an amount fixed by the committee, in no case less than £5,000 and in most cases much more, the amounts required being proportionate to the business underwritten. The number of underwriting members was more than 3,900 in 1955. Elaborate precautions have been taken to render the security of Lloyd's policy unimpeachable. The liability of each individual is unlimited. Each underwriter's accounts are subjected to an annual audit, when the auditor must certify that the underwriting assets of each underwriter are sufficient to meet his underwriting liabilities calculated in accordance with stringent regulations laid down by the committee.

Lloyd's has for two centuries been a centre for the collection and diffusion of maritime information. At every seaport of any importance and at many inland towns throughout the world Lloyd's agents are established to collect information, to give assistance in casualties and to survey and assess damaged cargo. There were in 1955 approximately 1,joo such agencies and subagencies.

Lloyd's Coffeehouse.—Lloyd's has had a remarkable and indeed a romantic history. A certain Edward Lloyd, the oldest record of whom is in the year 1688, kept a coffeehouse first in Tower street and afterward in Lombard street which, with other similar houses, became the resort of businessmen, some of whom were willing to subscribe policies insuring against sea risks. It thus became convenient for those seeking insurance, instead of going from office to office in search of insurers, to go to a coffeehouse where. instead of only one, several insurers might be found. At this time this was the only means of placing marine risks, but in 1720 charters were granted to the London and the Royal Exchange Assurance corporations, but no other companies or partnerships were allowed to insure marine risks. The grant of these charters was strenuously opposed by private underwriters for it had the effect of conferring a monopoly, but, as the corporations transacted a comparatively small amount of marine insurance, the virtual monopoly thus created became a powerful factor in stimulating the growth of insurance by individuals. As Lloyd's coffeehouse gradually became the centre for such insurance its power and importance developed during the early 18th century. In 1696 Lloyd printed a newssheet called *Lloyd's News* which, however, was soon dropped due to its publication of an erroneous statement of no importance in a report of the proceedings of the house of lords. *Lloyd's News* was not a specialized shipping paper and it was not until 1734 that *Lloyd's List* was established. This was devoted mainly to shipping news and as it has appeared continuously ever since it is the oldest London newspaper excepting the *London Gazette*. In the meantime, Lloyd had died in 1713 but the coffeehouse in Lombard street (on part of the site later occupied by Coutts' bank) was carried on under the same name, a name which has survived all the vicissitudes of the institution which bears it and which has been adopted all over the world as that of a sort of tutelary genius of shipping. It is for example curious to note that several foreign shipping companies bear the name of an English coffeehouse keeper of the 17th century.

In 1774 Lloyd's. under the guidance of John Julius Angerstein, perhaps the most outstanding personality who has appeared in its history, took up its abode in the Royal Exchange where it remained for more than a century and a half during a tenancy broken only by the period of rebuilding after the fire of 1838. In 1928 a new building was opened on the site of the East India house. and in 1952 the foundation stone was laid of another new building. The move to the Royal Exchange in 1774 was signalized by a departure from the status of a proprietary coffeehouse, the "Masters" as they were called becoming tenants at will to the subscribers. The outbreak of the French war in 1793 led to a period of remarkable expansion during which Lloyd's advanced in wealth and importance although the underwriters were at times subjected to losses which strained their resources; in 1794–95 one underwriter, Robert Sheddon, paid out losses of £190,000. During 1793–181j Lloyd's became an institution which exerted a salutary influence on the direction of naval operations in relation to sea-borne trade. It carried an insurance of more than £600,000 on bullion and specie from Veracruz, Mex. It is found constantly influencing the admiralty in regard to convoys. At a time when the state made no provision for war victims, Lloyd's inaugurated many subscriptions for that purpose, culminating in the Patriotic Fund established in 1803, which still existed in 1955 and which received great augmentations during World Wars I and II. Gifts of plate were made to Lord Nelson and to the captains at Trafalgar. A portion of the Nelson plate and a Trafalgar cup designed by John Flaxman later came into the possession of Lloyd's.

In 1811 under the influence of Joseph Marryat, M.P., father of the novelist Frederick Marryat, and himself a man of unusual ability, Lloyd's prepared the may for incorporation by the curious expedient of inducing the subscribers to sign a trust deed vesting the corporate funds in the committee of treasury and imposing bylaws on the subscribers. It was moreover at this period that the system of Lloyd's agencies was initiated, and the duties defined.

Incorporation, 1871.—In 1870 the control of the society over its members was found wanting. This led to the Act of Incorporation (Lloyd's act, 1871) which formed the constitution of Lloyd's as it still existed in 1955. The society was given power to make its own bylaws, to acquire real and personal property, and to do all acts in its corporate name. By the Act of Incorporation the society was restricted to marine insurance but by Lloyd's act, 1911, the power was given to carry on insurance of every description. Although individual initiative is still a most striking characteristic of Lloyd's the powers and activities of the corporate body have increased. The measures designed to make the security of a Lloyd's policy unquestionable were taken almost entirely after the act of 1871. Under the Assurance Companies acts. 1909 and 1946, special provisions are included with which Lloyd's underwriters comply.

There is no more striking illustration of the practical conservatism characteristic of Lloyd's, than the Lloyd's policy of marine insurance. Its germ is found in a Florentine policy of 1523. Its substance goes back to the 17th century. when a common printed form was gradually evolved. One of the first acts of Lloyd's, as a society, was to revise this form, with a view to resisting certain attempted innovations, and the policy, "revised and confirmed" on Jan. 12, 1779, was still in use in 1955, with practically no alterations and only three additions, the "Waiver clause" (1874), the clause excluding war risks (1898) and the "Frustration clause" (1919). In many respects the old form is inadequate to the requirements of modern commerce; but almost every phrase has been judicially interpreted and it is felt that revision would lead to much litigation. Its inadequacy has been rectified by the use of clauses devised to meet the special requirements of each class of insurance, which are printed separately and then affixed to the policy.

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LLOYD'S REGISTER OF SHIPPING, a society for the survey and classification of merchant shipping, which has set the standard for the construction and maintenance of ships throughout the world. While the head office is in London, the society is international in scope. It is governed by the industry it serves, without any element of governmental control, and its revenue is devoted to the furtherance of the objects for which it was established. The society had its origin, like the insurance institution known as the Corporation of Lloyd's (*q.v.*), in the coffeehouse kept by Edward Lloyd in the city of London in the reign of Charles II. For the assistance of underwriters and merchants who frequented the coffeehouse, a list of the ships offered for insurance of hulls and cargo proved useful. These lists became in 1760 a printed volume with a strictly limited circulation. Thus originated the register book and it is interesting to find that by 1775 the familiar A1 was used to denote the highest class of ship.

Differences arose regarding standards of classification, and in 1800 the shipowners published their own book. In 1834 the two registers were united under the name of Lloyd's Register of Shipping, and for the first time standard rules for shipbuilding were issued. In the reconstituted society the management was vested in a committee elected by the merchants, underwriters and shipowners of London, but from time to time representatives were added from shipping centres in the United Kingdom, and of shipbuilders, engineers and steelmakers, so that by 1955 it had more than 100 members. In addition to a strong technical committee which deals with the formulation of rules, there are local committees at Liverpool and in Scotland, and national committees in the United States, Australia and New Zealand, Canada, Denmark, France, the Netherlands, Spain and Sweden.

The register book is published annually in three volumes. The first contains particulars of all known seagoing merchant ships afloat of 100 or more tons gross, while the second and third volumes contain additional information of a technical nature and lists of shipowners, shipbuilders, docks and harbours of the world, etc. Registers of British and American yachts are also published, as well as quarterly and annual statistics regarding ships under construction throughout the world and ship casualties.

The society's main activity is the supervision of the construction of ships and their machinery, from the examination of plans and testing of material, through the various stages of building, up to the trial trip, and the holding of regular periodical surveys throughout the ship's life to ensure that she is fit to retain the society's class. Comprehensive rules providing standards of construction for ships and their propelling, electrical and refrigerating machinery are published by the society, and a staff of 850 surveyors is employed to carry out the highly specialized duties undertaken. These include the calculation and fixing of load lines on behalf of 41 different nations in accordance with the International Load Line convention, 1930, and the issue of safety certificates under the International Convention for the Safety of Life at Sea, 1948. Representatives are stationed at all principal ports and engineering centres throughout the world and the magnitude of the operations of Lloyd's Register may be gathered from the fact that, in 1954, 42% of the world's merchant tonnage was classed with the society, and 65% of the tonnage under construction was intended to receive the society's class.

A relatively new feature of the society's work is the inspection during manufacture and subsequent erection of material for land installations such as oil refineries, electric and atomic power stations, railways and chemical plants. (W. J. FN.)

LLWCHWR, an urban district in the Gower parliamentary division of Glamorgan, Wales, j mi. N.W. of Swansea and bounded on the west by the Loughor river. Pop. (1951) 25,882. Area 27.7 sq.mi. The district comprises four small towns: Gorseinon, the administrative and business centre, with steel and tinplate works; Loughor, the old borough which gives its name to the district and contains the ruins of a 13th- to 14th-century castle. a Perpendicular church and a fine modern bridge; Gowerton, a modern steel town where a "Flannel and Pleasure" fair has been held annually from early times; and Pontardulais, a modern tinplate manufacturing and coal-mining town, possessing the 12th-century church of St. Teilo, isolated on the river plain a little way out of the town. Pontardulais has gained a reputation for its music.

LOACH. The loaches (Cobitidae) are cyprinoid fishes, elongate in form, naked or with very small scales, with three to six pairs of barbels, with the air bladder reduced and wholly or partly enclosed in a bony capsule, and with the pharyngeal teeth in a single series. More than zoo species are known, mostly from mountain streams in central and southern Asia; three species occur in Europe, and one in Abyssinia. They are small fishes, few species attaining a length of 12 in. In low and stagnant ponds, loaches come to the surface and swallow air, the intestine serving as an organ of respiration. The British species, both of which extend through Europe and northern Asia to Japan, are the stone loach (Nemachilus barbatula) and the spined loach (*Cobitis* taenia); the latter has a movable lateral ethmoid, forming a bifid spine, which at rest lies in a groove below the eye.

LOAD LINE. A line (or rather the combination of a circular disk with horizontal line passing through its centre) which is placed on the side of a vessel to indicate the limit of loading when going into the open sea. The disk is 12 in. in diameter, and the upper edge of the line passes through the centre of the disk. The distance between this centre of disk and the edge of the uppermost continuous deck of an ordinary ship at the middle of the length is termed the "freeboard" (*q.v.*). The centre of the disk indicates the appropriate freeboard for the summer season; other lines give the loading for the tropical, winter and winter North Atlantic seasons.

See SHIPPING INDUSTRY.

LOANDA (LUANDA) : see ANGOLA.

LOANGO, a region of the west coast of Africa, extending from the mouth of the Congo to the mouth of the Ogowe. Prior to Africa's partition by European powers, it formed a kingdom by that name (also known as Brama) but was divided between French Equatorial Africa, the Portuguese district of Kabinda and the Belgian Congo. The roadstead of Loango, an insignificant coastal place, remained the only testimony of former grandeur. The inhabitants belong to the Bantu groups of Mayombe and Bakongo; older reports refer to the Loango inhabitants as Bafiote.

The early history of Loango is unknown. During the 15th and 16th centuries Portuguese merchants visited the kingdom which appears to have been founded by the king of the kingdom of Congo, located south of the Congo river. Although a vassal state as late as 1570, it achieved independence toward the end of that century and began to conquer some of the adjacent kingdoms. In the 17th century Loango became divided into many small, politically ineffective states. During this time the country was an important source of slaves for the new world. It was largely under Portuguese control, except for a brief period (1641–48) when the Dutch assumed control of the country's lucrative slave trade. By the middle of the 19th century the kingdom had been reduced in influence. In 1883 the king of Loango signed a treaty placing his country under the protection of France; it became part of the middle Congo territory. (H. A. WF.)

LOATUKO, the name by which a tribe formerly variously known as Latuko, Lotuko, Latouka. Latuka, etc., is known. The language known by this name is spoken over an area to the east of Bahr-el-Jebel, between 5° and 4° N. latitude. The language is one of a group of 26 designated the Nilo-Equatorial group, containing such well-known tongues as Bari, Nandi, Masai and Turkana. These languages have an interesting feature in the use of tones whose object is the fixation of the meaning of a word in cases where its position in the sentence is not sufficient to show this. In some of the allied languages the role of the tones is definite and fixed; for example in Masai the high tone indicates that the word is the subject of the sentence. while the low tone shows that the word is the complement of the next.

The Loatuko-speaking tribes, so far as they are known, comprise the Loatuko, the Lokoiya and the Lango (*q.v.*), the last named apparently a northern section of the originally Shilluk-speaking Lango of Uganda, who have been dominated by the Loatuko and come to speak their language. All are dolichocephalic, but the Loatuko, with an average stature of about 70 in., are taller by about 2 in. than the Lokoiya and Lango.

The social organization of the Loatuko is the best known of the group. Each of a number of independent territorial groups, often at enmity, has at its head a rain maker, who is its supreme chief. There is a clan organization with descent in the male line, and at death everyone becomes the animal associated with his clan. Besides the rain maker, there are a number of "fathers of the land," of very real power in the magico-religious sphere There are large stockaded villages, such as Tirangore (Tirangole), as well as hill villages, such as Logurun. with its homesteads scattered irregularly about the hillside. In some hill villages there are megalithic stone circles, with stones up to five or six ft high, built up to the present day and used as squatting places for the men. The Loatuko have initiation ceremonies into manhood, in which the lighting of a new fire by friction is one of the essential features.

There is a cult of the dead, concerning which little became known. while the nature of Naijok, perhaps associated with the firmament, has been even less understood. The remains of near relatives are dug up some months after burial and the bones exposed in pots under trees and in rock shelters. the reason as stated being the promotion of the fertility of their women. The bones of rain makers are treated with considerably more ceremony and form the chief contents of the rain shrines where great rain ceremonies take place. The Loatuko occupy mountainous country east of Gondokoro on the upper Nile. (C G. S.; X.)

LOBACHEVSKI, NIKOLAI IVANOVICH (1792–1856), Russian mathematician, the founder of a system of non-Euclidean geometry, was born in Nizhni-Novgorod, on Dec. 2 (new style; Nov. 21, old style), 1792. He studied in Kazan university, began teaching there in 1812, and was professor from 1822 to 1846. Lobachevski was one of the first mathematicians to become convinced of the possibility of a geometry different from that of Euclid and the first to publish, in 1829, such a system (see GEOMETRY: Non-Euclidean). Presented in a form hard to understand, it was met in the beginning with derision. Some recognition came during his lifetime (election to the Gottingen Scientific society in 1842) but full appreciation of his work came only at the end of the century, when the non-Euclidean geometries, by suggesting a new way of looking at space, had important implications for theoretical physics and the development of the theory of relativity. In addition to his work in geometry. Lobachevski proved an excellent administrator. At Kazan university. where he was rector from 1827 to 1846, he helped organize the teaching staff and arranged and enriched its library. He also furnished instruments for its observatory, collected specimens for its museums and provided it with proper buildings. In order to be able to supervise the erection of the buildings, he studied architecture. Efficient measures taken by Lobachevski during an outbreak of cholera in 1830 and a disastrous conflagration in 1842 prevented great losses in personnel and equipment of the university. He died at Kazan on Feb. 24 (new style), 1856.

Geometrische *Untersuchungen,* first published in 1840, was translated into English by G. B. Halsted (1891; new ed., 1914).

See F. Engel, N. I. Lobatchewsky (1899); a complete biography in Russian by V. F. Kagan (2nd ed. 1948); E. T. Bell, Men *of Mathematics* (1937). (G Y. R.)

LOBANOV-ROSTOVSKI, ALEXIS BORISOVICH, PRINCE (1824–1896), Russian statesman, was born on Dec. 30, 1824, and educated at the lyceum of Tsarskoe Selo. At the age of 20 he entered the diplomatic service, and became minister at Constantinople in 1859. In 1863 he retired but at the close of the Russo-Turkish War in 1878 he was sent as ambassador to Constantinople. In 1879 he was transferred to London, and in 1882 to Vienna; and in March 1895 he succeeded De Giers as foreign minister. In this position he showed much of the caution of De Giers, but adopted a more energetic policy in European affairs generally. Russian influence in the Balkan peninsula suddenly revived, and Russia's Balkan policy in the next years seemed to foreshadow the creation of a Balkan confederation hostile to Turkey; in reality Lobanov was merely trying to establish a strong Russian hegemony among these nationalities, and he did not desire a new crisis in the eastern question until such time as Russia could act independently of foreign powers. Accordingly, when Lord Salisbury proposed energetic action to protect the Armenians, Russia assumed the role of protector of the sultan and vetoed the proposal. At the same time efforts were made to weaken the triple alliance. the principal instrument employed being the entente with France. which Lobanov helped to convert into a formal alliance. In the far east he became the protector of China. Japan was compelled to give up its conquests on the Chinese mainland, so as not to interfere with the future action of Russia in Manchuria. Lobanov died on Aug. 30, 1896.

LÖBAU, a town of Germany, in the district of Dresden, on the Lobau water. 12 mi. S.E. of the town of Bautzen. Pop. (1950) 17,442. Löbau is first mentioned as a town in 1221; it received civic rights early in the 14th century and, in 1346, became one of the six allied towns of Lusatia. It suffered severely during the Hussite war and was deprived of its rights in 1547.

LOBBY, a corridor or passage, an anteroom, or entrance hall in a building. The entrance lobbies to legislative buildings are often convenient places for interviews between members of the legislature and the public. The pressure thus brought to bear upon members of legislative bodies has given rise to the expressions "lobbying" (q v.) and "lobbyist."

LOBBYING. In its broadest sense lobbying is the attempt of individuals and groups to influence public policy while avoiding direct political responsibility. Lobbying is a compulsive and universal political phenomenon. Narrower definitions of the term have caused increasing unrest among political scientists. For years, the popular, journalistic image was that of selfish private interests attempting by pernicious means to influence public officials, particularly legislators, in order to realize goals inconsistent with the public interest. But what means are "private" or are "selfish"? What goals are inconsistent with the "public interest"? Was the Boston Tea Party, which certainly was aimed at influencing public policy, an attempt by "selfish interests" using "pernicious means" to achieve "goals inconsistent with the public interest"? King George III would have said yes; Samuel Adams would have said no.

A free society by definition is one in which all comers are free to voice their divergent opinions and to petition their rulers for a redress of grievances. These basic constitutional rights make lobbying both certain and, in its most desirable forms, highly visible and useful in democratic societies. Some of the more obvious values of lobbies in a free society are the following: (1) they make articulate the demands, grievances and creative ideas of the many segments of the public which comprise a democratic order, and often preclude festering pockets of social unrest and group frustration; (2) they often provide to busy legislators and executives expert opinions on highly complex matters; (3) they are mutually suspicious watchdogs who sniff out each other's subtle importunities and make these visible to preoccupied public officials and the public at large; (4) they serve as mediums for disseminating information about public issues to important segments of the community.

This patent identification of lobbying with free societies tends to obscure the fact that at least some lobbying occurs in all political societies, including dictatorships and other tyrannies. It can be said with some justification, for example, that Moses "lobbied" the tyrant Pharaoh. Even the most ruthless of 20th-century dictatorships, Communist and Fascist, have been responsive to at least a few powerfully based or culturally persistent group interests; *e.g*, Junker and industrial interests in Nazi Germany, and pressures for cultural autonomy in some of the peripheral states of the Soviet Union. But many diverse interests, of course, have been concealed behind the monolithic façade of totalitarianism, and others have been totally and ruthlessly suppressed or destroyed. It is therefore fair to say that by democratic standards one index of a healthy political society is the number of visible lobbies actively contending in the public forum.

United States.—Lobbying in the United States has taken many forms: the open representation of group interests before legislative committees and administrative tribunals, the "buttonholing" of public officials in legislative lobbies (the origin of the term), offices, hotels, bars, restaurants or homes; telephoning, or the writing of letters or telegrams, to public officials, or the organizing of "grass-roots" campaigns for this purpose; the provision (or the withholding) of services or money to candidates during political campaigns with an implied *quid* pro *quo;* the making available of research and writing services to public officials; the designing of campaigns to influence major public-opinion formers in the press, radio, television and in other lobbies, in an attempt by indirection to build public attitudes or to weave an irresistible coalition of private pouer. Lobbying may be carried on by full-time officials of a single, vast pressure group; by lone operators with many "accounts"; or by simple petitioners taking time out from other things to state their hopes or their grievances. The real professionals in the lobbying business are often iormer congressmen, or iormer public officials, hired because they "know their way around.!'

In the Cnited States, lobbying as a subject oi serious investigation and analysis is a 20th-century phenomenon. Awareness of some of the underlying issues, however, is at least as old as the beginnings oi American independent national life. As Madison wrote in 1788 in no. 10 of the *Federalist Papers:* "A landed interest, a manufacturing interest, a mercantile interest, a monied interest, and many lesser interests, grow up of necessity in civilized nations, and divide them into different classes, actuated by different sentiments and views. The regulation oi these various and interiering interests iorms the principal task oi modern legislation, and involves the spirit oi party and faction in the necessary and ordinary operations oi government."

The problem oi lobbying became particularly serious in the United States in the final third of the 19th century when economic power was oiten rapidly acquired and ruthlessly abused. During the 1870s and early 1880s, for example, the power oi the railroad companies became so great that a dozen or more state legislatures and large segments oi the United States congress could well be said to have become pawns of the captains of that great industry. But as the railroads and the other great trusts of the latter part oi the 19th century were gradually tamed by public opinion, statute law and the competition of rival groups, the grosser techniques oi direct lobbying (bribery, women, wine, lifetime railway passes, etc.) were gradually withdrawn in favour of more genteel, indirect and, unfortunately in some circumstances, less visible methods oi wielding influence over public policy. Actually, the attempts in the United States in the 20th century to curb by law the evils of lobbying have been aimed almost exclusively at making lobbying practices more visible. Since 1890, which marked the passage of the first lobby registration act (Massachusetts), almost two-thirds of the states have passed laws specifically (if, on the whole, ineffectively) designed to focus the spotlight of publicity upon organized interests which attempt to influence legislative policy. Most of the remainder of the states have "improper practices" laws directed only at patently venal lobbying activities such as bribery and blackmail.

At the national level, interest in the problem of lobbying was first marked in 1907 when three bills on the subject were introduced in the congress. But it took almost 40 years oi abortive legislative measures and intermittent special investigations beiore a federal statute was actually passed. The major provisions oi the Federal Regulation of Lobbying act (title iii of the Legislative Reorganization act of 1946, 60 Stat. 839; 2 U.S.C. 261–270) are two: (1) any person who shall engage himself for pay or for consideration for the purpose of attempting to influence the passage or defeat of any legislation by the congress of the United States shall, before doing anything in furtherance of such object, register with the clerk of the house of representatives and the secretary of the senate; (2) every person, including an organization, who receives or spends money for lobbying must file cumulative quarterly statements with fhe clerk of the house of representatives and the secretary of the senate showing total contributions and expenditures for this purpose, complete with names and addresses oi contributors and recipients.

Both the senate and house reports accompanying the bill stated that the act ". . . does not apply to organizations formed for other purposes whose efforts to influence legislation *are merely incidental to the purposes for which formed"* (italics supplied). This enormous loophole, the summary and superficial character of information required in the quarterly reports, the absence oi publicity given to the list of registrants and backers and the failure of the act to provide for proper administration or eniorcement have repeatedly called into question its value. The same kinds of criticisms have been leveled with even more justification at most of the state laws in this field.

The dilemma of how to draft meaningful lobbying regulation or registration statutes without running afoul of constitutional rights or without creating unanswerable problems of definition and enforcement was pointed up by two major congressional investigations in the 1950s: the house select committee on lobbying under the chairmanship of Rep. Frank Buchanan (Dem., Pa.) (1950) and the senate special committee to investigate political activities, lobbying and campaign contributions under the chairmanship of Sen. John McClellan (Dem., Ark.) (1957).

The senate committee, particularly, emphasized that all except a few lobbying practices were so indirect or incapable of precise legal circumscription that conflicting views existed as to whether they were in fact, or in a constitutional sense should be, subject to the registration and reporting provisions of any federal lobbying act. For example, what about campaigns addressed to the public through newspapers, magazines, television or radio, containing implicit—but not explicit—appeals to the public to contact congress to influence legislation? Or, what about the preparation and distribution of books, pamphlets or data by research groups, which might influence legislation, but which were prepared without any specific intent to produce a particular legislative action? And yet, if these indirect and imprecise categories are excepted from lobbying statutes, how meaningful is it to spotlight the residue of traditional and more direct lobbying practices? And does it make sense to spotlight attempts to influence legislative action if no attempt is made to spotlight attempts to influence executive, administrative, political party and even certain kinds of judicial action? These have been some of the continuing issues raised by attempts to develop protection against the abuses of lobbying in the United States.

The constitutionality of the key registration and coverage provisions (eniorcement provisions were not involved) oi the 1946 Lobbying act was tested and upheld in 1954 by the supreme court in *United States* v. *Harriss* (347 U.S. 612). It is clear, however, that the supreme court will continue to look with the greatest care at possible iniringements of basic freedoms in the application or extension of existing legislation in this area.

Although they have varied greatly in influence over the years, some oi the most poweriul lobbies in the United States in the 20th century have been the following: for business, the National Association of Manuiacturers, the Chamber of Commerce of the United States and the Committee for Constitutional Government; ior labour, h American Federation of Labor-Congress oi Industrial Organizations (a d its most poweriul constituent unions) and the railroad brotherhoods; for agriculture, the American Farm Bureau federation, the National Grange, the National Milk Producers' federation and the National Farmers' union; and for veterans, the American Legion and the Veterans of Foreign Wars. Other powerful pressure groups (some oi them now deiunct or moribund) have included the Anti-Saloon league, the American Medical association, the American Petroleum institute, the American Retail federation, the Distilled Spirits institute, the League of Women Voters, the National Association of Electrical Companies and the National Education association.

Great Britain.— Lobbying in the United Kingdom has not been studied as extensively as in the Cnited States but the beginnings of an interesting descriptive literature developed in the 1950s. Because of Britain's reasonably disciplined party structure and because of the power of the prime minister and cabinet in the formulation of policy, it has rarely been recognized that pressure groups have probably been as influential in the United Kingdom as they have been in the United States. Some groups such as the large trade unions and key parts of the co-operative movement, for example, have been powerfully based policy-shaping elements within the Labour party. Business associations such as the British Employers' coniederation, the Federation of British Industries and the National Union of Manuiacturers have at times had a considerable indirect voice in Conservative party policy. A single agricultural association, the National Farmers' union, has contained up to 90% of the total farms in England and Wales; and, of course, as in all free societies, the United Kingdom has had a bewildering array of proiessional, religious, social-sectional and commodity interests which have attempted through direct and indirect contacts with government departments, with members of parliament and with various leaders influential in each party to influence public policy. But, as in the United States and other modern democracies, the worst excesses of lobbying have generally been checked in the United Kingdom by a combination of vigilance among competing groups and in the press, and by the ethics oi responsible civil servants and political leaders dedicated to the indispensable, if vague, norm of the public interest.

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LOBE, any round projecting part, specifically the lower part of the external ear, one of the parts into which the liver or lung is divided, also one of several parts of the brain, divided by marked fissures. *(See* LIVER; RESPIRATORY SYSTEM, ANATOMY OF; BRAIN: *Anatomy of the Brain.)* The diminutive "lobule" is applied to a similarly shaped portion of a gland, *e.g.,* breast. liver, when of microscopic size.

LOBELIA, the typical genus of the family Lobeliaceae, named after Matthias de Lobel, a native of Lille, botanist and physician to James I. It numbers about 250 species, natives of nearly all the temperate and warmer regions of the world, excepting central and eastern Europe and western Asia. They are annual or perennial herbs or undershrubs, rarely shrubby, although the "tree" lobelias found at high elevations on the mountains of tropical Africa are remarkable arborescent forms. The water lobelia (*L. dortmanna,* named by Linnaeus after Dortmann, a Dutch druggist), occurs throughout the north temperate zone. *L. urens* is only found in England, on heaths, etc., in Dorset and Cornwall. The genus is distinguished from *Campanula* by the irregular corolla and completely united anthers, and by the excessive acridity of the milky juice. The species earliest described and figured appears to be L. *cardinalis,* under the name *Trachelium americanum sive cardinalis planta,* "the rich crimson cardinal's flower"; Parkinson (1629), says, "it groweth neere the riuer of Canada, where the French plantation in America is seated." It is a native of the eastern United States (see CARDINAL FLOWER). This and several other species are cultivated as ornamental garden plants, *e.g.*, dwarf blue L. erinus from south Africa, which, with its numerous varieties, forms a familiar bedding plant, much used for edging. L. splendens and L. fulgens, growing from one to two feet high, from Texas and Mexico, have scarlet flowers; L. *tupa*, a Chilean perennial six to eight feet high, has reddish or scarlet flowers; L. tenuior, with blue flowers, is Australian and grown in the greenhouse, while L. georgiana, from North America, as well as L. *siphilitica* and its hybrids, also have blue flowers. The last-named was introduced in 1665. The hybrids raised by crossing cardinalis, fulgens, splendens and siphilitica constitute a fine group of fairly hardy and showy garden plants little known in America.

The species Lobelia *inflata*, the Indian tobacco of North America, is used in medicine, the entire herb, dried and in flower, being employed. The species derives its specific name from its characteristic inflated capsules. It is somewhat irritating to the nostrils, and is possessed of a burning, acrid taste. The chief constituent is a volatile liquid alkaloid (cf. nicotine) named lobeline, which occurs to the extent of about 30%. This is pungent, with a tobaccolike odour, and is very poisonous. From it is made a medicinal tincture of lobelia, used in treating spasmodic asthma and chronic bronchitis. Fatal cases of poisoning are not uncommon, even if only a few leaves or capsules and their seeds are ingested. Milder manifestations include vomiting, nausea, coma or convulsions. (N. TR.; X.)

LOBI, a long-headed, light-complexioned and well-proportioned people living in the Gaoua district of Upper Volta. There are traces of exogamy. They live in scattered groups of one or more united households without social organization, and there are no considerable villages. Descent is matrilineal. Inheritance goes to the brother and then to the son. The Lobi practise private vendetta, and use poisoned arrows (stropanthus). They are cultivators and cattle raisers, and animists in religion.

See H. Labouret, "La terre, la chasse et la guerre parmi les populations du Lobi," Annuaires et *Mémoires,* Comite' d'e'tudes *Historiques* et *Scientifiques* de *l'Afrique* occidentale *française* (1916–17).

LOBITO: see ANGOLA.

LOBO, FRANCISCO RODRIGUES (1579–1622), Portuguese poet, best known for his pastoral eclogues, was born in 1579 at Leiria, where he lived until he went to the University of Coimbra to study law. After taking his degree he entered the service of the duke of Braganza. Lobo was drowned in the Tagus, probably before the end of 1622. Some biographers have traced his Jewish descent and possible noble birth, but this is uncertain.

His first book of poems—*Romanceiro* (1596)—reveals a refined sensibility and skill in describing the moods of nature. At this time he was deeply influenced by Luis de Góngora y Argote, and 57 of the 61 poems were in Spanish, which remained a second language for Portuguese writers until the end of the 17th century. Lobo's last work, Jornada (published posthumously, 1623), a series of short poems welcoming Philip 111 to Lisbon. was written in pure Castilian. Although Lobo preferred writing pastoral poems—*e.g., Éclogas* (1605)—he also wrote an epic in 20 cantos on Dom Nuno Álvares Pereira, *O* Cortdestabre, (1609) but the narrative is monotonous and lacks Camões' vigour and inspiration. Lobo's pastoral trilogy—A Pviataveva (1601), *O* Pastor *Peregrino* (1608) and *O* Desenganado (1614)—contains his best eclogues. In the countryside where he was brought up, on the banks of the rivers Lis and·Lena, his shepherds and shepherdesses discourse wittily on the wiles and whims of love and the weariness of life. A similar pessimism, tempered with philosophical resignation, informs the prose dialogue *Corte na* Aldeia (1619), in which the author discusses, through his characters, such subjects as the harm resulting from the extinction of the Portuguese court under Spanish rule, the best system of education and the new theories of literary expression. Lobo has won a high place in Portuguese literature for his vivid descriptions of the countryside and for the sincerity of his lyrics.

See R. Jorge, Francisco Rodrigues Lobo (1920); C. A. Ferreira, "Francisco Rodrigues Lobo—Fontes inéditas para o estudo da sua vida e obra," in *Biblos,* vol. xix (1943). (L. DE S. R.)

LOBO, JERONIMO (1593–1678), Jesuit missionary, was born in Lisbon, Port., and entered the Order of Jesus at the age of 16. In 1621 he was ordered as a missionary to India, and in 1622 he arrived at Goa. With the intention of proceeding to Abyssinia, whose negus (emperor) Segued had been converted to Roman Catholicism by Pedro Paez, he left India in 1624. He disembarked on the coast of Mombasa, and attempted to reach his destination through the Galla country, but was forced to return. In 1625 he set out again, accompanied by Mendez, the patriarch of Ethiopia, and eight missionaries. The party landed on the coast of the Red sea, and Lobo settled in Abyssinia as superintendent of the missions in Tigré. He remained there until the death of Segued. Forced by persecution to leave the kingdom, in 1634 Lobo and his companions fell into the hands of the Turks at Massawa, who sent him to India to procure a ransom for his imprisoned fellow missionaries. He obtained the ransom, but could not induce the Portuguese viceroy to send an armament against Abyssinia. He embarked for Portugal, and after he had been shipwrecked on the coast of Natal, and captured by pirates, arrived at Lisbon. He obtained no support, and in 1640 he returned to India, and was elected rector and afterwards provincial of the Jesuits at Goa. He died in Lisbon on Jan. 29, 1678.

Lobo wrote an account of his travels in Portuguese, which appears never to have been printed, but was deposited in the monastery of St. Roque, Lisbon. Balthazar Telles made large use of the information therein in his *Historia* geral da Ethiopia a Alta (1660), often erroneously attributed to Lobo (see Machado's Bibliotlteca *Lusitana*). Lobo's own narrative was translated from a manuscript copy into French in 1728 by the abbé Joachim le Grand, under the title of Voyage *historique d'Abissinie.* In 1669 a translation by Sir Peter Wyche of several passages from a manuscript account of Lobo's travels was published by the Royal society (translated in M. Thévenot's *Relation* des voyages in 1673). An English abridgment of Le Grand's edition by Dr. Johnson was published in 173j (reprinted 1789). In a *Mémoire justificatif* en *réhabilitation* des *pères* Pierre Paez et *Jérôme* Lobo, Dr. C. T. Beke maintains against Bruce the accuracy of Lobo's statements as to the source of the Abai branch of the Nile.

See A. de Backer, *Bibliothèque* de la *Compagnie* de *Jésus* (ed. by C. Sommervogel, vol. iv, 1893).

LOBSTER, an edible crustacean found on the coasts of the north Atlantic and Mediterranean. The name is sometimes loosely applied to any of the larger Crustacea of the shrimplike or macrurous Decapoda, especially to such as are used for food.

The true lobsters, forming the family Homaridae, are distinguished by having the first three pairs of legs terminating in chelae or pincers. The first pair are large and massive. The common lobster (Homurus *gammarus*) is found on the European coasts from Norway to the Mediterranean. The American lobster (H. *americanus*), which should perhaps be ranked as a variety rather than as a distinct species, is found on the Atlantic coast of North America from Labrador to Cape Hatteras. A third species, found at the Cape of Good Hope, is of small size and of no economic importance. Both in Europe and in America the lobster is the object of an important fishery. It lives in shallow water. in rocky places and is usually captured in lobster pots, or creels, made of wickerwork or of hoops covered with netting, and having funnel-shaped openings permitting entrance but preventing escape. These traps are baited with pieces of fish, preferably stale, and are sunk on ground frequented by lobsters, the place of each being marked by a buoy. In Europe the lobsters are generally sent to market in the fresh state, but in America, especially in the northern New England states and in the maritime provinces of Canada, the canning of lobsters is an important industry. The European lobster rarely reaches 10 lb. in weight. though individuals of 1; lb. have been found, and in America there are authentic records of lobsters weighing from 30 to 34 lb. The latter specimen was just about 2 ft. long, with a crushing claw (the larger) measuring 15 in. long and 20½ in. in girth. Most of the U.S. catch comes from Maine.

The Norway lobster (*Nephrops norvegicus*) is found, like the common lobster, from Norway to the Mediterranean. It is a smaller species, found in deeper water and is generally captured by trawling.

The names rock lobster, spiny lobster, sea-crawfish and "langouste" refer to members of the family Palinuridae, readily distinguished from the Homaridae by the fact that the first legs are not provided with chelae or pincers. The European rock lobster (Palinurus vulgaris) ranges from southern Great Britain to the Mediterranean. All species are taken for food wherever they occur, especially in Florida and the West Indies, the Pacific coast of North America, Juan Fernandez. Australia, New Zealand and South Africa. Spears, traps and hoop nets are used in their capture.

The Murray lobster of Melbourne and Sydney is a large species of crayfish (Euastacus armatus), much used for food.

(See CRAYFISH; CRUSTACEA; MALACOSTRACA.) (W. L. ST.)

LOCAL EDUCATION AUTHORITY: see EDUCATION, HISTORY OF.

LOCAL GOVERNMENT. Some degree of local government characterizes every state in the world: the degree is all-significant. Local government means authority to determine and execute measures within a restricted area inside and smaller than the whole state. The variant, local self-government, is important for its emphasis upon the freedom of the locality to decide and act.

There is more than a technical importance in the difference between the two terms, because they are related to the distinction sometimes drawn between deconcentration and decentralization. Local government is often, but not necessarily, related to the former; local self-government to the latter. That distinctions have been made is important, even if they are blurred. By deconcentration some have meant that for the mere convenience of a congested central government some functions have been devolved to administration on the spot, rather than from the centre, but still administered through officials appointed by and responsible to the centre. Authority and discretion are vested in the centre. On the other hand, decentralization represents local government in areas where the authority to decide has been devolved to a council of locally elected persons acting in their own discretion with officials they themselves freely appoint and discipline.

The term local self-government has been traditionally used of local government in Great Britain and Germany. Thus the constitution of the west German republic says, "The *Gemeinden* (that is, local authorities) must be safeguarded in their right to regulate, under their own responsibility, all the affairs of local community within the limits of the laws." On the other hand, the constitution of the French fourth republic said, "The French Republic, one and indivisible, recognizes the existence of local administrative units. . . . The local administrative units shall be governed freely by councils elected by universal suffrage." This expresses the spirit of deconcentration. The Union of Soviet Socialist Republics constitution (chap. VII) makes provision for "the local organs of state power," but offers no breath of decentralization.

However tightly bound to the central office's authority and regulations, a degree of discretion in its local officials is unavoidable. Often. again, the fairly pure organs of local self-government, *e.g.,* a British county borough council, are obliged to execute the purposes of the central government. Primarily units of local self-government, they are simultaneously units of local obligation acting as ordered by the central government, for services, *e.g.,* education and police, willed and imposed by it.

Thus modern local government has a twofold aspect—it is a mixture of both deconcentration and decentralization, of central convenience and an acknowledgment that not all authority ought to be exerted by the centre. The mixture is revealed by the extent to which some of the powers exercised by local government units are exercised compulsorily and under fairly strict control by central authority with financial assistance, while others are not. This mixture produces the high complexity of modern local government. Further, local government is a departmentalization of the state's work, based on the territorial distribution of services, as contrasted with (a) division into departments at the centre, or, (b) as in the decentralization of functions to public corporations, such as the British Coal board or the metallurgical trust (Glavki) in the U.S.S.R. In local government, territorial distribution of power is the essence.

The history of local government in western Europe, Great Britain, the Gnited States and Russia, exhibits the growing awareness of its significance. This awareness is a product of a development of parochial and town life which began long before the modern state emerged between the 15th and 17th centuries. Any central control over these and other areas was, until the 18th century, rather scanty, though sometimes, as under Jean Baptiste Colbert in France or in 17th century Prussia already overlaid by the heavy hand of the central *Intendants* in the former and the war commissariat in the latter. Many Germanic states were nothing but cities; *e.g.,* the Hanse towns. In England and especially New England, the local units, parishes, towns, cities emerged from their origins as spontaneous self-governing units; so, also in Russia, although there the tsars took strict control of the cities through their provincial governors and over the *Mir*—the village-cum-agricultural unit—through taxes. the police and the *boyars;* the state colonized some cities from the beginning. The various local units were gradually integrated by the state which exacted obligations from them regarding peace. crime and police duties, taxes. military supplies, assistance to the poor and highways. By ordinances or statutes or judicial decisions local units were subordinated, so that the idea of an inherent right to self-government was extinguished. By the 19th century all local units were legal creatures of the state, subsidiary in authority on principle and acting independently by sufferance alone.

Indeed, the battle for the continuance of local self-government is desperate though not hopeless. The local freedoms of the 19th century were challenged by (1) speed of communications which has reduced administrative space time; (2) demands of a planned economy; (3) growth of nationwide parties with social welfare programs uniform for all parts of the nation; (4) growth of a consciousness favouring a national minimum of services; (5) realization that the best technical administration of modern utilities requires areas knitted together by a central plan and different from the traditional ones; (6) needs of civil defense against air attack. These are powerful forces working against claims to purely self-regarding government.

More than ever, on the other hand, local freedom is supported by need for (1) intimate local knowledge and variation; (2) intensity of local interest and enlistment of loyalty and co-operation; (3) small areas for easy impact of the citizen-consumers upon officials-producers; (4) an accessible area of political education; (5) counterweight to the abuse of central power; (6) the democratic value of a plurality of political experience and confidence. In all plans, decentralization, whether to a regional corporation such as the Tennessee Valley authority in the U.S., or to reformed traditional units, is pressing, necessary and fruitful.

COMPARATIVE STUDY OF CHARACTERISTICS

The chief characteristics of local government, which may be studied by comparison of Great Britain, France, Germany, the U.S. and the U.S.S.R. are (1) constitutional status; (2) areas and authorities; (3) powers; (4) finance and local freedom; (5) organization; (6) central controls.

Constitutional Status.—In Great Britain, the local authorities are subordinate corporations formed by acts of parliament or charters. Their powers and immunities derive from statute and judicial interpretation. They have many obligatory duties and a vast field of permissive powers. Each authority is independent within the sphere of power authorized by the central government: there is no hierarchy of authorities. Slight tutelary control over the health and roads services of the urban and rural districts has been given to the counties. Local councilors are freely elected and constitute the local executive as well as the legislature. There is no appointment or ratification of local executives by the central government, though certain important local officials require qualifications stipulated thereby. The local authorities combine many functions, and are not, like the school or sanitary districts so frequent in the U.S., single function or authorities created for a specific purpose. The local finances—rates—are locally raised in amount and appropriated in detail with practically no interference by the centre. Though local authorities have considerable freedom to use their permissive powers, and even their obligatory ones, they operate within judicial controls lest they act beyond their powers or are negligent, and are under continuous central administrative controls. A condition of local central partnership characterizes the system. Though the central controls have increased markedly in the last 30 years, local powers have also greatly increased. The local units are powerful. They exercise an important influence over the central administration through their members of parliament, and through their increasingly large representation on advisory councils and committees officially attached to the several departments. The nationwide associations of the different classes of local authorities exercise an advisory and representative influence on the centre and sustain the standard of local administration, as, similarly, the German association, the Deutscher Stadtetag, does.

French local government differs from the English in being both hierarchical and centralized. Though the municipal code of 1884 gives the municipalities a wide general scope of activity, these communes and *départements* are limited by strong central controls over their budgets, modified for the bigger cities by political influence. The inspectorial system, strong in Great Britain, because the relationship of government to the localities is direct, is of less consequence in the French, where hierarchical control seeps down through the *préfet* of the *département.* Obligatory functions which must be carried out by the municipalities can be inscribed by both the *maire* and the *prdfet.* The *prdfet* may be removed by the central authority at its discretion—he is appointed by it; the *maire,* until 1884 appointed by the central government, since elected by the local council, is removable by the central government for default in acting as the law requires, and is suspendible by order of the *préfet* for similar cause for from one to three months. Judicial control over the activities of local government is very heavy, culminating in the supreme administrative court, the *conseil d'ktat.* The rather severe centralization of French local government, a legacy of the *ancien rdgime,* jolted by the Revolution but radically re-established by Napoleon, is considerably criticized, but decentralization is very unlikely. The rural nature of France, despite many cities, and the fear of the divisive political passions of the people, most recently of the Communist party, militate against local freedom.

German local government (omitting the Nazi interlude) attempted to unite the agelong pride in free and enterprising civic life with the full popular enfranchisement that came first only in 1919. Its hierarchical system, with strong central surveillance reaching back to the 18th century, was a little eased during the Weimar period. The position of the local executives. *Bürgermeister* or *Magistrat,* ratifiable by the central government, was much troubled by the universal suffrage of 1919 which replaced the oligarchic three-class system. A very wide scope of authority was accorded to the *Gemeinde,* whether rural or urban, by the basic laws, such as the Prussian *Stadteordnung* of 1808, the *Kreisordnung* of 1872 and the *Provinzialordnung* of 1873. Though this authority came to be limited by financial stringency, German cities showed great enterprise and developed many utilities. The Nazi system in general kept the framework of areas and authorities but abolished all elections and substituted appointed councilors and executives dominated by Nazi *Gauleiters.* After World War II, the several states were glad to revive local self-government and the constitution guaranteed it.

In the U.S. the main features of the constitutional status of local authorities are the variety of arrangements in the various states and the large degree of freedom of the local units deriving from early English township forms reinforced by migration into new lands. Nevertheless. that freedom is subordinate and defined by state statutes and charters giving corporate status. The special charter, referring to individual cities; the general charter, which is a state-wide municipal code; the charter which confers status by classifying the local units for privileges—these are various means of trying to give the local units a status which relieves them of the need for repeated application to the legislature, while subjecting them to a firm pattern of permissions and limits. Amendments, however, still require suppliancy to the legislature; and growth requires powers in addition to the general grant.

In 26 states home rule charters, granted by the legislature, allow the city to draft its own charter by a local convention, sometimes requiring legislative ratification, sometimes not. Another system allows the local units to choose from among several forms of charter provided in a state general law. There is much independence and vigour, no hierarchy, little central administrative control and much judicial control to hold the units within their charter and statutory position. There are increasing direct relations between federal government and local units.

The local government system of tsarist Russia was one of absolute centralized hierarchy, executed through the governors of the 78 *guberniya,* with police, military and taxation powers, and the scantiest recognition of rights of local government. Provincial and village governments were dominated by the landlords who had an *ex officio* right to chairmanship of local administration, especially of the *zemstvo,* set up in 1864 to govern the provinces under strict control of the imperial governors. The *zemstvo* (with an indirect and unequal class franchise), nevertheless, made progress in educational, health, welfare and agricultural development in spite of the tsarist techniques of tyranny. The soviet constitution of 1936 and the decree on the city soviets (1933) and specific economic and social planning decrees give extraordinarily wide specified powers to the local units, but very rigorously subject them to hierarchical control of the next higher authorities upward to the central government of the various republics, and in some cases to the union itself. Authority and direction are heavily centralized and animated in the last resort by the all-union ministry of state administration and the public prosecutors. All units from lowest to highest are manipulated in unity by the ubiquitous activities of the Communist party, the members of which are required by the rules to form cells for administrative "fulfillment."

Generally speaking, then, local government as local self-government, is discernible more fully in the British and American environment than elsewhere, rather more in the German than in the French and hardly at all in the U.S.S.R. Yet centralization and control of units originally holding authority themselves are not inconsistent with vigorous first-line activity by the local units in the matters entrusted to them.

Areas and Authorities.—Local authorities in England and Wales are (from smaller units upward): 13,000 parishes (of minimal importance even in rural areas); 1.047 rural and urban districts (mainly health and minor roads authorities and some water supply); 309 noncounty boroughs like the districts, some of which, however, have police forces and elementary education and housing authorities—both about to disappear; 83 county boroughs, being great towns of 50.000 population and above, with the widest scope of local services including the public utilities; and 62 county councils, being mixed urban and rural areas. The county boroughs are independent of the counties; all other units have some of the services in their area rendered by the county council in whose area they fall.

In addition to these authorities, there are 2,000 joint authorities, councils, committees or boards, established to administer burials, water and electricity, sewerage and hospitals. There is a tendency in all countries to rely more upon such unions where the services are of a large-scale nature compared with the traditional units having responsibility. Local authorities are mutually independent: unanimity is required for joint schemes, which are amply permitted in the statutes. Even some counties are far too small for large-scale administration, while extremes of size in area and population may be encountered in each of the above-named classes of authorities.

Areas can be reformed after a procedure of local inquiry conducted by the central ministry of local government followed in the case of the creation and extension of county boroughs by legislation, and in the other cases by central administrative sanction. For the districts a maximum decennial review of areas is called for. In 1926 the creation of county boroughs was set back by the stipulation that the minimum population must be 75,000 in place of 50,000, as the counties suffered from the subtraction of area and taxable capacity. The movement for technically more justifiable regions is strong, but cannot prevail against local inertia and the claim that small areas are needed to activate democratic vitality. Nationalization of the electric and gas utilities facilitated the reform of the local units of production and distribution.

The French local government units are, in a downward order: 90 *dkpartements;* 311 *arrondissements;* 3,031 *cantons;* and 38,000 communes. The first-and the last are genuine units of local government; the middle two are only convenient administrative subdivisions and electoral, tax and *gendarmerie* districts. The *dd-partements* vary in size from 185 sq.mi. to more than 4,000 sq.mi., with an average population of 500,000. This framework, which serves the centralizing authority of the state, was established in 1790 to unify France by abolishing the traditional 35 *généralités* which partly coincided with and partly cut across the ancient provinces. The communes are the basic roots of local government. The name applies to units from the smallest village up to the capital. The span is from several acres to 400 sq.mi.; and from fewer than 100 people to the 3,000,000 people of Paris. Two-thirds have fewer than 500 inhabitants. Powers and practical hierarchical control vary accordingly, within the uniform pattern of the law. Area alterations can be made only by parliamentary statute, preceded by local vote, inquiry and acceptance by the *département* and *conseil d'état*. There is a regionalist movement which has been unsuccessful.

Indeed civil disruption fomented by the Communists in 1947 led to further centralization; France was divided into eight regions centring in the army commands in which all governmental power may instantaneously at need be transferred to the regional superprefects in emergencies; they are called inspectors general of administration on mission extraordinary, or I.G.A.M.E.

The German areas of local government are (in Germany as a whole): more than 50,000 *Gemeinden* (like the communes) divisible into *Stadt* and *Land,* urban and rural (one-third of the population live in the latter). Then, upward, the *Kreis* (equivalent roughly to county in England and the U.S.;) above this again, the *Regierungsbezirk* (government district), a unit of central government control and police authority; and above, the *Provinz* (only in Prussia, which was disintegrated after World War II).

There are also numerous joint authorities for roads, schools, health, fire, agriculture, water, gas and electricity. The *Gemeinden* exhibit an enormous diversity of area and population. There are *Stadtkreis* and *Landkreis;* the former, where the population is above 25,000, is a city-county (like the English county borough). There is a rather special kind of holding company local authority, the *Amt*, to administer the common affairs of some contiguous villages while they still remain separate *Gemeinden.* More important area changes require parliamentary statute. Free agreement among the local authorities is practically unobtainable. The impetus toward city-countyship is enormous, for the same reasons as toward county boroughship in England. The Nazi municipal order of 1935 gave wide powers of areal change to the national cabinet.

Whereas all other nations combine most local government functions in single compendious areas, the U.S. has distributed many of these, especially education. health and parks, to special authorities. The area structure of local government in the U.S. has a different foundation according to the historic settlements. In the south and south central region the chief unit is the county; in the north central, the combined county and township; in New England, the town. In some states, the people of each county may vote to divide the county into townships. There were altogether in the mid-1950s, about 3,050 counties. There were about 17,200 towns and townships; about 16,780 municipalities or cities; 67,350 (a decrease of 40% in 20 years) school districts, and about 12,320 other special function districts—in all, about 116,700 (a decrease of 25% over the last 20 years). The area of the counties varies from one to 20.000 sq.mi.—most generally, 400 sq.mi. to 600 sq.mi. The smallest had 227 inhabitants, the largest (Cook county, Ill., with Chicago) more than 4,500,000. The average was 45,000. Forty-four of the approximately 3,050 counties were completely urban; 77 contain central dominating cities. Some of the functions such as taxation, judicial registrations and records, first instance judicial action through the county court and justices of the peace and elections! are those of modern central rather than local authorities. Others like education, highways and bridges. social welfare, poor law, hospitals, pensions: health, defectives and delinquents are serious burdens on nonpopulous areas. Services remain inefficient or the state takes them over, for consolidation of counties is resisted. Some unions of counties have been formed for hospital and poorhouse administration.

Inset in the county is the city, with its own powers! and in direct relationship with the state government. Sometimes both city and county conduct for two concentric areas many similar services with substantial duplication of staff and organization. The cities are the areas of the heaviest integration of local government services. As elsewhere, there is antagonism between city and county, and the federal authority after the 1930s became an important direct supporter of city unemployment, public works, municipal utility and housing schemes. Towns, which are mostly but not exclusively semirural communities, and are fairly populous, in New England, New York, Pennsylvania and the north central states, play the part of the counties elsewhere and have city functions and sometimes city status also. As a part of a township or a county, there are habited centres, called villages or boroughs, a minimum of population usually being demanded by the state legislature before such a subdivision may become self-governing. Area problems in the U.S. revolve round the adjustment of county and city, and the problem of metropolitan areas. Here also, political vested interests and simple inertia obstruct modernization by the legislatures.

In Russia the tsarist areas replaced by territories or regions (*oblast*), include 4,411 districts *(raion)*, 1,442 cities and 459 boroughs (within cities), 2,307 settlements and 74,490 villages. At the top of the pyramid is the supreme soviet of the union republic. The upward relationship may be expressed in Lenin's phrase, "centralized supervision with decentralized activity." Within the cities of 100,000 there are subordinate soviets. of which Moscow has 240. Cities of more than 50,000 and specially important places of lesser population receive a status independent of the *raion* hierarchy and are directly subordinate to the republics. Attached to these cities are surrounding rural settlements which fully participate in the city government, but possess village soviets also. The republics enact these connections. A marked reduction of the local middle units of government has occurred since 1917, for urbanization since 1920 increased the soviet areas fifteenfold by the mid-1950s, and they were still in flux.

Powers.—Broadly speaking, the spatially big authorities in the hierarchy are concerned with financial and administrative supervision of the primary units, the provision of environmental and institutional and police services, and technical and financial supplements and assistance to the smaller authorities.

Authority to act is always a combination of specific grant and general grant by the central authority, sometimes with modifications by the administrative supervisory authorities and the courts.

In Great Britain, the specific grant of power is supreme. Powers are granted to the various classes of local authorities by general statutes, and by special addition to individual local authorities in private or local acts. The powers granted by general statute are either permissive; *e.g.,* libraries, or compulsory; *e.g.,* education or hospitals for infectious disease. The powers appear in the great statutes such as the Municipal Corporations act (1835) and the Local Government act (1933), which may be termed constitutive, or in acts on education or police, which may be called functional. The permissive powers offer remarkably wide opportunities for initiative. Where local authorities petition parliament for private acts, they may obtain the opportunity to pioneer, if they prove desirability and financial capacity, and successful administration is sometimes followed by granting extension of powers to all authorities. The merit of the system of specific grants is the addition of the good sense of the central authority to that of the local electorate in determining new services, which necessarily involve controls over local citizens and power to raise taxes. All the bigger authorities have a rather restricted by-law making poaer, heavily controlled by the courts.

In France and Germany the municipalities are given by the constituent statutes a general authority to act for the good proper to the municipality. But what is proper is legally challengeable by citizens, rind administratively by the central departments. Initiative is limited by the claims of other communities, private enterprise and the state organs. Also there are functions obligatory on the local units — from 50% to 80% measured in expenditures — prior to the discretibnary ones. The approval of the higher administrative authorities and the administrative courts is needed for utilities so that not very much is accomplished. In Germany from 1890 on, the cities proceeded remarkably with municipal enterprise. Despite specific grant in Great Britain. that country was probably unmatched in the extent of municipal management of utilities till the nationalization referred to.

In the United States counties have specific grants. The cities receive their powers in the charters. These are stated specifically, but in broad outline, while additional powers are granted from time to time.

The Russian republic constitution grants to all local authorities the power to "direct the cultural, political and economic construction of their respective territories," and the power to make decrees within the laws of the union and the republic. and then specifies further by requiring the local soviets to set up executive departments. The local soviets are generically unbounded in these powers, but in all are minutely subject to central plans.

The powers actually exercised by modern local authorities in the middle of the 20th century were immensely in advance of anything known in the early 19th century. Then the main services were highways, police, public assistance. the removal of health nuisances, perhaps fire fighting, perhaps infectious diseases, here and there public education. In Great Britain about 80% of the work of the local authorities came to include the modern social services and municipal enterprise: in other countries the situation was similar or was becoming so. The powers usually exercised by local authorities included education up to high school and technical schools (in the U.S sometimes colleges and universities); public health in a variety'of environmental and personal services; mental diseases; housing provision and management; town planning, zoning, building regulation; poor relief and, in the U.S., local administration of social security services; small holdings, allotments; parks and open spaces and playgrounds; agricultural improvement and land drainage. agricultural education; roads and bridges; streets; public lighting; fire fighting; police (larger authorities only, except in the U.S.); lower instance justice; foods and drugs. and weights and measures inspection; enterprises of gas, electric power, transport by trams and bus, water supply (in the German cities, laundries, milk supply, bakeries, theatres, concerts); and land purchase In the soviet system. the local soviets are subordinated units in the vast industrial and agricultural plans, the local soviets in their turn bringing the collective farms under especially stringent tutelage.

The tendency was toward more local powers, because all government was getting more power, but the development of planned economy, social security, public medical care and civil defense transferred the decision making and higher direction to the bigger authorities, though not excluding the smaller from direct local execution with much latitude therein.

Finance and Local Freedom. — The finances of local authorities have a bearing upon their administrative freedom. The crucial points are (1) their authority to raise revenue; (2) freedom of budget making; (3) the revenue basis; (4) the magnitude of their expenditures. Only (1) and (2) are discussed.

1. Revenue may be raised by authority of the general codes or the special statutes conferring powers. In France, tax freedom is limited by the need of superior authorization of the budget. In the Soviet Union the fully planned economy limits tax freedom, and the constitution itself requires that all local soviet budgets fit into, and be previously sanctioned by, the budgets of the republics.

In Great Britain and the United States, the principal financial limitations are on loans. In the former, previous administrative authority is required; in some states of the latter, limitations of total indebtedness are prescribed. The former introduces national investment policy and higher technical examination of the projects. German cities have wide financial freedom, though loans require higher sanction.

2. Local budgets need no superior approval, either in Great Britain or the U.S. In France, the *maire's* and the *préfet's* approval is required and they may require balancing and inscribe mandatory expenditures or invalidate optional expenditures. The German system also requires compulsory appropriations when higher authorities consider that provision is inadequate. In the soviet government, the higher authorities exercise penetrating control over revenue raising, appropriations and budgets.

In Great Britain grants-in-aid from the central authority play a very important financial and administrative role; in the U.S. rather less so. but with growing importance. In France and Germany the sharing of taxes with the central government was more important relatively than grants-in-aid. Grants and the form they take are instruments of superior control, regulation and stimulation. The ratio of revenue from local sources to total revenues from these and central grants in the late 1950s found Britain in the class of 40%–49%, Germany and the U.S. in the 60%–69% class and France in the 80%–89% class, while throughout the world (omitting the U.S.S.R.) there was a marked concentration around 20%–29%. In the Soviet Union, the local soviets draw revenue from the communized property allotted to them as public corporations by the union. Then they may add to the state turnover tax a percentage sanctioned by the superior local authorities to meet expenditure on functions authorized by them, these higher levels controlling their budget in minute detail.

Organization. — Local councils are elected by practically universal franchise for terms of three or four years, soviets for two. Soviet local elections are conducted by the Communist party; but nonparty members nominate and are nominated. Nearly 80% of the members of the village soviets and 40% of the city soviets are nonparty, but only four out of ten chairmen of the village soviets and practically none of the big city soviets are nonparty. The Communist party intelligentsia almost monopolizes the executive committees which run the government almost uncontrolled by the soviet. The local government statutes of all the countries concerned prescribe certain kinds of internal organization — mayor, chairman, aldermen, committees and commissions for executive and legislative operations and management of the permanent staffs.

Some significant differences deserve notice. The English form of internal organization is that of all-party committees each in touch with the technical or expert directors of departments. The only co-ordinator is the town or county clerk, in collaboration with the mayor or chairman who is annually elected from the council. The committees have a very large degree of delegated authority, subject to ratification by the council, but not to tax, raise a loan or make a contract. The French system has the centrally appointed *préfet* dominating the *de'partement* council; in the municipalities, the council elects the mayor. The former works with a secretary-general appointed by the central government. A small standing committee of the council, called the *commission départementale,* controls and co-operates with the *pre'fet* as regards the budget, the audit of expenditures and civic property. It has further delegated powers from the council. but not to tax or spend. The *maire* is served by a number of *adjoints,* chosen from the council by seniority and value of services to the commune, who supervise the various departments of municipal activity, and jointly act as an advisory body to the *maire* and draw up the budget.

In the German system, in the county, the chief executive is the *Landrat,* appointed by the central government, who co-operates with a small executive committee of the county council. In the rural communes, a chairman or *Biirgermeister* is elected by the council, and works with assistants or aldermen chosen by the councilors. The various states of Germany have diverse practices. In some there is a kind of bicameral system, called *Magistrat.* The elected council co-operates with the *Magistrat,* which is an administrative board of officials and some laymen chosen by the council led by the *Burgermeister*, the principal official—but since World War II, the *Magistrat's* power has been reduced to a suspensive veto only. In the *stadtrat* system, the elected council is singly the supreme authority, and works with an elected first *Bürgermeister,* but has an appointed second *Burgermeister* as its administrative officer. The system prevails in Bavaria. There is also the *bürgermeister* system, as in North Rhine-Westphalia, where the elected council has supreme authority, chooses its *Bürgermeister* who has a suspensive veto over the council's resolutions, and then a professional *Stadtdirektor* like a G.S. city manager, appointed for 12 years, as chief of administration.

In the U.S. system there are four conspicuous forms of organization: the town meeting, the commission system, the council and mayor system, the city manager system. In the first. the meeting of taxpayers settles main lines of policy, chooses selectmen and officials, accepts the budget, controls administration and checks expenditures. It is unwieldy for large cities. These then may be administered by a small number of commissioners elected simultaneously as heads of the executive departments and are collectively the general government of the city. The system encourages disintegration of leadership, and is on the decline. Elsewhere a council and some officials and the mayor are elected at the same time. There is a separation of legislative and executive authority at an enormous cost of energy which produces some but not all the desirable progress.

From the mid-1910s to the end of the 1950s, the city manager system developed strongly, until it applied to 1,275 cities, towns and counties, a great part of the increase coming after World War II. The elected council appoints an executive, a career official to energize, manage and appoint the officials, and to co-ordinate and make the budget—this official operating side by side with the elected mayor. The city manager is no tsar; he serves the council, and the local statutes give him a strong status, but it cannot be stronger than the authority of the council. His indefinite tenure may be cut short. In general, the United States system is distinguished by its use of the initiative and referendum, especially necessary in the commission form.

In the soviet system, the local soviet elects a presidium or executive committee from its members. This body is the formulator of policy as well as the executive—the council discusses and ratifies. The presidium is assisted by experts or interested citizens co-opted onto its committees. This practice of co-option was originated in Britain; many countries now practice it. The Soviet Union and some German states require of councilors an annual or semiannual "open house" to the public. Soviet councilors may be recalled by dissatisfied constituents, but this happens very rarely.

During the 19th century, local administration, having small power, was a field of much unpaid service, patronage and spoils. The merit and career system advanced. Appointments are made by the chief executive officials in the French and German systems, but according to general statutory qualifications and tests. In England, the central government by law prescribes the basic qualifications of some officials—the medical officer of health, the sanitary inspector, the police, teachers, etc., but appointment and management are fully by the local authorities, though since 1946 a nationwide examination and appointment and salary code has been fashioned and introduced by the local authorities' associations. Some officershave the right of appeal to the central authority against dismissal; *e.g.*, medical officers of health. In practically all large authorities and most small, a career service prevails. In the U.S. it has been estimated that civil service appointments total about 55% in the cities, and about 30% in the counties.

Central Control.—The intensity and techniques of administrative control by the central authorities are indexes of the limitation of local self-government. General tutelage is characteristic of France, Germany and Russia. It operates through continuous organized hierarchical vigilance and intervention downward from the designated central department through the higher to the lower levels of local authorities. In Great Britain statutory rules and orders made by the designated central department administering the statutes relating to local functions, advice, admonition, exhortation, preparation of scientific memoranda and reports of experience are parts of tutelage.

The sanction of administrative schemes is a more severe and specific form of central control: it is strong though not fully comprehensive in England. In France and Germany it is more comprehensive and in the Soviet Union it is total through the agencies already mentioned. In the U.S., higher sanction is rare and applies to welfare and public works schemes assisted by the federal authority, and occasionally to highways, education and hospitals financially assisted by the states.

Submission of periodic reports is universal, but applies in the U.S. mainly to the services already mentioned, and in some states to the local accounts. The growth of standards, scientific definition, forms and statistical analysis after the middle of the 19th century was a powerful instrument of centralization, since both local and central officials can be of one mind in reporting and deciding answers to governmental problems.

Audit of local accounts by central officials is severe and important in England; in France and Germany it is hierarchical, going finally in each case to the special courts of accounts. In the U.S., though accounting and fiscal practices are in some cases state regulated and the election of local auditors required, external and compulsory audit hardly exists. Inspection by central officers is the most distinctive feature of the English system, having been carried to a highly comprehensive and efficient stage in which the inspectors are not only investigating and enforcement-assisting agents. but counsellors on good practices, and flexible intermediaries between the capital and the localities. There is also inspection in the French and German systems, but it is overshadowed by the centralist form of the system. In the U.S. the small amount of inspection is related only to the services already mentioned. Action in default is very limited and rare in England; practically nonexistent in the U.S.; has been practised in Germany; is unnecessary in France because previous sanction *(tutelle)* and obligatory expenditure prevent local default. The central power to remove the French *maire* or the *prkfet* may be borne in mind. Stern hierarchical and party and newspaper criticism is designed to obviate local default in the U.S.S.R., but self-seeking and inefficiency often produce defects punished by recall.

Finally, personnel rules are laid down by the English central authority for some key officials; the office of *préfet* in France in 1945 was made a career service, intermingled with service in the central administration, following successful graduation from the government-sponsored École Nationale d'Administration. A few states in the U.S. exert some small influence on the civil service conditions of the localities; in Russia, the local soviets use the graduates of technical schools as screened by the Communist party. The payment or withholding of grants constitutes a sanction of these various instruments of central control. This is especially strong though flexible in England; much less so in France and Germany; firm over its small field in the U.S.; while the soviet system relies on other incentives, mainly fear or revolutionary zeal. In France and Germany, local authorities are subject to control by appeal to the administrative courts; in Britain, to the ordinary courts; in the U.S.S.R. no such appeals to a judiciary are entertainable, and the only recourse is to the hierarchy or the prosecutor's office.

Variety and development are marks of contemporary local government. Larger areas for local government with more central direction are on the way. Many new functions are impending. The feeling of attachment to the old areas is a retarding factor; the recognition that the small area has continuous human values and certain long-run technical advantages in assisting consumer control over administrators will force centralization to assume accommodating forms. The great associations of municipalities and the professional officials already contribute considerably to the efficiency of the localities, and their services are destined to be even more valuable as moderators of centralization. Yet the forces of modern large-scale economic organization and civil defense weaken the scope and independence of local self-government.

See also Index references under "Local Government" in the Index volume.

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(H. Fi.)

LOCAL OPTION. The term local option has been used to refer to a variety of permissive laws effective locally only after affirmative vote by the local electorate; for example, laws allowing political subdivisions a choice between forms of government or methods of representation.

It has particular significance, however, in alcoholic beverage control. In this context local option. or local veto as it is called in England, refers to a liquor control system under which each locality is permitted to vote upon the existence of legal dispensaries within its boundaries.

Early History.—Local option was a natural outgrowth of earlier licensing plans. As early as the 16th century English alehouses were licensed by the sessions of the peace and in the American colonies, though the licensing authority was first exercised by the governor. the advent of the American Revolution found the tradition of local licensing firmly established. The history of Massachusetts is typical; in 1633 it was provided that none should sell wine or strong water nithout leave of the governor or deputy governor. In 1645 the licensing authority nas shifted to the quarter courts and two years later to the county courts. In 1680 a provision was adopted prohibiting the court from issuing licences uithout the prior approval of the selectmen of the town in which the licensee sought permission to operate.

These provisions, and similar ones in the other colonies, were directed at policing the propriety and good morals of public houses and were not designed to implement total prohibition. The birth of the vigorous temperance movement of the 19th century coincided. however, with a trend toward the popular election of the county courts and their successors, and it was natural that the pressures of the early prohibition movement should be focused upon these officers. The reasoning of the prohibitionists ran thus: if the local governing body can deny one licence, it can deny all licences and local prohibition will be a reality. The problem became one of electing officials committed to a policy of "no licence."

The "no licence" movement met with several legal and practical obstacles. In 1844 the supreme court of North Carolina held that the discretion vested in the county court was not broad enough to sustain a policy of denying all applicants for retail liquor licences as "injurious to good morals" (*Attorney General* v. *Justices of Guilford,* 27 *N.C.* 315). In those states in which no legal objection was raised, although results in the rural areas were gratifying to the prohibitionists, temperance leaders were generally disappointed at their inability to carry the larger cities and towns and turned their attention to pressure for state-wide prohibition.

Local option in the sense of direct vote by locality on the question of prohibition came into vogue as a grudging concession to these pressures. The democratic flavour of local choice was never accepted by temperance workers. Theirs was a moral fight with a single ultimate goal. The *Cyclopedia of Temperance end Prohibition,* p. 394 (New York. 1881) frames the issue with candour. "By far the greatest of local option's defects is its rotten basis as to morals, where its presumptious elective system appears most audacious. With its majority rule set up as an origin of right, the results are most destructive to all proper conceptions of divine law." Within this ultimate objective, however, prohibitionists were willing to carry on their fight at all levels, adhering to the slogan provided by Judge Robert Pitman of Massachusetts, "Wherever license prevails, wrest every inch of territory you can for prohibition; wherever prohibition prevails, never surrender an inch to license, except from dire necessity" (*Alcohol and the State,* New York, 1877). By 1906, 30 states were operating under local option and more than half of all the counties. 60% of all the incorporated towns and villages and 70% of all the townships in the United States were dry.

Later History.—Local option in the United States disappeared, of course. with national prohibition. With repeal, though the older system of local licensing generally gave way to some form of central regulation, typically U.S. states returned to local option.

The plans varied greatly both as to voting unit and as to the alternatives placed before the electorate. In the typical state. cities and counties (incorporated towns often voting separately) may choose between total prohibition, sale of wine and malt beverages. package sale of distilled spirits and sale by the drink. Initiative in such elections is customarily left to petition by a fixed percentage of the qualified electors and elections may be held every year or two years.

In some communities elections may be held in a single precinct constituting at times not more than a few square blocks. Where precinct elections are permitted, however, they are usually considered as a device for protecting residential neighbourhoods from the influx of taverns, rather than an opportunity for an expression of wet or dry sentiment.

By the second half of the century, only two states in the United States still had state-aide prohibition. Mississippi and Oklahoma; in both of these dry states, however, alcoholic beverages could be sold providing they did not contain more than 4% (Mississippi) or 3.2% (Oklahoma) of alcohol by weight.

There were provisions for local option in approximately three-fourths of the states in the mid-1950s. The Distilled Spirits institute estimated that about 24,000,000 persons, including those in Mississippi and Oklahoma, lived in areas which prohibited the sale of distilled spirits. (J. D. Ls.; X.)

LOCAL TAXATION: see TAXATION, LOCAL.

LOCARNO (Ger. *Luggarus*), a town in the Swiss canton of Ticino (Tessin), of which until 1881 it was one of the three capitals (the others being Bellinzona and Lugano, qq v.). It is a health resort (pop., 1950, 7,767) built at the north end of Lago Maggiore.

Locarno is 14 mi. S.W. of Bellinzona by rail. An electric railway, opened in 1923, connects it with Domodossola and the Simplon via the Centovalli; another electric railway runs from Locarno along the Maggia valley.

The town was taken from the Milanese by the Swiss in 1512 and was subject to them until 1798, when it became a part of the canton Lugano in the Helvetic republic. In 1803 it became part of the new canton of Ticino. In its Palace of Justice in 1925 were held the sittings of the Locarno conference. *(See* LOCARNO, PACT OF.)

LOCARNO, PACT OF, a series of agreements made in 1925 whereby Germany, Belgium. France. Great Britain and Italy mutually guaranteed the peace in western Europe, and Germany undertook to arbitrate disputes with Belgium, France, Czechoslovakia and Poland. The treaties were initialed at Locarno, Switz., on Oct. 16 and signed in London on Dec. 1.

The pact was significant because it marked a break from the atmosphere of World War I, and former enemies committed themselves to a peaceful policy among themselves. The pact was, in a sense, a substitute for the Geneva protocol negotiated by the League of Nations in 1924 but never ratified.

The agreements consisted of (1) a treaty of mutual guarantee between Germany, Belgium, France, Great Britain and Italy; (2) arbitration agreements between Germany and Belgium and Germany and France; (3) a note from the former Allies to Germany explaining the use of sanctions against a covenant-breaking state as outlined in art. 16 of the League of Nations covenant; (4) treaties of guarantee between France and Poland and France and Czechoslovakia.

The treaty of guarantee provided that the German-Belgian and Franco-German treaties as fixed by the treaty of Versailles (*q.v.*) were inviolable; that Germany, Belgium and France would never attack, invade or wage war against each other except in "legitimate defense" or in consequence of a League of Nations obligation; that they would settle their disputes by pacific means; and that in case of an alleged breach of these undertakings, the signatories would come to the defense of the party adjudged by the League to be the party attacked and also in case of a "flagrant violation." The treaties between France and Poland or Czechoslovakia provided for mutual support against unprovoked attack.

To allay Russian suspicions. Germany in April 1926 concluded a neutrality pact with the Soviet Union and reaffirmed the treaty of Rapallo (*q.v.*), but this did not prevent Germany from joining the League in Sept. 1926. A further consequence of the pact was the evacuation of the Rhineland in 1930 five years ahead of schedule.

The clear meaning of Locarno was that Germany renounced the use of force to change its western frontiers, but agreed only to arbitration as regards its eastern frontiers, and that Great Britain promised to defend Belgium or France but not Poland and Czechoslovakia.

In March 1936 Germany sent troops into the Rhineland, which had been demilitarized by the treaty of Versailles, declaring that the situation envisaged at Locarno had been changed by the Franco-Soviet alliance of 1935. France regarded the German move as a "flagrant violation" of Locarno. but Great Britain declined to do so. and no action was taken. Germany made no effort to arbitrate its dispute with Czechoslovakia in 1938 or with Poland in 1939.

See William *M.* Jordan, *Great Britain, France, and* ***the*** *German Problem, 1918–1939* (1943). (B. E. S.)

LOCH, HENRY BROUGHAM LOCH, 1ST BARON (1827–1900) M.P., of Drylaw, Midlothian, was born May 23, 1827. After two years' naval service, he entered the East India company's military service, and in 1842 was commissioned in the Bengal light cavalry. In the Sikh war in 1845 he served on the staff of Sir Hugh Gough. In 1852 he became second in command of Skinner's Horse. At the outbreak of the Crimean war in 1854, Loch left India, and raised a body of irregular Bulgarian cavalry, which he commanded throughout the war. In 1857 he was appointed attaché to Lord Elgin's mission to the east, was present at the taking of Canton, and in 1858 brought home the treaty of Yedo. In April 1860 Loch again accompanied Lord Elgin to China, as secretary of the new embassy sent to secure the execution by China of its treaty engagements. The embassy was backed up by an allied Anglo-French force. With H. S. Parkes he negotiated the surrender of the Taku forts. During the advance on Peking Loch was chosen with Parkes to complete the preliminary negotiations for peace at Tungchow. They were accompanied by a small party of officers and Sikhs. On the discovery that the Chinese were planning an attack on the British force, Loch rode back and warned the outposts. He then returned to Parkes and his party under a flag of truce. All were made prisoners and taken to Peking, where the majority died from torture or disease. Parkes and Loch were at first put in irons, but were afterward more leniently treated. After three weeks their release was agreed, but they had only been liberated ten minutes when orders were received from the Chinese emperor, then a fugitive in Mongolia, for their immediate execution. Loch never entirely recovered his health after his experience in a Chinese dungeon.

Returning home Loch was made C.B., and for a while was private secretary to Sir George Grey, then at the Home Office. In 1863 he was appointed lieutenant-governor of the Isle of Man. In 1882 Loch accepted a commissionership of woods and forests, and two years later was made governor of Victoria. In June 1889 he succeeded Sir Hercules Robinson as governor of Cape Colony and high commissioner of South Africa.

The Boers were at the same time striving to frustrate Cecil Rhodes's schemes of northern expansion and planning to occupy Mashonaland, to secure control of Swaziland and Zululand and to acquire the adjacent lands up to the ocean. Loch firmly supported Rhodes, and, by informing Pres. Stephanus Kruger that troops would be sent to prevent any invasion of territory under British protection, he effectuallycrushed the "Banyailand trek" across the Limpopo (1890–91). Loch, however, with the approval of the imperial government, concluded in July–August 1890 a convention with President Kruger respecting Swaziland, by which, while the Boers withdrew all claims to territory north of the Transvaal, they were granted an outlet to the sea at Kosi bay on condition that the republic enter the South African Customs union. This convention was concluded after negotiations conducted with Kruger by J. H. Hofmeyr on behalf of the high commissioner, and was made at a time when the British and Bond parties in Cape Colony were working in harmony. The Transvaal did not, however, fulfil the necessary condition. and in view of the increasingly hostile attitude of the Pretoria administration to Great Britain Loch advocated the annexation by Britain of the territory east of Swaziland, through which the Boer railway to the sea would have passed. He induced the British government to adopt his view and on March 15, 1895, it was announced that these territories (Amatongaland. etc.), would be annexed by Britain. Meantime Loch had travelled to Pretoria to use his personal influence with President Kruger on behalf of the Uitlanders, and obtained the withdrawal of the commandeering regulations. In the following year he entered a strong protest against the new Transvaal franchise law. In 1895 he returned home and was raised to the peerage. He died in London on June 20. 1900.

LOCHABER, a district of southern Inverness-shire. Scot., stretching approximately from Loch Linnhe to Glen Spean and Loch Lochy. The scenery, wild and beautiful, includes Ben Nevis, through which a 15-mi. tunnel is part of the Lochaber hydroelectric scheme, designed to make use of a catchment area of 303 sq.mi. The powerhouse is close to Fort William. Pop. (1951) 9,330.

LOCHES, a town in France, capital of an arrondissement of Tours, in the *département* of Indre-et-Loire, 29 mi. S.E. of Tours by rail, on the left bank of the Indre. Pop. (1954) 4,181. Loches (the Roman Leucae) grew up around a monastery founded about joo by St. Ours and belonged to the counts of Anjou from 886 until 1205. when it was seized from King John of England by Philip Augustus, and from the middle of the 13th century until after the time of Charles IX the castle was a residence of the kings of France.

The picturesque town lies at the foot of the rock on which stands the castle of the Anjou family. surrounded by an outer wall and consisting of the old collegiate church of St. Ours. the royal lodge and the donjon. The church of St. Ours (10th, 12th centuries) has huge stone pyramids surmounting the nave and a beautifully carved west door. The royal lodge, built by Charles VII and used as the subprefecture, contains the tomb of Agnès Sorel and the oratory of Anne of Brittany. The donjon includes, besides the ruined keep (12th cent.), the Martelet, celebrated as the prison of Lodovico Sforza, duke of Milan. who died there in 1508, and the Tour Ronde, built by Louis XI and containing the famous iron cages in which state prisoners were confined.

Beaulieu ès-Loches, suburb of Loches, contains the remains of the 11th-century abbey church of the Holy Sepulchre. The chancel is of the 15th century.

LOCHGELLY, a small burgh of Fifeshire, Scot., about 7 mi. N.E. of Dunfermline by road. Pop. (1951) 9,103. The town, which is fairly modern, owes its present prosperity to the collieries in its immediate vicinity. The small Loch Gelly, from which the town takes its name, is situated $\frac{1}{2}$ mi. S.E., and has on its northern bank Lochgelly house, formerly a seat of the earl of Minto.

To the northeast rises the Benarty hill (1.167 ft.). Hallyards, about 2 mi. S.E. of Lochgelly, is a ruined house that once belonged to Sir William Kirkcaldy of Grange, who there received James V after his defeat at Solway Moss in 1542, and in 1570–72 held Edinburgh castle for James's daughter, Queen Mary.

LOCHGILPHEAD, a small burgh of Argyllshire, Scot.. at the head of Loch Gilp, a small arm on the western side of Loch Fyne, and at the eastern entrance to the Crinan canal, $38\frac{1}{2}$ mi. S. of Oban by road. Pop. (1951) 1,229. It is the administrative centre for the district of Mid-Argyll and a holiday resort. The disappearance of the herring from the loch has killed the once-flourishing fishing industry.

LOCHMABEN, a royal and small burgh of Dumfriesshire, Scot.. $8\frac{1}{2}$ mi, N.E. of Dumfries by road. Pop. (1951) 1,127. It is a delightfully situated holiday resort in Annandale, with several lakes and the Waters of Ae, Kinnel and Dryfe in the neighbourhood. In the parish church is a bell said to have been presented to the original kirk by Robert Bruce, whose statue stands in front of the town hall. At the southern end of Castle Loch are the ruins of Lochmaben castle, dating from the 13th century. where local tradition declares that Bruce was born. He exempted his followers in the district from feudal service and their descendants—the "kindly tenants of Lochmaben"—were confirmed in their tenure by the court of session in 1824. The Bruces had been closely associated with Lochmaben since David I granted Annandale to the second Robert Bruce.

The Lochmaben vendace. a small kind of whitefish, is found only in a few small lakes round Lochmaben. It is captured in fine nets and is considered a delicacy. There is another vendace. called the Cumberland vendace, in Lakes Derwentwater and Bassenthwaite. Lochmaben is famous for curling, and a team entirely composed of shoemakers (souters) who held their own against all comers once added the phrase "to souter" to the vocabulary of the sport. the word indicating a match in which the winners scored "game" to their opponents' "love."

LOCHNER, STEPHAN (c. 1400–1451), one of the most attractive of German painters. who is often compared to Fra Angelico and is considered to have brought the Cologne school to its peak of achievement, was born about 1400 in Meersburg. His name has come down to us through Albrecht Durer's diary of his journey through the Netherlands. in which he remarks that at Cologne he has had Master Stephan's tablets unlocked. By this he means the great, well-preserved triptych which presents the "Adoration of the Magi" and, on the wings, SS. Ursula and Gereon and their followers—that is, the patrons of Cologne. Formerly in the chapel of the town hall, it is now in the cathedral. In this work Lochner fills out the idealism of the older painters of the Cologne school with a seemingly inexhaustible wealth of naturalistic observation in the figures and composition, while the splendid plasticity of the draperies lends them a monumental dignity.

Lochner came to Cologne about 1430; he must previously have been in the Netherlands. The earliest work he did in Cologne was an altarpiece for the church of St. Lawrence. Only the centrepiece with the "Last Judgment" is now in Cologne (Wallraf-Richartz museum); the inner sides of the wings with the martyrdom of the apostles are in the Städel in Frankfurt. while the outer sides with "standing saints" are in the Pinakothek in Munich. The disconcertingly impressive posing of the saints and of the damned. with their back views and half-inducted profiles. the precise representation of the overturned tombstones and of the plants—this realistic vision came to Lochner through suggestions from the circle of the Limburg brothers. But his eye would never have moved beyond individual things if he had not attempted in the central picture to bind the various themes into a unity. In the light and delicate treatment of the objects and the people the work is already masterly.

A little later Lochner painted a small panel with "St. Jerome Meditating in his Study," a "Crucifixion with Saints" (Nürnberg), and for St. Katharine's, the church of the Teutonic order, a two-winged altarpiece painted on both sides, each with three saints. These are in the National gallery in London and the museum in Cologne.

In the later 1430s Lochner must have been in the Netherlands again, where he encountered the art of Van Eyck. The first work to reflect this influence is the "Madonna with the Violets," which was done for Elisabeth von Reichenstein, the abbess of the St. Cecilia chapter, about 1443. Van Eyck's influence is noticeable above all, however, in Lochner's chief work, the great town hall altarpiece described above. and in a charming little "Nativity." In 1447 he became a member of the town council, and from the same year dates the splendid "Presentation in the Temple" (Darmstadt museum), which was originally in St. Katherine's. The exquisite "Madonna in the Rose Bower" (Cologne museum) was painted soon afterward.

In 1451 Lochner died, probably being carried off by the plague. He had come to Cologne from afar, but he was in the deepest sense closely related to the city's genius. He became one of the greatest of Col'ogne's painters, subduing the naturalism of his early works and building up colour and form into a festal solemnity of representation.

Lochner must have had a highly productive workshop during all his years in Cologne. From it originated such works as the Gulbenkian collection's "Presentation in the Temple" (1445), Cologne museum's "Madonna in the Garden of Paradise With Saints," two altarpiece wings with St. John and Mary Magdalene now in the Pannwitz collection, and an "Adoration of the Christ Child" painted on canvas in the Diocesan museum in Cologne. Book illumination was also done in the workshop.

See O. H. Forster, *Stefan Lochner* (1938); A. Stange, *Deutsche Malerei der Gotik*, vol. iii, pp. 94–112 (1938). (A. SE.)

LOCK, MATTHIAS, English 18th-century furniture designer and cabinetmaker. The dates of his birth and death are unknown. He was a clever craftsman, a disciple of Chippendale, and was possibly in partnership with Henry Copeland. He belonged to that flamboyant school which derived its inspiration from Louis XV models, until he fell under the classical influence of Robert Adam so completely that it is often difficult to distinguish between them.

Many of Lock's original drawings are preserved in the Victoria and Albert museum, South Kensington, while the pieces themselves are often bolder and more solid than is suggested by the author's representations of them.

Among his works, some of which were issued in conjunction with Copeland, are: *A New Drawing Book of Ornaments* (n. d.); *A New Book of Ornaments* (1768); *A New Book of Pier Frames, Ovals, Girandoles, Tables, etc.* (1769); and *A New Book of Foliage* (1769).

LOCK. A device to prevent unauthorized entry to any building, room, container or hiding place, or to prevent seizure or movement of portable objects without the knowledge of the owners. The device may be mechanical, electrical, hydraulic or electronic in action. Its primary function is to fasten together temporarily two separate objects, such as a door to its frame. or a cover to a box by means of a bolt, bar, hook or wedge.

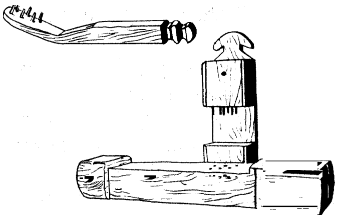

FIG. 1.—AN ANCIENT EGYPTIAN LOCK AND KEY

Proof that locks were in use at least as long as 4,000 years ago was furnished by the discovery of a wooden lock apparently from one of the doors of the ruined palace of Khorsabad near Nineveh. By the mid-1950s, no earlier examples had been found although historians suggest that locks of similar design were in use in previous civilizations. because their counterparts had been found in places far remote from ancient Egypt. Archaeologists working in such widely separated places as the Faeroe Islands, off the coast of Scotland, Japan and Norway had found almost identical models. When the prophet Isaiah said, "and the key of the house of David will I lay upon his shoulder" (xxii, 22), he probably alluded to a lock of this type. Fig. 1 shows an ancient Egyptian lock dismantled. Both the lock and the key are constructed entirely of wood.

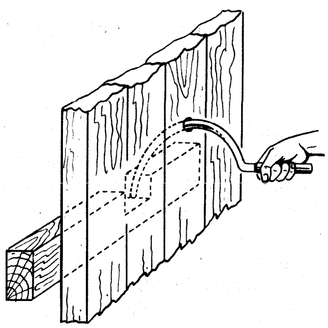

FIG. 2.—GREEK LOCK WITH HOOK KEY

The vertical piece of wood, the staple, is fixed to the doorpost and contains in the upper part movable pins, in this case, six in number; the crosspiece is the bolt. The pins in the staple fall into corresponding holes in the [illegible] by corresponding pins fixed on the key. Only the key made specially to fit the lock could operate it and a reasonable degree of security was achieved.

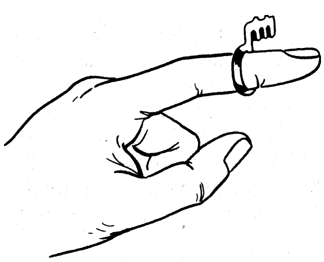

FIG. 3.— ROMAN FINGER RING KEY

The early Greeks employed a sliding bolt or bar in their locks, securing it by threading a rope through a hole and tying an intricate knot. Since only the owner could tie and retie the knot in exactly the same pattern, unauthorized entry could be detected easily. Security in this era depended upon the erstwhile thief's willingness to risk discovery and the certain punishment of death. The so-called Gordian knot of Greek mythology may have had its origin in this locking device.

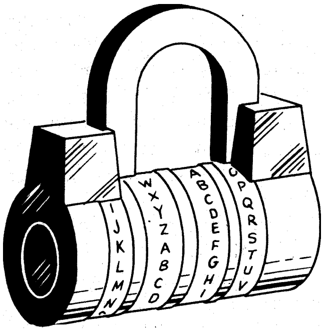

FIG. 4.— COMBINATION PADLOCK

Another Greek lock used in Homer's time (probably earlier than 800 B.C.) consisted of a wooden crossbar suspended by brackets on the inside of the door. The keyhole made its first appearance here. The bolt was moved to the locked or open position by inserting a large hook similar in appearance to a farmer's sickle through the keyhole far enough to reach the bolt. Fig. 2 shows the principle. The keys measured up to three feet in length. Carried on the shoulder, a key of this size and weight would also lend itself for use as a weapon of defense.

Metal locks came into being with the Romans. They used iron for the bodies of the locks and bronze for the keys. As a result, the locks themselves corroded and disintegrated, leaving no examples for future observation. Only the bronze keys remain. From these it has been learned that the Romans were the first to use wards or obstacles in the keyholes to prevent any but the correctly shaped key to move the bolt. Another contribution of the Roman lockmakers was the development of small keys, which were often attached to finger rings (fig. 3) so that they could be safely carried.

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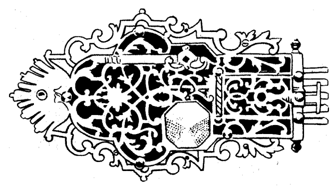

BY COURTESY OF 'ARKES & SONS

FIG. 5.—17TH-CENTURY LOCK AND KEY FROM TOURNEY. AIX-LA-CHAPELLE

Along with the Romans, the early Russians, Hindus and Chinese are credited with the development of the portable lock or padlock. Craftsmanship of the highest form found expression in these devices, which often took the form of birds. fish, dogs and geometric patterns. Gold and silver inlays and filigree work decorated their exteriors. From the east also, was introduced the puzzle lock, which contained hidden keyholes or disguised buttons to be pressed before the locks would open.

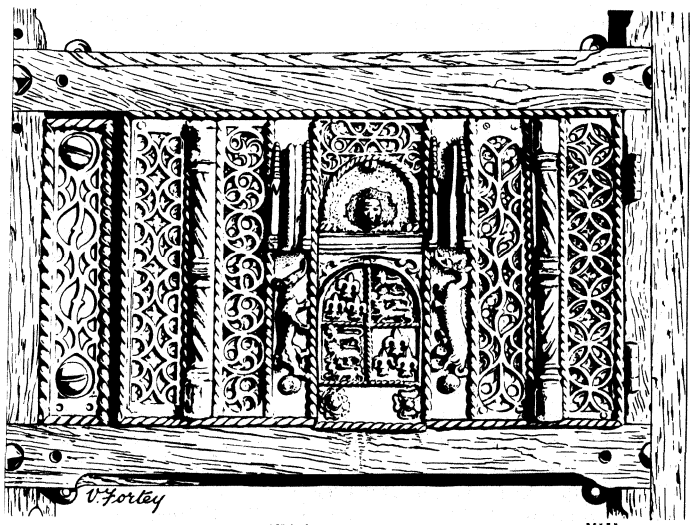

FIG. 6.— THE BEDDINGTON LOCK, BELONGING TO HENRY VIII

Combination locks had their beginnings with the Chinese. These were in padlock form and consisted of a number of lettered rings revolving around their bolts. When the correct combination of letters was set in a straight line, the bolt could be withdrawn from the rings. Fig. 4 shows a facsimile of a letter or combination padlock.

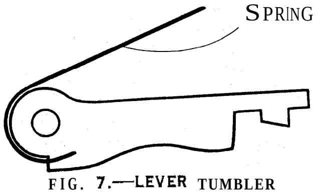

FIG. 7.—LEVER TUMBLER

The mediaeval and Renaissance periods produced locks of very beautiful-design as regards their exterior cases, but small attention was paid to security and convenience. Fig. 5 is a 17th-century lock of French origin. It measures 17¼ in. x 9½ in. and the key is 7¾ in. long. Fig. 6 shows a 16th-century lock 14 in. x 8 in., which belonged to Henry VIII. It is said that wherever he went the lock went with him and was screwed to his bedroom door.

Although locks of the mediaeval and Renaissance periods were massive and mechanically intricate, they had additional features to frighten away the boldest of thieves. There were locks that shot bullets at the would-be burglar, locks that would cut off his fingers if he attempted to reach the bolt works, and springs that ejected knives to stab him if he tampered with the keyhole.

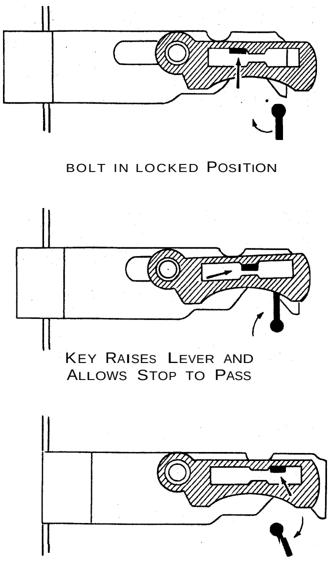

FIG. 8.— ACTION OF LEVER TUMBLER IN STAGES OF UNLOCKING

Improvements and Inventions.—Modern lock history began in the 18th century when French locksmiths employed lever tumblers (fig. 7) in their locks. Until that time, lock security depended upon intricately designed keyways, and obstructions placed around the keyhole to prevent all but the correct key from turning in the lock. These baffles. however. did not discourage the lock picker, who soon learned how to bypass them. The lever tumbler, acting as a secondary safety device, dropped into a notch in the bolt and secured it against moving or sliding until it was lifted up by the proper key.

In 1778 Robert Barron of England improved the construction by attaching a "stop" or stump on the bolt and devising a slotted lever tumbler that had to be raised an exact, specified height before the stop could pass through the slot (fig. 8). By employing several such tumblers, he achieved excellent security against pass-keys and lock picks. This principle is used in present day lever tumbler locks.

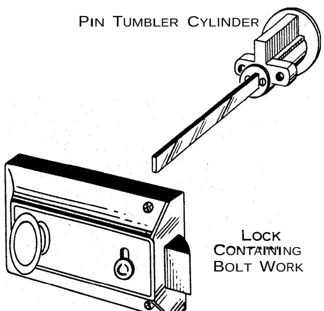

FIG. 9.—TYPICAL CYLINDER LOCK SEPARATED TO SHOW THE TWO MAJOR PARTS

Cylinder Locks.—In 1861, Linus Yale, Jr., of the United States revolutionized the lock industry with his invention of the pin tumbler lock. His contribution was threefold: he designed his lock so that it could be produced by machine tools on a mass production basis; he separated the key mechanism (pin tumbler cylinder) from the bolt (fig. 9), thus permitting application of his cylinder to any thickness of door, and to any style or position of bolt works; he eliminated the need for long, heavy keys since it was no longer necessary to penetrate the door to reach the bolt works. Fig. 10 shows a cutaway view of a pin tumbler cylinder with five pin tumblers. The inner cylinder, or plug, is prevented from rotating because the pins in the upper section extend into the plug thereby locking it securely. Fig. 11 shows the same cylinder with the correct key inserted. Each notch of the key has raised the lower segment of each tumbler to the surface of the plug. Hence. the plug is free to rotate as shown in the illustration. Literally, hundreds of thousands of variations requiring as many different keys are made available by merely changing the lengths of the pins. Additional individuality is obtained by varying the grooves of the keyway. When the word "lock" is used in connection with a pin tumbler cylinder lock, it refers to the assembly containing the bolt works. The pin tumbler cylinder is called simply the cylinder.

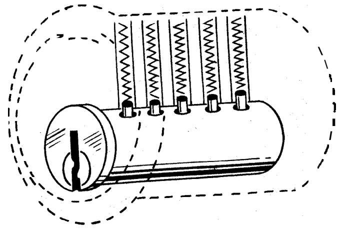
FIG 10—PIN TUMBLER CYLINDER IN LOCKED POSITION

The disk tumbler cylinder (fig. 12) is a variant of the pin tumbler cylinder. Instead of segmented pins, the locking function is provided by movable wafers or disks which lock the plug to the body of the cylinder. The use of disk tumbler cylinders is limited to low-priced locks.

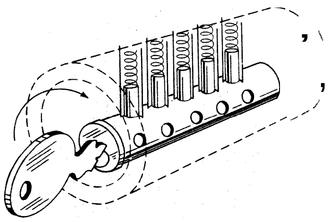
FIG. 11—PIN TUMBLER CYLINDER IN UNLOCKING POSITION

A further variation of the cylinder construction is the side bar cylinder (fig. 13), which is used in millions of motor vehicles. This cylinder contains six disk tumblers which are notched at the sides.

When the correct key is inserted. all six notches fall into alignment. The side bar immediately springs into the notches. thereby releasing the plug from the body of the cylinder and alloning it to rotate.

Modern locks are classified into six major groups. Fig. 14 to 17 illustrate the common types. A rim lock (fig. 14) is applied directly to the surface of the door. The mortise lock (fig. 15) fits into a cutout or cavity, which has [illegible] the fact that the tumbler mechanism is contained in the knob. This type was invented in 1909 by Ernest Schlage. A cabinet lock (fig. 17), as its name implies, is used on a cabinet door or drawer. A padlock (fig. 18) is a hanging lock which may be used in conjunction with two staples, a chain or a hinge type device known as a hasp. An electric switch lock (fig. 19) is a pin tumbler or disk tumbler lock that completes an electric circuit when the key is turned. These types are used in motor vehicles, electric panels and safety devices. While motor vehicle door locks appear to be another group, they are actually variations of the foregoing types, which have been designed specifically for use in metal doors.

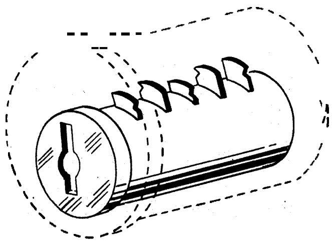
FIG. 12.— DISK TUMBLER CYLINDER

In addition to the groups listed above, there are special purpose [illegible] the inside of a room in case of emergency, but are secure against attack from the outside. Another type is the utility lock, which is used on parking meters and vending machines. There are coin box locks, billard cue locks, bottle top locks, gun trigger locks, bicycle locks, telephone locks and many other specially designed devices to guard specific objects.

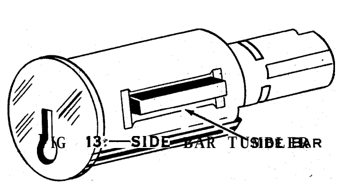
FIG. 13.—SIDE BAR TUMBLER

Master Keyed Locks.—Where many locks are used in one building or a series of buildings, the number of keys a person would have to carry could become a heavy burden. Although the simplest idea would be to set up all locks alike so that one key could operate them, the security feature would be lost. Everyone could open his neighbour's lock and vice versa. To avoid this situation, modern lockmakers and locksmiths employ "master key systems." By equipping each

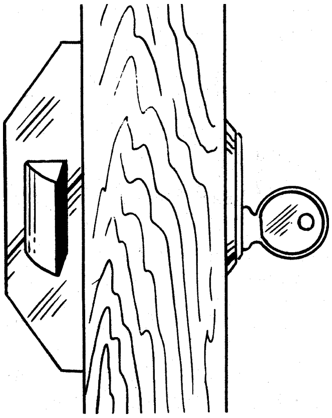

FIG. 14.—RIM LOCK

cylinder with an additional set of pin tumblers. each lock can be operated not only by a private key, but also by a master key that can open every lock in the establishment. This system is particularly useful in commercial buildings where individual tenants must have access to their own rooms, but not to their neighbour's, and where the landlord or custodian must have access to all rooms in case of emergency.

In some cases, the reverse of a master key system is required. For example, when a number of tenants in a building require access to a common entrance, they desire to use the keys for their rooms to open the entrance door also. The arrangement of tumblers in the entrance door lock is similar to that of the master key system in that additional pins are added. The pins, however, are added to the one lock only. This arrangement is known as the Maison system.

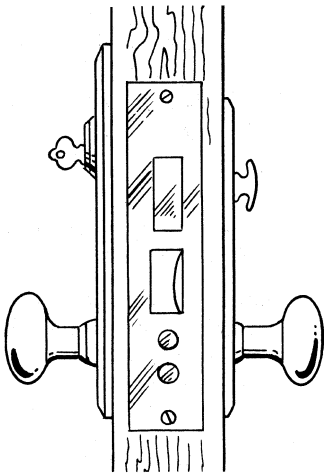

FIG. 15.— MORTISE LOCK

Combination Locks.—Combination locks are used primarily on safes, money chests and record cabinets, and do not require the use of a key. Fig. 20 illustrates a typical safe lock. It affords good security because the mechanism is completely enclosed. It has no keyway through which picks can enter. To open this lock, the operator is required to employ a given succession of numbers on the dial, which causes the tumblers within the lock to wheels

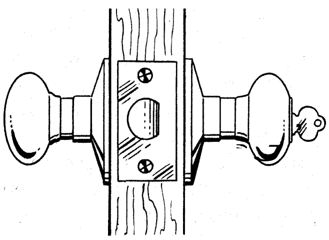

FIG. 16.—KEY-IN-KNOB LOCK

align themselves in such a manner that the bolt or locking levers become free to move into the unlocked position. A modern safe lock has three to five wheels. depending upon the factor of security required.

The use of combination locks in modern times dates from 1862 when Linus Yale, Jr., introduced them. Although minor improvements were added, the basic design remained unaltered until 1947 when Harry C. Miller invented the manipulation-proof combination lock. The need mas imperative, because by this time skilled burglars had learned to open ordinary combination locks by the sense of touch.

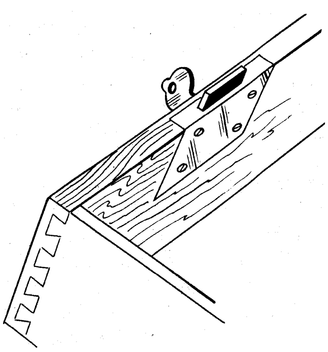

FIG. 17.— CABINET DRAWER LOCK

Time Locks.—In the latter part of the 19th century, bank robbers employed a new technique. They seized the officers or custodians, kidnapped and tortured them to obtain the combination of the locks. Thereupon they would proceed to the bank under cover of night and open the vault.

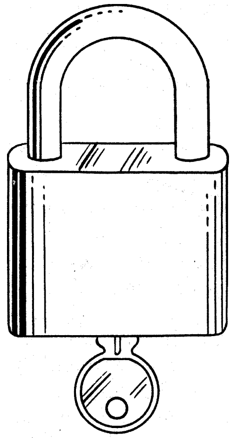

FIG. 18.—PADLOCK

To prevent this, James Sargent of Rochester, N.Y., invented the time lock in 1872. This device prevented the opening of the vault until such time as the bank was open for normal business. The time lock, which consists of a series of watch movements in addition to a combination lock, is standard equipment in almost every bank or depository throughout the world.

Safe-Deposit Locks.—The growth of the use of safe-deposit boxes, where people can store securities, valuable papers and jewels in a fireproof and guarded building, created a new need for locks of greater security. Since such depositories were placed in public buildings, additional precautions were necessary to prevent unauthorized persons from stealing keys and representing themselves as the renters of the boxes. Accordingly, a safe-deposit lock is so designed that two keys are required to open it. One key is in the possession of the box renter. Upon recognition of the renter, the guard and renter use their keys to open the box together. An additional feature,

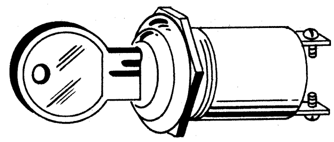

FIG. 19.—SWITCH LOCK

found in more expensive safe-deposit box locks, is the changeable key system. The combination or arrangement of the tumblers in such a lock may be changed by the insertion of a special key which frees the tumblers from their former set position. Upon the insertion of a new key, the tumblers rearrange themselves into a pattern that conforms to the new key. This feature prevents the transference of the key used by a former box holder to a new holder.

Electronic and Remote Control Locks.—The need for maximum security in the military establishments of various governments and in prisons has led to the development of complex locking systems that are combined with alarms, recording devices and automatic controls. In the mid-1950s, a series of research programs developed remote control devices by which vaults and compartments might be opened by someone situated miles away. Although these devices may fall more properly in the category of electronic, electric or hydraulic systems, they are considered by the lock industry to be the natural outgrowth of the quest for greater physical security and, as a consequence, lie within the lockmakers' field of research.

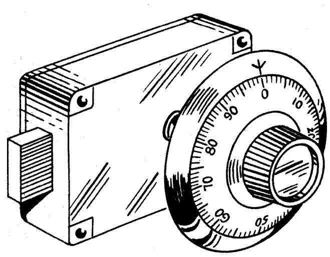

FIG. 20.— SAFE LOCK

Although almost every civilized country in the world has its lockmakers, the major producers at mid-20th century were the United States, Great Britain and Germany. In the bid for the world market, Australia, Canada, Denmark, France, the Netherlands, Italy, Japan and Sweden played increasingly important roles.

Bibliography.—*Locksmith Ledger* (1946–57); Adon Brownell, *Taking the Mystery Out of Builders' Hardware*, 2nd ed. (Philadelphia, 1956); *Locks and Builders' Hardware* (Staffordshire, 1950); Vincent J. M. Eras, *Sloten En Sleutels Door De Eeuwen Heen* (Dordrect, Netherlands, 1941); Sigfried Giedion, "A Complicated Craft Is Mechanized," *Technol. Rev.* (Nov. 1943); Albert A. Hopkins, *The Lure of the Lock* (New York, 1928). (M. L. Sr.)

LOCK, in canal or dock engineering, a watertight chamber, closed by gates at each end, used as a means of transferring vessels from one level or reach of a canal or canalized river to another;

or at the entrance of a dock to enable vessels to be raised from a lower to a higher level, or vice versa.

Entrance locks are not usually embodied in the construction of dock works unless the range of tide is considerable, exceeding 14 ft. or thereabouts. An analogous principle is used in compressed air working where air-locks are employed for the transfer of men and materials from atmospheric to higher pressures and vice versa.

See WATERWAYS, INLAND; PANAMA CANAL, etc.

(N. G. G.; X.)

LOCKE, DAVID ROSS: *see* NASBY, PETROLEUM V.

LOCKE, JOHN (1632–1704), English philosopher. the inspirer of the Age of Enlightenment and of Reason in England and in France and. more than a quarter of a millennium after his death, still a powerful influence on the life and thought of the west, was born on Aug. 29, 1632, at Wrington, Somersetshire. His father, a small landowner and attorney. was a strict but genial Puritan who fought on the parliamentary side in the Civil War. The relations between father and son were ideal and left their mark on Locke's educational theory. In 1646 he entered Westminster school. Probably the warnings in *Some Thoughts concerning Education* against learning by rote and against beginning the study of languages by grammar were suggested by his own experiences at school. In 1652 he entered Christ Church, Oxford. then under John Owen, the Puritan dean and vice-chancellor of the university.

For some years after Locke entered. Oxford was ruled by the Independents. who were among the first in England to advocate religious toleration. But Locke's hereditary sympathy with the Puritans was gradually lessened by the intolerance of the Presbyterians and the fanaticism of the Independents, and he had no use for the scholastic philosophy still taught at Oxford. From 1661 to 1664 he was lecturing in Greek. rhetoric and philosophy. The works of Descartes gave him a relish for philosophy, although he often differed from them. We find him experimenting in chemistry in 1663, also in meteorology. in which he was always interested. Locke's religious disposition attracted him to theology. but he felt that he had no real vocation for holy orders and turned to medicine as a possible profession. Then began his friendship with Robert Boyle and with Thomas Sydenham. Sydenham adopted empirical methods in medicine, just as Boyle did in chemistry, and Locke interested himself deeply in the experiments of both.

In 1666, soon after his return from accompanying Sir Walter Vane on his mission to the elector of Brandenburg. Locke met Lord Ashley, afterward first earl of Shaftesbury. This was the beginning of a lasting friendship, sustained by common sympathy with liberty—civil, religious and philosophical. In 1667 he moved to Exeter house. Lord Ashley's London residence, to become his confidential secretary. Although he retained his studentship at Christ Church, he found a home with Shaftesbury for 1j years.

At Exeter house Locke held informal reunions to discuss debatable questions in moral and political philosophy, science and theology. One of these, in 1670, is historically memorable. "Five or six friends," he says in opening the *Essay,* "meeting at my chamber, and discoursing on a subject very remote from this, found themselves quickly at a stand by the difficulties that arose on every side." Locke proposed to attempt some criticism of man's abilities and of the limits of his understanding. What was thus "begun by chance, was continued by entreaty, written by incoherent parcels, and, after long intervals of neglect, resumed again as humour and occasions permitted." In 1690, the issue was given to the world as *An Essay concerning Humane Understanding.*

The discussion here referred to took place in 1671, and later in the same year Locke wrote two drafts of the *Essay* which are extant in the valuable Lovelace collection of his papers. The study of these papers in the 20th century shed a flood of fresh light on the *Essay* itself and on Locke's philosophy generally. They consist of a large collection of letters, notebooks! journals, catalogues of his library, etc., with many manuscript pieces. In addition to the two drafts of the *Essay,* some of the more important manuscripts in the collection belonging to this period bear the following titles: *Treatise on Civil Magistrates,* 1660; *Essays on the Law of Nature, 1663; An Essay concerning Toleration,* 1667. They reveal Locke's early interest in questions of moral and political philosophy, in toleration and in those matters which afterward concerned him in his published works. Though the latter did not appear for another two decades or so it is clear that throughout these years Locke seized every opportunity to meditate upon the problems discussed in them.

The fall of Shaftesbury in 167j and his own ill-health drove Locke from English political circles to France, where he spent three years, partly at Montpellier and partly in Paris.

In Paris he met men of science and letters—Peter Guenellon, the Amsterdam physician; Ole Romer. the Danish astronomer; Nicolas Thoynard, the critic; Melchisédech Thkvenot, the traveller: Henri Justel, the jurist: and François Bernier, the expositor of Pierre Gassendi. But there is no mention of Nicolas Malebranche or of Antoine Arnauld. In 1679 Locke resumed his relations with Shaftesbury, at Thanet house in Aldersgate, London. It was a time of plots and counterplots. and in the end Shaftesbury was committed to the Tower. tried and acquitted. More insurrectionary plots followed in 1682, after which, suspected at home, Shaftesbury escaped to Holland and died at Amsterdam in Jan. 1683. In these two years Locke was much at Oxford and in Somerset; but our information concerning his activities is scant. The letters of Humphrey Prideaux and of John Fell show that Locke was suspected at court. Correspondence with his Somerset friend. Edward Clarke. of Chipley, describes Locke's life in those troubled years and reveals the opening of his intimate intercourse with the Cudworth family. The letters allude to toleration in the state and comprehension in the church and show an indifference to theological dogma.

In 1683, Locke retired to Holland, then the asylum of exiles in search of liberty of thought, where he spent more than five years. For a time he was in danger of arrest at the instance of the English government. After months of concealment at Amsterdam, under the assumed name of Dr. Van der Linden he escaped; but he was deprived of his studentship at Christ Church by order of the king, and Oxford was thus closed against him. In Holland he met Philipp van Limborch, the Remonstrant professor of theology, and Jean Le Clerc, whose *Bibliothèque universelle et historique* was then the chief organ in Europe of men of letters. Locke contributed several articles. It was his first appearance as an author, although he was now 54 years of age.

The *Essay* was finished in Holland, and a French epitcme appeared in 1688 in Le Clerc's journal, the forecast of the larger work. Locke was then at Rotterdam, where he was a confidant of political exiles, including Gilbert Burnet and Charles Mordaunt (later 3rd earl of Peterborough and Monmouth); and h became known to William of Orange. William landed in England in Nov. 1688; Locke followed in Feb. 1689, on the ship which carried the princess Mary.

After his return to England Locke emerged into European fame. Within a month after he reached London he had declined an offer of the embassy to Brandenburg and accepted the modest office of commissioner of appeals. His defense of religious liberty, the *Epistola de Tolerantia,* was published at Gouda in the spring of 1689 and translated into English in the autumn by William Popple, a Unitarian merchant in London. *Two Treatises oj Government,* in defense of the right of ultimate sovereignty in the people, followed, with the intention of demonstrating William III's right to the throne. The *Essay concerning Humane Understanding* appeared early in 1690. He received £30 for the copyright.

The course of public affairs disappointed him, for the settlement at the Revolution fell short of his ideal of toleration and civil liberty. In spring 1691 he went to live at Oates manor in Essex, the country seat of Sir Francis Masham. Lady Masham was the accomplished daughter of Ralph Cudworth and had been his iriend before he went to Holland. At Oates he enjoyed for 14 years as much domestic peace and literary leisure as was consistent with broken health and sometimes anxious visits to London on public affairs. In his letters and otherwise we have pleasant pictures of its domestic life and the occasional visits of his friends, among others Lord Peterborough, the Lord Shaftesbury of the *Characteristics,* Sir Isaac Newton, William Molyneux and Anthony Collins.

The *Letter concerning Toleration* involved him in controversy. An *Answer* by Jonas Proast of Queen's college, Oxford, had drawn forth in 1690 a *Second Letter*. A rejoinder in 1691 was followed by Locke's elaborate *Third Letter for Toleration* in 1692. In the latter year he also addressed to Sir John Somers *Some Considerations of the Consequences of the Lowering of Interest, and Raising the Value of Money*. When he was in Holland he had written letters to his friend Clarke of Chipley about the education of his children. These letters formed the substance of *Some Thoughts concerning Education* (1693). which remains an educational classic. Sor were the "principles of revealed religion" forgotten. The subtle theological controversies of the 17th century made him anxious to show the simplicity of fundamental Christianity. In the *Reasonableness of Christianity as delivered in the Scriptures* (anon., 1695), Locke sought to separate the teaching of Jesus from later accretions. This involved him in controversies that lasted for years, and his *Vindication,* followed by a *Second Vindication* in 1697, added fuel to this fire. Above all, the great *Essay* was assailed and often misinterpreted by philosophers and divines. John Norris having criticized it in 1690, Locke's second winter at Oates was partly employed in *An Examination of Père Malebranche's Opinion of Seeing all Things in God* and in *Remarks upon some of Mr. Norris's Books,* tracts which throw light upon his own ambiguous theory of perception through the senses (they were published after his death). *A* second edition of the *Essay,* with a chapter added on "Personal Identity" and numerous alterations in the chapter on "Power." appeared in 1694. The third, a reprint. was published in 1695. John Wynne's well-known abridgment helped to make the book known in Oxford, and his friend William Molyneux introduced it in Dublin. In 1695 a revival of controversy about the currency diverted Locke's attention. Events in that year occasioned *Short Observations on a Printed Paper intituled "For Encouraging the Coinage of Silver Money in England and Keeping it there"* and *Further Considerations concerning Raising the Value of Money*.

In 1696 Locke accepted a commissionership on the board of trade which entailed frequent visits to London. In the autumn Edward Stillingfleet. bishop of Worcester, in his *Vindication of the Doctrine of the Trinity,* charged Locke with disallowing mystery in human knowledge, especially in his account of the metaphysical idea of "substance." Locke replied in Jan. 1697. Stillingfleet's rejoinder appeared in May, followed by a *Second Letter* from Locke, to which the bishop replied in the following year. Locke's *Third Letter* was delayed until 1699, in which year Stillingfleet died. One of the ablest of the other critics of the *Essay* was John Sergeant, a Catholic priest, in *Solid Philosophy Asserted against the Fancies of the Ideists* (1697). He was followed by Thomas Burnet, William Sherlock, Henry Lee and others. The *Essay* itself meanwhile spread over Europe, impelled by the name of its author as the chief philosophical defender of civil and religious liberty. The fourth edition appeared in 1700, with important additional chapters on "Association of Ideas" and "Enthusiasm." What was originally meant to form another chapter appeared among Locke's posthumous writings as *The Conduct of the Understanding,* one of his most characteristic works.

In 1700 Locke resigned his commission at the board of trade and devoted himself to biblical studies and religious meditation. He turned to the Epistles of St. Paul and applied the spirit of the *Essay* and the ordinary rules of critical interpretation to a literature which he venerated as infallible. The results, *A Paraphrase and Notes on St. Paul to the Galatians* and *A Paraphrase and Notes on the Epistles to the Corinthians* were published in 1705 and in 1706; and a tract on *A Discourse of Miracles,* written in 1702, also appeared posthumously. His last days were occupied in beginning a *Fourth Letter on Toleration,* never finished, in reply to an attack made by Jonas Proast in 1704. Locke died on Oct. 28, 1704, and was buried by the parish church of High Laver.

(A. C. F.; R. I. *A.)*

LOCKE'S PHILOSOPHY

Theory of Knowledge.—Locke was thoroughly suspicious of the view that a thinker could work out in his study by pure reason alone the truth about the universe. Much as he admired Descartes, he feared this speculative spirit in him, and he despised it in the scholastic philosophers. In this sense he rejected metaphysics. Knowledge of the world around us could only be gained by experience and reflection on experience, and this knowledge was being gained by Boyle. Sydenham, Christiaan Huygens and Newton. They were the true philosophers who were advancing knowledge. Locke set himself the humbler task. as he conceived it, of understanding how this knowledge was gained. What was "the original. certainty and extent of human knowledge, together with the grounds and degrees of belief, opinion and assent"?

Empiricism.—As for "the original", the answer was plain. Knowledge of the world around us began in sense-perception, and knowledge of ourselves in introspection, or "reflection" in Locke's language. It did not begin in innate knowledge of maxims or general principles, and it did not proceed by syllogistic reasoning from such principles. In the 17th century there had been much vague talk about innate knowledge, and in book i of the *Essay concerning Humane Understanding* Locke examines this talk and shows its worthlessness. The case that he makes against innate ideas, being now of historic interest only, need not detain us. In book ii of the *Essay* he begins by claiming that the sources of all knowledge are sense-experience and reflection; they are not themselves, however, instances of knowledge in the strict sense, but they provide the mind with the materials of knowledge—and already Locke is opening the door for the phenomenalism and the idealism of the future. Sense-experience is not direct knowledge of the world as it is. The senses provide the mind with "material"; he is not sure what to call the material so provided, perhaps "species" (as the Scholastics did) or "notions", but he finally decides on "ideas." These are the objects "before the mind," but we must not assume that the ideas are the physical objects. Rather they represent them; and though we may concur with common sense that, for instance, physical things have size, shape, weight, as they appear to have, yet in respect to colour, taste, smell and so on we may seriously doubt whether things are as they appear to be in sense-experience. In a word. Locke accepts the representative theory of sense-perception and holds that while some of the representations are exact copies of the physical, most of them are not. On this basis he distinguishes between what he calls primary qualities, such as size, weight, etc., and secondary, such as colours, tastes, smells and sounds.

Locke now proceeds to group and classify the ideas, with a view to showing that the origin of all of them lies in sensation and reflection. For though they are immediately "before the mind" not all of them are simple. Many of them are compounded and their simple parts can be revealed on analysis. It is these simples alone which are given in sensation and reflection. Out of them the mind forms complex ideas, though Locke is ambiguous on this point. For while he uses the language of "forming" or "compounding" and speaks of the "workmanship" of the mind. yet the compounding is frequently in accordance with what is perceived "to go together" and is not arbitrary. A conflict is apparent between Locke's desire to sustain the common-sense view that we do know physical objects and the demands of his compositionalist theory that all ideas can be reduced to the simple ideas of sensation and reflection of which they were originally compounded. Further troubles met him in his attempt to classify ideas. While the idea of a particular apple may be a complex of round, sweet, red, etc., what of the general idea of apple? And what of ideas of relation, such as taller than, identical with, etc.? Locke's compositionalism in this part of the *Essay* is patently insecure; yet its purpose is clear. namely, to provide him with a method of showing that all ideas, however remote they may appear to be from sense-experience and reflection. are in fact derived from these sources and from no other. This applies even to the idea of infinity itself. Ideas of space, time and number and mathematical ideas are derived, too, from simple ideas; Locke saves himself from the difficulties inherent in this position by the superficiality of his treatment.

So, too, his reflections upon cause and effect, had they been elaborated, would undoubtedly have led him into acute difficulties.

He does admit one failure. As an empiricist he can give no account of the idea of substance; it is, he thinks, essential and not to be denied, and yet it is not a simple idea given in sensation or reflection nor is it derived from simple ideas so given. In fact he can say little of it; it is "a-something-I-know-not-what." Thus the case for empiricism cannot be said to be entirely established by book ii, but Locke thinks it strong enough for him to persist in the view that our knowledge of the physical world is wholly derived from sense-perception.

Self-Knowledge.—Some of our ideas are not of things outside us, but are reflexive and of ourselves. Locke finds it necessary to classify these in book ii and in doing so sets doun the foundations of empirical psychology. His source of information is introspection and rarely the observation of behaviour. His account of sense-perception is celebrated for its appreciation of the part which the interpretative mind plays in perceiving; he makes valuable remarks on memory, on discerning, on comparing, on madness, on pleasure and pain, on the emotions and on the association of ideas.

He holds that we have an intuitive knowledge of our own existence and supposes that we exist as material and immaterial substances, but he is none too clear about this and at one point plays with the idea that we are simply material substances to which God has "superadded" a power of thinking. His most valuable contribution. however, is his account of personal identity. Having distinguished between different types of identity, he argues that personal identity depends on self-consciousness. I am the person who did so-and-so 20 years ago because I can remember myself doing it. This is the key to the identity of persons.

Language.—Locke tells us that book iii. on language, "cost him more pains" than any other book of the Essay; yet it is the book which has been most neglected. To understand our thinking and knowing we must understand the language with which we think and communicate our thoughts. Words are conventional signs; but signs, according to Locke, not immediately of things but of ideas of things, so that he carries his theory of ideas into his account of language. Frequently, the idea signified by the word is not clear and sometimes we use words when we have no ideas corresponding to them. This is particularly so in the case of general words, without which language would be so impoverished as to lose most of its worth What is involved in the use of general words? The answer, in Locke's mind, is bound up with the theory of universals Does the general word stand for a particular idea which is used in a representative capacity? Or is the universal nothing more than a creation of the mind, through abstraction, to which is attached a name? Or, again, is it simply the manner in which we desire that this general word be used? Locke considers these matters without giving a definite answer, but in dealing with natural substances he is inclined strongly toward a conceptualism, according to which the use of general words is possible only because in using them we have in mind "nominal essences," that is to say, not the real essences of things but what we mean by these general words. On this view what we mean is the concept, something we have ourselves brought about, the "workmanship of the understanding." Locke also discusses the names of simple ideas and of relations, and it is interesting to find the crude beginnings of a discussion of what are today called logical or operative words.

Book iii contains also a valuable account of definition, which denies the theory that all definition must be per genus et *differentiam.* The final chapters deal with the inevitable imperfections of language and with avoidable abuses.

Conclusions.—After the consideration of the "materials" of knowledge in book ii and of language in book iii, Locke is ready to discuss the nature and extent of human knowledge. It is noticeable that the tone of book iv is more rationalistic than is that of the previous books, and this is because the scepticism which emanated from his empiricism drove him to find the ideal of knowledge in the indubitable certainties of mathematics. Here he was on common ground with the rationalists of his day, and indeed the direct influence of Descartes seems to be observable in the opening chapters of book iv. Knowledge is perception; not sense-perception but intellectual perception or intuition. We do not, however. gain all the knowledge that we require by direct intuition: we have frequently to proceed discursively, that is. by demonstration. But even when this is so, each step in the demonstration is observed intuitionally, so that knowledge in the strict sense is essentially intuitive. "This part of knowledge is irresistible and, like bright sunshine, forces itself immediately to be perceived, as soon as ever the mind turns its view that way; and leaves no room for hesitation, doubt or examination."

Unfortunately, what can be so intuited is limited, as is too what can be demonstrated. We need not confine strict knowledge entirely to mathematics. but the intuition of relations within the physical world is beyond us Books ii and iii have shown that we deal directly with ideas and nominal essences and that the inner nature of real things cannot be known by us, so that "science." in the exact sense of perfectly certain knowledge, is not possible in this sphere. The only possibility of intuiting, consistent with books ii and iii, is that within the world of ideas, an ideal world, be it noted, which is for Locke empirically derived and not intellectual in character. Kno ledge in general term, he accordingly defines as the intuition or "perception of the connection of and agreement, or disagreement and repugnancy, of any of our ideas." If we keep ourselves within ideas—and this is the case in mathematics, for instance—we gain indubitable knowledge, but when we deal with ideas "whose archetypes are without them" we are less sure.

The connections between ideas may be of four kinds: (1) identity or diversity; (2) relation, such as larger than, wider than, etc.; **(3)** co-existence, such as the co-existence of malleableness and yellowness in my idea of gold; and (4) real existence. Of these four, knowledge of identities and differences is as wide as the ideas themselves: if, that is to say, we have the idea of a spade we know that that idea is itself, and that it is not the idea, for example, of a hammer.

Secondly, in dealing with the relations between ideas which are their own archetypes, for instance in mathematics, we need seek no further than the intuition or perception itself. But when, thirdly, we affirm co-existences there is an implied reference beyond the idea to the thing itself; and clearly this is also the case when, fourthly, we say that something exists. In these cases, therefore, our certain knowledge is not likely to extend very far.

In other words, Locke is distinguishing here between logical and factual truth. Of the former, he thinks, certain knowledge is possible but not of the latter.

In spite of this, and somewhat inconsistently, Locke thinks we do have knowledge approaching certainty in our "sensitive knowledge" of the existence of physical things. Further, we intuit our own existence. In these cases knowledge which is not an apprehension of a relation between ideas is none the less certain But he makes it clear that, for the most part, when we talk of knowledge of the physical world and of ourselves, such knowledge is probable and not certain. He recognizes the need for a logic of probability; though he does little himself in the chapters devoted to probable knouledge at the end of book iv to meet that need. Yet it should be added that the important regular-sequence theory of induction, afterward developed by Berkeley and Hume, is put forward in the pages of Locke's Essay. He speaks, too, in book iv, though only briefly, of "habitual knowledge" and is aware of the dispositional element in knowledge.

Political **Theory.**—Locke's most important work on political philosophy is that entitled Two Treatises of Government (1690). The first treatise is a refutation of Sir Robert Filmer's defense of the divine right of kings; the second and more important treatise refutes the absolutist theory of government as such, particularly that found in Hobbes' Leviathan, though the latter work is not mentioned. The whole sets out the political philosophy of the revolution of 1688 and seeks to help "establish the throne of our great restorer, our present King William." Locke defines political power as "a right of making laws, with penalties of death, and consequently all less penalties for the regulating and preserving of property and of employing the force of the community in the execution of such laws, and in the defence of the commonwealth from foreign injury, and all this only for the public good." He seeks to show the inevitability of this institution in terms of the theories of natural law and of social contract, now discredited. The outcome of his explanation is that only such political power can be justified as is genuinely "for the public good." This means that government is a trust. forfeited by a ruler who fails to secure the public good. The ruler's authority, that is to say, is conditional rather than absolute. Nor does the individual abrogate all his rights when he enters a civil society. He has established his right to property. by "mixing his labour" with things originally given to mankind in common, but now made his own by his labour. (Here in germ is the labour theory of value) He has the right to expect political power to be used to preserve his property, in his own person and in his possessions. He has the right to think as he chooses, to worship as he wishes. to freedom in speech. In fact the one right which he gives up in entering a civil society is the right to judge and punish his fellow man which is his right in the state of nature. He quits his "executive power of the law of Nature" and "resigns it to the public"; he himself makes himself subject to the civil law and finds his freedom in voluntary obedience. "Freedom of men under government is to have a standing rule to live by . . . a liberty to follow my own will in all things where that rule prescribes not, not to be subject to the inconstant, uncertain, unknown arbitrary will of another man." To secure this freedom, Locke favoured a mixed constitution: the legislative should be an elected body, whereas the executive is usually a single person. the monarch; and he argues for a separation of legislative and executive powers. The people are ultimately sovereign, though it is not always clear on Locke's theory where the immediate sovereignty lies. But the people always have the right to withdraw their support and overthrow the government if it fails to fulfil its trust. In economic theory Locke adopted the principles of the mercantilists.

Moral Philosophy.—One searches in vain for a consistent moral theory in Locke. His view that morality can be a science, as certain as mathematics, is well known. This might imply a rationalism, and there are indeed rationalist trends in his moral philosophy; although sometimes when advocating a science of morals he seems to have in mind simply the possibility of an exact analysis of the terms used in moral discourse and the clarification of moral statements. At other times, he puts forward a hedonist theory. "That we call *good* which is apt to cause or increase pleasure or diminish pain in us." But not every good is moral good: "*Moral* good and evil is only the conformity or disagreement of our voluntary actions to some law, whereby good or evil is drawn on us, from the will and power of the law-maker." On this view law rests on God's will, "the true ground of morality," though in saying this Locke does not appear to be consistent with what he says elsewhere of the law of nature.

On the question of free will, discussed in the *Essay*, Locke's position at first is determinist, but in the second edition he tries—not very successfully. it must be admitted—to defend the indeterminist theory by holding that man can always "*suspend* the execution and satisfaction" of any of his desires.

Theory of Education.—A good education, in Locke's view, attends to both the physical and the mental. The body is not to be coddled, on the contrary it is necessary that it should be hardened in various ways. The good educator insists on exercise, play and plentiful sleep, "the great cordial of nature." Young children should be allowed to give vent to their feelings and should be restrained rarely; "the chief art is to make all that they have to do sport and play too." As for mental training, character comes first before learning; the educator's aim is to instil virtue, wisdom and good breeding into the mind of the young. Parents, too, must interest themselves in their children's upbringing and, as far as possible, have them near; for no educative force is more powerful than the good example of parents. A stock of useful knowledge must be imparted. languages, the pupil's own and another modern language together with Latin (Locke thought the practice in his day of teaching Hebrew, Greek and Arabic generally was misguided); geography, history, some anatomy; mathematics, as the "powers of abstraction develop"; and later a little civil law and an introduction to morals, natural science and philosophy. For recreation, training in the arts, crafts and useful hobbies should be available, but these should not take up too much of a young man's time.

Religion.—Locke's reaction against the "enthusiasm" of the sects in his youth had been sharp, and he disliked religious fanaticism throughout his life. He was a broad, tolerant Anglican anxious to heal the breach in English Protestant ranks. His own views on church government and on the priesthood were close enough to those of the dissenters to have made union possible, for he favoured the liberal views of the Latitudinarians, of the Cambridge Platonists and of the Remonstrants of Holland. This becomes manifest in his *Reasonableness of Christianity,* while his commentaries on the Epistles of St. Paul make him one of the pioneers of modern biblical criticism. Two essentials, and two alone, he thinks, are involved in being a Christian: first, that a man should accept Christ as God's Messiah, secondly, that he should live in accordance with Christ's teaching. His point of view is not far removed from that of the Deists on the one hand and the Unitarians on the other, yet he cannot be grouped with them. Christianity, though reasonable, needs revelation as well as reason, for human reason alone is inadequate: there is an experience of God "through His Spirit" without which all religion is empty. However, any act of persecution in the name of religious truth is wholly unjustified, since our knowledge and understanding are so confined.

Bibliography.—After the *Posthumous Works of Mr. John Locke* had appeared in 1706, *The Works of John Locke* were published in 1714 (3 vol.), the second edition in 1722, the third in 1727, the fourth in 1740, the tenth in 1801 (10 vol.). The *Essay concerning Humane Understanding* appeared in 1690 and three other editions appeared in Locke's lifetime; *see* the edition by A. C. Fraser, 2 vol. (Oxford, 1894). *Two Treatises of Government* appeared in 1690; new ed. by J. W. Gough (London, 1946). Both the *Essay* and the *Treatises* are published in the Everyman Library (London, 1947 and 1953). *Some Thoughts concerning Education* appeared first in 1693; *see* J. W. Adamson (ed.), *Locke's Educational Writings,* 2nd ed. (Cambridge, 1922). Two early drafts of the *Essay* have been published, the first by R. I. Aaron and J. Gibb (Oxford, 1936), the second by B. Rand (Cambridge, Mass., London, 1931). *See* also *Essays on the Law of Nature,* ed. by W. von Leyden (London, 1954).

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LOCKE, *MATTHEW* (*c.* 1630–1677), English musician, perhaps the earliest English writer for the stage, was born at Exeter, where he became a chorister in the cathedral. His music, written with Christopher Gibbons (son of Orlando Gibbons), for James Shirley's masque *Cupid and Death,* was performed in London in 1653. He wrote some music for Sir William Davenant's *Siege of Rhodes* in 1656; and in 1661 was appointed composer in ordinary to Charles II. During the following years he wrote a number of anthems for the Chapel Royal, and excited some criticism on the score of novelty, to which he replied with considerable heat (*Modern Church Music; pre-accused, censured and obstructed in its Performance before His Majesty, April 1st, 1666, etc.*; copies in the Fitzwilliam museum, Cambridge, and the Royal College of Music). A good deal of music for the theatre followed, the most important being for Davenant's productions of *The Tempest* (1667) and of *Macbeth* (1672), but some doubt as to this latter has arisen, Henry Purcell, John Eccles and Richard Leveridge, being also credited with it. He also composed various songs and instrumental pieces, and published some curious works on musical theory.

Locke died in Aug. 1677, an elegy being written by Purcell.

LOCKE, WILLIAM JOHN (1863–1930), English novelist and playwright, born on March 20, 1863, in Georgetown, Demerara, was educated at Trinidad and St. John's, Cambridge. He died at Paris on May 15, 1930.

He wrote *The Morals of Marcus Ordeyne* (1905); *The Beloved Vagabond* (1906, dramatized 1908); *Stella Maris* (1913); *The Wonderful Year* (1916); *The Rough Road* (1918); *The House of Baltazar* (1920); *The Mountebank* (1921); *The Coming of Amos* (1924); *The Great Pandolfo* (1925); *The Old Bridge* (1926); *Ancestor Jorico* (1929). His original plays include *My. Cynic* (1899); *The Lost Legion* (1900): *and The Man from the Sea* (1910).

LOCKERBIE, a small burgh of Dumfries, Scot., in the district of Annandale, 12 mi. N.E. of Dumfries by road. Pop. (1951) 2,621. It is near the Roman road and of the Roman camps in the vicinity the best preserved is Burnswark (Birrenswark). Lockerbie is famous for its sheep sales. particularly for the great August lamb fair. The Tower of Lockerbie was once the stronghold of the Johnstones. long the ruling family under whose protection the town grew up. At Dryfe Sands, about 2 mi. W., the Maxwells were almost exterminated by the Johnstones in 1593, hence "Lockerbie Lick" became a proverbial expression, signifying an overwhelming defeat.

LOCKHART, JOHN GIBSON (1794–1854), Scottish writer and editor, was born on July 14, 1794, in the manse of Cambusnethan in Lanarkshire. He was sent to the Glasgow high school, where he showed himself clever rather than industrious. He fell into ill-health, and had to be removed from school before he was 12; but on his recovery he was sent at this early age to Glasgow university, and displayed so much precocious learning, especially in Greek, that he was offered a Snell exhibition at Oxford. He was not 14 when he entered Balliol college, where he acquired a great store of knowledge outside the regular curriculum. He read French. Italian, German and Spanish, was interested in classical and British antiquities, and became versed in heraldic and genealogical lore. In 1813 he took a first class in classics in the final schools. For two years after leaving Oxford he lived chiefly in Glasgow before settling to the study of Scottish law in Edinburgh, where he was called to the bar in 1816. A tour on the continent in 1817, when he visited Johann W. von Goethe at Weimar, was made possible by the kindness of the publisher, William Blackwood, who advanced money for a promised translation of Friedrich von Schlegel's *Lectures on the History of Literature,* which was not published until 1838. Edinburgh was then the stronghold of the Whig party, whose organ was the *Edinburgh Review,* and not until 1817 did the Scottish Tories find a means of expression in *Blackwood's Magazine.*

After a somewhat humdrum opening, *Blackwood* suddenly electrified the Edinburgh world by an outburst of brilliant criticism. John Wilson (Christopher North) and Lockhart had joined its staff in 1817. Lockhart no doubt took his share in the caustic and aggressive articles which marked the early years of *Blackwood;* but he was not responsible for the virulent articles on Samuel Taylor Coleridge and on "The Cockney School of Poetry"; *i.e.,* on Leigh Hunt, John Keats and their friends. He has been persistently accused of the later *Blackwood* article (Aug. 1818) on Keats. but he showed at any rate a real appreciation of Coleridge and William Wordsworth. He contributed to *Blackmood* many spirited translations of Spanish ballads, which in 1823 were published separately. In 1818 he met Sir Walter Scott, and the acquaintance soon ripened into an intimacy which resulted in a marriage between Lockhart and Scott's eldest daughter Sophia, in April 1820.

The Lockharts spent the winters in Edinburgh and the summers at a cottage at Chiefswood. near Abbotsford. In 1820 John Scott, the editor of the *London Magazine,* wrote a series of articles attacking the conduct of *Blackwood's Magazine,* and making Lockhart chiefly responsible for its extravagances. In a duel in 1821 between Christie and Scott. Scott was killed.

Between 1818 and 1825 Lockhart worked indefatigably. In 1819 *Peter's Letters to His Kinsfolk* appeared, and in 1822 he edited Peter Motteux's edition of *Don Qnixote,* to which he prefixed a life of Miguel Cervantes Saavedra. Four novels followed: *Valerius* (1821), *Some Passages in the Life of Adam Blair, Minister of Gospel at Cross Meikle* (1822). *Reginald Dalton* (1823) and *Matthew Wald* (1824). But his strength did not lie in novel writing. In 1825 Lockhart accepted the editorship of the *Quarterly Review,* which had been in the hands of Sir John Taylor Coleridge after William Gifford's resignation in 1824. He had established his literary position, and, as the next heir to "Milton Lockhart," the property of his unmarried half-brother. William. he was sufficiently independent, though he had abandoned the legal profession. In London he had great social success, and was recognized as a brilliant editor.

He contributed largely to the *Quarterly Review* himself, his biographical articles being especially admirable. He showed the old railing spirit in an amusing but violent article in the *Quarterly* on Alfred Tennyson's *Poems* of 1833, in which he failed to discover the mark of genius. He continued to write for *Blackwood;* he produced for *Constable's Miscellany* in 1828 what remains the most charming of the biographies of Robert Burns; and he undertook the superintendence of the series called "Murray's Family Library," which be opened in 1829 with a *History of Napoleon.*

But his *magnum opus* was the *Life of Sir Walter Scott, 7* vol., (1837–38; 2nd ed.. 10 vol., 1839). Lockhart was taxed in some quarters with ungenerous exposure of his subject, but to most minds the impression conveyed by the biography a-as, and is, quite the opposite. Thomas Carlyle did justice to many of its excellencies in a criticism contributed to the *London and Westminster Review* (1837). Lockhart's account of the transactions between Scott and the Ballantynes and Archibald Constable caused great outcry; and in the discussion that followed he showed unfortunate bitterness by his pamphlet, "The Ballantyne Humbug Handled." The *Lift? of Scott* has been called, after James Boswell's *Johnson,* the most admirable biography in the English language.

Resigning the editorship of the *Quarterly Review* in 1853, he wintered in Rome, and being taken to Abbotsford by his daughter Charlotte (Mrs. James Robert Hope-Scott), he died there on Nov. 25, 1854.

Lockhart's *Life,* 2 vol. (1897), was written by Andrew Lang. A. W. Pollard's edition of the *Life of Scott* (1900) is the best.

LOCKJAW: *see* TETANUS.

LOCKOUT: *see* STRIKES AND LOCKOUTS.

LOCKPORT, seat of Niagara county, in western Yew York, U.S., 25 mi. N.K.E. of Buffalo, and part of the Buffalo standard metropolitan area. The city owes its name to five double locks of the Erie canal (now part of the New York State Barge Canal system), which overcome a difference of 66 ft. between the levels of Lake Erie and the Genesee river. Abundant electric poner from Niagara falls serves diversified manufacturing interests, including pulp and paper, flour. wallboard, plastics. textiles, brooms, glass, foundry, brass and bronze products. automobile radiators and parts and sundry machine shop products. Located in the heart of the Niagara frontier fruit belt, the district is noted for its apple, peach and cherry orchards. Quarrying of limestone is also significant. In 1792–93, the Holland Land company bought the present Lockport site. and in 1816 sold most of it to Esek Brown, a local tavern proprietor. and 14 others. In 1822 the settlement was made the county seat and in the following year it became a temporary headquarters for construction on the Erie canal. Lockport was incorporated as a village in 1829 and as a city in 1865. For comparative population figures *see* table in NEW YORK: *Population.*

(A. G. SE.)

LOCKYER, SIR JOSEPH NORMAN (1836–1920), English astronomer, a pioneer in the application of the spectroscope to the sun and stars, was born at Rugby on May 17, 1836. Educated partly on the continent, He obtained a clerkship in the war office in 1857 and was appointed secretary to the royal commission on science in 1870. He became professor of astronomical physics in the Royal College of Science in 1881 and director of the Solar Physics observatory in South Kensington in 1885; he conducted eight governmental expeditions for observing total solar eclipses between 1870 and 1905.

Lockyer initiated, in 1866, the spectroscopic observations of sunspots; announced, in 1868, that the prominences were upheavals in a layer around the sun, which he named the chromosphere, and applied C. J. Doppler's principle to the sun in 1869. In 1865, Lockyer and P. J. C. Janssen, working independently, discovered a spectroscopic method of observing solar prominences without the aid of an eclipse, and to commemorate this discovery a medal bearing the names of both astronomers was struck by the French government in 1872. With the co-operation of Lady Lockyer, he built an observatory at Sidmouth where he carried out many important photographic and spectroscopic researches. He inaugurated the periodical *Nature* in 1869 and edited it until a few months before his death at Salcombe Regis. Devon, on Aug. 16, 1920. He received a Rumford medal from the Royal society in 1874 and was vice-president of the society in 1892–93. He was created knight commander of the Bath in 1897.

In addition to his many scientific papers, Lockyer wrote Stonehenge and Other British Stone Monuments Astronomically Considered (1906) and *Inorganic Evolution* (1900).

See T. M. and W. L. Lockyer, *Life* and Work *of Sir Norman Lockyer* (1928). (O. J. E.)

LOCMARIA, a village of western France, on the west shore of the Gulf of Morbihan. in the *département* of Morbihan. $8\frac{1}{2}$ mi. S. of Auray by road. Pop. (1954) 112. Locmaria has a small port, and oyster culture is carried on close to it. Roman remains are to be seen, but the place owes its fame to the very large megalithic monuments in the vicinity. A great menhir, broken into four pieces by lightning in the 18th century, measured about 67 ft. in height and from 9 to 13 ft. in thickness.

LOCOMOTION, ANIMAL. It is characteristic of animals that they can move about in search of food, foothold and mates, or away from enemies and hurtful influences; this locomotion is effected in a great variety of ways, from the seemingly simple amoeboid flowing of many one-celled animals to the complex, coordinated muscular movements of higher forms.

MANY-CELLED ANIMALS

Among multicellular animals there are four chief methods, which, following F. W. Gamble, may be illustrated by picturing a man in a boat.

Pulling. — The man may reach forward with a boat hook. fasten it to some prominence like a tree root, and pull the boat forward. This is the pulling method, and is well illustrated by leeches and starfishes. When looping along, the leech exhibits the following order: fixing its mouth and loosening the posterior sucker, it pulls its body forward, contracting its longitudinal muscles. At the end of this process the posterior sucker has been brought forward almost to touch the margin of the mouth, and the body is arched upward like a croquet hoop. Then the posterior sucker being fixed, the mouth is freed, and the body is protruded forward to a new position of attachment. This protrusion is effected by a contraction of circular and diagonal muscles. which squeeze the body forward. The mouth is re-attached, the posterior sucker is loosened, and the sequence is repeated.

Punting. — The man may stand up in the boat and use a pole as a lever, pressing it against the floor of the stream. This "punting" is one of the commonest modes of animal locomotion, being exhibited by all the animals that have firm appendages usable as levers against a base. A beetle hurrying across the roadway, a crab walking over a rock. a frog jumping among the grass, an ostrich sprinting at full speed. a man walking — all are using levers which propel the body forward by pressing against a hard surface. Sometimes there are complications, which, however, do not essentially affect the principle of the method employed. Thus the fresh-water mussel may make its flabby "foot" tense with blood, close a sphincter muscle nhich prevents backflow, and then pull the ploughsharelike organ backward against the sand. thus pushing its body forward. The foot has to be re-extended before the next step is taken. This method approaches pulling as does the locomotion of snails, chitons and slugs; these forms creep over solid surfaces by means of their fleshy foot, the muscular waves of which propel the animal along.

Sculling. — The man in the boat may stand in the stern and "scull," using a single oar to displace masses of water alternately to right and left. This is a common method among swimming animals, such as fishes and whales. In most fishes the swimming organ is that part of the body extending beyond the anus. It consists almost entirely of strong W-shaped blocks of muscle, dovetailed into one another, and centred in the flexible backbone. By alternately bending and straightening the posterior body, masses of uater are displaced, and thus the fish is propelled forward. In cetaceans (whales, dolphins, etc.) locomotion is similar, but a complication is introduced by the adaptive shape of the tail flukes. In true seals (Phocidae) the hind limbs are permanently turned backward and bound up with the short tail, forming a unified functional propeller. The principle is the same in cases like sea snakes and swimming leeches, where the gripping of the water and the using of it as a resistant mass, against which to contract, extend over the whole length of the body.

Rowing. — The man in the boat may row, the principle being the simultaneous exertion of pressure on each side. Thus the platypus rows in the water with its webbed forefeet, and the turtle with its paddles. Rowing in the air is the essence of flight in birds. bats and insects, though here part of the energy must be expended in keeping the body from sinking. Brittle stars or ophiuroids sometimes strike the sand with their posterior arms and may be said to row along the solid substratum, and in the mole's rapid turning in the ground the forelimbs are used like oars as if the animal was rowing in the ground. The insect known as the water boatman (*Notonecta*) swims back-downward in the pool, using its long third pair of legs as oars. In many birds of the auk family the wings are used as well as the feet in swimming underwater.

Other Methods. — The analogy of the man in the boat becomes somewhat forced when applied to out-of-the-way modes of animal locomotion. of which a few examples may be given. A jellyfish swims by alternately expanding and contracting the disclike or bell-like body. The rapid contraction drives the water out from the mouth of the bell, and the medusa is propelled in the opposite direction. Cuttlefishes expand their mantle cavity, and having filled it with water proceed to close it by a hook-and-eye contrivance, so that the water cannot leave by the way it entered, but is forced, as the cavity contracts, through a narrow funnel. As the jet comes out with considerable strength, the body is driven rapidly through the water, with the head and tentacles extended in the wash. The same method of propulsion by a posterior outgush of water is seen in larval dragonflies. Somewhat unusual, again, is the way in which lobsters jerk themselves tail-foremost in the water by suddenly flexing the posterior body (abdomen) forward and downuard. This displaces a mass of water toward the head. On occasion the common scallop (Pecten) can jerk itself off the sea floor with an energetic snap of its shell valves, and continue swimming thus for some time.

In some ways the strangest mode of animal locomotion is exhibited by the common sea urchin (Echinus) on a firm flat surface. This animal habitually moves by means of its tube feet, and also utilizes its spines, which are swayed on ball-and-socket joints by basal muscles. But Echinus is also able to tumble along on the tips of the five teeth of its chewing apparatus (Aristotle's lantern) which project out of the mouth. The lantern can be swayed from side to side by powerful muscles, and the locomotion is a stumbling along on the tips of the teeth. The sea urchin's track shows at short intervals the indentations of the teeth, and marks of spines in between.

Mechanisms of Locomotion. — The movements of most multicellular animals are effected by muscles, and there is an important distinction between the unstriped or smooth muscle of sluggish animals, such as tapeworms, and the striped or striated muscle of ordinary active animals (see MUSCLE AND MUSCULAR SYSTEM). The most important general fact is that unstriped muscles contract slowly, and are therefore found in sluggish animals, and in the slowly moving parts of active animals, as the walls of the food canal and arteries. Apart from these and similar exceptions, the muscle fibres in active animals are cross-striped and quickly contracting. Some of the lower animals such as turbellarian and nemertean worms are covered with cilia, fine hairlike projections (see CILIA) which assist in locomotion; but above the level of these two classes cilia cease to be locomotor except in larval forms, like the trochospheres of marine annelids and mollusks and in newly hatched tadpoles. Starfishes and some other echinoderms are richly provided with external cilia, but these are used for wafting food particles, not for locomotion. Above nemerteans cilia become of great internal importance, for they may line a windpipe, an excretory tube, a female genital duct and so forth. Myonemes are contractile plasmic threads, anticipations of muscle fibres, but intracellular. An instance of their occurrence is the axial filament inside the noncontractile sheath of the stalk of the bellanimalcule (Vorticella).

See F. W. Gamble, *Animal Life* (1908). (J. A. TH.; X.)

VERTEBRATES

Except for primitive kinds of animals that wait for food to come to them, it is necessary for all animals to move in search of nourishment and to escape from enemies. Hence, locomotion has perhaps been the largest single factor in the progressive evolution of the bodily form of vertebrates, if not of all active animals. In simplest terms, as in the amoeba, locomotion is merely the shifting of the centre of gravity; and this involves only a horizontal factor. In the vast majority of cases, however, there is concerned also a vertical factor, for elevating the body above the surface, and this brings in equilibrium. There can be no effective locomotion without balance. Vertebrates employ two main methods for movement. One is the wriggling of the body through the environment, and the other is by means of limbs. The latter is accomplished by the swing of the limb about the hip or shoulder as a hub, to move the foot forward, and then the limb is swung from the foot to move the body forward. The principles are simple, but friction of moving parts, physiology of nerve and muscle, bodily form and constitution introduce a vast complexity to the subject.

In Water.—Aquatic locomotion of vertebrates is accomplished either by undulations of the body or action of the limbs. Speedy fish, salamanders and lizards undulate the body in a series of curves in the horizontal plane. As the centre of gravity is in the forward half of the body—or rather of the total length—the lashing of the usually flattened tail thrusts obliquely backward against the water and drives the animal forward. Fish do not swim rapidly with their paired fins but use these for stabilizers or for slow, creeping movements. There are two sorts of limb movements used by quadrupedal mammals and birds when swimming. One employs a direct thrust against the water, as in rowing, used by surface swimming birds and terrestrial mammals, and is inefficient. The other employs an oblique thrust, as in sculling with a single oar or in the screw of a steamer. It is a much more efficient method but is evolved from the other and is used by almost all birds when swimming underwater, by the forelimbs of sea lions and the hind limbs of hair seals and walruses. High adaptation for swimming involves a fusiform or cigar-shaped body, with centre of gravity forward of the middle; flattening and broadening of the tail vertically in fish and reptiles (ichthyosaurs) and horizontally in mammals (sirenians, cetaceans) and eventual disappearance of the external part of the hind limbs.

On Land.—Terrestrial locomotion is of many kinds, but for practical purposes these may be divided into movements by means chiefly of the body, chiefly of four limbs and chiefly of two limbs. Movement by means of body action is illustrated in lizards or salamanders with reduced limbs, and in snakes, and involves what may be termed swimming on land, where the resistance of the water is replaced by inequalities of the surface against which the curves of the body may thrust. Thus, a snake glides through grass or climbs a bush. A snake can travel only inefficiently over a smooth surface; but some snakes are able, in varying degree, to assist locomotion by action of their ventral scales, which are alternately slightly raised and lowered by muscular action. Vertebrates with large bodies and small limbs progress chiefly by throwing the body from side to side, thus advancing first one of a pair of limbs and then the other. In these, locomotion still is chiefly by the trunk and its muscles.

Development and Use of Limbs.—As the limbs develop in size and power, they take over an increasing proportion of the function of locomotion and the contortions of the trunk are reduced. In primitive limbed vertebrates, the body rests upon the ground when not in movement, the leg action is laboured, the legs are directed to the side and have a somewhat circular motion. Typically, diagonal limbs are used together, so that the animal actually trots, in slow or fast tempo. As locomotor facility evolves, the limbs operate increasingly in the fore-and-aft plane, the limb segments are straightened so that the animal has its feet more beneath the centre of gravity and the body is held above the ground when at rest. In speedy vertebrates, every weighty part of the body contributes to the dynamics of locomotion, in balancing, counterbalancing and shifting the centre of gravity. In heavy-tailed animals (most dinosaurs, kangaroos) the conformation of the tail is determined mainly by locomotional needs. Length of neck is determined mostly by feeding habits in connection with length of leg, but weight of head and length of neck together have a very strong effect upon gait, as also has length of body.

Gaits *of Four-footed* Animals.—Gaits of quadrupeds may most conveniently be divided into symmetrical and asymmetrical gaits, and the former again subdivided into those in which each foot is placed separately and in which the feet are placed in pairs. In the walk, each foot of a quadruped is placed at regular time intervals. In typical sequence the advancement of a front foot is followed by the diagonal hind foot, and then the other front foot. The tempo may be so slow that three feet are always on the ground, or so fast that in some phases only a single foot is on the ground at a time. The latter gait is then termed the running walk, or single-foot. It is not quite so speedy as the trot or pace and few animals adopt it naturally, without training, except the elephant, whose only speedy gait it is. The centre of gravity is shifted with each footfall, or four times in each cycle; so, at speed, this is a tiring gait.

There are two different symmetrical gaits in which the feet are placed in pairs. When diagonal feet are so placed, this is termed the trot; and, when laterals, the pace or amble. At slow tempo, in which two feet are always on the ground, the former is used by sluggish or clumsy animals, particularly of broad beam, like heavy lizards, tortoises and badgers. At speed, during which there is an interval of suspension, with no feet on the ground, it is the intermediate gait (between walk and gallop) favoured by most sizable mammals, for the reason that it involves the least shifting of the centre of gravity and so is the least fatiguing, at a given rate of travel. It is also favoured at top speed by certain mammals that have very heavy antlers or necks too short to swing properly with the rhythm of their gallop, like bull moose and caribou.

In the pace, the lateral limbs, of first one side and then the other, are used in unison. In successive steps the centre of gravity must therefore be shifted from side to side, and this it is inconvenient to do at slow tempo. Accordingly, no animal is known to employ this gait in walking. At a faster tempo it is employed by some dogs (most often setters) and camels; occasional horses take to it naturally. Any trotting horse may be taught to pace by means of a harness and it is thought by some to be a shade faster than the trot. It has the advantage of escaping interference by the hind with the forefeet but seems to be more tiring.

The only asymmetrical gait is the gallop, and by this method the great majority of mammals travel at their greatest rate. This gait is characterized by unevenness of the interval between footfalls, of the support pattern and of the shifts in the centre of gravity. There is typically but one period of body suspension during each cycle. In short, all details of this gait are grouped in sequential phases. The fact that the gallop is the fastest gait in most mammals fitted for rapid progression is due to a combination of circumstances: in each cycle there is a single summation of effort and a single recovery, thus allowing time for a rhythmic swing of every part of the body, which the symmetrical gaits do not afford;

the body is bent and extended in the vertical plane, adding to the strength of the limb effort; a head of considerable weight and neck of considerable length help by swinging back and forth; hind legs act together, or in close sequence, to give the animal a forward thrust; the forelegs are used to keep the body from falling, to thrust it upward in preparation for the following cycle and to a minor extent to assist the forward motion. The lope or canter is largely an artificially induced slow gallop, for the comfort of the rider. The footfall sequence in the gallop varies to a great degree with the speed or kind of animal. In most typical patterns, one hind foot (either) is followed by the other, widely spaced, and then either by the diagonal (transverse gallop) or the ipselateral (lateral gallop) forefoot, the other forefoot following. A galloping horse may lead with either front foot or change from one to the other, probably to rest its muscles. Horses, as well as rhinoceroses, goats, sheep, cattle, camels and cats, seem to prefer the transverse gallop, while the lateral gallop is favoured by dogs, deer, antelope and giraffe. The interval of total suspension of the horse is after the second forefootfall; of the deer, after the second hind footfall, while in the whippet both occur. Very active mammals with short legs or long, limber bodies gallop with the hind legs close together or even employ them as a unit to accomplish the half bound or the bound; but so far as known, the forefeet are always used separately. Mention should be made of the peculiar gait of the mule deer, which at speed spurns the ground with all four feet in unison, a most effective gait for mounting steep hills.

The kinds of animals that are adapted to rapid quadrupedal locomotion are so numerous that it is impossible in a sentence or two to describe the anatomical details correlative thereto. In general there is a lengthening of the limbs and lightening of their terminal portions. The lower leg and forearm are lengthened relative to the thigh and upper arm, and finally the metacarpals and metatarsals become much elongated and reduced in number, while toe walking and finally a hoofed posture is assumed. As the legs become longer, the neck must keep pace in grazing kinds, and this development is of the greatest assistance to speed. Cursorial mammals lacking a long neck may be recompensed by having a very limber back.

Gaits of Two-footed Animals.—Bipedal gaits comprise the two-time walk and run, using the hind feet alternately, and the one-time hop or leap, the latter termed saltatorial progression. Both are very specialized modes of locomotion. The former is evolved from the trot and is attributable to the developmental ascendancy of the hind legs over the forelegs, or the specialization of the latter for other purposes, as in gibbons and birds. This is illustrated by some speedy lizards with large hind legs, as the basilisk. When progressing at low speed the latter is quadrupedal, but at high speed the forelegs are too small to equal the stride of the longer pair, and the animal rises upon its hind legs. This probably was also the explanation of bipedalism in dinosaurs. A long or heavy tail, for balance, is a decided advantage in the development of this type of locomotion. The case of man is somewhat different, and he developed bipedalism despite the absence of a tail. Man is an enigma in many respects. In spite of his long legs he is not specialized cursorily and is a very poor runner for his size. Doubtless his bipedalism was greatly helped, if not determined, by the way in which his ancestors used the arms for purposes other than progression, as for holding tools and carrying objects, as many other primates may be observed to do in lesser degree. Most bipedal dinosaurs had long tails for balancing, and rather short necks, while the true tails of birds are practically absent, and they rely upon the back and forth action of their long necks for equilibrium when walking. At speed, cursorial birds are prone to spread their wings for balance.

The bipedal hop or ricochet, using both feet in unison, may have been developed in two ways: by the ancestors of birds, hopping from branch to branch, and by small mammals that used this method for passing over low plant growth in their path, as deer mice may be observed to do. The gait that is most comfortable is the one favoured by an animal. It is doubtful whether an animal weighing more than a few pounds would adopt the bipedal hop, but after the gait had once become established in the behaviour pattern it could be retained during an increase in bodily size. In moderate development it is probably more advantageous for dodging than for actual speed. In high specialization it involves great elongation of the hind legs, particularly a relative increase in the terminal segments and reduction in the number of digits.

At the same time a compensating reduction in the length of the forelimbs takes place.

A short neck and a long tail, usually with a terminal tuft of hair in the case of rodents, is of advantage. It is true that frogs have no tail, but they are fitted for a single mighty leap into a place of refuge, or for erratic hopping about without proper balance to attain real linear speed.

Other Modes of Locomotion.—Brachiation, or swinging from limb to limb by the arms, is a method of locomotion followed by gibbons, orangutans, chimpanzees and in modified form by the spider monkey. The most expert of these is the gibbon. Brachiators have very long arms, long fingers and small thumbs.

Climbing, or scansorial locomotion, is done by many amphibians, reptiles and mammals but involves no special gaits or pronounced modifications.

Gliding is followed by flying squirrels of dissimilar relationships in North America, Africa and Asia; by Australian flying phalangers and by Asiatic flying lemurs, by means of membranes stretching between their widely spread limbs and assisted by a furry, flattened tail. They can thus travel in a descending line from one tree to another.

True *flight* is possible only in the extinct pterodactyls, in birds and in bats (see FLIGHT [NATURAL]).

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ONE-CELLED ANIMALS

Among unicellular organisms locomotion is effected by flagella, by cilia, by myonemes and in an amoeboid fashion. Each flagellum or cilium is a thread of protoplasm, sometimes with an axial filament. It is alternately flexed and straightened, as one might bend one's arm at the elbow and elongate it again. It is interesting to notice that among multicellular animals also cilia are very common, from the lowest to the highest, except in nematodes and arthropods, where the abundant chitin apparently precludes their development.

Amoeboid movement, probably the most primitive mode of animal locomotion, has been much studied; but it is difficult to form a clear picture of what happens. An ordinary amoeba, a naked blob of living matter, protrudes blunt fingerlike processes and draws others in, continually altering its shape but not its volume. It glides along at the rate of about three-quarters of an inch an hour. It is probably in some way gripping the substratum by a very delicate external plasma-membrane, which is continually giving way anteriorly, and being reinstated posteriorly. This film is the seat of surface-tension effects, and the tension seems to increase anteriorly and decrease posteriorly. But attentive scrutiny shows that the amoeba is rather rolling than gliding. For a definitely recognizable particle may be seen moving along the upper surface of the cell, in the direction in which the amoeba is moving, then disappearing over the front, and, after a while, re-appearing at the posterior end; and so da capo, as if there were a "caterpillar-wheel"-like movement. Moreover, there is a deeper protoplasmic streaming, connected with intricate physical and chemical changes. There are indications of rapid changes of the protoplasm from "sol" to "gel" states and back again (see PROTOPLASM and PROTOZOA). It is very interesting to notice that this most primitive mode of locomotion is retained in varied expression even in higher animals; *e.g.,* in the outgrowing tip of embryonic nerve cells and in the excursions of phagocytes.

For a more complete discussion on locomotion among the Protozoa see L. H. Hyman, *The* Invertebrates: Protozoa Through Ctenophora, vol. 1 (1940). (J. A. TH.; X.)

LOCOMOTOR ATAXIA (synonyms, tabes *dorsalis,* syphilitic posterior spinal sclerosis), a progressive degeneration of the nervous system, caused by syphilis, involving the posterior columns of the spinal cord with other structures and causing muscular inco-ordination and disorder of gait and station. The essential symptoms—stamping gait, and swaying with the eyes shut, the occurrence of blindness and of small fixed pupils—were recognized by M. H. Romberg (1851), but it was the clinical genius of G. Duchenne and his masterly description of the symptoms which led to its acceptance as a definite disease (1858); he named it locomotor ataxia after its most striking symptom. In 1869 Argyll Robertson discovered that the eye pupil is inactive to light but acts upon accommodation in the great majority of cases. This most important sign is named the Argyll Robertson pupil. With a greater knowledge of the widespread character of this disease and its manifold variations in the complex of symptoms, the tendency among neurologists is to revert to the term employed by Romberg—tubes dorsalis. "Locomotor ataxia," although it expresses a characteristic feature of the disease. has this objection: it is a symptom which does not occur in the first (preataxic) stage of the disease; indeed many years may elapse before ataxia comes on, and sometimes the patient, after suffering long from the disease, may die from an iritercurrent complication, without being ataxic.

There are three stages: (1) the preataxic, (2) the ataxic and (3) the bedridden paralytic. The duration of the first stage may be from one or two years, up to 20 years or even longer. In this stage various symptoms may arise. The patient usually complains of shooting, lightninglike pains in the legs, which he may attribute to rheumatism. If a physician examines him he will almost certainly find the knee jerks absent and Argyll Robertson pupils present; probably on enquiry he will ascertain that the patient has had some incontinence or retention of urine. In other cases, temporary or permanent paralysis of one or more muscles of the eyeball (which causes squint and double vision), a failure of sight ending in blindness, attacks of vomiting (or gastric crises). painless spontaneous fractures of bones and dislocations of joints, failing sexual power and impotence, may lead the patient to consult a physician, when this disease will be diagnosed, although the patient may not as yet have had locomotor ataxia. All patients, however, if they live long enough, pass into the second ataxic stage. The sufferer complains of difficulty of walking in the dark; he sways with his eyes shut and feels as if he would fall (Romberg's symptom) ; he has the sensation of walking on wool, numbness and formication of the skin, and many sensory disturbances in the form of partial or complete loss of sensibility to pain, touch and temperature. These disturbances affect especially the feet and legs, and around the trunk at the level of the fourth to the seventh ribs, giving rise to a "girdle sensation." There may be a numbed feeling on the inner side of the arm, and muscular inco-ordination may affect the upper limb as weil as the lower, although there is no wasting or any electrical change. The ataxic gait is characteristic, owing to the loss of reflex tonus in the muscles, and the absence of guiding sensations from all the deep stxuctures of the limbs. muscles, joints, bones, tendons and ligaments, as well as from the skin of the soles of the feet; therefore the sufferer has to be guided by vision as to where and how to place his feet This necessitates the bending forward of the body, extension of the knees and broadening of the basis of support; he generally uses a walking stick or even two, and he jerks the leg forward as if he were on wires, bringing the sole of the foot down on the ground with a nide stamping action. If the arm be affected, he is unable to touch the tip of his nose with the eyes shut. Sooner or later he passes into the third. bedridden stage, with muscles wasted and their tonus so much lost that he is perfectly helpless.

The complications which may arise are intercurrent affections due to septic conditions of the bladder, bedsores, pneumonia, vascular and heart affections. About 10% of the cases, at least, develop general paralysis of the insane. This is not surprising seeing that it is due to the same cause, and the etiology of the two diseases is such as to lead many neurologists to consider them one and the same disease affecting different parts of the nervous system. *Tabes dorsalis* occurs with much greater frequency in men than in women. (See VENEREAL DISEASES.)

Its incidence became much rarer because of the great improvement in the treatment of early syphilis and the increase in public knowledge of proper prophylaxis.

LOCOWEED, certain North American species of the genera Astragalus and Oxytropis of the Leguminosae (pea family), found mainly in arid and semiarid regions of the western and southwestern United States, which when ingested cause a cattle disease called loco ("mad"). Animals so poisoned stagger and become stuporous. The toxic properties may result from selenium absorption by the plant (some Astragalus species), or an unknown intrinsic alkaloid (in certain Oxytropis species). Some Astragalus species also produce a poison which does not induce true locoism. Wholesale eradication appears to be impossible, but individual plants may be killed chemically.

LOCRI, a people of ancient Greece (Gr. Λοκροί), inhabiting two distinct districts, one extending from the northeast of Parnassus to the northern half of the Euboean channel, between Boeotia and Malis, the other southwest of Parnassus, on the north shore of the Corinthian gulf, between Phocis and Aetolia. The former were divided into the northern Locri Epicnemidii, situated on the spurs of Mt. Cnemis, and the southern Locri Opuntii, so named from their chief town Opus. Homer mentions only these eastern Locrians; their national hero in the Trojan War is Ajax Oileus, who often appears afterward on Locrian coins. The Opuntians were thought by some to be of "Lelegian" origin (see LELEGES), but they were Hellenized early (though matriarchal customs survived among them). The westerly Locri "in Ozolae" on the Corinthian gulf, a rude and barbarous people, make no appearance in Greek history till the Peloponnesian War. The Locrian dialect resembles that of Elis. A colony of Locrians settled, about the end of the 8th century B.C., at the southwest extremity of Italy. Their founder was Euanthes. See LOCRI below.

LOCRI, an ancient city of Magna Graecia, Italy. The original inhabitants were, it has recently been ascertained, of Sicilian race (MacIver, Iron Age, 210). They occupied the Zephyrian promontory (Capo Bruzzano some 12 mi. N. of Capo Spartivento), and though after three or four years they moved 12 mi. north, still near the coast, 2 mi. S. of Gerace Marina below the modern Gerace, they still retained the name of Locri Epizephyrii to distinguish them from the Ozolian and Opuntian Locri of Greece itself. The foundation of Locri goes back to about 683 B.C. It was the first Greek community to have a written code of laws given by Zaleucus in 664 B.C. From Locri were founded the colonies of Meisma and Hipponium. It repelled the attacks of Croton and found support in Syracuse against Rhegium: it was thus an active adversary of Athenian aggrandisement. Pindar extolls it in the 10th and 11th Olympian odes. Stesichorus (*q.v.*) was indeed of Locrian origin. Dionysius I of Syracuse selected his wife from Locri: its territory was then increased, and the circuit of its walls was doubled, but it lost its freedom. In 356 B.C. it was ruled by Dionysius II. From the battle of Heraclea to the year 205 (when it was captured by P. Cornelius Scipio Africanus Maior, and placed under the control of his legate Q. Pleminius), Locri was continually changing allegiance between Rome and her enemies; but it remained an ally. It was destroyed by the Saracens in 915.

Excavations in 1889–90 discovered an Ionic temple (the Doric style being usual in Magna Graecia) at the northwest angle of the town—originally a cella with two naves, a closed pronaos on the east and an adytum at the west, later converted into a hexastyle peripteral temple with 34 painted terra cotta columns. This was destroyed about 400 B.C. and a new temple built on the ruins, heptastyle peripteral, with no intermediate columns in the cella and opisthodomos, and with 44 columns in all. The figures from the pediment of the twin Dioscuri, who according to the legend assisted Locri against Crotona, are in the Naples museum. The environs yielded many archaic terra cottas, and large trenches, covered with tiles, contained some 14,000 scyphoi arranged in rows. A Doric temple was also cleared under the house called Casa Marafioti: the fine equestrian group in terra cotta from the western gable is, with other objects from Locri, in the museum at

Syracuse. There was also a sanctuary of Persephone from which came numerous votive tablets of the 5th century B.C. Much work has also been done in cemeteries, most of the tombs belonging to the 5th and 4th centuries, though the earliest are pre-Hellenic (9th–7th centuries).

The city walls. the length of-which was nearly 5 mi., consisted of three parts—the fortified castles (φρούρα) with large towers, on three different hills, the city proper, and the lower town—the latter enclosed by long walls running down to the sea. Under Rome, the city was restricted to the plain near the sea. Prehistoric objects confirm the accounts of Thucydides and Polybius that the Greek settlers were preceded by Siculi.

See Orsi in *Notizie degli* Scavi (1901–17). (T. A.)

LOCUS, a term used in geometry with the meaning suggested by the Latin *locus,* place. In plane geometry it is the curve (including a straight line) which contains all points in the plane that satisfy a given condition, and which contains no points that do not satisfy the given condition; *e.g.,* in a plane the locus of a point at a given distance from a fixed point is the circle of which the fixed point is the centre and the given distance is the length of the radius. The term is also applied to figures in space of three dimensions, the locus corresponding to the circle being a sphere (considered as a surface). The locus is then a curve surface. The finding of the locus of an equation, or inversely, is a basic problem of analytic geometry (*q.v.*). Among the loci there considered are the conic sections (*q.v.*). The term is readily extended to higher dimensions.

LOCUST, any of certain insects of the family Acrididae (see ORTHOPTERA) which at times multiply greatly and migrate long distances in destructive swarms. In Europe, the term "locust" connotes large size; smaller acridids are called grasshoppers (*q.v.*). In North America "locust" and "grasshopper" are used for any acridid. Unfortunately cicadas (order Hemiptera) are also called locusts or harvest locusts; the 17-year locust is the periodical cicada.

The Phases of Locusts.—In 1921 B. P. Uvarov satisfactorily explained for the first time the sporadic coming of locust swarms and the apparent disappearance of the insects between times by the phase theory, later substantiated and elaborated by many workers. Each plague species exists in two phases, solitary and gregarious, connected by transitional forms. The extreme phases differ in coloration, form, physiology and behaviour. Solitary phase nymphs vary in colour and pattern, adjust their colour to

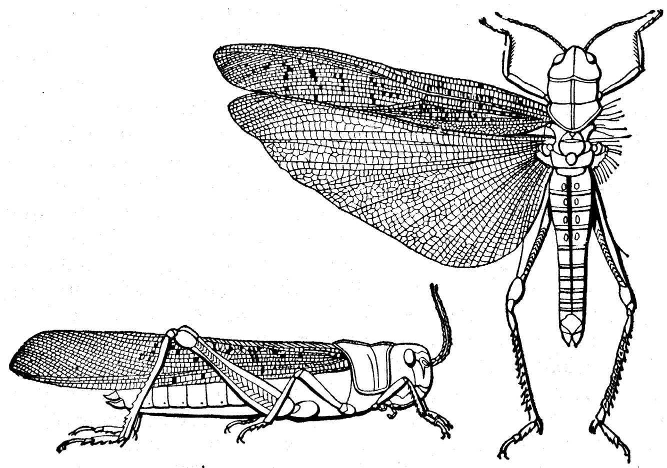


FIG. 1.—LOCUSTA MIGRATORIA IN ITS MIGRATORY PHASE

This insect is one of the chief locusts of the old world and in this phase causes great destruction to crops and other vegetation

match that of their surroundings, do not congregate, have low metabolic and oxygen-intake rates and are sluggish. Gregarious phase nymphs have a black and yellow (orange) coloration of fixed pattern, are gregarious, have high metabolic and oxygen-intake rates and are active and nervous; their temperature is higher because their dark pigments absorb more radiation. Adults differ less in colour, but often notably in form. The solitary phase has shorter wings, longer legs, narrower pronotum with higher crest and larger head; the gregarious phase has a more saddle-shaped pronotum with broader shoulders and long, ample wings.

Progeny of the solitary phase, reared in crowds, change toward the gregarious type; and if the crowding is of sufficient degree and duration, the extreme of the gregarious migratory phase is produced. Progeny of the gregarious phase, reared in isolation, revert to the solitary phase. By rearing single nymphs in constantly agitated cages J. C. Faure (1932) showed that the effects of crowding result from the unceasing activity it induces. The solitary phase is the normal state of the species, while the gregarious phase is a physiological response to violent fluctuations in the environment. Within the territory of each species its solitary phase exists at all times and in a wide variety of oecological conditions. Swarms do not form in the regions most favourable to the species, but in marginal areas where suitable habitats are restricted and climatic balance is delicate. Here a succession of

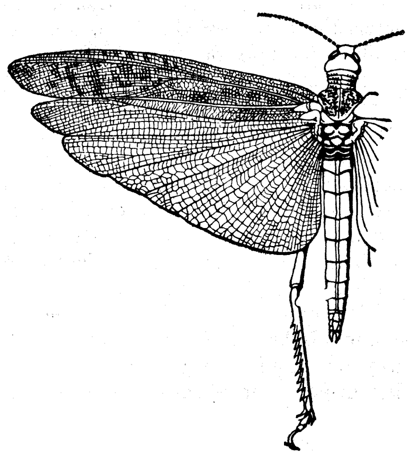


FIG. 2.—OLD WORLD LOCUST (SCHISTOCERCA GREGARIA)

favourable seasons enables the restricted populations to expand into adjoining areas, but return of unfavourable conditions forces the enlarged populations back into the small permanently habitable areas and crowding results. The exact circumstances vary with the species and region. Thus the outbreak areas of *Locusta* migratoria are of four oecological types: (1) deltas of rivers entering the Caspian and Aral seas and Lake Balkash (and similar situations in China and Africa), surrounded by arid sandy tracts; here the extent of the grassland habitat of the locust changes greatly as a result of irregularities of floods; (2) grassland areas adjoining deserts, subject to extreme fluctuations in precipitation with corresponding changes in extent of habitable area; (3) islands of dry warm soil in central Russia, a region generally too cold and wet for the species; there overcrowding occurs after several exceptionally warm dry years; (4) grasslands produced by periodic burning in the unfavourable, humid, tropical forestlands of the Philippines; their extent varies greatly, leading to frequent overcrowding and production of the gregarious phase.

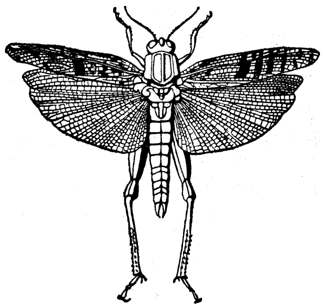
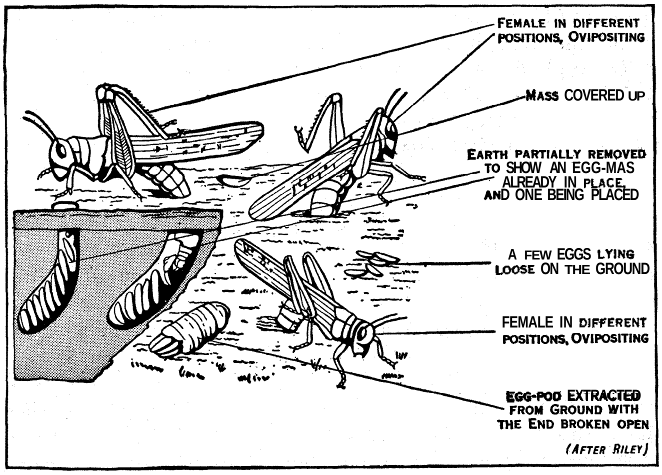


FIG. 3.—CALLIPTAMUS ITALICUS, COMMON IN SOUTHERN EUROPE

Locusts of the gregarious phase are restless and irritable; the bands of nymphs wander, and adult swarms take flight spontaneously on warm dry days when their body temperature is high. The muscular activity of flight further raises their temperature, and a swarm can therefore cease flying only when conditions change. Rain, a drop in temperature or nightfall will usually stop a flight. The distances travelled may be great; swarms have been seen 1,200 mi. at sea and *Schistocerca gregaria* reached England in 1869, probably from west Africa. The flights are not purposive and often end in destruction of the swarm. Some swarms are very large; a flight of the desert locust across the Red sea in 1889 was estimated as 2,000 sq.mi. in extent. The gregarious instinct is strong, and swarms remain compact even when reduced to small size by high mortality; they are dispersed, with resultant transformation into the solitary phase, only by storms and other external factors.

Important Species.—The migratory locust *(Locusta migratoria,* with its races *rossica, migratoria, migratorioides, capito* and *manilensis)* has a wider range than any other acridid. It is found in grasslands throughout Africa. most of Eurasia south of the Taiga forest, the East Indies, tropical Australia, and New Zealand. The desert locust *(Schistocerca gregaria)* inhabits dry grasslands and deserts from Africa to the Punjab. Its swarms arrive during the summer monsoons in India; in autumn they migrate to Iran and Arabia with others from Africa, and thence spread to soviet Asia, Syria, Palestine and Egypt. In late fall some return to India and East Africa, where breeding occurs during the next monsoon rains. The smaller Italian and Moroccan locusts *(Calliptamus italicus* and *Dociostaurus maroccanus)* do much injury in the Mediterranean area; the second is found discontinuously east to Turkestan. In South Africa the brown and red locusts *(Locustana pardalina* and *Nomadacris septemfasciata)* are both very destructive. In Central and South America the chief migratory species is the South American locust *(Schistocerca paranensis)*, of which the nonmigratory *S. americana* of the United States may possibly be the solitary phase. The Rocky mountain locust or lesser migra-



BY COURTESY OF THE U.S. DEPT. OF AGRICULTURE

FIG. 4.—ROCKY MOUNTAIN LOCUST (MELANOPLUS SPRETUS)

tory grasshopper (*Melanoplus mexicanus* phase *spretus*) wreaked havoc on the prairie farms of Canada and the United States in the 1870s, but later disappeared; it is probably the gregarious phase of the common and widespread *M. mexicanus* (*atlanis*), which is, with the clear-winged grasshopper (*Camnula pellucida),* a major crop pest in North America. Many other species of Acrididae in different regions occasionally increase to plague proportions, but few of them compare in economic importance with those named above.

Control Measures.—Once well started, a locust plague is almost impossible to check, and only palliative measures can be taken. These have included destruction of egg-masses laid by invading swarms (1,300 tons were destroyed in Cyprus in 1881), trenches to trap the nymphs, hopperdozers (wheeled screens, upon striking which locusts fall into troughs containing water and kerosene), poison baits and aeroplane dusting of swarms and breeding grounds with insecticides. The control problem is made difficult by the great extent of the territory affected, with many invasions beginning in sparsely populated, undeveloped regions. Permanent control requires both national and international action. It is possible because locust swarms do not arise simultaneously over wide regions, but in a few localized outbreak areas, many of which are known. From 1930–38 five International Locust conferences were held. In 1932 the Anti-Locust Research centre was set up in London; it directed international surveys and field studies and, during World War II, large-scale campaigns in Africa and Asia against the desert locust. Warnings were given of incipient outbreaks and swarm movements, and control measures were planned and supervised. Ultimately many outbreak areas may be made oecologically unsuitable for production of the gregarious phase, when the oecology and behaviour of each plague species are better known.

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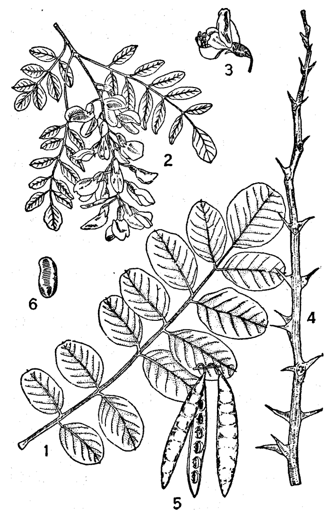
LOCUST, any tree of the genus *Robinia,* which comprises about 15 species native to North America and Central America, belonging to the family Leguminosae. The best-known species (*R. pseudoacacia*) was introduced into Europe in 1636. This tree, the black locust, often erroneously called acacia, is widely cultivated as an ornamental tree. It grows from 30 to 60 ft. high, and bears long, graceful compound leaves with 9 to 17 bright-green oblong leaflets, and white fragrant flowers in loose pendulous racemes, recalling the laburnum. There are many varieties, varying in the method of growth, the presence or absence of thorns (persistent spinose stipules) on the branches and the colour of the flower.



FROM HARRAR, "GUIDE TO SOUTHERN TREES" (MCGRAW-HILL BOOK COMPANY, INC.)

BLACK LOCUST

1. Leaf. 2. Cluster of flowers. 3. Individual flower, enlarged. 4. Twig. 5. Fruit. 6. Seed

In the eastern United States, where it is native, the black locust may have a trunk three or four feet in diameter. It is a valuable timber tree, the wood being heavy, hard, strong, close-grained and durable.

The clammy locust (*R. viscosa*), a tree sometimes 40 ft. high, with pinkish flowers, and the rose acacia or bristly locust (*R. hispida*), a small shrub, with showy rose-coloured flowers and hispid twigs, both native to the southeastern United States, are also cultivated for ornament.

The shipmast locust, a variety of black locust, is used extensively in reforestation projects, and as a good street tree resistant to dust, wind and smoke. The honey locust (*q.v.*) is a different genus of leguminous tree, *Gleditsia.* (N. TR.; X.)

LÓCZY, LAJOS (1849–1920), Hungarian geologist. who first scientifically described the mountains that connect the Kuen-Lun chains with the northeast Indian chains behind the Red basin of Szechwan. Born at Pressburg (Bratislava) on Nov. 2. 1849. he studied at the Zürich polytechnic, obtaining his engineer's diploma in 1874, and from 1877 to 1880 traveled through India and China as geologist to the expedition of Count Bela Széchenyi which he described in his principal work (1890). In 1886 he became professor of geology at the University of Budapest, and in 1908 director of the Hungarian Geological institute. He completed geological researches in China, in Hungary and, during World War I, in Serbia. His researches concerning the steppe formations of the Gobi and the northern Hwang-Ho territory are also of great importance. His other important work is a monograph on the Hungarian lake Balaton, in which the formations of the region are explained. His posthumous works include a new geological map of pre-World War I Hungary, and a book on the geology of west Serbia, which revolutionized the geological map of Serbia. He died at Balatonaracs on May 13, 1920.

LODER, BERNARD CORNELIUS JOHANNES (1849–1935), Dutch jurist. From 1873 to 1908 Loder practised as a lawyer in Rotterdam and from 1908 to 1921 was a judge of the high court of justice of the Netherlands. In 1905, 1909, 1910 and 1922 he represented the Netherlands at the diplomatic Sea conferences at Brussels. He presided at the conference of the Scandinavian kingdoms, Switzerland and the Netherlands, held in 1920. The Permanent Court of International Justice at The Hague appointed him its first president in 1922 and he retained this position until early in 1925.

LODGE, EDMUND (1756–1839), English writer on heraldry, was born in London on June 13, 1756, son of Edmund Lodge, rector of Carshalton, Surrey. He held a cornet's commission in the army, from which he resigned in 1773. In 1782 he became Blue Mantle pursuivant at arms in the College of Arms. He subsequently became Lancaster herald, Norroy king-at-arms, Clarencieux king-at-arms, and, in 1832, knight of the order of the Guelphs of Hanover.

He died in London on Jan. 16, 1839. He contributed the literary matter to *Portraits of Illustrious Personages of Great Britain* (1814, etc.). known familiarly as "Lodge's Portraits." His chief work on heraldry was *The Genealogy of the existing British Peerage* . . . (1832; enlarged ed., 1859).

LODGE, HENRY CABOT (1850–1924), U.S. statesman and author, was born in Boston, Mass., on May 12, 1850. He graduated from Harvard college in 1871 and the Harvard Law school in 1875; was admitted to the Suffolk (Mass.) bar in 1876; and from 1876–79 was instructor in American history at Harvard. He was a member of the Massachusetts house of representatives in 1880–81, and of the national house of representatives from 1887–93. In 1893 he was elected U.S. senator from Massachusetts, a place he continued to hold for nearly 32 years.

His continuous service in the senate brought recognition during the closing years of the Roosevelt administration and under Taft as one of the most prominent of the Republican leaders. He was a member of the Alaskan Boundary Commission of 1903, and of the U.S. Immigration Commission of 1907. He served as permanent chairman of the Republican national conventions of 1900, 1908 and 1920. During the Republican-Progressive split which led to the election of Woodrow Wilson in 1912, Lodge maintained his personal friendship with Roosevelt, while he held true to his long-established principles of party regularity by supporting Taft, the Republican nominee.

In 1914 Lodge supported Wilson's demand for the repeal of the Panama tolls exemption, but lost confidence in him as a result of the president's handling of the Mexican problem in 1914, and thereafter became one of his principal critics. He opposed Wilson's Caribbean policy and Colombia treaty, and desired the entrance of his country into World War I after the sinking of the "Lusitania." In Jan. 1916 he offered a resolution calling for armed intervention in Mexico.

With the entrance of the United States into World War I, Lodge called for united support of the president in all policies that might increase the war effort of the United States, although he opposed the Overman act, designed to organize war-making agencies. Wilson's peace policies were another matter. In 1915 and 1916 Lodge had advocated a league of nations and the principle of compulsory arbitration. But the conviction that the United States must always keep its word, which had led Lodge to support President Wilson's demand for the repeal of the Panama Canal tolls exemption in 1914, led him to oppose President Wilson's draft of the League. He felt that it embodied commitments which, when the moment came, the United States would not and could not keep. In 1918 Lodge became Republican floor leader of the senate and chairman of the foreign relations committee. He believed: that the League of Nations and the Versailles treaty should be separated; that the League covenant should be changed to provide that the United States should determine for itself what were and what were not domestic questions; that the United States should have more than mere equality of voting with the small countries: and that the League should not commit the United States to preserve the territorial integrity and political independence of League members except with the consent of congress. These beliefs were sustained in essence 25 years later when the senate dealt with the United Nations charter. Lodge succeeded in attaching to the treaty embodying the League of Nations reservations to carry out these beliefs. Wilson refused to accept the reservations. On March 19, 1920, the treaty, which had been reintroduced, having been previously defeated both with and without reservations, failed by seven votes to secure the necessary two-thirds vote of the senate, the Democratic senators voting against it at the wish of the president.

As the successful leader of the opposition to Wilson, Lodge's prestige was increased. He served as one of the four U.S. delegates at the Washington Conference on the Limitation of Armaments in 1921. His influence waned after he opposed Harding's proposal for joining the World Court, but he was re-elected to the senate in 1922 by a narrow margin. He died at Boston on Nov. 9, 1924, at the age of 74.

Senator Lodge was one of the chief congressional figures of the last decade of the 19th and the first two decades of the 20th centuries. Regarded by some as cold and distant in manner, he enjoyed the prestige indicated by his popular appellation, the "scholar in politics," and held the respect of his colleagues on both sides of the senate.

His literary production started early and continued until the close of his life. In 1873–76 he edited the *North American Review* with Henry Adams; and in 1879–81, with John T. Morse, Jr., he edited the *International Review*. In 1884–90 he was an overseer of Harvard college. His doctoral thesis at Harvard was published with essays by Henry Adams, J. L. Laughlin and Ernest Young, under the title *Essays on Anglo-Saxon Land Law* (1876). He wrote: *Life and Letters of George Cnbot* (1877); *Alexander Hamilton* (1882), *Daniel Webster* (1883) and *George Washington* (2 vol., 1889), in the American Statesmen series; *A Short History of the English Colonies in America* (1881); *Studies in History* (1884); *Boston* (1891), in the Historic Towns series; *Historical and Political Essays* (1892); with Theodore Roosevelt, *Hero Tales From American History* (1895); *Certain Accepted Heroes* (1897); *The Story of the American Revolution* (2 vol., 1898); *The War With Spain* (1899); *A Fighting Frigate* (1902); *A Frontier Town* (1906); with J. W. Garner, *A History of the United States* (4 vol., 1906). He edited *The Works of Alexander Hamilton* (9 vol., 1885–86); *The Federalist* (1891); *André's Journal* (1903); and *Education of Henry Adams* (1918).

See William Lawrence, *Henry Cabot Lodge* (1925); John A. Garraty, *Henry Cabot Lodge: a Biography* (1953). (C. SEY.; H. C. L.)

LODGE, HENRY CABOT, (1902–), U.S. political figure and ambassador to the United Nations, was born in Nahant, Mass., July 5, 1902, the grandson of Henry Cabot Lodge (*q.v.*). He studied in France, graduated from Middlesex school, Concord, Mass., in 1920 and Harvard university *(cum laude)* in 1924. Six of Lodge's ancestors served in the U.S. senate; his grandfather spearheaded the senate defeat of the Versailles treaty at the end of World War I. Lodge prepared for politics through an active career in journalism as a reporter for the *Boston Evening Transcript* and later as editorial writer for the *New York Herald Tribune*. He served two terms on the Massachusetts general court, 1933–36. In 1936 he was elected as a Republican to the U.S. senate from Massachusetts, and was re-elected in 1942. In 1941 and 1942 he went on extended active duty as a reserve officer with the U.S. army. In Feb. 1944 he resigned his senate seat to go on active duty with the U.S. army. He won re-election in 1946 but his senate seat was successfully challenged by Rep. John F. Kennedy in 1952. In that year Lodge had devoted much of his time to promoting the presidential campaign of Gen. Dwight D. Eisenhower. In 1953 President Eisenhower appointed him as permanent U.S. representative to the United Nations with ambassadorial rank and cabinet membership. In the sena'e, Lodge was liberal on domestic issues and consistently voted for a strong national defense. His military service in Libya, Italy, France and Germany strengthened his conviction that the UN was the only instrument for working toward world peace. Lodge's cabinet status gave him more freedom in shaping U.S. policy in the UN than had been enjoyed by his predecessors. He played a prominent role in many critical UN debates and was escort officer for Nikita Khrushchev's tour of the U.S. in 1959. In July 1960 the Republican convention nominated Lodge for the vice-presidency on a ticket headed by

Vice-Pres. Richard M. Nixon. In November they lost to the Democratic ticket headed by Sen. John F. Kennedy. (C. P. C)

LODGE, SIX OLIVER JOSEPH (1851–1940), English physicist who studied lightning and electricity and was a leader in psychic research, was born at Penkhull, Staffordshire, on June 12. 1851. He entered Cniversity college, London, in 1872, and obtained his doctorate in 1877. In 1875 he was appointed reader in natural philosophy at Bedford College for Women. and in 1879 he became assistant professor of applied mathematics at University college, London. Two years later he was called to the chair of physics in University college, Liverpool, where he remained until in 1900 he was chosen first principal of the new Birmingham university. He retired from this position in 1919 He was knighted in 1902. His original work includes investigations on lightning, the seat of the electromotive force in the voltaic cell, the phenomena of electrolysis and the speed of the ion, electromagnetic waves and wireless telegraphy, the motion of the ether near the earth and the application of electricity to the dis-, persal of fog and smoke. In addition to numerous scientific memoirs he wrote, among other works, *Lightning Conductors and Lightning Guards, Signalling Across Space Without Wires* (1897), *Modern Views of Electricity* (1889), Electrons (1907) and *The Ether of Space* (1909).

After 1910 Sir Oliver Lodge became increasingly prominent in psychic research. A strong believer in the possibility of communicating with the dead, he interested himself in a serious endeavour to reconcile science and religion. Among his publications dealing with this subject are *The Survival of Man* (1909) and *Raymond, or Life and Death* (1916). *See* also his autobiography *Past Years* (1931). He died on Aug. 22, 1940 at Lake, near Salisbury.

LODGE, THOMAS (*c.* 1557–1625), English miscellaneous writer. chiefly remembered as a lyric poet and the author of the prose romance *Rosalynde* (the source of *As You Like It*), was a son of Sir Thomas Lodge, lord mayor of London in 1562. Born between May 1557 and April 1558, probably in London, he entered the Merchant Taylors' school in 1571, Trinity college, Oxford, in 1573 (graduating in July 1577), and Lincoln's Inn, London. in April 1578. His earliest work (*c.* 1579) is an unlicensed pamphlet in reply to Stephen Gosson (*q.v.*), which Gosson answered in *Plays Confuted in Five Actions* (1582), censuring Lodge as "little better than a vagrant, looser than liberty, lighter than vanity itself." His mother's will (Sept. 1579) shows that he had soon wearied of the law and that his family found him spendthrift and not to be trusted with money.

An Alarum Against Usurers (1584) answered Gosson's attack on his character, and its exposure of the ways in which young heirs were lured into extravagance and debt almost certainly reflects personal experience. Lodge appended to the *Alarum* both a prose tale, *The delectable Historie of Forbonius and Prisceria,* and a verse lament, *The Lamentable Complaint of Truth Over England,* and this collection foreshadowed the ways in which he chiefly employed his pen for the next 12 years: in verse (*Scillaes Metamorphosis,* 1589; *Phillis,* sonnets and other poems, 1593; *A fig for Momus,* eclogues, satires and epistles, 1595); in romances (*Rosalynde,* 1590; *Robert, Second Duke of Normandy,* 1591; *Euphues Shadow,* 1592; *William Longbeard,* 1593; *A Margarite of America,* 1596); and in pamphlets (*Catharos,* 1591; *The Divel Conjured,* 1596; *Wits Miserie, and the Worlds Madnesse,* 1596; *Prosopopeia,* 1596). In 1594 he published *A Spiders Webbe* (last heard of in the sale of John Hutton's books, 1764) and also two plays: *The Wounds of Civill War* and *A Looking Glasse for London and England* (the latter written in collaboration with Robert Greene).

As an alternative to this effort to maintain himself by writing. Lodge tried the career of adventurer. In the dedications to *Rosalynde* and *A Margarite of America* he mentions two voyages: the first to Terceira and the Canary islands, and the second to South America with Thomas Cavendish on his disastrous last voyage (Aug. 1591) ; but neither seafaring nor literary enterprise served to keep him from poverty and he found a more secure profession when he graduated in medicine at Avignon (Jan. 1598). He was incorporated M.D. of Oxford in 1602 and practised in the Netherlands, where he took refuge at times as a recusant, and in London, where he died in 1625. Apart from *A Treafise of the Plague* (1603) and *The Poore Mans Talentt* (a manual of domestic medicine, first printed by the Hunterian club, 1881), the works of the latter part of his life are translations: of selections from Luis de Granada (1601), of the works of Josephus (1602), of the prose works of Lucius Annaeus Seneca (1614), and of a French commentary on the *Semaine* of Du Bartas (1621).

Much of Lodge's work before 1600 was, in fact, surreptitious translation, the result partly of the stress laid on imitation in literary theory and partly of financial need, which encouraged mere compilation. The latter accounts for his poorest work (*Catharos* and *Tlze Divel Conjured*); the former gives importance and quality to his best. But in spite of some crude hackwork, there is no doubt of the genuineness of his literary interests and abilities. He had no gift for drama or for finding copy without the aid of books, but in most of his verse and some of his romances he showed a capacity for selection and assimilation which was creative. The first and last of his verse collections (*Scillaes Metamorphosis* and *A fig for Momus*) are historically important as forward-looking in both matter and style. Many of his well-known lyrics first appeared in his romances where the link between poem and story encouraged some interesting experiments. Of the romances, *Rosalynde,* deservedly popular on its own account, is rivaled only by *A Margarite of America,* an arresting and dramatically plotted tale combining Senecan motives with the artifice of Euphuism and Arcadian romance in a manner which cannot be entirely credited to its source. This was. according to Lodge, "a historie in the Spanish tong" which he found in the Jesuit college at Santos during his visit to Brazil and, although doubt has sometimes been cast on this claim, the Jesuit library was certainly pillaged by Cavendish's followers. Of the prose pamphlets, *Wits Miserie* is, with the *Alarum,* the most readable for its Nashe-like cameos of London life. It is this ready response to fashions of one kind and another that makes Lodge's work important: having "so written as he had read." he is representative of an age schooled to draw both matter and style from literary models, and the variety of his work (to which he so often drew attention) gives him a place in the history of an unusual number of literary kinds.

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LODI, town and episcopal see of Lombardia, Italy, province of Milano, 20½ mi. S.E. of Milan by rail, on a hill above the right bank of the Adda, 230 ft. above sea level. Pop. (1951) 29,231. The city is' in a very rich dairy district. The cathedral (1158), with Gothic façade and 16th-century lateral tower, has a restored interior. The church of the Incoronata, erected by Battaggio (1487 onward) in Bramantesque style, is an elegant octagonal domed structure, decorated nith frescoes by the Piazza family, natives of the town. and four large altarpieces by Calisto Piazza. The 13th-century Gothic church of San Francesco has 14th-century paintings. The Palazzo Modegnani has a fine gateway in the style of Bramante, and the hospital a cloistered quadrangle. Besides an extensive trade in cheese (Lodi producing more Parmesan than Parma) and other dairy produce, there are manufactures of hemp ropes, linen, silk, majolica and chemicals.

The ancient Laus Pompeia lay 3½ mi. W. and the site is still occupied by a considerable village, Lodi Vecchio, with the old cathedral of S. Bassiano. In the middle ages Lodi was second to Milan in northern Italy. A dispute with the archbishop of Milan about the investiture of the bishop of Lodi (1024) began a long feud. In 1111 and again in 1158 the Milanese laid the whole plsce in ruins. A number of the Lodigians had settled on Colle Eghezzone; and their village soon grew up under the patronage of Frederick Barbarossa into a new city of Lodi (1162). Lodi was before long compelled to enter the Lombard league, and in 1198 it formed an offensive and defensive alliance with Milan, on which after 1416 it became dependent. The duke of Brunswick captured it in 1625 in the interests of Spain; and it was occupied by the French (1701), by the Austrians (1706), by the king of Sardinia (1733), by the Austrians (1736), by the Spaniards (1745) and again by the Austrians (1746). On May 10, 1796, was fought the battle of Lodi between the Austrians and Napoleon, which made the latter master of Lombardy.

LODZ, a *voivodship* (province) in the west of Poland, bounded on the northeast by the province of Warszawa, on the northwest by Poznan, and on the south by the province of Kielce. Area, 6.589 sq.mi.; pop. (1931). 2,632,434; (1960) 1,597,600. The province was occupied by Germany in World War II but was returned to Poland in 1945. The southern part of the province is a continuation of the plateau of Kielce; the northern part consists of lowlands washed by the Warta and its tributary, the Prosna. It was formerly covered by forests and lakes and formed the lesser principalities of Kalisz, Sieradz and Łęczyca. The forests have been mostly destroyed, and agriculture and cattle breeding are extensively carried on, the crops principally raised being rye, wheat, oats, barley and potatoes. But the importance of the area was increased by the rapid rise of the textile industry in Lodz. Pabjanice, Tomaszów, Zgierz and other towns. Cotton spinning and weaving is the most important industry, but woollens, linens, silks and other fabrics are also manufactured. while the embroideries of Kalisz are of importance. The whole area suffered almost complete destruction during World War I, and had to face new economic problems after the restoration of the factories. Previously designed to supply the Russian and oriental markets, the textile industry of Lodz specialized in coarse materials and neglected the finer fabrics. After 1918, however, the greatly enlarged home market and the markets of western Europe demanded finer materials. and great changes were made to meet the new situation. The revival of the industry was amazing, in spite of the relative lack of new capital. Lodz again suffered heavily from war during the German invasion of Sept. 1939. It was immediately overrun by German forces under Gen. Johannes Blaskowitz, and Berlin announced the capture of Lodz, the chief city, on Sept. 9. By a decree signed in Berlin Oct. 8. 1939. and effective after Nov. 1, the whole province was incorporated into Germany proper.

The chief towns of the province, which is the most thickly populated area of Poland after Silesia, are Lodz (708,400), Piotrków (53,000), Pabjanice, Tomaszów, Zgierz, Łęczyca and Sieradz.

LODZ, a city and *voivodship* (province) within but independent of Lodz *voivodship* in central Poland and the seat of a Roman Catholic bishopric, lies 907 ft. above sea level on the watershed of the Vistula and Oder rivers, 81 mi. S.W. of Warsaw. Pop. (Sept 1, 1939. est.) 672,000; (Dec. 1950 census) 620,183; (1960) 708.400, Administrative area: 81.8 sq.mi. The town is built about a seven-mile-long north-south thoroughfare, Piotrkowska street, which links Independence and Freedom squares. Two other parallel thoroughfares are Kosciuszko avenue to the west and Kilinski street to the east. These thoroughfares are crossed in an east-west direction by many streets named for prominent Poles.

From an insignificant place at the beginning of the 19th century Lodz grew rapidly into the main centre of the Polish textile industry. The first mills were founded during 1815–30 when the government of Congress Poland encouraged industrialization. But the period of great expansion began in 1851 when the tsarist government abolished the customs frontier between Congress Poland and Russia proper, thus opening a big market for Lodz manufacture. Between 1860 and 1897 the town's population rose from 26.000 to 314,000. Between 1840 and 1906 its administrative area was 10.4 sq.mi.; between World Wars I and II it was increased to 22.8 sq.mi. In 1931 Lodz had 604.629 inhabitants; including 62% Poles, 30% Jews and 7% Germans. In the mid-1950s about 70% of the population was employed in the textile industry.

Before World War II Lodz had no institutions of higher education. There were 9 in 1957, including a university, a school of engineering and 249 other schools. There were also 22 hospitals with twice as many beds as in 1945. After World War II water supply, drainage and public transport were greatly improved.

Lodz was the main centre of the Polish Socialist movement before World War I. Between 1915 and 1918 and again from 1939 to 1945 the town was under German occupation. During the second occupation it was renamed Litzmannstadt (after a general who distinguished himself in Nov. 1914) and the town and its province were incorporated into the greater reich. After Poland's liberation, Warsaw having been destroyed and Lodz being almost untouched, many central administrative offices were accommodated in Lodz. (Ln. S.)

LOEB, JACQUES (1859–1924), German-U.S. pioneer in experimental biology, was born at Mayen (near Coblenz), Ger., on April 7, 1859, and studied at Berlin and Munich before receiving an M.D. degree from the University of Strasbourg in 1584.

Lectures on highly metaphysical philosophy he attended in Berlin in 1880, as a young man seeking an understanding of the human mind. appear to have turned him against all things metaphysical and to have exerted a marked influence on his future thought and career.

His work in biology began at the universities of Wiirzburg (1886–88) and Strasbourg (1888–90), and at the Naples biological station (1889–91). In 1891 he went to the United States, becoming successively professor at Bryn Mawr college, Bryn Mawr, Pa., (1891–92), The University of Chicago (1892–1902) and the University of California, Berkeley (1902–10). In 1910 he became a member of the Rockefeller Institute for Medical Research in New York city and continued in that position until his death on Feb. 11, 1924, while vacationing in Bermuda. Much of his experimental work was done at the Marine Biological laboratory at Woods Hole, Mass.

Loeb's continued insistence upon a mechanistic concept of life and his denial of all metaphysical views assumed the proportions of a crusade and brought him into conflict with' the vitalistic school, which still had strong supporters among biologists. Although Isaac Newton had enunciated the basic principles of physics about two centuries earlier, Loeb worked in the period of the great success of the Newtonian principles in the physical sciences.

The conservation of matter and of energy, the second law of thermodynamics and James Clerk Maxwell's electromagnetic theory relating light and electricity had been established. J. Willard Gibbs had begun his investigations, organic chemistry had received its great impetus from the contributions of F. A. Kekulé and rapid advances in the synthesis of organic compounds were being made. The successful culmination of the basic Newtonian mechanistic system had led to its general acceptance in the physical sciences; all thinking in the sciences was being carried out in its terms.

The lifework of Loeb was devoted to the application of Newtonian principles to living systems. The introduction of non-Newtonian principles, such as quantum mechanics, and the uncertainty principle, although begun while Loeb was still active, came too late to exert any appreciable influence on the concept that guided his work.

Popular interest, attended by some controversy, was attracted to Loeb's experiments on artificial parthenogenesis, beginning in 1899, when he succeeded in bringing about the development of larvae of the sea urchin from unfertilized eggs by exposing them to controlled changes in their environment; this work was later extended to the production of parthenogenetic frogs, which he raised to sexual maturity. In addition to artificial parthenogenesis, Loeb is remembered for his work on the physiology of the brain, animal tropisms, regeneration and the duration of life. In his later years he made important contributions to the theory of colloidal behaviour, applying the principles of Gibbs and of F. G. Donnan to the chemistry of proteins.

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LOEFFLER, CHARLES MARTIN TORNOV (1861–1935), composer, was born at Miihlhausen, Alsace, Jan. 30, 1861. Part of his childhood was spent in Russia near Kiev, but he was educated in Switzerland. He studied the violin under Leonard and Massart at the Paris Conservatoire and under Joachim at the Berlin Hochschule, taking composition in Paris under Guiraud and in Berlin under Kiel. In 1881 he went to the United States, and played violin in the Boston Symphony orchestra, but resigned in 1903 to devote himself to composition. Among his significant works after 1903 were: *A Pagan Poem* for orchestra and piano; *Memories of My Childhood,* another symphonic poem; and *Canticle of the Sun,* commissioned by Mrs. Elizabeth Sprague Coolidge, with Mme. Povla Frijsh as soloist, for the opening of the Chamber Music hall, Library of Congress, Oct. 1925, outstanding in that first memorable chamber music festival in the capital of the United States. Other compositions were *Quartet in A Minor; Les Veillées de l'Ukraine;* and *Divertimento in A Minor,* both for orchestra and violin; *The Death of Tintagiles* for orchestra and viola d'amore; *Deux Rhapsodies* for oboe, viola and piano; *Divertissement Espagñol* for orchestra and saxophone; *By the Waters of Babylon,* a setting of Psalm 137, for female chorus; *For One Who Fell in Battle,* eight-part chorus; *Hora Mystica,* symphony; music for four strings to the memory of Victor Chapman; two symphonic poems, *La Bonne Chanson* and *La Villanelle du Diable; Three Movements; Fantastic Concerto* for orchestra and violoncello; and several songs.

LOESS. Typical loess is a soft, porous rock, pale yellowish or buff in colour; one characteristic property is its capacity to retain vertical or even overhanging walls in the banks of streams. These vertical walls exist in China, where they stand in some places 500 ft. high and contain innumerable cave dwellings; ancient roads. too, have worn vertically downward deep into the deposit, forming trenchlike ways. This character in the loess of the Mississippi region in the United States gave rise to the name "bluff formation." A coarse columnar structure is often exhibited on the vertical weathered faces of the rock. Another characteristic is the presence throughout the rock of small capillary tubules, which appear to have been occupied by rootlets; these are often lined with calcite.

Loess usually is calcareous; some geologists regard this as an essential property, and when the rock has become decalcified, as it frequently is on the surface by weathering. they call it loessloam. In the lower portions of a loess deposit the calcium carbonate tends to form concretions, which on account of their mimetic forms have been called loess dolls. Bedding is absent from typical loess. The mineral composition varies somewhat in different regions, but the particles are always small; they consist of angular grains of quartz, fine particles of hydrated silicates of alumina, mica scales and undecomposed fragments of feldspar, hornblende and other rock-forming silicates.

In Europe and North America loess deposits are associated with the margins of the great ice sheets of the glacial period; thus in Europe they stretch irregularly through the centre eastward from the northwest of France, and are not found north of the 57th parallel. Most geologists are agreed that the true loess is an aeolian or wind-borne rock, formed most probably during periods of tundra or steppe conditions. But it seems clear that certain deposits classed as loess in western Europe do not really belong to this category, being of alluvial origin and related to the brick earths of southeastern England. *See* PLEISTOCENE EPOCH; WIND EROSION AND DEPOSITION: *Dust Storms and Dust Deposits; see* also references under "Loess" in the Index volume. (F. J. P.)

LOEW, MARCUS (1870–1927), motion-picture executive and pioneer motion-picture theatre owner, was born May 8, 1870, in New York city, son of an Austrian immigrant. Leaving school at the age of nine to help support his family, he later found modest prosperity in the fur business.

Attracted by the new popularity of moving pictures Loew owned a chain of nickelodeons by 1905 and thereafter acquired many leading theatres for combined vaudeville and motion-picture exhibition.

In 1920 Loew's, Inc. purchased a production company named Metro Pictures Corp., and in 1924 the Goldwyn Pictures Corp (from nhich Samuel Goldwyn had resigned) was absorbed. The name became Metro-Goldwyn-Mayer to represent the newly hired management group headed by Louis B. Mayer.

Loew died on Sept. 5, 1927, almost at the end of the silent film era. His estate was estimated at $30,000,000. Neither flamboyant nor notably original. Loew was a show-business consolidator who made possible some of Hollywood's finest film achievements.

See Bosley Crowther, *The Lion's Share* (1957). (R. D. MacC.)

LOEWI, OTTO (1873–1961), German pharmacologist and Nobel laureate, was born at Frankfurt am Main on June 3, 1873, and was educated at Strasbourg and Munich universities. After becoming doctor of medicine in 1896, he devoted himself to physiological chemistry and pharmacology. In 1898 he was appointed assistant in the pharmacological institute at Marburg, and in 1901–02 he spent some months at University college, London, under E. H. Starling. Returning to Marburg, he was made titular professor of pharmacology in 1904, but in 1905 he went to Vienna as associate professor. From 1909 to 1938 he was professor of pharmacology in Graz, Aus. In 1940, he went to the United States, becoming research professor at the College of Medicine of New York university. He died in New York city on Dec. 25, 1961.

In 1936 Loewi and his lifelong friend Sir Henry Hallett Dale received jointly the Nobel prize for medicine for discoveries relating to the chemical transmission of nerve impulses. Between 1921 and 1926 Loewi and his colleagues showed that stimulation of the nerves in the perfused frog's heart led to the appearance of a substance which could readily inhibit a second heart receiving the perfused fluid from the first. This substance was finally shown to be acetylcholine, which had been first isolated from biological material by Dale in 1914. Loewi's experiments provided the first definite proof that chemical substances were concerned in the transmission of nervous impulses. He also carried out important researches on diabetes, digitalis, adrenaline and the vegetative nervous system, and in 1908 he devised "Loewi's test" for pancreatic function. (W. J. BP.)

LÖFFLER, FRIEDRICH AUGUST JOHANNES (1852–1915). German bacteriologist, one of the greatest names in the history of bacteriology, was born at Frankfurt an der Oder on June 24. 1852, the son of an army surgeon. He studied medicine at Würzburg university and at the Friedrich Wilhelm university in Berlin and. after serving in the Franco-German War, he obtained his M.D. degree at Berlin in 1874 After further service as an army doctor he became an assistant in the imperial health department (1879–84), where he was closely associated with Robert Koch. In 1888 he was appointed professor of hygiene at Greifswald and he was rector of that university, 1903–07. In 1913 he succeeded G. Gaffky as director of the Robert Koch Institute for Infectious Diseases in Berlin. He died in Berlin on April 9, 1915.

In 1884 Loffler discovered *Corynebacferium diphtheriae,* the causal organism of diphtheria, and simultaneously with P. Roux and A. Yersin he indicated the presence of diphtheria exotoxin. Among his other notable achievements were the discovery of *Pfeifferella mallei,* the causative organism of glanders (1882), the discovery of the cause of swine erysipelas and swine plague (1885), and of *B. typhi murium* (1891). In collaboration with P. Frosch he found that foot-and-mouth disease is caused by a filter-passing virus, the first occasion on which a virus was recognized as the cause of an animal disease. (W. J. BP.)

LOFFT, CAPEL (1751–1824), English miscellaneous writer, was born in London on Nov. 14, 1751. He was educated at Eton and at Peterhouse college, Cambridge, which he left to become a member of Lincoln's inn. He became the patron of Robert Bloomfield. the author of *The Farmer's Boy,* and secured for him the very successful publication of that work. Byron, in a note to his *English Bards and Scotch Reviewers,* ridiculed Lofft as "the Maecenas of shoemakers and preface-writer general to distressed versemen; a kind of gratis *accoucheur* to those who wish to be delivered of rhyme, but do not know how to bring forth." He died at Montcalieri, near Turin, Italy, on May 26, 1824.

LOFOTEN AND VESTERAALEN, a group of islands off the northwest coast of Norway, between 67° 30' and 69° 20' N., and between 12° and 16° 35' E., part of the Norwegian county of Nordland. The extreme length of the group from Andenaes, at the north of Andö. to Rost, is about 150 mi.; the aggregate area, about 1,560 sq.mi. It is separated from the mainland by the Vestfjord, Tjaeldsund and S'aagsfjord, and is divided into two sections by the Raftsund between Hindo and Öst-Vaagö. To the west and south of the Raftsund lie the Lofoten Islands proper, of which the most important are Öst-Vaagö, Vest-Vaago and Moskenaesö; east and north of the Raftsund are the islands of Vesteraalen, the chief being Hindo, Lango and Andö. The islands, which are of granite or gneiss, are a partially submerged mountain range, and are lofty and rugged. The highest points are hloisalen (4,153 ft.) on Hindo and Higravstind (3,809 ft.) on Öst-Vaagö, near the Raftsund and Troldfjord.

The long line of jagged peaks seen from the Vestfjord forms one of the most striking prospects on the Norwegian coast. The channels which separate the islands are narrow and tortuous, and generally of great depth; they have remarkably strong tidal currents, particularly the Raftsund and the famous Maelstrom, or Moskenstrom, near Moskenaes. Though situated within the Arctic circle, the climate of the Lofoten and Vesteraalen group is not rigorous and the coast is never frozen. The isothermal line which marks a mean January temperature of 32° F. runs south from the Lofotens, passing east of Bergen onward to Gothenburg and Copenhagen. The prevailing winds are from the southwest and west, the mean temperature is 38.5" F., and the annual rainfall is 43.34 in.

In summer the hills have only patches of snow. Much of the interior is bleak cranberry moor. Cattle are reared, but the growth of cereals (chiefly barley) is insignificant.

The characteristic industry is the cod fishery carried on along the east coast of the Lofotens in the Vestfjord in the spring. During the season this employs many thousands from all parts of Norway. The fish, dried on the cliffs during early summer, ordinarily are exported from Bergen to Spain, Holland, Great Britain, Belgium, etc., and the fish heads are used as cattle food. Industries arising out of the fishery are the manufacture of cod-liver oil and of artificial manure in factories at Svolvaer, Henningvaer, Kabelvaag, etc. The summer cod fisheries and the lobster fishery are also valuable.

Herring is taken in large quantities off the west coasts of Vesteraalen. Svolvaer, built on rocky islands off Öst-Vaagö, is the "capital" and chief port and trading centre; and Kabelvaag is another fishing port. Lödingen also, at the head of the Vestfjord on Hindo, is a port of call. A church existed at Vaagen (Kabelvaag) in the 12th century and Hans Egede, the missionary of Greenland, was pastor. Steamers trade between Hamburg or Oslo and Hammerfest, and local communication is chiefly by small boats, for there are few roads.

The largest island in the group, and indeed in Norway, is Hindo, with an area of 849 sq.mi. On Andö there is a bed of coal at the mouth of the Ramsaa.

Lofoten became well known in World War II as the scene of British commando raids against the Germans.

LOFTUS, ADAM (*c.* 1533–1605), archbishop of Xrmagh and Dublin, and lord chancellor of Ireland, was educated at Cambridge. He accompanied the earl of Sussex to Ireland as his chaplain in 1560, and three years later was consecrated archbishop of Armagh by Hugh Curwen, archbishop of Dublin. In 1567 he was translated to the archbishopric of Dublin, where the queen looked to him to carry out reforms in the church. On several occasions he temporarily executed the functions of lord keeper, and in Aug. 1581 he was appointed lord chancellor of Ireland. It was largely through his influence that the corporation of Dublin granted the lands of the priory of All Hallows as a beginning of the endowment of Trinity college, of which he was named first provost in the charter creating the foundation in 1591. Loftus died in Dublin on April j, 1605.

See J. R. O'Flanagan, *Lives of the Lord Chancellors of Ireland* (1870).

LOG, MARITIME, an instrument for measuring the speed of a ship through the water. From its original meaning the term has come to be applied to the daily progress of a ship and also to the full written record of the voyage of a ship or flight of an airplane. The more exact term for such a written record is "logbook."

The oldest type of log of a practical nature was the "chip log." It consisted of the log chip, log reel, log line and log glass. The chip was a small piece of pie-shaped wood with a small lead weight on its circular side that caused it to float upright in the water and resist being towed. The log line was attached to the chip by a three-part bridle. one part fastened to a peg in the chip that could be pulled out by a jerk on the line when it was desired to haul in the chip. The part of the line, about 15 fathoms in length. next to the chip was called the "stray line" and its limit was marked by a piece of bunting. The remainder of the line was kept on the reel until used. It was marked off at intervals of $47\frac{1}{4}$ ft. by pieces of cord, called "knots," worked into the log line. The log glass was a 28-second sandglass. The measurements of the log line and time were based on the following equation:

$$\frac{47\frac{1}{4}\text{ ft.}}{6{,}080\text{ ft. (nautical mile)}} = \frac{28\text{ sec.}}{3{,}600\text{ sec. (hour)}}$$

To measure speed with the log, the chip with peg in place was dropped into the water from the stern and the log line was allowed to pay out from the reel. When the piece of bunting marking the end of the stray line unwound from the reel the sandglass was inverted. After 28 seconds had elapsed the number of knots that had passed overboard was counted. The number of knots that ran out in 28 seconds was the speed of the ship in nautical miles per hour. Some log lines were marked by bits of cloth to indicate fifths of a knot. For higher speeds a 14-second glass was used and the number of knots running out was multiplied by two.

The chip log gave the speed only at the time it was used. The desirability of knowing the distance run over an extended period of time brought into use many different types of patented rotating logs. In these the chip was replaced by a rotator, similar to a propeller, towed astern by a braided line. The revolutions of the rotator were transmitted by the braided line to a clockwork recording device on the stern of the ship where the result appeared on a dial as nautical miles made through the water. Because of the location of the recording dial on the stern rail, or taffrail, these logs are commonly known as taffrail logs. Many logs utilizing a rotator to indicate the distance traveled have been used, but all are liable to error if the rotator is fouled by floating weeds. At speeds greater than 15 knots in rough sea they are not accurate.

Logs installed in modern U.S. ships ascertain the ship's speed by means of a Pitot tube. A typical log built by the Pitometer Log corporation consists of a tube projecting through the bottom of the ship into undisturbed water. The tube is projected through a sea valve so it can be replaced if damaged or if the vessel enters shoal water. The tube has one forward-facing orifice called the dynamic-pressure orifice and two orifices at right angles to it called the static-pressure orifices. When the ship is stopped the pressure is the same in the dynamic and static connections but when the vessel steams ahead the dynamic pressure exceeds the static pressure. This difference in pressure varies as the square of the ship's speed.

Another part of the log consists of a small variable-speed electric motor driving a centrifugal water pump. In such a pump the dynamic pressure produced by the pump varies as the square of the speed of the motor. The pressure produced by the speed of the ship is exerted against a bellows which is balanced by pressure produced by the pump. Movement of the bellows operates the speed control of the motor making it exactly balance the pressure produced by the ship. With this accomplished, the speed of the pump and motor corresponds to the speed of the ship.

Attached to the shaft of the electric motor is a magneto which generates voltage proportional to the speed of the ship. This voltage is transmitted to the navigating bridge where it actuates the equivalent of a voltmeter whose graduated dial constantly indicates the speed of the ship in knots. The pump motor also drives a counting device which counts the revolutions made by the motor and transmits this information to the bridge as nautical miles steamed through the water. The dials on the bridge furnish the same information as the speedometer in an automobile. This type of log may also be arranged to draw a graph on a moving paper tape indicating the speed of the ship continuously during an entire voyage.

Since there is no continuous flow of water through the Pitot orifices the possibility of the openings being clogged with drifting material is slight, and since the actuating pressure is the difference between static and dynamic pressure there is no error caused by change in draft of the ship. (M. R. D.)

LOGAN, JOHN, also known as TAHGAHJUTE (*c.* 1725–1780), American Indian leader, by birth a Cayuga, the son of Shikellamy, a white man who had been captured when a child by the Indians, had been reared among them and had become a chief. John Logan lived for some time near Reedsville. Pa.. and moved to the banks of the Ohio river about 1770. He was not technically a chief but acquired great influence among the Shawnees. into which tribe he married. He was on good terms with the whites until April 1774, when, friction having arisen between the Indians and the whites, a band of marauders, led by one Greathouse, attacked and murdered several Indians, including Logan's sister and other relatives. Believing that Capt. Michael Cresap was responsible for this murder, Logan sent him a declaration of hostilities, the result of which was the bloody conflict known as Lord Dunmore's war. Logan refused to join the Shawnee chief, Cornstalk, in meeting Gov. Dunmore in a peace council after the battle of Point Pleasant, but sent him a message now famous as an example of Indian eloquence. Logan took to drink and in 1780 was killed near Lake Erie by his nephew, whom he had attacked.

See Brantz *Mayer's Tah-gah-jute or Logan the Indian and Captain Michael Cresap* (Baltimore, *1851;* 2nd ed. Albany, 1867) and F. B. Sawvel, *Logan the Mingo* (1921).

LOGAN, JOHN (1748–1788), Scottish poet, was born at Soutra, Midlothian, in 1748. In 1771 he was presented to the charge of South Leith, but was not ordained till two years later. In 1770 he published *Poems on Several Occasions by Michael Bruce.* In 1781 he published his own *Poems.* Logan was accused of having appropriated in his *Poems* (1781) verses written by Michael Bruce (*q.v.*). The statements of John Birrell and David Pearson on behalf of Bruce were included in Dr. Anderson's *Life of Logan.* The charge of plagiarism has been revived from time to time.

LOGAN, JOHN ALEXANDER (1826–1886), American soldier and political leader, was born in what is now Murphysborough, Ill., on Feb. g, 1826. He had no schooling until he was 14; he then studied for three years in Shiloh college, served in the Mexican War as a lieutenant of volunteers, graduated from the law department of Louisville university in 1851 and practised law with success. He entered politics as a Douglas Democrat. In 1858 and 1860 he was elected to the national house of representatives. Though unattached and unenlisted, he fought at Bull Run, and then returned to Washington, resigned his seat and entered the Union army as colonel of a regiment of volunteers, which he organized. He was regarded as one of the ablest officers who entered the army from civil life. In Grant's campaigns terminating in the capture of Vicksburg he rose to the rank of major-general of volunteers; in 1863 he was placed in command of an army corps, and after the death of McPherson he was in command of the army of the Tennessee at the battle of Atlanta. When the war closed, Logan resumed his political career as a Republican and was a member of the national house of representatives from 1867 to 1871, and of the U.S. senate from 1871 until 1877 and again from 1879 until his death. He was always a violent partisan and was identified with the radical wing of the Republican party. His war record and his large personal following, especially in the Grand Army of the Republic, contributed to his nomination for vice-president in 1884 on the ticket with James G. Blaine, but he was not elected. His impetuous oratory, popular on the platform, was less adapted to the halls of legislation. When commander-in-chief of the Grand Army of the Republic in 1868–71, he successfully urged the observance of Memorial or Decoration day. He died at Washington, D.C., on Dec. 26, 1886.

LOGAN, SIR WILLIAM EDMOND (1798–1875), Canadian geologist, was born in Montreal on April 20, 1798, of Scottish parents. He was educated partly in Montreal and at the high school and University of Edinburgh, where Robert Jameson excited his interest in geology. In 1831 he took charge of a colliery and copper-smelting works in Swansea. In 1840 Logan brought before the Geological society of London his paper "On the character of the beds of clay lying immediately below the coal seams of South Wales, and on the occurrence of coal boulders in the Pennant Grit of that district." He pointed out that each coal seam rests on an underclay with rootlets of *Stigmaria,* and expressed his opinion that the underclay was the old soil in which grew the plants from which the coal was formed. To confirm this observation he visited America in 1841 and examined the coal fields of Pennsylvania and Nova Scotia, where he found the underclay almost invariably present beneath the seams of coal. In 1842 he took charge of the newly established geological survey in Canada, and continued as director until 1869. Logan was elected a fellow of the Royal society in 1851.

Logan died at Castle Malgwyn, Pembrokeshire, on June 22, 1875.

LOGAN, a city of Utah, U.S., and seat of Cache county, is a college community and a distribution and marketing centre, on the Logan river, 80 mi. N. of Salt Lake City. Logan, with its many trees and gardens, is laid out at the mouth of scenic Logan canyon on terraces of prehistoric Lake Bonneville. It has an elevation of 4.535 ft. above sea level, with nearby Wasatch mountain peaks towering more than 5.000 ft. higher.

The city takes its name from the river, named for Ephraim Logan, a trapper of the 1820s. Believing Cache valley too cold for agriculture, Mormon colonizers did not arrive until 1855–56, and it was 1859 before Logan itself was founded; the city was incorporated in 1866. Grains and sugar beets nere found to grow well, and subsequently dairying and stockbreeding thrived. A gray, twin-towered temple. completed in 1884, made Logan a Mormon religious centre. Utah State university, formerly the state agricultural college (founded 1888) has profoundly influenced the community. The Utah Northern railroad, built to Logan in 18'73 and to Montana in 1877–81. was later incorporated into the Union Pacific system.

For comparative population figures *see* table in UTAH: *Population.* (D. L. M.)

LOGANBERRY (LOGAN BLACKBERRY). This well-known fruit originated as a hybrid between the wild blackberry (*Rubus ursinus*) of the Pacific coast and the red raspberry. The fruit was raised from seed in 1881 in the garden of Judge J. H. Logan at Santa Cruz, Calif. It is grown commercially in large quantities, especially in Oregon and Washington and in England and Tasmania. The Logan is a vigorous, nearly trailing, blackberry-like plant with three- to five-foliate leaves, prickly canes and deep wine-red, tart, high-flavoured berries that separate from the stem as do the blackberries. The fruit is canned, frozen for preserve or pie stock, or made into wine. The Phenomenal, originated by Luther Burbank, is very similar to the Logan, but bears slightly larger fruit. The Young (Youngberry), Boysen (Boysenberry), Pacific and Cascade are related berries that have the high aroma and flavour of the Logan and of the native blackberry. Research by M. B. Crane and P. T. Thomas in England and Waldo and Darrow in the U.S. department of agriculture indicates that the Logan probably originated as a hybrid of an octoploid blackberry fertilized with diploid pollen of a red raspberry. Hybrids of this kind are similar in appearance to the Logan. L. H. Bailey proposed the species name R. *loganobaccus* for this cultivated blackberry. *See* also DEWBERRY. (J. R. MAG.)

LOGANIACEAE, a family of dicotyledonous plants including herbs, vines, shrubs and trees, chiefly tropical but with some representatives in temperate regions. About 33 genera and 700 species are recognized. The largest and most important genus is *Strychnos* in the tropics of both hemispheres, the seeds of various species, but especially those of *S. nux vomica,* yielding the drug strychnine (*q.v.*). Many species of *Buddleia* and one of *Gelsemium,* the yellow jessamine of the southeastern United States, are cultivated for ornamental purposes. (E. D. ML.)

LOGANSPORT, principal town and seat of Cass county, north-central Indiana, U.S., 70 mi. N.N.W. of Indianapolis, at the confluence of the Wabash and Eel rivers. It is a trading centre for an agricultural area comprising Cass, Carroll, Pulaski, Fulton, Miami and White counties, and an important shipping point for livestock and grain.

Manufactures include air-operated and hydraulic laboursaving equipment, die castings, electronic and electrical controls, automobile and airplane parts, metal stampings, screw products, hardwood lumber, fishing tackle, fire-fighting apparatus, mechanical rubber goods, metal springs and women's foundation garments.

Two of Logansport's public utilities, water and electricity, are municipally owned. A large state mental hospital is located there.

Title to the land was acquired by treaty in 1826 from the Miami and Pottawatomie Indians. The town was platted in 1828 and named after a Shawnee chief, the so-called Captain Logan (d. 1812), who was evidently an ally of the Americans in the War of 1812. It was incorporated as a town in 1831 and as a city in 1838.

For comparative population figures *see* table in INDIANA: *Population.* (WI. BA.)

LOGAR, a river and valley of Afghanistan. The Logar river drains a wide tract of country, rising in the southern slopes of the Sanglakh range and receiving affluents from the Kharwar hills, northeast of Ghazni. It joins the Kabul river a few miles below the city of Kabul. The Logar valley, which is watered by its southern affluents, is rich and beautiful, about 40 mi. long by 12 mi. wide, and highly irrigated throughout. Lying in the vicinity of the capital, the district contributes largely to its food supply.

LOGARITHMIC DECREMENT is the measure of the rate of decay of any exponentially damped oscillation. It is the Naperian logarithm of the ratio of the first to the second of two successive current amplitudes in the same direction. The logarithmic decrement can also be considered as a constant of a simple radio circuit, being π times the product of the resistance by the square root of the ratio of the capacity to the inductance of the circuit. Measurement of logarithmic decrement is of great importance since it makes possible the determination of the equivalent resistance of the circuits under consideration, and also gives information concerning the lengths of the wave trains. The value of the sum of the decrements of two circuits may be obtained from their resonance curve.

LOGARITHMS. By shortening processes of computation, logarithms have doubled the working speed of astronomers and engineers and others working with masses of mathematical data. The explanation of this highly practical branch of mathematics begins most conveniently with the exponential expression b^l which represents some number n, so that we may write $n = b^l$. In the elementary theory we assume b, n, 1 to be real numbers, b and n positive, and b greater than unity. If we know b and the exponent l, we may compute n. For example, if $b = 10$, $l = 3$, then $n = b^2 = 103 = 1{,}000$. If any two of the three numbers b, 1, n are given, the third may be computed. To develop the elementary theory of logarithms we assume the number n and the base b to be given; then the exponent 1 may be found. For the case under consideration (when b and n are both positive and b is greater than unity), the actual existence of one and only one real value 1 can be established by the modern theories of irrational numbers, such as that of J. W. Dedekind. For, if we make a "cut" of all ordered real numbers by placing in one class every number α for which $b^\alpha \leqq n$, and in the other class every number β for which $b^\beta > n$, then if N is the number defined by the "cut," we must have $b^N = n$, for the reason that every other assumption leads to an evident contradiction. That is, if we assume that $b^N < n$, then another number b^{N_1} exists which lies between b^N and n, and there are numbers in the first class greater than N, which is contrary to assumption. A similar result is reached if we assume that $b^N > n$.

The number l is called the logarithm of the number n to the base b, in which case n is sometimes called the antilogarithm of l. From a knowledge of the properties of the expression b^2 it becomes evident that certain values of the base b are more convenient than others. Thus, b is selected to be positive, because a negative b would produce undesired fluctuations in the signs of n, when l takes successively the values 1, 2, 3, 4, . . . , while for $l = \frac{1}{2}$, $\frac{1}{4}$, . . . the n would be an imaginary number. It is evident also that $b = 1$ would place limitations upon the possible values of n corresponding to the real exponents 1, since $1^l = 1$. Accordingly, when the base is unity, 1 is the only real number having a real logarithm. If b lies between 0 and 1, then l decreases as n increases, a relation that is workable in practice, though not particularly desirable. Hence we assume, as was done above, that b is positive and greater than 1.

Of all possible values greater than 1 which might be chosen as the base, two have been selected, which yield two systems of logarithms. One value is $b = 10$, used in the common logarithms, chosen because of certain practical advantages that accrue from a base which is the same as the scale of our number system. Common logarithms have also been called Briggsian logarithms, after Henry Briggs (*q.v.*). The other value taken for the base is 2.718 . . . ; it is usually represented by the letter e, and belongs to a type of irrational numbers called transcendental numbers. The logarithms having the base e are called natural logarithms, or sometimes, less appropriately, hyperbolic or Naperian logarithms. The base 10 yields logarithms that are most convenient for the purposes of computation; the base 2.718 . . . yields logarithms which lead to simpler formulas in higher analysis than other systems, and are therefore the most "natural" ones to use.

General Properties. — According to the definition of logarithms given above, *logarithms are exponents*, and therefore are endowed with the properties of exponents, viz.,

$$b^{l+l_1} = b^l \cdot b^{l_1}, \quad b^{l-l_1} = b^l / b^{l_1}, \quad b^{ll_1} = (b^l)^{l_1} \tag{1}$$

where l and l_1 may be positive or negative, rational or irrational real numbers. In the theory of logarithms, if $b^2 = n$, we use the notation $l = \log, n$, and we read this, "1 is the logarithm of n to the base b." As $b^0 = 1$ and $b^1 = b$, it is evident that no matter what value different from zero the base may have, the logarithm of 1 is zero, and the logarithm of the base itself is unity. Writing $b^2 = n$ and $b^{l1} = n_1$, the three exponential formulas (1) translated into the notation of logarithms, become

$$l + l_1 = \log_b nn_1, \quad l - l_1 = \log_b n/n_1, \quad ll_1 = \log_b (n)^{l_1} \tag{2}$$

Substituting log, n for l, log, n_1 for l_1, we have

$$\log_b n + \log_b n_1 = \text{loga}\ nn_1, \quad \log_b n - \text{loga}\ n_1 = \log_b n/n_1, \\ p \log_b n = \log_b (n^p) \tag{3}$$

Stated in words: (1) The logarithm of a product is equal to the sum of the logarithms of the factors; (2) the logarithm of a quotient is equal to the logarithm of the dividend minus the logarithm of the divisor; (3) the logarithm of a power of a number is equal to the product of the exponent and the logarithm of the number itself. *(See* EXPONENT.)

Common Logarithms. — Since $10^0 = 1$ and $10^1 = 10$, the logarithm of 1 is zero and the logarithm of 10 is unity. Any number between 1 and 10 has a common logarithm which lies between 0 and 1. Similarly, since $10^2 = 100$, any number between 10 and 100 has a common logarithm which lies between 1 and 2; and since $103 = 1{,}000$, any number between 100 and 1,000 has a common logarithm which lies between 2 and 3; and so on. Thus the logarithm of 75 is nearly 1.87506. The integral part of the logarithm is called the characteristic; the decimal part is called the mantissa. From the relations just given we obtain the general statement that *the characteristic of the common logarithm of a number greater than* 1 *is one less than the number of integral figures.* Thus, 3768.5 has four integral figures (3, 7, 6 and 8); hence its logarithm has the characteristic 3. From the relations $10^0 = 1$, $10^{-1} = .1$, $10^{-2} = .01$, $10^{-3} = .001$, etc., we obtain a corresponding rule for decimal fractions less than unity, and also the provision that the mantissa shall be positive; namely, the rule that the *characteristic of the common logarithm of a decimal fraction less than unity is negative and is numerically one more than the number of zeros immediately following the decimal point.* Thus, 0.000107 has three zeros immediately following the decimal point and the characteristic of its logarithm is -4. The minus sign is sometimes written above the characteristic, thus $\bar{4}$, to serve as a reminder that it applies only to the characteristic and not to the mantissa. It is simply for convenience that the mantissa, when different from zero, is always taken to be positive. This is accomplished by framing the rules for finding the characteristic. as was done above, so that. when the mantissa is not zero, the characteristic is always the integer immediately below the true value of the logarithm. and the fractional value (the mantissa) must be added to the characteristic to secure the true value of the logarithm. Thus the logarithm of .07 lies between -1 and -2; it might be taken to be -1 and a minus mantissa or -2 and a positive mantissa. The latter course is chosen, for the reason that the computation involving mantissas is simplified by taking them to be always positive.

The great advantage of the common system of logarithms lies in the fact that the mantissa of the same sequence of figures is the same, no matter where the decimal point is placed. Thus, 3.7568 and 375.68 have different characteristics but the same mantissa. This fact is evident from the relation

$$3.7568 \times 100 = 375.68$$

which indicates that the logarithm of 3.7568 is less than that of 375.68 by exactly 2. which is the logarithm of 100. This property of the mantissa and the simple rules for finding the characteristic make it possible to prepare tables of common logarithms in very much more compact form than for other systems. Characteristics are omitted altogether from the tables and are supplied by the computer.

Natural Logarithms. — To show how natural logarithms arise in analysis, we find the derivative of $y = \log_b x$, where b is any positive constant greater than 1. We obtain $y + h = \log_b (x + k)$,

$$h = \log_b (x + k) - \log_b x = \log_b \frac{x + k}{x} = \log_b \left(1 + \frac{k}{x}\right), \text{ and}$$

$$\frac{h}{k} = \frac{1}{x} \cdot \frac{x}{k} \cdot \log_b \left(1 + \frac{k}{x}\right) = \frac{1}{x} \cdot \log_b \left(1 + \frac{k}{x}\right)^{\frac{x}{k}}$$

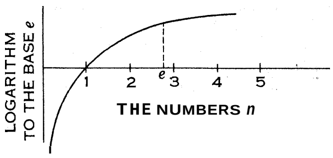
The derivative $\frac{dy}{dx}$ is the limit of $\frac{h}{k}$, as $k \to 0$. Thus we are led to consider the limit of $\left(1 + \frac{1}{n}\right)^n$, where $n = \frac{x}{k}$. This limit can be shown to exist, but the proof, when n may assume any real values, rational or irrational, is somewhat long. It is one of the fundamental limits in mathematics. Expanding $\left(1 + \frac{1}{n}\right)^n$ by the binomial theorem and letting $n \to \infty$, we obtain the rapidly convergent series

$$e = 1 + 1 + \frac{1}{2!} + \frac{1}{3!} + \cdots + \frac{1}{n!} + \cdots = 2.718281828459 \cdots$$

We thus obtain $\frac{dy}{dx} = \frac{1}{x} \log_b e$. If we take the base $b = e$, so that $\log_e e = 1$, this expression reduces to the simpler form $\frac{dy}{dx} = \frac{1}{x}$

The notation $\ln n$ often is used for the natural logarithm of n, since $\log n$ usually stands for the common logarithm of n. To avoid ambiguity the base may be designated, as in $\log_e n$.

From the graph (see fig.) it is evident to the eye that positive numbers less than 1 have negative logarithms. Numbers very close to 0 have negative logarithms whose numerical values are very large. The vertical axis is an asymptote to the curve. These statements are true also for the graphs of common logarithms and of logarithms to any base $b > 1$. It is a curious special property of the graph for natural logarithms that only one of its points has co-ordinates, both of which are rational numbers, namely the point (1, 0). In other words, the equation $l = \log_e n$, or $e^l = n$, can be satisfied by only one set of numbers l and n, of which both are real and rational, namely $n = 1$ and $l = 0$. This unexpected and curious property is rendered even more subtle by the additional fact that in all other sets of values for n and l, at least one of the two numbers is a very special type of irrational, called transcendental. As already stated, the base e is itself a transcendental number. A number is called transcendental when it is not algebraic; *i.e.*, when it cannot be the root of an algebraic equation, $x^m + ax^{m-1} + bx^{m-2} + \ldots + fx + g = 0$, where m is any positive integer and the coefficients a, b, . . . , f, g are all integers. or zero, except that g cannot be zero since that would change the degree of the equation. Algebraic numbers include all integers and rational fractions, and also all irrational numbers which are roots of algebraic equations of the kind here described. The proof that e is transcendental was a notable achievement of the French mathematician Charles Hermite in 1873.



GRAPH OF NATURAL LOGARITHMS
(*see* TEXT FOR EXPLANATION)

If in the figure we imagine all algebraic numbers marked on the n-axis and also on the l-axes, the points so marked are "dense" on each axis; *i.e.*, between any two algebraic numbers, no matter how close they are to each other, there exists at least one other algebraic number, *e.g.*, the arithmetic mean of the two. If in the nl-plane we imagine all points marked which have an algebraic abscissa n and also an algebraic ordinate l, then the entire plane is "densely" covered by these algebraic points. In spite of this fact. the logarithmic curve possesses the extraordinary property of not containing any of these algebraic points, except only $n = 1$ and $l = 0$. With this exception, all points of the curve must have at least one co-ordinate which is an irrational of the transcendental type; the curve finds its way through this complicated maze of points without hitting more than once a point whose coordinates are both algebraic. "How would Pythagoras celebrate such a discovery." exclaims Felix Klein. "if the ordinary irrational seemed to him worthy of a hecatomb!"

Change of Base. — The change of logarithms from one base to another is effected by a formula obtained as follows: If

$$n = b^l = b_1^{l_1}$$

then taking the logarithm to the base b gives

$$l \cdot \log_b b = l_1 \cdot \log_b b_1$$

Since $\log_b b = 1$, we have $l = l_1 \cdot \log_b b_1$, or

$$\log_b n = \log_{b_1} n \cdot \log_b b_1$$

If we take $b = 10$ and $b_1 = e$, we obtain

$$\log_{10} n = \log_e n \cdot \log_{10} e, \text{ where } \log_{10} e = 0.434294481903251 \ldots$$

is a constant factor sometimes called the modulus of the common system of logarithms. For the special case when $n = b$, we obtain $1 = \log_c b \cdot \log_b c$. Suppose that we know the common logarithm of 200 and we wish to compute the natural logarithm of 200. We have from the above

$$\log_e 200 = \log_{10} 200 \div \log_{10} e = 2.30103 \ldots \div 0.43429 \ldots = 5.2983 \ldots$$

the natural logarithm of 200.

Logarithms of Complex Numbers. — If, in the equation $b^l = n$, b is a positive real number and l is either positive or negative, but real, then n must necessarily be positive, for a positive number raised to a power that is real, though either positive or negative, always yields a positive result as its principal value. Under these restrictions a negative number has no logarithm. This limitation causes no embarrassment in computation with logarithms, for we proceed as if all factors were positive. If the number of negative factors is odd, we mark the final result as negative. From the standpoint of theory, however, the failure of the elementary exposition to include the logarithm of negative numbers indicates a lack of generality. It is found that, as soon as we drop the limitation that l shall be real, and permit l to become imaginary or complex. any number n, whether positive or negative or even complex, has not only one logarithm, but an infinite set of them. To establish this fact we make use of two well-known theorems in trigonometry. One theorem states that the periodicity of the sine and cosine functions is $2m\pi$, where m is any integer. The other theorem, due to Roger Cotes and Leonhard Euler, is expressed by the formula

$$e^{i\theta} = \cos\theta + i\sin\theta \tag{4}$$

where $i = \sqrt{-1}$ and θ is any angle measured in radians. Accordingly we obtain

$$e^{i\theta} = \cos\theta + i\sin\theta =$$
$$\cos(\theta + 2m\pi) + i\sin(0 + 2m\pi) = e^{i\theta + 2im\pi}$$

Suppose now that $n = p + iq$, and $l = c + id$, where p, q, c, d are real numbers; then, for simplicity, taking e as the base of the system of logarithms, we obtain

$$p + iq = e^{c+id} = e^c \cdot e^{id} = e^c(\cos d + i\sin d) \tag{5}$$

Equating the real numbers and also the imaginary numbers, we obtain the numerical relations

$$p = e^c \cdot \cos d, \qquad q = e^c \cdot \sin d$$

Allowing for periodicity, we obtain from (5) the more general equation

$$p + iq = e^c[\cos(d + 2m\pi) + i\sin(d + 2m\pi)] = e^{c + i(d\ 2m\pi)} \tag{6}$$

and $$\log,(p + iq) = c + i(d + 2m\pi) \tag{7}$$

If we write $z = p + iq$ and $p = \sqrt{(p^2 + q^2)}$, then log p = c and we obtain formula (7) in the form

$$\log, z = \log, p + i(d + 2m\pi) \tag{8}$$

As formula (7) is a general expression which is true for every integral value of m, we see that the number of logarithms of $z = p + iq$ is infinite. Let us consider some special cases. To find the logarithm of a negative number, say -1, we take $n = -1$, $p = -1, q = 0$, and obtain from formula (6) $c = 0$, and

$$\cos(d + 2m\pi) = -1$$

therefore d = π, and finally from formula (7)

$$\log_e(-1) = i\pi(1 + 2m) = i\pi, 3i\pi, 5i\pi, \text{etc.}$$

That is, the natural logarithm of -1 has, in this more general theory. an infinite number of logarithms, all imaginary. In the case of i, we find

$$\log_e i = i\left(\frac{\pi}{2} + 2m\pi\right) = \frac{i\pi}{2}, \frac{5i\pi}{2}, \frac{9i\pi}{2}, \text{etc.}$$

Similarly, for the logarithm of e, we obtain

$$\log, e = 1 + 2im\pi = 1, 1 + 2i\pi, 1 + 4i\pi, \text{etc.}$$

That is, e has one real logarithm, namely 1; all the others are imaginary. Note that the integer m may also take negative values.

The conclusion reached is that in this more general treatment of logarithmic theory, every number has an infinite set of logarithms which are all imaginary except when the number n is positive, in which case there is one real logarithm to the base e which is the same as the natural logarithm obtained by the more restricted theory.

"Gaussian" Logarithms.——When $\log_{10} a$ and $\log_{10} b$ are known, there is often great need of a process for finding $\log_{10}(a + b)$ and $\log_{10}(a - b)$, without making it necessary to pass from log a and log b to a and b. To achieve this expeditiously the Italian physicist Zecchini Leonelli in 1803 suggested a new type of table. A five-place table of this type was published in 1812 by Karl Friedrich Gauss; hence the name "Gaussian logarithms." Six-place tables of this kind are due to Karl Bremiker, to Siegmund Gundelfinger and to George W. Jones. A seven-place table was brought out by T. Wittstein. Leonelli and Gauss used a table consisting of three columns of figures, which Gauss marked by the letters A, B, C. Gauss lets $A = \log x$, $B = \log\left(1 + \frac{1}{x}\right)$, $C = \log(1 + x)$, where x is a number greater than 1. It is seen that $A + B = C$. The table is arranged according to positive values of A, increasing from 0 up to a point where B vanishes within the desired degree of approximation. Then if $\log(a + b)$ is to be determined from log a and log b, observe that, when $a > b$ and $\frac{a}{b} = x$,

$$\log(a + b) = \log a\left(1 + \frac{b}{a}\right) = \log a\left(1 + \frac{1}{\frac{a}{b}}\right) = \log a + B \tag{9}$$

The computation proceeds as follows: Find A from the equation $\log a - \log b = A$; in the table find the B which corresponds to A; add B to log a.

If $a < b$, simply interchange a and b, and take

$$\log(a + b) = \log b + B$$

To find $\log(a - b)$ from log a and log b, use column B or C, according as $\log a - \log b$ is greater or less than log 2. If it is greater, take $\log a - \log b = B$; here $\frac{a}{b} = 1 + \frac{1}{x}, \frac{1}{x} = \frac{a}{b} - 1$; hence

$$\log(a - b) = \log b\left(\frac{a}{b} - 1\right) = \log b - A \tag{10}$$

In computing, find the A which corresponds in the table to B; subtract A from log b.

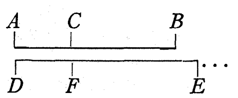
When $\log a - \log b$ is less than log 2, put $\log a - \log b = C$; then $\frac{a}{b} = 1 + x$, $x = \frac{a}{b} - 1$, and

$$\log(a - b) = \log b\left(\frac{a}{b} - 1\right) = \log b + A \tag{11}$$

In the table find the A which corresponds to C; add A to log b.

Since the time of Gauss, logarithmic addition and subtraction tables have been rearranged in several different ways. Some writers increase the number of columns, while others reduce the number of columns to two. No agreement has yet been reached as to what arrangement is the best.

History **of** Logarithms.—Logarithms were invented independently by John Napier, a Scotsman, and by Joost Bürgi, a Swiss. The logarithms which they invented differed from each other and from the common and natural logarithms now in use. Napier's logarithms were published at Edinburgh in 1614 under the title *Mirifici logarithmorum canonis descriptio*. When, in 1620, Biirgi's logarithms appeared at Prague under the title *Arithmetische und Geometrische Progresstabulen*, Napier's logarithms were already known and admired quite generally throughout Europe. To modern readers Napier's logarithms are a great curiosity. because of their singular properties and their strange mode of derivation. His theory and mode of computation are fully set forth in a second book *Mirifici logarithmorum canonis constructio*, which appeared in 1619, two years after his death. This book was translated into English in 1889 by W. R. Macdonald. Napier invoked kinematic notions in the development of his theory. One point moves along the line segment AB with a velocity decreasing so that when at any point C its



velocity is proportional to the remaining distance CB. A second point starts at the same time and with the same initial velocity, moving on the unlimited line DE with uniform velocity. Then, by definition, if C and F are simultaneous positions of the two points. DF is the logarithm of CB. The successive distances DF, taken at equal intervals of time, yield an arithmetical series whose terms are increasing; the corresponding distances CB yield a geometric series whose terms are decreasing. In the translation of these kinematic concepts into numbers, Napier begins by taking the distance $AB = 10^7$, and the distance AC passed over during the first small time-interval equal to 1. Clever devices are employed for the computation of the two series. His object was to simplify trigonometric computation. Hence his book of 1614 is not what is ordinarily called a table of logarithms of numbers, but a table of logarithmic sines which can be used also as a table of the other trigonometric functions. Since sin 90° is of frequent occurrence in computation, he thought it most convenient to take its logarithm to be zero. But sin 90° is equal to the radius of the circle which he assumed to be 10^7. Hence the logarithm of 10^7 was taken to be zero.

It is of interest to develop a formula expressing the relation between Napier's logarithms of 1614 and the modern natural logarithms. If $AB = a = 10^7, DF = x$ and $CB = y$, then $AC = a - y$. The velocity of the point C at any moment is $\frac{d(a-y)}{dt} = y$. Integrating, we obtain $-\log_e y = t + c$, where c is a constant of integration. To determine this constant, assume the initial conditions of motion to be $t = 0$ and $y = a$; substituting these values, $c = -\log_e a$. The uniform motion of the point F on the second line yields $\frac{dx}{dt} = a$ as its velocity. Consequently $x = at$, the constant of integration being zero in this case. Substituting for t and c their values, $-\log_e y = \frac{x}{a} - \log_e a$, observing that $a = 10^7$ and $-\log y = \log \frac{1}{y}$, and remembering that, by Napier's definition of a logarithm, $x =$ Nap. log y, we have

$$\text{Nap. log } y = 10^7 \log_e \frac{10^7}{y} \qquad (12)$$

Assuming the properties of natural logarithms, the various properties of the logarithms of Napier may be deduced from this compact formula. We see that Napier's logarithms increase as the numbers y decrease, that $y = 10^7$ has the logarithm 0, and that a number y larger than 10^7 has a negative logarithm. We see also that, in Napier's system, the logarithm of a product xy of two numbers is not equal to the sum of the logarithms of the numbers x and y. How is it possible to use such numbers in computation? The answer is that, according to the custom of the time, trigonometric computation was carried on by the aid of proportions, such as $\sin A : \sin C = a : c$. An unknown term, sin A, is found by two operations, one a multiplication and the other a division. For these two operations combined, Napier's logarithms give correct results. In other words, in his system the relation holds, $\log \sin A - \log \sin C = \log a - \log c$. Since Napier in 1614 did not take the logarithm of 1 to be 0, his logarithms, unmodified, do not admit *of a* base; *i.e.*, the relation of a number to its logarithm cannot be expressed by the equation $b^l = n$.

Bürgi's Logarithms.—Bürgi's publication of 1620 is, in arrangement, a table of antilogarithms. The logarithms are printed in red and the numbers in black. His explanation of his logarithms was not printed until 1856 (*Archiv für Mathematik und Physik,* vol. xxvi, pp. 316–344, 1856). But Bürgi did not have the concept of a logarithmic base any more than had Napier. Neither of them started out from the relation $b^l = n$. The possibility of defining logarithms as exponents was recognized by John Wallis in 168j and by Johann Bernoulli in 1694, but not until 1742 was a systematic exposition of logarithms based on this idea, by William Jones. Burgi started out with the comparison of arithmetic and geometric series, which indicates clearly that when inventing his logarithms he adopted the point of view taken before him by Michael Stifel and other algebraists for the purpose of illustrating the addition of exponents in multiplication, and the subtraction of exponents in division.

Invention of Common Logarithms.—The invention of the common system of logarithms resulted from the combined efforts of Napier and Henry Briggs. The share taken by each is described by Briggs in his *Arithmetica* logarithmica (1624):

I myself, when expounding this doctrine publicly in London to my auditors in Gresham college, remarked that it would be much more convenient that zero should be kept for the logarithm of the whole sine (as in the Canon *mirificus*) but that the logarithm of the tenth part of the same whole sine, that is to say, 5 degrees 44 minutes and 21 seconds should be 10000000000 And concerning that matter I wrote immediately to the author himself; and as soon as the season of the year and the vacation of my public duties of instruction permitted I journeyed to Edinburgh, where, being most hospitably received by him, I lingered for a whole month. But as we talked over the change in the logarithms he said that he had for some time been of the same opinion and had wished to accomplish it; he had however published those he had already prepared until he could construct more convenient ones, if his affairs and his health would admit of it But he was of the opinion that the change should be effected in this manner, that 0 should be the logarithm of unity and 10000000000 that of the whole sine; which I could not but admit was by far the most convenient. So, rejecting those which I had previously prepared, I began at his exhortation to meditate seriously about the calculation of these logarithms.

This statement contains all the information that has been handed down on the part taken by the two mathematicians in the invention of common logarithms. Briggs's and Napier's suggestions, described in this passage, do not quite yield the common logarithms. If R is the radius, Briggs's suggestion was that $\log R = 0$ and $\log \frac{R}{10} = 10^{10}$. Napier's improved suggestion was $\log 1 = 0$ and $\log R = 10^{10}$. It was a later change, nowhere specifically described, which replaced $\log R = 10^{10}$ by $\log 10 = 1$. Briggs began his computing of tables by extracting the square root of 10 fifty-four times in succession and at each step dividing the logarithm by 2. Thus $\log \sqrt{10} = \log 3.162 \ldots = 0.5$; $\log \sqrt[4]{10} = \log 1.778 \ldots = 0.25$; etc. His publication of 1624 contained the logarithms to 14 places of the numbers 1 to 20,000 and from 90.000 to 100,000. The gap 20.000 to 90,000 was filled up by Adrian Vlacq, a Dutch bookseller then residing in London, who in 1628 published tables from 1 to 100.000. Tables of common logarithms of trigonometric functions were first published by Edmund Gunter in 1620; more extensive ones, computed in part by Briggs and completed by Henry Gellibrand, were published by Vlacq at his own expense. The word "characteristic." as used in the theory of logarithms, first occurred in Briggs's tables of 1624; the word "mantissa" was introduced by John Wallis in his Algebra of 1693.

Origin of Natural *Logarithms.*—Natural logarithms first arose as more or less accidental variations of Napier's original logarithms. Their real significance in analysis was not recognized until later. The earliest natural logarithms occur in the 1618 edition of Edward Wright's translation into English of Napier's *Descriptio,* where in an anonymous appendix, very probably written by William Oughtred, there is a small table containing logarithms of 72 sines. used in a process of interpolation. The latter are natural logarithms with the decimal point omitted. In the 1622 edition of John Speidell's *New* Logarithms there is included a table of logarithms of the numbers 1 – 1.000; except for the omission of the decimal point, these are natural logarithms. The earliest table to appear after the importance of natural logarithms in analysis nas generally understood was published more than a century later, in 1770, by Johann Heinrich Lambert, an Alsatian. He included a seven-place table of natural logarithms of the numbers 1 – 100 in his *Zusätze zu* den Logarithmischen und *Trigonometrischen* Tabellen.

Controversies About Logarithms of Complex *Numbers.*—The history of this subject affords an interesting example of how able intellects may for a long time grope hopelessly in the dark but through persistent effort may finally reach general, consistent and elegant results. In 1712 and 1713 G. W. Leibniz and Johann Bernoulli discussed in their correspondence the question whether negative numbers have logarithms. Leibniz contended that since a positive logarithm corresponds to a number larger than unity and a negative logarithm to a positive number less than unity, the logarithm of -1 was not really true, but imaginary (non-existent); hence the ratio $-1 \div 1$, having no logarithm, is itself imaginary. Bernoulli maintained that -1 has a logarithm, since $dx : x = -dx : -x$, and, integrating, $\log x = \log(-x)$. Thus x and $-x$ have the same logarithm.

A second discussion of this question took place in a correspondence between Johann Bernoulli and Leonhard Euler in the years 1727–31. Euler uncovered the inconsistencies of Bernoulli's conclusion that $\log x = \log(-x)$, and also of views which he himself had entertained. Somewhat later, Euler exchanged letters with Jean d'Alembert on this topic and disproved the latter's contention that $\log(-1) = 0$. About 1747 Euler succeeded in creating a consistent theory of logarithms of negative and complex numbers, but d'Alembert advanced arguments against it—metaphysical, analytical, and geometrical in nature — which shrouded the subject in a dense haze and helped to prolong the controversy to the beginning of the 19th century.

Euler published in 1749 an article De la controverse entre Mrs. Leibnitz et Bernoulli sur les logarithmes, *négatifs* et imaginaires, which gives the modern results that $\log n$ has an infinite number of values, which are all imaginary, except when n is a positive number, in which case one logarithm out of this infinite number is real. These conclusions were so novel and the theory of imaginary numbers in algebra was so little understood that in his day Euler's theory was not understood or generally accepted as valid.

In the early part of the 19th century the general theory of logarithms was elaborated, and Euler's results were confirmed by Martin Ohm, John Graves, John Warren, A. J. H. Vincent, Augustus De Morgan, William R. Hamilton and others.

Methods of Computing *Logarithmic* Tables. — For the computation of logarithms numerous processes were devised by Napier, Briggs, James Gregory, Abraham Sharp and others. Nicolaus Mercator in 1668 derived the infinite series

$$\log(1+x) = x - \frac{x^2}{2} + \frac{x^3}{3} - \frac{x^4}{4} +$$

which, though convergent for $-1 < x \leqq 1$, is worthless for practical computation because of its slow convergence. John Wallis in 1695 deduced from it the rapidly convergent series

$$\tfrac{1}{2}\log\frac{1+z}{1-z} = z + \tfrac{1}{3}z^3 + \tfrac{1}{5}z^5 +$$

and G. F. Vega, in his Thesaurus of 1794, let $z = 1/(2y^2 - 1)$ and obtained expressions converging rapidly.

See also ARITHMETIC: *Logarithms;* INTERPOLATION; MATHEMATICAL TABLES; NOMOGRAPHY.

BIBLIOGRAPHY.—For details on the modern technique of logarithmic computation and ior lists of leading publications of logarithmic tables, *see* the *Napier Tercentenary Memorial Volume* (1915). Among other publications of logarithmic tables are: a 10-place table of logarithms of numbers to 100,000 (1910); also an 8-place table to 200,000, and trigonometric tables to every sexagesimal second, by J. Bauschinger and J. Peters; a 14-place table of logarithms of sines and tangents to every 10 sexagesimal seconds, by H. Andoyer (1911). (F. CA.; X.)

LOGAU, FRIEDRICH, FREIHERR VON (1604–1655), German epigrammatist, was born at Brockut near Nimptsch in Silesia in June 1604. He entered the service of the duke of Brieg, and in 1644 was made ducal councilor. He died at Liegnitz on July 24, 1655.

Logau's epigrams, which appeared under the pseudonym "Salomon von Golaw" (an anagram of his real name), show great range and variety of expression. They are contained in two collections: Erstes *Hundert deutscher Reimensprüche* (1638), and *Deutscher Sinnge-dichte* drei *Tausend* (1654). He satirized the court life, the useless bloodshed of the Thirty Years' War, the lack of national pride in the German people and their slavish imitation of the French in customs, dress and speech. He regarded himself as a follower of the poet Martin Opitz, but he did not allow such a tie to influence his independence.

LOGGERHEAD (Caretta caretta), a carnivorous marine turtle inhabiting tropical seas. See TURTLE.

LOGGIA, in architecture. is a room, gallery or hall open to the air on one or more sides, associated particularly with the Mediterranean and near eastern regions, where an open sitting room with protection from the hot sun was desired. Ancient Egyptian houses often had a loggia on their roofs, or an interior loggia facing upon a court. In medieval and Renaissance Italy the loggia was used frequently in conjunction with a public square or piazza. Thus the Loggia dei Lanzi, begun 1376, consists of three gigantic arches dominating one side of the main square of Florence. Another at Florence, the Loggia degli Innocenti, begun in 1419 after the design of Filippo Brunelleschi, marks the first appearance of the Renaissance revival of classic forms. The loggia was also an essential feature of villas and often had outstanding decoration, such as that of Raphael and his assistants in the Villa Farnesina at Rome. (D. R. CN.)

LOGIA, a title used to describe a collection of the sayings of Jesus Christ, and therefore generally applied to the "Sayings of Jesus" discovered in Egypt by B. P. Grenfell and A. S. Hunt. There is some question as to whether the term is rightly used for this purpose. It does not occur in the papyri in this sense. Each "saying" is introduced by the phrase "Jesus says," (legei) and the collection is described in the introductory words of the 1903 series as logoi, not as logia. Some justification for the employment of the term is found in early Christian literature. Several writers speak of the oracles of (or concerning) the Lord. Polycarp, for instance, speaks of "those who pervert the oracles of the Lord" (Philipp. 7), and Papias, as Eusebius relates, wrote a work with the title "Expositions of the Oracles of the Lord." The expression has been variously interpreted. It need mean no more than narratives of (or concerning) the Lord; on the other hand, the phrase is capable of a much more definite meaning, and there are many scholars who hold that it refers to a document which contained a collection of the sayings of Jesus and which is believed to be the source, or the principal source, of the teachings of Jesus found in Matthew and Luke but not in Mark.

"The Sayings." — These fragments, to which the term Logia is also applied, consist of: (1) a papyrus leaf containing seven or eight sayings of Jesus discovered in 1897; (2) a second leaf containing five more sayings discovered in 1903; and (3) two fragments of unknown Gospels, the former published in 1903, the latter in 1907. All these were found among the great mass of papyri acquired by the Egyptian Exploration fund from the ruins of Oxyrhynchus, one of the chief early Christian centres in Egypt, situated about 120 mi. S. of Cairo. The eight sayings discovered in 1897 may be translated as follows:

1. ". . . and then shalt thou see clearly to cast out the mote that is in thy brother's eye."

2. "Jesus saith, Except ye fast to the world, ye shall in no wise find the kingdom of God; and except ye make the sabbath a real sabbath, ye shall not see the Father."

3. "Jesus saith, I stood in the midst of the world and in the flesh was I seen of them, and I found all tnen drunken, and none found I athirst among them, and my soul grieveth over the sons of men, because they are blind in their heart, and see not. . . ."

4. ". . . poverty . . . ."

5. "Jesus saith, Wherever there are two, they are not without God, and wherever there is one alone, I say, I am with him. Raise the stone and there thou shalt find me, cleave the wood and there am I."

6. "Jesus saith, A prophet is not acceptable in his own country, neither doth a physician work cures upon them that know him."

7. "Jesus saith, A city built upon the top of a high hill and stablished can neither fall nor be hid."

8. "Jesus saith, Thou hearest with one ear [but the other ear hast thou closed]."

The "sayings" of 1903 are as follows:

1. "Jesus saith; Let not him who seeks . . . cease until he finds and when he finds he shall be astonished; astonished he shall reach the kingdom and having reached the kingdom he shall rest."

2. "Jesus saith (ye ask? who are those) that draw us (to the kingdom if) the kingdom is in Heaven? . . . the fowls of the air and all beasts that are under the earth or upon the earth and the fishes of the sea (these are they which draw) you and the kingdom of Heaven is within you and whosoever shall know himself shall find it. (Strive therefore?) to know yourselves and ye shall be aware that ye are the sons of the (Almighty?) Father; (and?) ye shall know that ye are in (the city of God?) and ye are (the city?)."

3. "Jesus saith, A man shall not hesitate . . . to ask concerning his place (in the kingdom. Ye shall know) that many that are

first shall be last and the last first and (they shall have eternal life?)."

4. "Jesus saith, Everything that is not before thy face and that which is hidden from thee shall be revealed to thee. For there is nothing hidden nhich shall not be made manifest nor buried which shall not be raised."

5. "His disciples question him and say, How shall we fast and how shall we (pray?) . . . and what (commandment) shall we keep . . . Jesus saith . . . do not . . . of truth . . . blessed is he "

First Gospel Fragment. — The fragment of a lost Gospel which was discovered in 1903 contained originally about 50 lines, but many of them have perished and others are undecipherable. The translation, as far as it can be made out, is as follows:

1–7. "(Take no thought) from morning until even nor from evening until morning either for your food what ye shall eat or for your raiment what ye shall put on." 7–13. "Ye are far better than the lilies which grow but spin not. Having one garment what do ye (lack)? . . ." 13–15. "Who could add to your stature?" 15–16. "He himself will give you your garment." 17–23. "His disciples say unto him, When wilt thou be manifest unto us and when shall we see thee? He saith. When ye shall be stripped and not be ashamed . . ." 41–46. "He said. The key of knowledge ye hid: ye entered not in yourselves, and to them that were entering in, ye opened not."

Second Gospel Fragment. — The second Gospel fragment discovered in 1907 "consists of a single vellum leaf, practically complete except at one of the lower corners and here most of the lacunae admit of a satisfactory solution." The translation is as follows:

". . . before he does wrong makes all manner of subtle excuse. But give heed lest ye also suffer the same things as they: for the evil doers among men receive their reward not among the living only, but also await punishment and much torment. And he took them and brought them into the very place of purification and was walking in the temple. And a certain Pharisee, a chief priest. whose name was Levi. met them and said to the Saviour, Who gave thee leave to walk in this place of purification: and to see these holy vessels when thou hast not washed nor yet have thy disciples bathed their feet? But defiled thou hast walked in this temple, which is a pure place, wherein no other man walks except he has washed himself and changed his garments, neither does he venture to see these holy vessels. And the Saviour straightway stood still with his disciples and answered him, Art thou then. being here in the temple, clean? He saith unto him, I am clean; for I washed in the pool of David and having descended by one staircase, I ascended by another and I put on white and clean garments, and then I came and looked upon these holy vessels. The Saviour answered and said unto him. Woe ye blind, who see not. Thou hast washed in these running waters wherein dogs and swine have been cast night and day and hast cleansed and wiped the outside skin which also the harlots and flute-girls anoint and wash and wipe and beautify for the lust of men; but within they are full of scorpions and all wickedness. But I and my disciples who thou sayest have not bathed have been dipped in the waters of eternal life which come from . . . . But woe unto the . . . ."

Probable Date of the "Sayings." — These documents have naturaliy excited considerable interest and raised many questions. The papyri of the "sayings" date from the 3rd century and most scholars agree that the "sayings" themselves go back to the 2nd. The year A.D. 140 is generally assigned as the *terminus* ad *quem*. There is a considerable diversity of judgment, however, with regard to the value of the collection.

1. Some scholars maintain that the collection goes back to the 1st century and represents one of the earliest attempts to construct an account of the teaching of Jesus. They are therefore disposed to admit to a greater or less extent and with widely varying degrees of confidence the presence of genuine elements in the new matter.

2. Sanday and many others regard the sayings as originating early in the 2nd century and think that, though not "directly dependent on the Canonical Gospels," they have "their origin under conditions of thought which these Gospels had created." The "sayings" must be regarded as expansions of the true tradition, and little value is therefore to be attached to the new material.

With the knowledge at our disposal, it is impossible to reach an assured conclusion between these two views. The real problem, to which no solution has been found, is to account for the new material in the "sayings." There seems to be no motive sufficient to explain the additions that have been made to the text of the Gospels. It cannot be proved that the expansions were made in the interests of any sect or heresy. Unless new discoveries provide the clue, or some reasonable explanation can otherwise be found, there seems to be no reason why the "sayings" should not be regarded as containing material to be taken into account in the critical study of the teaching of Jesus.

Date of the Gospel Fragments. — The 1903 Gospel fragment is so mutilated in many of its parts that it is difficult to decide upon its character and value. It appears to date from before 150, and to be taken from a Gospel which followed more or less closely the version of the teaching of Jesus given by Matthew and Luke. The second Gospel fragment (1907) seems to be of later origin than the documents already mentioned. Grenfell and Hunt date the Gospel, from which it is an excerpt, about 200. There is considerable difficulty with regard to some of the details. The statement that an ordinary Jew was required to wash and change his clothes before visiting the inner court of the temple is quite unsupported by any other evidence. Nothing is known about "the place of purification" nor "the pool of David." Nor does the statement that "the sacred vessels" mere visible from the place where Jesus was standing seem at all probable. But if the inaccuracy of the fragment in this important respect is admitted, the historical character of the whole episode breaks down and it is probably to be regarded as an apocryphal elaboration of Matt. xv, 1–20, and Mark vii, 1–23.

See the *Oxyrhynchus Papyri*, part i (1897), part iv (1904), part v (1908). (H. T. A.; X.)

LOGIC is the systematic study of the structure of propositions and of the general conditions of valid inference by a method which abstracts from the content or *matter* of the propositions and deals only with their logical *form*. This distinction between form and matter is made whenever we distinguish between the logical soundness or validity of a piece of reasoning and the truth of the premisses from which it proceeds, and in this sense is familiar in everyday usage. However, a precise statement of the distinction must be made with reference to a particular language or system of notation, a *formalized language*, which shall avoid the inexactnesses and systematically misleading irregularities of structure and expression that are found in ordinary (colloquial or literary) English and in other natural languages, and shall follow or reproduce the logical form — at the expense, where necessary, of brevity and facility of communication. To adopt a particular formalized language is thus to adopt a particular system or theory of logical analysis. And the formal method may then be characterized by saying that it deals with the objective form of *sentences* which express propositions, and provides in these concrete terms criteria of meaningfulness, of valid inference, and of other notions closely associated with these — among which we mention the notions of logical compatibility, analytic or logical truth, probable inference, and degree of confirmation.

The topics of inductive and probable inference, confirmation, and degree of confirmation belong to *inductive logic*, and are treated in the articles INDUCTION and PROBABILITY. In this article we confine attention to the remaining part of logic, or *deductive logic*. And we also omit treatment of *modal logic*, partly because this branch of deductive logic (though its beginnings go back to Aristotle) is still in a much more unsettled state than the remainder. But works on modal logic and modality are included in the bibliography.

FUNDAMENTALS OF MODERN LOGIC

The Propositional Calculus is, in most developments, the most elementary branch of logic, on which the others are based. It deals with the *sentence connectives*: "and," "or," "if," "not," "if and only if," and others of similar character. And in order to analyze and exhibit the logical properties of the connectives it employs also propositional variables p, q, r, . . . , which are to be thought of as variables replaceable by sentences.

In strictness the sentences by which the propositional variables are replaceable should be sentences of some appropriate formalized language (for instance, one of the functional calculi which are described below, or one of the systems of set theory). But for informal expository purposes we may employ also declarative sentences of the English language. Thus, with $\supset$ as notation for "if . . . then," the expression $p \supset q$ of propositional calculus may be thought of as having (by substitution for p and q) such instances as the following: "If you are not satisfied, we will refund your money," "If there are any survivors of the disaster, they are in need of immediate help," "If Vidkun Quisling was a patriot, then n-butyl mercaptan is a perfume."

Of the various systems of notation which are in use, me here adopt a particular one for purposes of exposition. We shall use the sign $\sim$ to denote negation ("$\sim p$" to mean "not p"), the sign $\supset$ to denote the *conditional* ("$p \supset q$" to mean "if p then q" or "not both p and not q"), the sign $|$ to denote non-conjunction ("$p|q$" to mean '(not both p and q"), juxtaposition or a dot to denote conjunction ("pq" or "$p \cdot q$" to mean "p and q"), the sign $\equiv$ to denote the biconditional ("$p \equiv$ q" to mean "p if and only if q"), the sign v to denote inclusive disjunction ("$p \vee q$" to mean "p or q or both"), the sign $\not\equiv$ to denote exclusive disjunction ("$p \not\equiv q$" to mean "p or q but not both^x).—As the word "or" is am-biguous in ordinary English usage between inclusive disjunction and exclusive disjunction, the two signs v and $\not\equiv$ are provided for the two meanings of the word. The signs $\supset$ and $\equiv$ may often conveniently be read as "implies" (or "implies that") and "is equivalent to" respectively; but these readings must be employed with a certain caution not to misunderstand them, since the terms implication and equivalence in ordinary usage often suggest that there is some relationship between the logical forms of the propositions or the sentences involved, whereas the truth of $p \supset$ q and of $p \equiv$ q (upon substitution of particular sentences for p and q) requires no such relationship. The connective $\supset$ is also said to stand for material implication, distinguished from formal implication (defined below) and strict implication (a notion of modal logic). Similarly, $\equiv$ is said to stand for material equivalence.

There are various ways in which some of the sentence connectives named above can be defined in terms of others. If the sign of non-conjunction (*Sheffer's* stroke) is taken as primitive, all the other connectives can be defined from this one. Also, if the signs of negation and inclusive disjunction are taken as primitive, all the others can be defined in terms of these; likewise if the signs of negation and conjunction are taken as primitive. But because of its special role in the rule of *modus* ponens and in the deduction theorem (see below), we here prefer to include $\supset$ as one of the primitive connectives. Therefore we take $\sim$ and $\supset$ as primitive, and define the remaining connectives as follows:

$$[\mathrm{A}|\mathrm{B}] \rightarrow [\mathrm{A} \supset \sim\mathbf{B}] \qquad [\mathrm{A} \equiv \mathrm{B}] \rightarrow [[\mathrm{A} \supset \mathrm{B}][\mathrm{B} \supset \mathbf{A}]]$$
$$[\mathbf{AB}] \rightarrow \sim[\mathrm{A}|\mathbf{B}] \qquad [\mathbf{A} \vee \mathbf{B}] \rightarrow [\sim\mathrm{A}\ \mathbf{3}\ \mathbf{B}]$$
$$[\mathrm{A} \cdot \mathrm{B}] \rightarrow \sim[\mathrm{A}|\mathrm{B}] \qquad [\mathbf{A} \not\equiv \mathbf{B}] \rightarrow \text{--}[\mathbf{A} \equiv \mathbf{B}]$$

Here the bold capital letters stand for arbitrary well-formed *formulas* of the propositional calculus (in the technical sense defined below)—or, when appropriate, for arbitrary well-formed formulas of some more extensive formalized language containing the propositional calculus as a part. And the arrow is to be read "is defined as," or "is an abbreviation for."

To formulate the propositional calculus explicitly, we first list the primitive symbols. These are the two connectives $\sim$ $\supset$, the two brackets [ ], and an infinite list of propositional variables p, q, 7, s, p_1, q_1, r_1, s_1, p_2, $\cdot \ldots$ Any finite sequence of the primitive symbols is a formula. But as some formulas are evidently not meaningful, we define a subclass, the well-formed *formulas*, by the following *formation* rules: i. A propositional variable standing alone is a well-formed formula. ii. If A is a well-formed formula, $\sim\mathbf{A}$ is a well-formed formula, iii. If A and B are well-formed formulas, [A $\supset$ **B**] is a well-formed formula.

Hereafter the bold capital letters shall stand for well-formed formulas of the propositional calculus—or later also well-formed formulas of other calculi or formalized languages—and the condition of well-formedness shall be understood without explicit repetition in every case.

In writing well-formed formulas we may abbreviate them by means of the definitions listed above; for instance, $[pq]$ is to be understood as an abbreviation of $\sim[p \supset \sim q]$, and [p $\equiv$ [p v q]] is to be understood as an abbreviation of [[p $\supset$ $[\sim p \supset q]][[\sim p \supset q] \supset p]]$, *i.e.*, as an abbreviation of $\sim[[p \supset [\sim p \supset q]] \supset \sim[[\sim p \supset q] \supset p]]$. Also well-formed formulas may be abbreviated by omission of brackets, in accordance with the three following conventions: (1) A bold dot is used to indicate that the scope of an omitted pair of brackets extends from the point where the dot appears, forward to the end of the formula; for example, $p \supset \centerdot\, q \supset \centerdot\, r \supset s$ is an abbreviation of [p $\supset$ [q $\supset$ [r $\supset$ s]]]. *(2)* In restoring omitted brackets, and so far as not otherwise indicated by bold dots, the scope of a pair of brackets belonging to a conditional, a biconditional, or an exclusive disjunction is to be made wider than the scope of a pair of brackets belonging to an inclusive disjunction or a non-conjunction, and the latter in turn wider than the Scope of a pair of brackets belonging to a conjunction; for example, $\sim p$ v q $\sim r$ > pq v rs is an abbreviation of $[[\sim p \vee [q \sim r]] \supset [[pq] \vee [rs]]]$, *i.e.*, of $[[\sim\sim p \supset \sim[q \supset \sim\sim r]]\ \mathbf{3}\ [\sim\sim[p\ \mathbf{3} \sim q] \supset \sim[r \supset \sim s]]]$. **(3)** Where neither of the two preceding conventions applies, brackets are restored in accordance with the convention of association to the left; for example, $p \supset$ [q $\supset$ r] $\supset \sim s \supset \centerdot\, p \supset q \supset r$ is an abbreviation of $[[[p \supset [q \supset r]] \supset \sim s] \supset [[p\ \mathbf{3}\ q] \supset r]]$.

It must be understood that these abbreviations are not an actual part of the formalized language—the propositional calculus, or better, the particular formulation of propositional calculus which we are here stating. *E.g.*, the formalized language expresses the inclusive disjunction of p and q by $[\sim p \supset q]$, and it is merely a device for our typographical convenience in writing about the formalized language, serving the purposes of brevity and perspicuity, that we sometimes abbreviate this as $[p \vee q]$, or as p v q. Especially, the rules of inference stated below are to be applied to the well-formed formulas themselves, and not to their abbreviations.

As axioms of the propositional calculus we take the three following:

1. $p \supset q \supset \centerdot\, q \supset r \supset \centerdot\, p \supset r$
2. $\sim p \supset p \supset p$
3. $p \supset \centerdot \sim p \supset q$

The assertion of the axioms is of course meant in the sense that they hold for any p, q, and r whatever. These particular axioms are due to Jan Łukasiewicz; they represent only one of many possible choices of axioms from which the same theorems follow by means of the two rules of inference below. Convenient verbal readings of the axioms, in which advantage is taken of the two readings of >, are as follows: 1. If p implies q, if q implies r, then p implies r. 2. If not-p implies p, then p. 3. p implies that, if not-p, then q.—Axiom 1 expresses the transitive law of material implication, and 2, the law of Clavius.

The rules of inference are the two following: I. Rule of substitution. From A, if B is any well-formed formula and b is a propositional variable, to infer the result of substituting B for b throughout A. II. Rule of *modus* ponens. From [A $\supset$ B], and A, to infer B.—In an application of I, we call A the premiss, and the result of the substitution the conclusion. In an application of II, [A $\supset$ B] is the major premiss, A is the minor premiss, and B is the conclusion.

A theorem of the propositional calculus is obtained from the axioms by a succession of applications of the rules of inference. Or more explicitly, a proof of a theorem is a finite sequence of well-formed formulas, of which the last one is the theorem in question, and each of which either is an axiom or is inferred from earlier formulas in the sequence by one of the two rules of inference; and a theorem is then any well-formed formula of which there is a proof.

For example, a proof may be constructed as follows, of the theorem $p \supset$ p (the *reflexive* law of material implication). Axiom 1 is first taken as premiss for an application of the rule of substitution. The substitution of $\sim p$ > p for q gives p > $[\sim p > p]$ $\supset \centerdot \sim p \supset p \supset r \supset \centerdot\, p \supset$ r, and from this by substitution of p for r (another application of the rule of substitution) is inferred $p \supset [\sim p \supset p] \supset \centerdot \sim p \supset p \supset p \supset \centerdot\, p \supset p$. This last is to be the major premiss in an application of *modus* ponens. Axiom 3 is the source of the minor premiss $p \supset \centerdot \sim p \supset p$ (obtained by substituting p for q). Hence by *modus* ponens is inferred $\sim p \supset p \supset p$ $\supset \centerdot\, p \supset p$. Axiom 2 is then taken as minor premiss, and by another application of *modus* ponens is inferred $p \supset p$.

Other theorems are the following, which may be proved in the order named (though the proofs are generally not as easy as the example just given): $p \supset . q \supset p$ (law of *affirmation of* the consequent), $\sim q \supset \sim p \supset . p \supset q$ (converse law of *contraposition*), $\sim p \supset . p \supset q$ (law *of* denial *of the* antecedent), $p \supset q \supset p \supset p$ (*Peirce's law*), $p \supset [p \supset q] \supset . p \supset q$, $p \supset . p \supset q \supset q$ (*law of* assertion), $p \supset [q \supset r] \supset . q \supset [p \supset r]$ (law *of commutation*), $q \supset r \supset . p \supset q \supset . p \supset r$, $p \supset [q \supset r] \supset . p \supset q \supset . p \supset r$ (*self-distributive* law *of* material implication), $\sim\sim p \supset p$ (law *of* double negation), $p \supset \sim\sim p$ (converse law *of* double negation), $p \supset q \supset . \sim q \supset \sim p$ (law *of* contraposition), $p \supset q \supset . p \supset \sim q \supset \sim p$ (law *of reductio* ad absurdum), $\sim . p \sim p$ (law *of* contradiction), $p \vee \sim p$ (law *of* excluded middle), $pq \supset r \supset . p \supset . q \supset r$ (*law* of exportation), $p \supset [q \supset r] \supset . pq \supset r$ (law *of* importation), $[p \supset q][p \supset r] \supset . p \supset qr$ (law of composition), $\sim[pq] \equiv \sim p \vee \sim q$ and $\sim[p \vee q] \equiv \sim p \sim q$ (De Morgan's *laws*), $[p \supset q] \vee [q \supset p]$.

The last theorem in the foregoing list is sometimes spoken of as one of the "paradoxes" of material implication. It is not a paradox in the sense of an antinomy and is not inconsistent with important uses of $\supset$ as expressing an implication relation. But it shows a divergence of the meaning of $\supset$ from some of the various meanings of the words "if then" in ordinary usage, and especially from their familiar but not very definite meaning in conditions contrary to *fact*. (To illustrate the latter we quote the conditional sentence, "If Vidkun Quisling had been a patriot, then *n*-butyl mercaptan would be a perfume," which must be distinguished from the corresponding sentence with a simple condition, quoted above, and indeed is clearly false.)

We shall speak of a valid *inference of* the propositional *calculus* not only within the propositional calculus itself but also within a more extensive formalized language containing the propositional calculus as a part. Namely a substitution instance of a theorem of the propositional calculus is any well-formed formula (of the more extensive formalized language) which results from a theorem of the propositional calculus by substituting specific well-formed formulas (of the more extensive language) for one or more of the propositional variables. And an inference from hypotheses $\mathbf{A}_1$, $\mathbf{A}_2$, . . . , $\mathbf{A}_n$ to a conclusion B is called a valid inference of the propositional calculus if B can be obtained from the hypotheses $\mathbf{A}_1$, $\mathbf{A}_2$, . . . , $\mathbf{A}_n$, together with any number of additional premisses which are either theorems of the propositional calculus or substitution instances of theorems of the propositional calculus, by a succession of applications *of* the *rule of modus* ponens only.

Within the propositional calculus itself, if the inference from $\mathbf{A}_1$, $\mathbf{A}_2$, . . . , $\mathbf{A}_n$ to $\mathbf{B}$ is a valid inference of the propositional calculus, it can be shown that $\mathbf{A}_1 \supset . \mathbf{A}_2 \supset . \ldots \mathbf{A}_n \supset \mathbf{B}$ must then be a theorem of the propositional calculus. This general result, which is not a theorem *of* the propositional calculus but a theorem about the propositional calculus, is known as the deduction theorem. We shall see below that it can be extended to other more extensive formalized languages.— It is in the sense that the rule of *modus ponens* and the deduction theorem are both fulfilled that we are able to think of and use $\supset$ as expressing an implication relation (in spite of the so-called paradoxes of material implication).

It is convenient to use such words as "theorem," "proof," "premiss," "conclusion" both for propositions, in whatever language expressed, and for formulas expressing propositions in some fixed formalized language. However, theorems about a particular formalized language are distinguished from theorems of the language by calling the former *metatheorems.* The deduction theorem is, *e.g.*, a metatheorem of the propositional calculus, in contrast with, say, Peirce's law, which is a theorem of the propositional calculus. The metatheorems of a formalized language are said to belong to the metatheory of the language: and though we shall here treat the metatheory informally, it may itself be organized as a formalized language, which is then called a meta-language of the first language as object language. (See METATHEORY; SEMANTICS IN LOGIC.)

We go on to explain some additional metatheorems of the propositional calculus.

The two primitive connectives (hence all connectives definable from them) denote truth-functions: *i.e.*, the truth-value (truth or falsehood) of $\sim p$ and of $p \supset q$ is uniquely determined by the truth-values of p and q. In fact the truth-value of $\sim p$ is falsehood when the truth-value of p is truth, and truth when the truth-value of p is falsehood. And (corresponding to the four theorems $p \supset . q \supset . p \supset q$, $p \supset . \sim q \supset \sim . p \supset q$, $\sim p \supset . q \supset . p \supset q$, $\sim p \supset . \sim q \supset . p \supset q$) the truth-value of $p \supset q$ is falsehood when the truth-value of p is truth and the truth-value of q is falsehood, and the truth-value of $p \supset q$ is truth in each of the three remaining cases. These determinations of the truth-value of $\sim p$ and of $p \supset q$ in terms of the truth-values of p and q, by using (say) 0 for truth and 1 for falsehood, may conveniently be displayed in the form of tables, which are then called truth-tables of negation and material implication.

The truth-tables enable us, given a well-formed formula of the propositional calculus and an assignment of a truth-value to each of its variables, to reckon out by a mechanical process the truth-value of the entire formula. (For example, if the values of p and q are both 1, the value of $p \supset q$ is 0, hence the value of $p \supset q \supset p$ is 1, hence the value of Peirce's law $p \supset q \supset p \supset p$ is 0.) If, for all possible assignments of truth-values to the variables, the calculated truth-value of the entire formula is 0, or truth, the formula is said to be a tautology. The test whether a well-formed formula is a tautology is effective, since in any particular case the total number of different assignments of truth-values to the variables is finite, and the calculation of the truth-value of the entire formula can be carried out separately for each assignment of truth-values to the variables.

Now it may be verified that the three axioms, 1–3, given above are tautologies, and that the two rules of inference preserve tautologies in the sense that if the premiss or premisses are tautologies the conclusion must be a tautology. Hence every theorem of the propositional calculus is a tautology. By a more difficult argument it may be shown that every tautology is a theorem. Hence the truth-table test for tautologies (just described) can be used to decide, for any given well-formed formula of the propositional calculus, whether it is a theorem. This is a solution of the *decision* problem of the propositional calculus.

As corollaries of the solution of the decision problem, it follows that the propositional calculus is consistent in the sense that $\mathbf{A}$ and $\sim\mathbf{A}$ cannot both be theorems, and complete in the sense that if $\mathbf{A}$ is not a theorem the addition of A as an extra axiom would result in inconsistency. By a different method it may be shown that the three axioms and the two rules of inference are independent in the sense that completeness is lost if any one of them is omitted.

In one sense the solution of the decision problem renders unnecessary the statement of axioms and rules of inference of the propositional calculus. For we might instead merely stipulate that every tautology shall be a theorem. However, this summary procedure provides no analysis of the logical relationships of the theorems among themselves, and no method by which to trace the consequences of a particular law of the propositional calculus or to formulate the situation which results when particular laws are rejected.

An example of the last is provided by the intuitionistic school of mathematics (see MATHEMATICS, FOUNDATIONS OF), which rejects the law of excluded middle and some other related laws of negation. To formulate the propositional calculus of mathematical intuitionism we may modify our above formulation as follows. Axiom 2 is replaced by the weaker axiom $p \supset \sim p \supset \sim p$, and there are then added the two further axioms. $p \supset . q \supset p$, $p \supset [p \supset q] \supset . p \supset q$. These axioms suffice for the intuitionistic laws of implication and negation. But as the definitions of conjunction and inclusive disjunction, given above, no longer serve to yield the characteristic properties of these connectives, it is necessary to introduce these two connectives as additional primitives, and to add also the axioms: $pq \supset p$, $pq \supset q$, $p \supset . q \supset pq$, $p \supset p \vee q$, $q \supset p \vee q$, $p \supset r \supset . q \supset r \supset . p \vee q \supset r$. Then finally, after this last addition, the axiom $p \supset . q \supset p$ may be dropped as not independent: in fact we can prove the theorem $p \supset . p \supset . q \supset p$ using only the axioms $p \supset . q \supset pq$, $pq \supset p$, and the transitive law, and then $p \supset \centerdot q \supset p$ follows by the axiom $p \supset [p \supset q] \supset \centerdot p \supset q$.

Using this formulation of the intuitionistic propositional calculus we can show that not only the law of excluded middle is not a theorem, but also the law of Clavius, the converse law of contraposition, Peirce's law, and the law of double negation fail; but the introduction of any one of these as an added axiom would restore all the others as theorems. The "paradox" $[p \supset q] \vee [q \supset p]$ is still a consequence in the form $\sim[p \supset q] \supset \centerdot q \supset p$, but not in the form containing the disjunction sign.

A Logistic System, or Calculus, is the purely formal part of a formalized language, taken in abstraction from any meaning or interpretation.

A logistic system is determined by giving its vocabulary, or list of primitive symbols, defining certain finite sequences of the primitive symbols to be well-formed *formulas*, listing certain well-formed formulas as axioms, and finally, stating rules of inference, by means of which a well-formed formula may on given conditions be inferred (as conclusion) from a set of one or more well-formed formulas (as premisses). A theorem of the logistic system is then defined to be a well-formed formula of which there is a proof, *i.e.*, a finite sequence of well-formed formulas each of which is either an axiom or inferred from earlier formulas in the sequence by one of the rules of inference, the last formula in the sequence being the theorem.

It is usually required that the set of rules of inference shall be effective, in the sense that there shall be a definite procedure or test by which, whenever a particular proposed conclusion from given premisses is before us, we can always actually decide whether the proposed inference is correctly made in accordance with one of the rules of inference; further that the set of axioms shall be effective, in the sense that there shall be a test by which, whenever a particular well-formed formula is before us, we can always decide whether it is an axiom (this requirement is satisfied when the axioms are a finite list which has been written out in full, but may also be satisfied in some cases of an infinite set of axioms). For these two requirements it will generally be necessary that the definition of well-formedness shall also be effective, in the sense that there shall be a test by which, whenever a particular formula is before us, we can always decide whether it is well-formed or not.

The reason for these requirements lies in the nature of the notion of a proof—as it is commonly understood, or as it is needed for the purposes of deductive logic (and, as a special case, in connection with mathematical proof). Namely it is a part of the notion of proof that a proof shall carry final conviction of the theorem proved (*i.e.*, of course, for any one who admits the axioms and rules of inference on which the proof is based). But without the requirements of effectiveness, it might happen that some one confronted with a proof of a theorem (and admitting the axioms and rules of inference) might nevertheless continue to doubt the theorem, because of doubt that the alleged proof actually is a proof in accordance with the axioms and rules. In such a case the proposer of the proof might fairly be asked to give a supplementary proof that it is a proof—and for purposes of deductive logic, this supplementary proof ought then to be treated as part of the whole proof, and included with it when the process of proof is formalized by the logistic method.

Though in the light of the requirements just explained, the notion of being a proof, in a particular logistic system, must be effective, it is clear that in general the notion of being a theorem may not be effective. For a well-formed formula is established as a theorem if a proof of it is found, but the failure of a particular investigator to find a proof may not necessarily mean that there is no proof to be found. It may indeed be possible in particular cases, by special methods, to establish as a metatheorem that a certain well-formed formula is not a theorem. But this is not to say that there is a general test by which it is always possible, whenever a well-formed formula is given, to decide effectively whether or not it is a theorem.

Such a general effective test, by which to recognize any arbitrary given well-formed formula of a particular logistic system as being or not being a theorem, is called a decision procedure for the particular system. And the problem to find a decision procedure for a logistic system is called the decision problem of the system. As a particular example, we have seen (above) a solution of the decision problem of the full propositional calculus—or, as this particular logistic system is often called because of the character of the decision procedure, the two-valued propositional calculus. There exist also decision procedures for the intuitionistic propositional calculus, but none of them is as simple as that for the two-valued calculus. On the other hand there are logistic systems for which there is no solution of the decision problem, not merely in the sense that none has been found, but in the sense that it has been established as a metatheorem that none can exist; examples of such systems (which will be discussed below) are the pure functional calculus of first order and of all higher orders—but the singulary functional calculi of first and second orders (obtained from the corresponding pure functional calculi by omitting all functional variables which are more than singulary) do have decision procedures.

As already indicated, the two-valued propositional calculus, the intuitionistic propositional calculus, and other systems to be introduced below may be considered as examples of logistic systems. Each is namely a logistic system if regarded as determined by its vocabulary, its *formation* rules (defining the well-formed formulas of the particular system), its axioms, and its rules of inference, in abstraction from any meaning or interpretation. The logistic system becomes a formalized language if suitable meanings are given to its well-formed formulas, as is done informally in this article, and as may be done more accurately by providing definitions of truth and of satisfaction in the manner outlined in the article SEMANTICS IN LOGIC—or if sense as well as denotation is to be provided for (see the same article), then by *rules* of sense, which are similar in character to the rules that compose the step-by-step definition of satisfaction, but which deal directly with the sense.

In general, if a logistic system has any sound interpretation, *i.e.*, any non-trivial way of giving meanings to its well-formed formulas in conformity with the formation rules, axioms, and rules of inference, it will have many such. Thus the same logistic system is common to many different formalized languages, and the results (theorems and metatheorems) for the logistic system hold equally for all the formalized languages, with appropriate changes of interpretation.—The point may be illustrated by the case of the pure functional calculus of first order (which we now go on to treat), each different domain of individuals providing a different sound interpretation and hence a different formalized language.

The Functional Calculus of First Order has, besides the notations of the propositional calculus (propositional variables and sentence connectives), also notations for propositional functions and the *quantifiers*.

To explain these new notations and their meanings we return to the notion of a sentence, which we have already employed in explaining the use of propositional variables.

A propositional form is an expression which is like a sentence except that it contains a number of variables, of any kinds, at places at which a corresponding sentence must contain fixed names or terms (constants)—the difference being that a sentence may be said simply to be true, or false, but a propositional form must rather be said to be true, or to be false, for some system of values of its variables. To turn to elementary mathematics for examples, "$49 + 36 = 85$" and "$59 + 36 = 85$" are sentences, the first one true and the second one false. But "$x + 36 = 85$" is a singulary propositional form, the adjective singulary indicating that there is one variable of which values are to be considered. It may not be said to be true, or to be false, but rather it is true for the value 49 of x, and false for the value 59 of x; or in a different terminology (see SEMANTICS IN LOGIC), "$x + 36 = 85$" is satisfied by the value 49 of x, and by no other value of x. Similarly "$x^2 + y^2 = 85$" is a binary propositional form, which is true for (satisfied by) the pair of values 7, 6 of x, y; also true for the values 6, 7 of x, y; also true for the values

2, 9 of x, y; but false for the values 5, 8 of x, y. Even "$x + y - x = y$"—being a binary propositional form rather than a sentence—must not be said just to be true, but to be true *for* all values of x, y.

In the foregoing examples the variables are numerical variables, *i.e.*, variables whose values are numbers. As examples of propositional forms containing variables of other kinds we may cite the quaternary form, "The distance from P to Q is less than the distance from R to S," in which the values of the variables P, Q, R, S are points; and the singulary form, "If x is a man, then x is mortal," in which the values of x are, say, concrete material things.

As an extreme case, and as a matter of terminological convenience, it is usual to consider a sentence as being a kind of a propositional form, namely a propositional form in which the number of variables is 0 (or more correctly, as we shall see below, in which the number of free variables is 0).

As *universal quantifier* we shall use the notation consisting of a variable between parentheses; *e.g.*, if the variable is x, the notation is (x). The meaning is roughly indicated by saying that the universal quantifier corresponds to such English words as "all," "every", or better indicated by saying that if a universal quantifier with some particular variable, say x, is prefixed to a singulary propositional form whose variable is x, the resulting expression is a sentence, which is a true sentence if and only if the propositional form is true for all values of x. For example, "(x) [if x is a man, then x is mortal]" is a sentence (of a certain ill-defined language which we here use for temporary illustrative purposes only, a half-formalized version of English); and in fact, on the best available evidence, it is a true sentence. Again, "$(x)\ [x + 36 = 85]$" is a false sentence. However, a universal quantifier may be prefixed also, with analogous meaning, to a propositional form which is more than singulary—or even, as a quite special but nevertheless allowable case, to a sentence. For example, "$(y)\ [x^2 + y^2 = 85]$" is a singulary propositional form; and since, as it happens, this singulary form is false for all values of x, the sentence "$(x)\sim(y)[x^2 + y^2 = 85]$" is true. Again "$(y)\ [x + y - x = y]$" is a singulary propositional form, true for all values of x; and hence "$(x)(y)[x + y - x = y]$" is a true sentence. And again "$(x)[49 + 36 = 85]$" is a true sentence, because "$49 + 36 = 85$" is a true sentence.

As *existential quantifier* we shall use the sign $\exists$ followed by a variable, with parentheses enclosing both. The meaning corresponds roughly to that of the English word "some" (in the sense "at least one") or of the phrase "there is a." And if an existential quantifier with, say, the variable x is prefixed to a singulary propositional form whose variable is x, the resulting expression is a sentence, which is true if and only if the propositional form is true for at least one value of x. The usage is otherwise similar to that of the universal quantifier, as a few examples will suffice to illustrate. If the meaning of the numerical variables x, y is such that they include the negative as well as the positive numbers among their values, "$(\exists y)[x + y = 85]$" is a singulary propositional form which is true for all values of x, and therefore "$(x)(\exists y)[x + y = 85]$" is a true sentence. Also "$(\exists x)(\exists y)[x + y = 85]$" is true. But "$(\exists y)(x)[x + y = 85]$" is a false sentence, as there is no one number y such that $x + y$ is always 8; for every number x. On the other hand, "$(\exists y)(x)[x \times y = 0]$" is true, as there is one number y, namely 0, such that $x \times y$ is always 0.

When a quantifier with a particular variable is prefixed to a propositional form, all occurrences of that variable in the resulting expression, including the occurrence of the variable in the quantifier itself, are said to be *bound* occurrences of the variable. Other occurrences of a variable, not bound, are called *free* occurrences. It is not excluded that a propositional form may contain both bound and free occurrences of the same variable; in fact, if A is a propositional form containing free occurrences of a certain variable, and B contains bound occurrences of that variable, then $[A \supset B]$ and $[B \supset A]$ each contain both bound and free occurrences of the variable. The variables which have bound occurrences in a given propositional form are called the bound variables of the form, and those which have free occurrences in it are called its *free variables*.

Having these last definitions, we must now go back and make the following amendment to our first account of propositional forms as it was given above The variables of which values are to be considered in a propositional form are only the free variables of the form. And the form is said to be true or to be false for some system of values of its free variables (or in the other terminology, to be satisfied or not satisfied by a system of values of its free variables). A propositional form is singulary if it has just one free variable, *binary* if it has just two different free variables, and so on, regardless of the number of bound variables. A sentence has no free variables; but it may have any number of bound variables, since the presence of bound variables does not prevent the sentence from expressing a particular proposition (making a particular statement or assertion).

For purposes of introductory exposition, we may describe a *propositional function* as obtained by abstraction from a propositional form. A binary propositional form, for instance, determines an association of a truth-value with each system—*i.e.*, each pair—of values of its free variables, since for each such pair of values the propositional form is either true or false. And if this scheme of association of truth-values with pairs of things is taken as an abstract correspondence, independent of its expression in any particular language or of any particular notation for it, we have a binary propositional function. If, say, F is a binary propositional function thus obtained from a binary propositional form, and a, b is a pair of things of appropriate kind, we use the notation $F(a, b)$ to express that truth is associated with the pair a, b in the abstract correspondence; hence we have that $F(a, b)$ if and only if the propositional form is true for the system of values a, b of its free variables.

Similarly, if F is a singulary propositional function obtained by abstraction from a singulary propositional form, we have that $F(a)$—or, as we shall say in words, that F holds of the argument a—if and only if the propositional form is true for the value a of its free variable. And generally, if F is an n-ary propositional function obtained by abstraction from an n-ary propositional form, we have that $F(a_1, a_2, \cdots, a_n)$—or in words, that F holds *among* the *arguments* $a_1, a_2, \ldots, a_n$—if and only if the propositional form is true for the system of values $a_1, a_2, \cdots, a_n$ of its free variables.

A propositional function obtained by abstraction from a propositional form must not be identified with the latter, since in fact different propositional forms may well sometimes determine the same scheme of association of truth-values with ordered sets of n arguments, that is, the same propositional function. A propositional form must also not be used as a name of the corresponding propositional function, since the propositional function is a fixed particular thing, of which no expression containing free variables may serve as name; but the propositional form with an abstraction operator prefixed (see ABSTRACT AND ABSTRACTION) is rather to be used as a name of the propositional function, where the abstraction operator, like the quantifiers, has the effect of changing free variables to bound variables. For example, if A is a singulary propositional form with free variable x, then $\hat{x}\mathbf{A}$ or $\lambda x\mathbf{A}$ (we shall here use the latter) is a name of the singulary propositional function obtained from A by abstraction.

Moreover, propositional functions must not be limited to those obtained or obtainable from propositional forms by abstraction, especially if only propositional forms belonging to one particular (formalized or other) language are considered. But abstractly, any scheme of the sort described (*i.e.*, by which truth-values are made to correspond to ordered sets of n arguments) is a propositional function, however it may have come to be known, or even if the particular propositional function never comes to be known.

It should be added that the term "propositional function" is used with various meanings and shades of meaning by different writers, the terminology being not yet fixed. Sometimes "propositional function" is used to mean what we here call a propositional form, or in a way that involves confusion between this and one of the more abstract meanings.

But as the term has just been explained, and as it will be used in this article, a singulary propositional function may be identified with a class or set, and a binary propositional function may be identified with a (binary) relation. Thus the notation "$F(a)$" may be read not only as "F holds of the argument a" but also as "a belongs to the class F"; and "$F(a, b)$" may be read as "the relation F holds between a and b" or "a bears the relation F to b."

In the functional calculus of first order, the arguments of the propositional functions considered are taken as belonging to a fixed domain, the domain of individuals. Any well-defined class of things may be chosen as the domain of individuals, subject to the one restriction that it shall not be empty, *i.e.*, that there shall be some individuals. (And we shall here use the term domain *of* individuals to mean a domain that is not empty.) But a definite domain of individuals must be fixed upon in order to have an interpretation of the calculus and thus a particular formalized language.

Individual constants are symbols used as names of particular individuals. Individual *variables* are variables which have individuals as values, and which are therefore under appropriate circumstances replaceable by individual constants, in the same sense in which propositional variables (see above) are replaceable by sentences. Likewise, n-ary *functional* constants (or n-ary predicates, as they are also called) are symbols used to denote particular n-ary propositional functions. And n-ary *functional* variab'es are variables which have n-ary propositional functions as values, and which are therefore under appropriate circumstances replaceable by n-ary functional constants.

In our present formulation of functional calculus of first order we shall use as individual variables the letters x, y, z, t, u, v, w, x_1, y_1, z_1, t_1, u_1, v_1, w_1, x_2, . . . ; we shall use as propositional variables the same which were used in the propositional calculus; as singulary functional variables, F^1, G^1, H^1, F^1_1, G^1_1, H^1_1, F^1_2, . . . ; as binary functional variables F^2, G^2, H^2, F^2_1, . . . ; and so on for ternary functional variables, quaternary functional variables, ... The superscripts 1, 2, 3, . . . upon the functional variables, distinguishing them as singulary, binary, ternary, . . ., are necessary in principle, especially in connection with the semantics of the language, in order to avoid using the very same symbol with two or more different meanings. But in practice, and as an abbreviation, the superscript may usually be omitted as being uniquely determined by the context.

The *alphabetic* order of the individual variables is the order in which they were just listed, *i.e.*, x, y, z, t, u, and so on. Likewise in the case of the functional variables of each kind, the alphabetic order is that in which they were just listed.

The name *functional ca'culus of* first *order* is applied to any one of many (different but closely related) logistic systems, which differ only in regard to the list of primitive symbols. All of these systems include as primitive symbols a sufficient list of sentence connectives and quantifiers, and also the notation which was explained above (consisting of parentheses and commas) for the holding of a propositional function, among certain arguments or of a certain argument. The individual variables are, further, always among the primitive symbols. And the remaining primitive symbols must belong to one of the categories of propositional variables, functional variables, individual constants, or functional constants.

The *pure functional* calculus *of first* order has all the propositional variables and functional variables as primitive symbols, and no individual constants or functional constants. An applied functional calculus of first order contains individual constants or functional constants or both, among its primitive symbols. A simple applied functional calculus of first order is an applied functional calculus of first order in which there are no propositional or functional variables among the primitive symbols.

As primitive connectives and quantifiers for functional calculus of first order we shall here use the signs of negation and material implication. and the universal quantifier. However, as in the case of the propositional calculus, other choices are possible. (And in fact the article SEMANTICS IN **LOGIC** makes use of negation, inclusive disjunction, and universal quantification as primitive.)

The well-formed formulas are defined by formation rules, which we here state in such a form that they can be used equally for any of the different functional calculi of first order: i_0. A propositional variable standing alone is a well-formed formula. i_1. If f is a singulary functional variable or a singulary functional constant, and x is an individual variable or an individual constant, then $\mathbf{f}(\mathbf{x})$ is a well-formed formula. i_n. If f is an n-ary functional variable or an n-ary functional constant, and $\mathbf{x}_1$, $\mathbf{x}_2$, . . . , $\mathbf{x}_n$ are individual variables or individual constants or both, not necessarily all different, then $\mathbf{f}(\mathbf{x}_1, \mathbf{x}_2, \ldots, \mathbf{x}_n)$ is a well-formed formula. ii. If A is a well-formed formula, $\sim\mathbf{A}$ is a well-formed formula. iii. If $\mathbf{A}$ and B are well-formed formulas, $[\mathbf{A} \supset \mathbf{B}]$ is a well-formed formula. iv. If $\mathbf{A}$ is a well-formed formula, and x is an individual variable, then $(\mathbf{x})\mathbf{A}$ is a well-formed formula.

Every well-formed formula in a functional calculus of first order is a propositional form or a sentence, as in the case of the propositional calculus and other formalized languages which we shall consider in this article. However, there are many important cases (not here treated) in which the well-formed formulas include formulas that are not propositional forms or sentences but, *e.g.*, names of propositional functions, or of numbers, or of concrete material things. And indeed it would not be unnatural, in the case of the functional calculi of first order, to take the individual constants, individual variables, functional constants, and functional variables to be well-formed formulas when they stand alone — although the standard convention, in this particular case, is rather that which is given by the formation rules above.

In abbreviating well-formed formulas of functional calculus of first order, we omit superscripts upon functional variables (as already described), we use the same conventions regarding omission of brackets which were explained above in connection with the propositional calculus, we use the same definitions (of $[\mathbf{A} \mid \mathbf{B}]$ etc.), also the definition of the existential quantifier,

$$(\exists \mathbf{x})\mathbf{A} \rightarrow \sim(\mathbf{x})\sim\mathbf{A},$$

where $\mathbf{x}$ is an individual variable, also further the following definitions:

$$\begin{aligned}
&[\mathbf{A} \supset_{\mathbf{x}} \mathbf{B}] \rightarrow (\mathbf{x})[\mathbf{A} \supset \mathbf{B}]\\
&[\mathbf{A} \equiv_{\mathbf{x}} \mathbf{B}] \rightarrow (\mathbf{x})[\mathbf{A} \equiv \mathbf{B}]\\
&[\mathbf{A} \wedge_{\mathbf{x}} \mathbf{B}] \rightarrow (\exists \mathbf{x})[\mathbf{AB}]\\
&[\mathbf{A} \supset_{\mathbf{xy}} \mathbf{B}] \rightarrow (\mathbf{x})(\mathbf{y})[\mathbf{A} \supset \mathbf{B}]\\
&[\mathbf{A} \equiv_{\mathbf{xy}} \mathbf{B}] \rightarrow (\mathbf{x})(\mathbf{y})[\mathbf{A} \equiv \mathbf{B}]\\
&[\mathbf{A} \wedge_{\mathbf{xy}} \mathbf{B}] \rightarrow (\exists \mathbf{x})(\exists \mathbf{y})[\mathbf{AB}]
\end{aligned}$$

and likewise with three or more subscripts x, y, $\mathbf{z}$, etc., where the subscripts x, y, $\mathbf{z}$, . . . must be individual variables and all different in each case.

The relation between propositional functions that is expressed, in accordance with the above definitions, by the sign $\supset$ followed by one or more individual variables as subscripts is called *formal* implication (the standard term, though the adjective "formal" has here a rather different meaning from that which we have given to it elsewhere). For example, in the case of singulary propositional functions, $F(x) \supset_x G(x)$ (*i.e.*, the well-formed formula which is thus abbreviated) is said to express that F formally implies G, or in different words, that $F(x)$ formally implies $G(x)$ with respect to x; and in the case of binary propositional functions, $F(x, y) \supset_{xy} G(x, y)$ expresses that F formally implies G, or that $F(x, y)$ formally implies $G(x, y)$ with respect to x and y.— In similar fashion the sign $\equiv$ followed by individual variables as subscripts is said to express the relation of *formal* equivalence between propositional functions.

Now by including rules of substitution among the rules of inference, it is possible to make a formulation of the pure functional calculus of first order in which the number of axioms is finite. But because of rather complicated explanations which would be necessary in connection with one of the substitution rules in particular (that for functional variables) we here prefer a formulation without rules of substitution and with an infinite number of axioms. The infinite set of axioms is then given by means of five axiom schemata, which we shall state. And this procedure has *the further advantage that the same five axiom schemata (though not the same infinite set of axioms) are sufficient for any one of the other first-order functional calculi, as well as for the pure calculus.*

The first three of the axiom schemata are as follows:

1. $\mathbf{A} \supset \mathbf{B} \supset . \mathbf{B} \supset \mathbf{C} \supset . \mathbf{A} \supset \mathbf{C}$
2. $\sim\mathbf{A} \supset \mathbf{A} \supset \mathbf{A}$
3. $\mathbf{A} \supset . \sim\mathbf{A} \supset \mathbf{B}$

The first axiom schema means, e.g., that if **A**, **B**, **C** *are any well-formed formulas of the first-order functional calculus under consideration (possibly all three different, or possibly some of them the same), then* $A \supset B \supset . B \supset C \supset . A \supset C$ *is an axiom. In the case of the pure first-order functional calculus, two of the axioms which are instances of the first axiom schema are, for instance,* $p \supset q \supset . q \supset r \supset . p \supset r$ *and* $\sim q \supset [F(x) \supset G(x)] \supset . F(x) \supset G(x) \supset (x)H(x, y) \supset . \sim q \supset (x)H(x, y)$.

The fourth axiom schema is the following:

4. $A \supset_x B \supset . A \supset (x)\mathbf{B}$, *provided that x is an individual variable which is not a free variable of A.*

In order to state the fifth axiom schema, it is necessary first to explain another metatheoretic notation. In using bold capital letters to stand for well-formed formulas, we shall sometimes add after the letter an indication of one of the free variables it may contain, providing by this device a convenient notation for the process of substituting one free variable for another. For example, if we use Ax to stand for a well-formed formula which has or may have x as a free variable, then Ay shall stand for the well-formed formula obtained from Ax by substituting y for all free occurrences of x in Ax—provided, however, that if any of the free occurrences of x in Ax are in a well-formed part of Ax of the form (y)C, then Ay shall be obtained from Ax by first substituting **z** *for all bound occurrences of y in Ax and then substituting y for all free occurrences of x in Ax,* **z** *being the first individual variable in alphabetic order that does not occur in Ax. In the special case that* **A**x *does not actually contain x as a free variable, Ay is the same as Ax. And the same notation may be used also for substitution of a constant for a free variable, so that, e.g., if a is any individual constant, Aa stands for the result of substituting a for all free occurrences of x in Ax.*

Employing this notation, we state the fifth axiom schema:

5. $(\mathbf{x})\mathbf{Ax} \supset Ay$, *where x is an individual variable, Ax is a well-formed formula which may have* **x** *as a free variable, and* **y** *is an individual variable or an individual constant.*

To use the case of the pure functional calculus of first order for illustration, following are some examples of instances of axiom schema 5, which are therefore axioms:

$$(x)F(x) \supset F(y)$$
$$(y)F(y) \supset F(y)$$
$$(y)F(x, y) \supset F(x, x)$$
$$(x)(y)F(x, y) \supset (z)F(y, z)$$
$$(z)[F(z) \supset G(z)] \supset . F(x) \supset G(x)$$
$$(z)[F(x) \supset G(x)] \supset . F(x) \supset G(x)$$

To complete the formulation of first-order functional calculus as a logistic system (whether the pure first-order functional calculus or one of the others), it remains only to state the rules of inference. These are the two following: II. *Rule of modus ponens. From* $A \supset B$ *and A, to infer B.* III. *Rule of generalization. From A, if x is any individual variable, to infer* $(\mathbf{x})\mathbf{A}$.

In an application of the rule of generalization, the variable **x** *is said to be generalized upon.*

Where $\mathbf{A}_1, \mathbf{A}_2, \ldots, A,$, *B are well-formed formulas of one of the functional calculi of first order, we say that the inference from the hypotheses* $\mathbf{A}_1, \mathbf{A}_2, \cdots, A,$ *to the conclusion B is a valid inference of first-order functional calculus if B can be obtained from the hypotheses* $\mathbf{A}_1, \mathbf{A}_2, \cdots, A,$ *, together with the axioms of the particular functional calculus of first order, by a succession of applications of the two rules of inference, modus ponens and generalization, subject to the restriction that no variable shall be generalized upon which is a free variable of any of the hypotheses* $\mathbf{A}_1, \mathbf{A}_2, \ldots, A,$. *(The distinction which is made here between "hypotheses" and "premisses" may be ignored only if the hypotheses are without free variables.)*

For example, from the single hypothesis $F(x)$ *there is a valid inference to the conclusion* $(y) . \sim F(x) \supset F(y)$, *namely by taking as major premiss the axiom* $F(x) \supset . \sim F(x) \supset F(y)$, *which is an instance of axiom schema* **3**, *and applying modus ponens, and then generalizing upon y. On the other hand there is no valid inference from the hypothesis* $F(x)$ *to the conclusion* $(x)F(x)$, *and indeed it is informally evident that the definition ought not to allow this as a valid inference—i.e., from the hypothesis that a particular individual x belongs to the class F, it does not in general follow that all individuals belong to the class F.*

There is not space to treat in detail particular theorems and valid inferences of first-order functional calculus. But some of the simplest of the latter will be mentioned below in the discussion of traditional logic. And we list here the following important metatheorems (omitting their proofs, with one exception):

The Deduction Theorem.—If there is a valid inference (of first-order functional calculus) from the hypotheses $\mathbf{A}_1, \mathbf{A}_2, \cdots, A,$ *to the conclusion B, there is a valid inference also from the hypotheses* $\mathbf{A}_1, \mathbf{A}_2, \ldots, \mathbf{A}_{n-1}$ *to the conclusion* $A, \supset B$. *Hence if there is a valid inference from the hypotheses* $\mathbf{A}_1, \mathbf{A}_2, \ldots, A,$ *to the conclusion B, then* $\mathbf{A}_1 \supset . \mathbf{A}_2 \supset . \ldots A, \supset B$ *is a theorem. And, as a special case, if there is a valid inference from the single hypothesis A to the conclusion B, then* $A \supset B$ *is a theorem.*

Tautologies.—Every tautologous well-formed formula is a theorem, i.e., every well-formed formula which is a tautology of the propositional calculus or is obtained from such a tautology by substitutions for the propositional variables.

Substitutivity of Equivalence.—If $\mathbf{M} \equiv N$ *is a theorem, if A is a theorem, and if B is obtained from A by replacing M by N at one or more places (not necessarily at all occurrences of M in A), then B is a theorem.*

Reduction to Prenex Normal Form.—There is an effective procedure by which, given a well-formed formula A of a first-order functional calculus, there may be found a well-formed formula B of the same first-order functional calculus, such that $A \equiv B$ *is a theorem, and B is in prenex normal form—i.e., B consists of a quantifier-free well-formed part, called the matrix, and of a preceding part which is called the prefix and which consists of a number of universal and existential quantifiers prefixed to the matrix, subject to the condition that the variables occurring in the quantifiers in the prefix shall be all different and shall all occur also in the matrix. (As special cases, the quantifiers constituting the prefix may be all universal, or they may be all existential, or the prefix may even be null so that B consists entirely of the quantifier-free matrix.)*

Consistency.—A and $\sim\mathbf{A}$ *cannot both be theorems of a first-order functional calculus. The proof of this is by considering, for any well-formed formula of first-order functional calculus, a corresponding well-formed formula of the propositional calculus which is obtained as follows. From the given formula of first-order functional calculus, first delete (universal) quantifiers, so as to obtain a quantifier-free formula, then replace every propositional variable and every well-formed part of the form* $\mathbf{f}(\mathbf{x})$ *or* $\mathbf{f}(\mathbf{x}_1, \mathbf{x}_2, \ldots, \mathbf{x}_n)$*—cf. the formation rules* i_0, i_1, i_n—each *by the propositional variable p. (For example, if the given formula is* $(x)(y)F(x, y, z) \supset . p \supset q \supset (\exists z)G(z)$, *the deletion of quantifiers yields* $F(x, y, z) \supset . p \supset q \supset \sim\sim G(z)$, *and hence the corresponding formula of the propositional calculus is* $p \supset . p \supset p \supset \sim\sim p$.) *As the reader may verify, every axiom of first-order functional calculus has the property that the corresponding formula of the propositional calculus is a tautology; moreover, the rules of inference preserve this property, i.e.,* if *in an application of one of the rules of inference the premiss or premisses have this property, the conclusion must have it also; hence every theorem has this property. But A and* $\sim\mathbf{A}$ *cannot both have this property (indeed, of the two corresponding formulas of the propositional calculus, the second one is obtained from the first by prefixing the sign* $\sim$, *so that not both can be tautologies). Hence not both A and* $\sim\mathbf{A}$ *can be theorems.*

The Metatheory of the Pure Functional Calculus **of** *First Order contains many results of greater depth than the elementary* *fundamentals which have been discussed above. Only a few of these* will be briefly *indicated here.*

A well-formed *formula is said to be satisfiable in a particular non-empty* domain *if,* when *that domain is taken as the domain of individuals, the formula is satisfied by at least one system of values* of *its free variable? which has individuals (of the domain in question) as values of the individual variables, n-ary propositional functions as values of the n-ary functional variables, and truth-values as values of the propositional variables. Similarly a well-formed formula is said to be valid in a particular* non-*empty domain if, when that domain is taken as the domain of* individuals, *the formula is satisfied by every such system of values of its free variables.* A *well-formed formula is said to be satisfiable if it is satisfiable in some non-empty domain, calid if* it *is valid in every non-empty domain. Evidently, A is satisfiable in a particular domain if and only if $\sim\mathbf{A}$ is not valid in that domain, and A is satisfiable if and only if $\sim\mathbf{A}$* is *not valid.*

The validity of a well-formed *formula in a domain of individuals depends only on the number of individuals in the domain. And in fact* well-formed *formulas (i.e., of the pure functional calculus of first order) can be classified as follows: there are those which are valid in no domain of individuals; for every positive integer n, there are those which are valid in domains of not more than n individuals but not valid in larger domains; there are well-formed formulas which are valid in every finite domain of individuals but not valid in an infinite domain; and there are the valid* well-formed *formulas. It can be shown that every* well-*formed formula belongs to one of these classes.—As examples we cite $(\exists x)(y) \centerdot [F(x, y) \supset F(y, x)] \vee [F(x, x) \equiv F(y, y)]$,* valid *in domains of not more than three individuals, but not in larger domains, and $(\exists x)(y)(\exists z) \centerdot F(z, x) \supset F(z, y) \supset \centerdot F(x, y) \supset F(x, x)$, valid in all finite domains of individuals, but not in infinite domains.*

The above statement includes the following theorem of Leopold Loewenheim: *If a well-formed formula is valid in the domain of positive integers (i.e., when the positive integers 1, 2, 3, ... are taken as the* individuals), *it is valid. As a corollary, or as another form of the metatheorem, if a well-formed formula is satisfiable, it is satisfiable in the domain of positive integers.*

It can be shown that every theorem of the pure functional calculus of first order is valid (since the axioms are valid and the rules of inference preserve validity). The converse of this is the completeness (meta)theorem *of Kurt Goedel: Every valid well-formed formula is a theorem.*

A class of well-formed formulas (finite or infinite in number) is said to be consistent if it does not contain formulas $\mathbf{A}_1$, $\mathbf{A}_2$, .., A, from which as hypotheses there is a valid inference to a conclusion B and also to $\sim\mathbf{B}$. A *class of* well-formed *formulas is said to be simultaneously satisfiable in a* particular *non-empty domain if, when that domain is taken as the domain of individuals, the formulas are simultaneously satisfied by at least one system of values of the free variables. And a class of well-formed formulas is said to be simultaneously satisfiable if it is simultaneously satisfiable in some non-empty domain.*

According to an extension of Loewenheim's theorem by Thoralf Skolem, if a class of well-formed formulas is simultaneously satisfiable, it is simultaneously satisfiable in the domain of positive integers. And according to a closely related meta*theorem due to Goedel, if a class of well-formed formulas is consistent, it is simultaneously satisfiable.*

TRADITIONAL LOGIC

The name traditional logic is given to that part of the ancient and mediaeval logic which survived the decline of scholasticism and long remained with *little change as a traditionally important part of philosophy. Though historically an independent doctrine, with a viewpoint and method that differ from the logistic* method *explained above, it can be exhibited as a part of modern logic, and this is the course which we shall follow here. In doing this it is necessary to make certain changes (as noted below), of which some remove uncertainties or correct confusions of the traditional doctrine, and others, though not required from the point of view of traditional logic itself, are desirable in order to incorporate it into the body of modern logic and to give it its proper place in relation to the remainder.*

Categorical Propositions are propositions of the traditional subject-predicate form, having a subject S and a predicate P. The four forms—All *S* is *P*, *No S* is *P*, *Some S* is *P*, *Some S* is *not P—are traditionally designated by the letters A, E, I, O respectively. Examples are: All men are mortal (A), All men die (A), No man can serve two masters (E), Some prime numbers are odd (I),* **A** *large island is in the bay (I), All that glitters is not gold (O). Propositions of the forms A and I are called affirmative; E and* **O**, *negative; A and E, universal; I and* **O**, *particular.*

The subject and predicate of a categorical proposition are together called the terms of the proposition. Thus in the third example above, the terms are the subject, man, and the predicate, able to serve two *masters.*

In writing categorical propositions in logistic form we shall use functional constants s *and* p *to stand for the subject and predicate, so that the four forms appear as follows: $\mathbf{s}(x) \supset_x \mathbf{p}(x)$, $\mathbf{s}(x) \supset_x \sim\mathbf{p}(x)$, $\mathbf{s}(x) \wedge_x \mathbf{p}(x)$, $\mathbf{s}(x) \wedge_x \sim\mathbf{p}(x)$.*

This manner of representing the categorical propositions is not faithful in all particulars to the traditional account. But among various possibilities it seems to be on the whole the best, and we *shall employ it here, noting the four following points of divergence:*

1. We have defined the notations $\supset_x$ and $\wedge_x$ in terms of the universal quantifier and the two *primitive connectives $\sim$ and $\supset$, whereas the traditional account might be thought to be more closely reproduced if $\supset_x$ and $\wedge_x$ were primitive notations.*

2. The traditional account associates the negation in E and O with the copula, that is, with the words "is" or "is not" that join the subject and predicate, whereas here we *prefix the sign $\sim$ to the subformula $\mathbf{p}(x)$.—*In *regard to 1 and 2 it would be possible to reproduce the traditional account more closely by using four primitive notations A, , E_x, I_x, O_x, where $[\mathbf{s}(x)\ A_x\ \mathbf{p}(x)]$, $[\mathbf{s}(x)\ E_x\ \mathbf{p}(x)]$, $[\mathbf{s}(x)\ I_x\ \mathbf{p}(x)]$, $[\mathbf{s}(x)\ O_x\ \mathbf{p}(x)]$ are to have the meanings of $\mathbf{s}(x) >, \mathbf{p}(x)$, $\mathbf{s}(x) >, \sim\mathbf{p}(x)$, s (~∧)x $\mathbf{p}(x)$, $\mathbf{s}(x) \wedge_x \sim\mathbf{p}(x)$ respectively (and the usual quantifiers and sentence connectives could then be defined in terms of these). But it seems preferable not to complicate the formulation of first-order functional calculus in this way.*

3. *The traditional account includes also, under A and E, propositions expressed in the forms $\mathbf{p}(\mathbf{a})$ and $\sim\mathbf{p}(\mathbf{a})$ respectively, where a is an individual constant. For example, "Socrates is mortal" is considered as expressing an A proposition, and "Socrates is not mortal," an E proposition, the subject being the singular term, Socrates. These singular propositions, as they are called, mill be ignored in our account of opposition and immediate inference, but will appear in connection* with *the categorical syllogism as giving special forms (called singular forms) of certain syllogisms.*

4. Some aspects of the traditional account require that A and E be represented as we have here, others that they be represented by the conjunctions $(\exists x)\mathbf{s}(x) \centerdot \mathbf{s}(x) \supset_x \mathbf{p}(x)$ and $(\exists x)\mathbf{s}(x) \centerdot \mathbf{s}(x) \supset_x \sim\mathbf{p}(x)$ respectively. The problem of choosing between these two *interpretations (or finding a satisfactory third alternative) is known as the problem of existential import of categorical propositions. In our account below we shall meet the difficulty by introducing $(\exists x)\mathbf{s}(x)$ as a separate premiss at those places where it is required.*

Opposition, Immediate Inference.— According to the square **of** *opposition, if the subject and predicate are fixed, A and O (i.e., $\mathbf{s}(x) \supset_x \mathbf{p}(x)$ and $\mathbf{s}(x) \wedge_x \sim\mathbf{p}(x)$) are contradictory, E and I are contradictory, A and E are contrary, I and O are subcontrary, A and I are subaltern, E and O are subaltern. The* two *propositions of a contradictory pair cannot be both true and cannot be both false. Under the premiss $(\exists x)\mathbf{s}(x)$, the contrary pair, A, E, cannot be both true, the subcontrary pair, I, O, cannot be both false, and each of* the *propositions A and E has its subaltern proposition as a consequence.*

Simple conversion of a categorical proposition consists in interchanging the subject and predicate. Thus the converses of $\mathbf{s}(x) \supset_x \mathbf{p}(x)$, $\mathbf{s}(x) \supset_x \sim\mathbf{p}(x)$, $\mathbf{s}(x) \wedge_x \mathbf{p}(x)$, and $\mathbf{s}(x) \wedge_x \sim\mathbf{p}(x)$

are respectively $\mathbf{p}(x) \supset_x \mathbf{s}(x)$, $\mathbf{p}(x) \supset_x \sim\mathbf{s}(x)$, $\mathbf{p}(x) \wedge_x \mathbf{s}(x)$, and $\mathbf{p}(x) \wedge_x \sim\mathbf{s}(x)$. Simple conversion is a generally valid inference only in the case of **E** and **I.**

Obversion of a categorical proposition is effected by replacing p by a functional constant $\mathbf{q}$ which denotes the negation of the propositional function (the complement of the class) that is denoted by $\mathbf{p}$, and at the same time inserting $\sim$ if not already present or deleting it if present. In terms of the abstraction operator, the functional constant q is $\lambda x\sim\mathbf{p}(x)$. Thus the obverse of $\mathbf{s}(x) \supset_x \mathbf{p}(x)$ is $\mathbf{s}(x) \supset_x \sim\mathbf{q}(x)$ (the obverse of *All men are mortal* is *No men are immortal)*. Similarly, the obverse of $\mathbf{s}(x) \supset_x \sim\mathbf{p}(x)$ is $\mathbf{s}(x) \supset_x \mathbf{q}(x)$, the obverse of $\mathbf{s}(x)$ *A,* $\mathbf{p}(x)$ is $\mathbf{s}(x)$ *A,* $\sim\mathbf{q}(x)$, and that of $\mathbf{s}(x)$ *A,* $\sim\mathbf{p}(x)$ is $\mathbf{s}(x) \wedge_x \mathbf{q}(x)$.

The name ('immediateinference" is given to certain inferences from one categorical proposition as premiss to another as conclusion, all of them being valid inferences either of first-order functional calculus or of an extended calculus embracing the abstraction operator A. The immediate inferences include obversion of *A*, E, **I**, *O*, simple conversion of E, I, and subalternation of *A*, E—of which subalternation requires the additional premiss $(\exists x)\mathbf{s}(x)$. Other immediate inferences may be obtained by means of sequences of these; e.g., given that all men are mortal we may take the obverse of the converse of the obverse and so infer that all immortals are non-men (called by some the contrapositive, by others the obverted contrapositive).

Conversion *per accidens*, or *by limitation*, of a proposition *A* may be described as consisting of subalternation followed by simple conversion. Thus from the premisses $\mathbf{s}(x) \supset_x \mathbf{p}(x)$ and $(\exists x)\ \mathbf{s}(x)$ it yields the conclusion $\mathbf{p}(x)$ *A,* $\mathbf{s}(x)$. Conversion *per accidens* of *E* is also possible, by a simple conversion followed by subalternation.

Categorical Syllogism. — The name "categorical syllogism" is given to certain valid inferences of first-order functional calculus which involve as premisses two categorical propositions having a term in common — the *middle term*. Using functional constants *s*, m, p to stand for the *minor term*, the middle term, and the *major term* respectively, we give the traditional classification into figures and moods. In each case we give the *major premiss* first, the *minor premiss* immediately after it, and the conclusion last; in some cases we give a third (existential) premiss which is suppressed in the traditional account. Where in consequence of the admission of singular propositions (as noted above) two different forms of valid inference appear under the same figure and mood, we give the singular forms in a separate list.

First Figure

Barbara: $\mathbf{m}(x) \supset_x \mathbf{p}(x)$, $\mathbf{s}(x) \supset_x \mathbf{m}(x)$; $\mathbf{s}(x) \supset_x \mathbf{p}(x)$.
Celarent: $\mathbf{m}(x) \supset_x \sim\mathbf{p}(x)$, $\mathbf{s}(x) \supset_x \mathbf{m}(x)$; $\mathbf{s}(x) \supset_x \sim\mathbf{p}(x)$.
Darii: $\mathbf{m}(x) \supset_x \mathbf{p}(x)$, $\mathbf{s}(x)$ *A,* $\mathbf{m}(x)$; $\mathbf{s}(x) \wedge_x \mathbf{p}(x)$.
Ferio: $\mathbf{m}(x) \supset_x \sim\mathbf{p}(x)$, $\mathbf{s}(x) \wedge_x \mathbf{m}(x)$; $\mathbf{s}(x) \wedge_x \sim\mathbf{p}(x)$.

Second Figure

Cesare: $\mathbf{p}(x) \supset_x \sim\mathbf{m}(x)$, $\mathbf{s}(x) \supset_x \mathbf{m}(x)$; $\mathbf{s}(x) \supset_x \sim\mathbf{p}(x)$.
Camestres: $\mathbf{p}(x) \supset_x \mathbf{m}(x)$, $\mathbf{s}(x) \supset_x \sim\mathbf{m}(x)$; $\mathbf{s}(x) \supset_x \sim\mathbf{p}(x)$.
Festino: $\mathbf{p}(x) \supset_x \sim\mathbf{m}(x)$, $\mathbf{s}(x) \wedge_x \mathbf{m}(x)$; $\mathbf{s}(x)$ *A,* $\sim\mathbf{p}(x)$.
Baroco: $\mathbf{p}(x) \supset_x \mathbf{m}(x)$, $\mathbf{s}(x)$ *A,* $\sim\mathbf{m}(x)$; $\mathbf{s}(x)$ *A* $\sim\mathbf{p}(x)$.

Third Figure

Darapti: $\mathbf{m}(x) \supset_x \mathbf{p}(x)$, $\mathbf{m}(x) \supset_x \mathbf{s}(x)$, $(\exists x)\mathbf{m}(x)$; $\mathbf{s}(x)$ *A,* $\mathbf{p}(x)$.
Disamis: $\mathbf{m}(x)$ *A,* $\mathbf{p}(x)$, $\mathbf{m}(x) \supset_x \mathbf{s}(x)$; $\mathbf{s}(x)$ *A,* $\mathbf{p}(x)$.
Dstisi: $\mathbf{m}(x) \supset_x \mathbf{p}(x)$, $\mathbf{m}(x) \wedge_x \mathbf{s}(x)$; $\mathbf{s}(x) \wedge_x \mathbf{p}(x)$.
Felapton: $\mathbf{m}(x) \supset_x \sim\mathbf{p}(x)$, $\mathbf{m}(x) \supset_x \mathbf{s}(x)$, $(\exists x)\mathbf{m}(x)$; $\mathbf{s}(x)$ *A,* $\sim\mathbf{p}(x)$.
Bocardo: $\mathbf{m}(x) \wedge_x \sim\mathbf{p}(x)$, $\mathbf{m}(x) \supset_x \mathbf{s}(x)$; $\mathbf{s}(x) \wedge_x \sim\mathbf{p}(x)$.
Feriso (or Ferison): $\mathbf{m}(x) \supset_x \sim\mathbf{p}(x)$, $\mathbf{m}(x)$ *A,* $\mathbf{s}(x)$; $\mathbf{s}(x)$ *A,* $\sim\mathbf{p}(x)$.

Fourth Figure

Bamalip (or Bramantip): $\mathbf{p}(x) \supset_x \mathbf{m}(x)$, $\mathbf{m}(x) \supset_x \mathbf{s}(x)$, $(3x)\mathbf{p}(x)$; $\mathbf{s}(x)$ *A,* $\mathbf{p}(x)$.
Calemes (or Camenes): $\mathbf{p}(x) \supset_x \mathbf{m}(x)$, $\mathbf{m}(x) \supset_x \sim\mathbf{s}(x)$; $\mathbf{s}(x) \supset_x \sim\mathbf{p}(x)$.
Dimatis (or Dimaris): $\mathbf{p}(x)$ *A,* $\mathbf{m}(x)$, $\mathbf{m}(x) \supset_x \mathbf{s}(x)$; $\mathbf{s}(x) \wedge_x \mathbf{p}(x)$.
Fesapo: $\mathbf{p}(x) \supset_x \sim\mathbf{m}(x)$, $\mathbf{m}(x) \supset_x \mathbf{s}(x)$, $(\exists x)\mathbf{m}(x)$; $\mathbf{s}(x)$ *A,* $\sim\mathbf{p}(x)$.
Fresison: $\mathbf{p}(x) \supset_x \sim\mathbf{m}(x)$, $\mathbf{m}(x)$ *A,* $\mathbf{s}(x)$; $\mathbf{s}(x)$ *A,* $\sim\mathbf{p}(x)$.

Singular Forms

Barbara: $\mathbf{m}(x) \supset_x \mathbf{p}(x)$, $\mathbf{m}(\mathbf{a})$; $\mathbf{p}(\mathbf{a})$.
Celarent: $\mathbf{m}(x) \supset_x \sim\mathbf{p}(x)$, $\mathbf{m}(\mathbf{a})$; $\sim\mathbf{p}(\mathbf{a})$.
Cesare: $\mathbf{p}(x) \supset_x \sim\mathbf{m}(x)$, $\mathbf{m}(\mathbf{a})$; $\sim\mathbf{p}(\mathbf{a})$.
Camestres: $\mathbf{p}(x)$ **3,** $\mathbf{m}(x)$, $\sim\mathbf{m}(\mathbf{a})$; $\sim\mathbf{p}(\mathbf{a})$.
Darapti: $\mathbf{p}(\mathbf{a})$, $\mathbf{s}(\mathbf{a})$; $\mathbf{s}(x)$ *A,* $\mathbf{p}(x)$.
Felapton: $\sim\mathbf{p}(\mathbf{a})$, $\mathbf{s}(\mathbf{a})$; $\mathbf{s}(x) \wedge_x \sim\mathbf{p}(x)$.

The last two singular forms, in which the middle term is singular, are classed separately as the *expository* syllogism.

Some add the five so-called weakened moods, Barbari, Celaront, Cesaro, Camestros, Calemos, to be obtained by subalternation of the conclusion from Barbara, Celarent, Cesare, Camestres, Calemes respectively. The five moods of the fourth figure are sometimes classed instead as indirect moods of the first figure, the major and minor premisses being interchanged, and the names being then given as Baralipton, Celantes, Dabitis, Fapesmo, Frisesomorum.

The names of the moods have a mnemonic significance, in which the first three vowels indicate whether the major premiss, minor premiss, and conclusion, in order, are A, E, I, or *O*, and some of the consonants indicate the traditional reductions of the other moods to the four direct moods of the first figure *(see* Logic, History of).

Hypothetical Syllogism, Disjunctive Syllogism, Dilemma. — Besides the categorical syllogism, the traditional logic treats also a number of other kinds of *mediate* inference (*i.e.*, inference from two or more premisses), including especially the *hypothetical syllogism* (or conditional syllogism), the *disjunctive syllogism*, and the *dilemma*. All of these can be exhibited as valid inferences of the propositional calculus, and we shall give them here in this fdrm.

In particular, we shall render the words "if" or "if. . then," as used in stating the traditional hypothetical (or conditional) propositions, by the sign $\supset$ of material implication, although this is certainly contrary to the intention of traditional writers. In the Port-Royal Logic, for example, the contradictory negative of **If** *you eat of the forbidden fruit you will die* is given as *Although you eat of the forbidden fruit you will not die*— whereas if material implication were intended, the contradictory should be rather, *You will eat of the forbidden fruit and you will not die.* Yet in the same work it is explained that a conditional proposition may be true although both parts of it (both the antecedent and the consequent) are false, provided only that the consequence is correctly drawn. By this it is not meant that the consequent must follow logically from the antecedent, but, as is clear from the discussion and the examples given, that the consequent must follow from the antecedent together nith known truths which are taken into consideration. However, this account overlooks that, if two propositions are both false, it is always possible to infer one from the other by means of appropriately chosen truths, which may then be supposed to be knomn and taken into consideration. It is in this way that the traditional account leads to material implication as the best means of representing it consistently within a more complete theory. An alternative amendment of the traditional account indeed suggests itself, by seeking a satisfactory logistic theory of an implication connective which shall reproduce more closely the ordinary usage of "if . . then" in future conditions and conditions contrary to fact, but this has never been successfully carried out. (Compare the discussion of material implication in the first part of this article.)

There is also a question whether the word "or," as used in stating the traditional disjunctive propositions, shall be understood as denoting inclusive disjunction or exclusive disjunction. Here the traditional logic is more explicitly inconsistent — since, although most of the inferences are valid inferences under either interpretation of the word "or," one of them, the *modus ponendo tollens*, is valid only for exclusive disjunction, and the two complex dilemmas are valid only for inclusive disjunction. We shall use exclusive disjunction in *modus ponendo tollens*, but inclusive disjunction elsewhere.

In each entry in the following table the major premiss is given first, or the two major premisses in the case of the dilemmas, then the minor premiss, then the conclusion.

Hypothetical Syllogism

Modus ponens: $A \supset B$. A; B.
Modus tollens: $A \supset B$, $\sim B$; $\sim\mathbf{A}$.

Disjunctive Syllogism

Modus tollendo ponens: $A \vee B$, $\sim\mathbf{A}$; B.
Modus tollendo ponens: $\mathbf{A} \vee B$, $\sim\mathbf{B}$; $\mathbf{A}$.

Modus ponendo *tollens:* $\mathbf{A} \mid \mathbf{B}, \mathbf{A}; \sim\mathbf{B}$.
Modus ponendo *tollens:* $\mathbf{A} \mid \mathbf{B}, \mathbf{B}; \sim\mathbf{A}$.

Dilemma

Simple constructive dilemma: $A \supset C, B \supset C, A \vee B; C$.
Simple destructive dilemma: $A \supset B, A \supset C, \sim B \vee \sim C; \sim A$.
Complex constructive dilemma: $A \supset B, C \supset D, A \vee C; B \vee D$.
Complex destructive dilemma: $A \supset B, C \supset D, \sim B \vee \sim D; \sim A \vee \sim C$.

The inferences from $A \supset B$ and $C \supset A$ to $C \supset B$, and from $A \supset B$ and $C \supset \sim B$ to $C \supset \sim A$ are sometimes added as pure hypothetical syllogisms, and the above simpler forms of the hypothetical syllogism are then distinguished as mixed hypothetical. Some older works, including the Port-Royal Logic, add a copulative syllogism, with major premiss $\overline{} \centerdot AB$, minor premiss A and conclusion $\sim B$, or minor premiss B and conclusion $\sim A$.

TYPE THEORY AND SET THEORY

In the functional calculus of first order there is provision only for individuals as arguments of propositional functions, and it is only individual variables which may be bound by quantifiers. Since the domain of individuals is fixed in advance, and since the classes and relations (and propositional functions generally) which are values of the functional variables are not among the individuals of the fixed domain, this imposes a limitation upon what can be expressed in the notation of the calculus. Indeed it may be thought that the propositions of logic have a character of universal generality which demands for its expression the use of variables of unrestricted range, whose values are not confined to a fixed domain but may he either individuals or classes or relations or anything else whatever. And just this was maintained in particular by Gottlob Frege.

However, the uncritical attempt to introduce such variables of unrestricted range leads to a system which is inconsistent, if besides the variahles of unrestricted range, say x, y, z, x_1, ..., we employ also the usual sentence connectives and quantifiers, and a notation, say $\epsilon(x, y_1, y_2, \ldots, y_n)$, to mean that x is an n-ary propositional *function* and holds among the arguments y_1, y_2, ..., y_n, and adopt what seem to be the natural and obvious axioms and rules of inference. Namely in such a system the antinomy of Bertrand Russell or that of C. Burali-Forti (see ANTINOMY) can be reproduced formally, *i.e.*, in the form of proofs of contradictory theorems of the system. And in fact the significance of these antinomies lies less in their informal statement in words than in their influence upon the construction of logistic systems, through the possibility of their logistic formalization.

In order to obtain a system more comprehensive than functional calculus of first order without falling into antinomy, there are two directions which have been followed. One of these, the direction of type theory, avoids altogether the use of variables of unrestricted range, and introduces instead many different kinds of variables with different restricted ranges. The other, the direction of set theory, has variables of unrestricted range, but imposes restrictions in regard to the existence of sets determined by given conditions. (The word "set" is here used to mean a class which can belong to another class as a member of it, since some forms of set theory admit also classes which are not sets; but outside the context of set theory the words "class" and "set" are generally used synonymously.)

As typical of the two directions we shall describe briefly the simple theory of types, and a form of set theory which is based on the system proposed by Ernst Zermelo in 1908.

The Simple Theory of Types can be described as obtained from the pure functional calculus of first order by successive additions to it.

The first step is to modify the formation rule iv to provide that $(x)\mathbf{A}$ shall be well formed when x is a propositional or functional variable as well as when x is an individual variable. The resulting system is the pure *functional* calculus *of second* order, if suitable axioms and rules of inference are provided (which will not be stated here, but are similar to those for functional calculus of first ortler).

Then functional variables of various higher types are adjoined. Namely if $c_1, c_2, \ldots, c_n$ are non-negative integers, then $(c_1, c_2, \ldots, c_n)$ is a type, and an infinite list of variables of this type is provided: $F^{(c_1, c_2, \cdots, c_n)}$, $G^{(c_1, c_2, \cdots, c_n)}$, ... A formation rule provides that, if f is of type $(c_1, c_2, \ldots, c_n)$, then $f(x_1, x_2, \ldots, x_n)$ is well-formed on condition that each variable x_i is of the type indicated by the corresponding integer c_i, *i.e.*, that x_i is an individual variable if c_i is 0, x_i is a propositional variable if c_i is 1, and x_i is an m-ary functional variable of lower type (one of the variables F^m, G^m, H^m, F^m_1, ...) if c_i is $m + 1$. The values of the variables of type $(c_1, c_2, \ldots, c_n)$ are propositional functions of the kind which is indicated by this formation rule. And the resulting system, if the new variables of higher types occur only as free variables, and if again suitable axioms and rules of inference are provided, is the *pure functional* calculus of third order. Upon further modifying the formation rule iv, to allow the new variables of higher types to occur also as bound variables, the *pure functional calculus of fourth* order is obtained.

Then the next step is to adjoin functional variables of still higher types; *e.g.*, one of these new types is $(0, (2, 3), (3))$, and if f is a variable of this type, then $f(x_1, x_2, x_3)$ is well-formed on condition that x_1 is an individual variable, x_2 is a variable of type $(2, 3)$, and x_3 is a variable of type (3).

In this way, by successive adiunctious of functional variables of higher and higher types—with appropriate changes, at each stage, in the formation rules, axioms, and rules of inference—the pure functional calculi of all finite orders are obtained. The logistic system which embraces all of these in a single system is the pure functional *calculus* of *order* ω.

A notation $=$, to express that two things are the same or identical, may be introduced by definition:

$$x = y \rightarrow (F^e) \centerdot F^e(x) \supset F^e(y),$$

where x and y arr variable? of the same type, and where the particular letter F is used, with type superscript e so chosen as to make $F^e(x)$ and $F^e(y)$ well-formed.

Finally, to the axioms of the pure functional calculus of order ω, there are added one special axiom, the axiom *of infinity*, and two special axiom schemata, which provide the axioms *of* extensionality and the *axioms* of choice.

The axiom of infinity is to the effect that the number of individuals is infinite. There are many ways in which an axiom having this as a consequence may be formulated in the notation of the system, of which the following (based on an idea of Kurt Schuette) is perhaps the briefest:

$$(\exists F)(x)(\exists y)(z) \centerdot \sim F(x, x)\ F(x, y) \centerdot F(z, x) \supset F(z, y)$$

The axioms of extensionality are that two n-ary propositional functions are identical if they hold among exactly the same ordered sets of n arguments:

$$f(x, y, \ldots, u) \equiv_{xy\ldots u} g(x, y, \ldots, u) \supset f = g,$$

where $x, y, \ldots, u$ is any ordered set of n different variables (which may be of various types, the same or different, n being any positive integer), and where f and g are variables of such type as to make $f(x, y, \ldots, u)$ and $g(x, y, \ldots, u)$ well-formed.

The axioms of choice, or multiplicative axioms as they are also called, are:

$$c(f)c(g) \supset_{fg} [f(x)g(x) \supset_x f = g] \supset (\exists h) \centerdot$$
$$c(f) \supset_f \centerdot f(z) \supset_z (\exists y) \centerdot f(x)h(x) \equiv_x x = y,$$

where c, f, g, h, x, y, z are variables which must be no two the same, and of such types that the formula is well-formed.

For the simple theory of types without axiom of infinity a proof of consistency is possible which is similar to that given above for the functional calculus of first order, and which, although more complicated, employs only methods of essentially the same elementary character. On the other hand it is a consequence of Goedel's incompleteness theorem (see the explanation below) that any proof of consistency of the system with axiom of infinity cannot be of such elementary character, but must employ methods of proof that in some sense surpass anything available in the simple theory of types itself.

The Set Theory of **Zermelo** can be described as obtained by adjoining atIditional axioms to a simple applied functional calculus of first order which has one binary functional constant ϵ and one individual constant Λ. The constant ϵ denotes the relation of membership in a set, so that $\epsilon(x, y)$ may be read as "x belongs to the set y" or "y is a set and x is a member of y." The constant Λ denotes the empty set (the set which has no members). The individual variables may in this theory be regarded as variables of unrestricted range, in the sense that the theory assumes the existence of no entities (sets or others) that cannot be values of the individual variables.

In writing well-formed formulas we shall abbreviate $\epsilon(\mathbf{x}, y)$ as $\mathbf{x}\epsilon y$; *i.e.*, to state it as a definition: $\mathbf{x}\epsilon y \rightarrow \epsilon(\mathbf{x}, y)$.

The notation $=$ may be introduced by a definition analogous to that given above in connection with the simple theory of types: $x = y \rightarrow x\epsilon z \supset_z y\epsilon z$. A notation $\subset$, to express that one set is a part of (a subset of) another, may be introduced by a similar definition: $\mathbf{x} \subset \mathbf{y} \rightarrow z\epsilon x \supset_z z\epsilon y$. In both cases z is to be chosen as the first individual variable (in alphabetic order) which is different from both x and y.

To provide for the notion of an ordered pair, a notation $\{x, y, z\}$ may be introduced to express that z is the ordered pair of x and y: $\{x, y, z\} \rightarrow u\epsilon z \equiv_u \blacksquare [v\epsilon u \equiv_v v = x] \vee \blacksquare v\epsilon u \equiv_v \blacksquare v = \mathbf{x} \vee \mathbf{v} = \mathbf{y}$, where $\mathbf{u}$ and $\mathbf{v}$ are to be chosen as the first two individual variables different from x, y, and z. Relations may then be dealt with in the theory by understanding a relation to be a set of ordered pairs.

The axioms of the theory are those of the functional calculus of first order, and in addition the following axioms and axiom schemata:

Axiom of extensionality: $zex \supset \blacksquare z\epsilon x \equiv_z z\epsilon y \supset x = y$.

Axiom of the empty set: $\sim x\epsilon\Lambda$.

Axiom of pairing: $(3t) \blacksquare zet \equiv_z \blacksquare z = x \vee z = y$.

Axiom of summation of sets: $(3t) \blacksquare z\epsilon t \equiv_z (\exists y) \blacksquare z\epsilon y \cdot y\epsilon x$.

Axiom of the set of subsets: $(3t) \blacksquare zet \equiv_z z \subset x$.

Axioms of subset formation: $(\exists t) \blacksquare z\epsilon t \equiv_z \blacksquare z\epsilon x \cdot \mathbf{A}z$, where $\mathbf{A}z$ is a well-formed formula which may have z as a free variable but does not have t as a free variable.

Axiom of choice: $y\epsilon x \cdot z\epsilon x \supset_{yz} [u\epsilon y \cdot u\epsilon z \supset_u y = z] \, 3 \, (\exists t) \blacksquare y\epsilon x \supset_y \blacksquare$ WE)! $\supset_w (3v) \blacksquare u\epsilon y \cdot u\epsilon t \equiv_u u = v$.

Axiom of infinity: $(\exists t) \blacksquare \Lambda\epsilon t \blacksquare x\epsilon t \supset_x (\exists y) \blacksquare y\epsilon t \blacksquare z\epsilon y \equiv_z \blacksquare z\epsilon x \vee z = x$.

Axioms of replacement: $y\epsilon x \supset_y (3u)[\mathbf{A}yz \equiv_z z = u] \supset (\exists t) \blacksquare z\epsilon t \equiv_z (\exists y) \blacksquare y\epsilon x \cdot \mathbf{A}yz$, where $\mathbf{A}yz$ is a well-formed formula which may have y and z as free variables but does not have t or u as a free variable.

Axioms of excluded infinite regress: $(3x)\mathbf{A}x \supset (3x) \blacksquare \mathbf{A}x \blacksquare y\epsilon x \supset_y \sim\mathbf{A}y$, where $\mathbf{A}x$ is a well-formed formula which may have x as a free variable but does not have y as a free variable.

The way in which the theory seeks to avoid antinomy may be seen in particular in connection with the axioms of subset iormation. An uncritical formulation might well have included the stronger axiom schema $(\exists t) \blacksquare z\epsilon t \equiv_z \mathbf{A}z$, providing for the existence of a set t of those things z (sets and others) which satisfy an arbitrary given condition $\mathbf{A}z$. But this axiom schema would lead directly to the Russell antinomy, upon taking $\mathbf{A}z$ to be $\sim z\epsilon z$. The weaker schema actually used (the axioms of subset formation) provides only for the existence of a set t of those things z which belong to a previously given set x and satisfy the condition $\mathbf{A}z$. This is not known to lead to antinomy; but $\sim(\exists t) \blacksquare z\epsilon t \equiv_z \sim z\epsilon z$ is a theorem.

Concerning the history of these axioms for set theory, see the paragraph about Zermelo in the article LOGIC. HISTORY OF. The axioms of replacement and of excluded infinite regress are additions to the original axiom system of Zermelo. and are sometimes omitted, as although they are independent and for some purposes important, there are also many purposes for which they are not needed. On the other hand, if the axioms of replacement are retained in the form in which we have here stated them, they have the effect of rendering the axioms of subset formation non-independent; *i.e.,* the axioms of subset formation may then be omitted from the list on the ground that they can be proved as theorems by using the axioms of replacement.

An extension of the Zermelo set theory which is due to John von Neumann and Paul Bernays (see the paper of Bernays cited in the bibliography) adds, to the sets of the Zermelo theory, also classes which are not sets, *i.e.,* which cannot be members of other classes or sets. And for every condition $\mathbf{A}z$ expressed in the notation of the Zermelo theory there is a class of those elements z which satisfy Az—where an element is a set or anything capable of being a member of a set. (In particular there is, according to this extended theory, a class of elements z such that $\sim z\epsilon z$, but not a set of such elements.)

Two other, different, systems of set theory are treated by W. V. Quine, one in his paper cited in the bibliography, and the other in the 1951 edition of his book. The latter, due jointly to Quine and Hao Wang, is related to Quine's system of 1937. These are not forms of the Zermelo theory but seek to exclude the antinomies by different means.

Goedel's Incompleteness Theorem.— In contrast with the completeness theorem for the pure functional calculus of first order, all known systems of type theory or set theory which are of sufficient strength to provide a logical foundation of mathematics are incomplete. We state this incompleteness theorem, due to Goedel, in the slightly stronger form which was given to it by Barkley Rosser. On the hypothesis that the system in question—it may be in particular either the simple theory of types or any of the systems of set theory mentioned above—is consistent, there is a well-formed formula A which is a sentence (hence without free variables) such that neither $\mathbf{A}$ nor $\sim\mathbf{A}$ is a theorem.

The proof of the metatheorem proceeds by constructing a particular well-formed formula $\mathbf{A}$, and then showing that, ii the system is consistent, A cannot be a theorem, and $\sim\mathbf{A}$ cannot be a theorem. However, it can also be shown that, if the system is consistent, the proposition expressed by A is true. More accurately, me can show, by means that are formalizable in the system itself, "If the system is consistent, then ______," filling the blank with a statement of the proposition that is expressed by A. Hence the further metatheorem follows that the consistency of the system cannot be proved by means that are formalizable in the system itself. (This brief statement oi the matter is incomplete, and some essential explanations which are here omitted will be found in the article MATHEMATICS, FOUNDATIONS OF.)

Both the incompleteness theorem and the further theorem about the possibility of a consistency proof have the striking feature that they hold not only for a particular system but for any arbitrary extension of it that may be obtained by adjoining additional axioms or rules of inference or both, provided only that the requirement is satisfied that the axioms and rules of inierence shall be effective (as described in the first part of this article, in explaining the notion of a logistic system). Having a particular system, which we suppose consistent, and having constructed the sentence A which is then true but not a theorem. we may indeed strengthen the system by adding A to it as an axiom. But the resulting stronger system is still incomplete: in it a particular sentence B may again be constructed by the same method, and it may be shown on the hypothesis of consistency that neither B nor $\sim$B is a theorem, and that the proposition expressed by B is true.

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LOGIC, HISTORY OF. In this article the history of logic is presented as follows:

I. Ancient Logic
  1. Aristotle
  2. Theophrastus
  3. Stoics and Megarians
  4. The Last Period

II. Logic in India
  1. Origins
  2. The Old Nyaya (Pracina-nyaya)
  3. The New Nyaya (Nyavya-nyaya)

III. Scholastic Logic
  1. Period of the "Old Logic" (Ars Vetus)
  2. Period of the "New Logic" (Ars Nova)
  3. Rise of Terministic Logic
  4. Classical Period of Scholastic Logic
  5. Decline of Scholastic Logic

I. ANCIENT LOGIC

1. Aristotle.—The history of ancient logic begins with Aristotle. This is not to say that until Aristotle's time no one mas capable of reasoning correctly. The works of Plato are full of interesting arguments, valid and invalid, and, indeed, the same may be said for nearly all of ancient literature—whether written by philosophers, mathematicians, scientists, historians, grammarians or even by poets—both before and after the discovery of the syllogism. However, in determining the scope of a history of logic, one should not fail to distinguish sharply between the use of logical principles, which may be attributed to anyone who reasons, and the *mention and study* of such principles. Only the latter is specifically the business of logic and accordingly is relevant to its history. It is true that the logician himself, like any other theorist, will have to construct arguments and proofs concerning his subject matter. Nevertheless, it is important even in his case to distinguish between the principles he mentions and those he uses. Thus. for instance, when Aristotle proves his various assertions about the syllogism he often argues in accord with inference patterns which are clearly not syllogistic and which, since he never discusses them explicitly, cannot be considered a part of his logic.

Most of Aristotle's contributions to logic are found in a group of treatises known in later times under the title *Organon* and consisting of the *Categories*, *De Interpretatione*, the *Analytics*, the *Topics*, and the *Sophistical Refutations*. These treatises also contain much that lies outside the field of logic. All of them are written in the abbreviated, notebook style which is typical of the entire Aristotelian corpus, and they abound in textual difficulties. The authenticity of the first two is open to doubt, and the order in which the various works were written is unknown. Yet despite such problems and obscurities one cannot fail to be impressed by the sure and masterful way in which Aristotle sets forth his remarkable discoveries in logic. Most of the relevant material is found in the *Prior Analytics* and the *De Interpretatione* (*Peri-hermenias*), and we shall therefore restrict ourselves to a quite summary treatment of the remaining portions of the *Organon*.

The *Categories* begins with a division of linguistic expressions into simple and composite. Examples of the composite are "A man runs," "A man wins"; of the simple, "man." "ox." "runs," and "wins." Xristotle then states that every simple expression means one of the following: substance. quantity. quality, relation, place. time, position, state, action, affection: and he devotes the remainder of the treatise to a discussion of these categories. Most of what is included is not directly relevant to the history of logic. but there are a few passages which bear upon the question of interpreting the important idiom "is predicated of." in terms of which syllogisms are typically stated by Aristotle. Unfortunately, the evidence afforded by these passages tends only to confirm what we gather from the *Analytics,* namely, that Xristotle was not fully clear whether he was speaking of a relation between a thing and a word, or between two things, or between two words. The difficulty is well illustrated by his statement of the one logical principle mentioned in the *Categories:*

> Whenever one thing is predicated of another as of a subject, everything said of what is predicated will also be said of the subject; for example, man is predicated of some particular man, and animal of man; thus animal will be predicated of the particular man also.

The *De Interpretatione* continues the classification of linguistic expressions and sets forth some elementary logical relations among declarative sentences of the simplest types. Sentences, as well as the nouns and verbs of which they are composed, are defined as certain species of significant sounds. Observing that some of them, *e.g.,* prayers, are neither true nor false, Xristotle dismisses these as "belonging to the study of rhetoric or poetry" and restricts the discussion to declarative sentences. These are divided into simple and composite: the simple either affirms or denies something of something. while the composite results from conjoining simples. Further restricting the subject to simple sentences, Aristotle divides them into eight groups, explaining as follows: Some things are universal. he says, and some are particular. By "universal" he means what is of such a nature as to be predicated of many things; by "particular." what is not of such a nature; thus Man is a universal. and Callias is a particular. Now some of our (simple declarative) sentences concern a universal as subject, and others concern a particular. For example. the positive and negative sentences "Socrates is white," "Socrates is not white" both concern a particular. viz., Socrates. Of those which have a universal subject, several kinds are distinguished. Such sentences as "Every man is white" and "No man is white," later known respectively as *A*- and *E-propositions,* are said to be of a universal character and about a universal subject. The words "every" and "no" are the marks of the universal character, and in these examples Man is the universal subject. There are two kinds of sentences which are not of a universal character but are nevertheless about a universal subject. First we have such sentences as "Some man is white" and "Xot every man is white." later called **I**- and *O-propositions,* and described in the *Prior Analytics* as "particular" sentences. In addition there are sentences like "Man is white" and "Man is not white," called "indefinite" in the *Prior Analytics.*

An affirmation and a denial which have the same subject and predicate, but one of which is of a universal character while the other is not, are called "contradictories" by Aristotle. Thus, "Every man is n-hite" and "Not every man is white" are contradictories, as are "No man is white" and "Some man is white." Of a pair of contradictories, exactly one must be true. An affirmation and denial which have the same subject and predicate and each of which is of a universal character are called "contraries." It is not possible for both members of a pair of contraries to he true, hut it can happen that both of their contradictories are true. In other words. contraries may be simultaneously false. This is the case, for example, with the contraries "Every man is white" and "No man is white." In the centuries after Xristotle these relationships were presented schematically by means of the well-known Square of Opposition. which first appears in Apuleius' commentary on *De Interpretatione.*

The remainder of the treatise consists of an unsystematized miscellany of observations. some interesting. some obscure and confused. There is a discussion purporting to show that if one member of every pair of contradictory sentences is true and the other is false, then everything happens by necessity and nothing by chance. The argument is unclear. hut it appears to rest in part upon a confusion between true sentences like "Necessarily. if 'Snow is white' is true. then snow is white" and their more idiomatic (as also in Greek) but strictly false counterparts. "If 'Snow is white' is true, then necessarily snow is white." On another subject. Aristotle makes the interesting point that the word "is" has a different sense in "Homer is" from what it has in "Homer is a poet," and that the former of these sentences does not follow from the latter. In still another place he notices that some predicates will combine in a way in which others will not: thus. from "Socrates is two-footed" and "Socrates is a man" we can deduce correctly "Socrates is a two-footed man"; whereas from "He is good" and "He is a shoemaker" it would be incorrect to infer "He is a good shoemaker." This is reminiscent of the Platonic example: "He (a dog) is yours and he is a father. Therefore, he is your father." The core of Aristotle's logic is in the first seven chapters of Book I of the *Prior dnalytics*. There. within the space of a very few pages, is set forth the theory of the syllogism, an intellectual discovery that was of unequaled magnitude for its time and which dominated the science of logic for 2,000 years.

Aristotle first describes the kinds of sentences which may be components of syllogisms. The classification is somewhat different from that given in *De Interpretatione*. Every premiss and conclusion. he says, affirms or denies something of something and thus is positive or negative. It will also be universal, particular, or indefinite. A universal sentence asserts that something belongs to all or none of something else; a particular sentence asserts that something belongs to some or not to some or not to all of something else; an indefinite sentence merely asserts, neither in general nor in particular, that something belongs or does not belong to something else, *e.g.*, that pleasure is not good. Strictly speaking, the foregoing is an account only of assertoric premisses; there are also problematic premisses, to the effect that something *may* belong to something else; and apodictic premisses, which state that something *must* belong to something else. These also are divided into six kinds, in the same way in which the assertoric premisses are so divided. It will be noticed that no mention is made of sentences with particular subjects (in later terminology, singular sentences, or singular propositions). They are entirely ignored in the *Prior Analytics*, and consequently the ancient and familiar example of a syllogism:

All men are mortal.
Socrates is a man.
Therefore, Socrates is mortal.

is quite un-Aristotelian. Furthermore. the indefinite sentences, too, are very nearly ignored by Aristotle. According to Alexander, the reason is that they are "equivalent" to particular sentences.

In preparation for his deductive exposition of the syllogistic Aristotle states the laws of conversion. The universal negative sentence converts into a universal negative; *e.g.*, if no pleasure is good. then no good will be pleasure. The universal and particular affirmative sentences convert! but into particular affirmatives; *e.g.*, if every pleasure is good, then some good is pleasure, and if some pleasure is good, then again some good is pleasure. The particular negative does not convert, since, for example, it does not follow that if some animal is not a man, then some man is not an animal. Using variables Aristotle states these laws in a general way and demonstrates them by procedures known as *ekthesis* and *reductio ad impossibile:*

First, then, let the premiss AB be a universal negative. If *A* belongs to no B, then *B* will not belong to any *A*. For if it belonged to some A—for instance, to C—then it would not be true that A belonged to no B, for *C* is one of the B's. And if *A* belongs to all B, then B mill belong to some *A*. For if it belonged to no *A*, *A* would belong to no *B*, whereas it was assumed to belong to all B. And likewise if the premiss is particular. For if A belongs to some B, then necessarily B belongs to some A, since if it belonged to none, *A* mould belong to no B. On the other hand, if A does not belong to some *B*, it is not necessary that *B* should not belong to some *A*; for example, let *B* be Animal and *A* be Man. For Man does not belong to every Animal, but Animal does belong to every Man.

The Aristotelian definition of "syllogism" is as follows: a syllogism is discourse in which, certain things being posited, something else follows necessarily from their being so. However. his definition is far too wide, applying to nearly all valid arguments, and it does not agree with his own practice. A much better idea of what is meant by "syllogism" may be derived from an examination of the syllogistic formulas actually set forth. The following literal translations will serve this purpose and will illustrate the methods of reduction. Important words which do not occur in Aristotle's abbreviated statements but which seem to be required by the sense and syntax are enclosed within parentheses. The scholastic names for the moods are due to Peter of Spain.

Barbara. For if *A* (is predicated) of all *B* and *B* of all *C*, it is necessary for *A* to be predicated of all *C*. (*An. Pr.* I, 25 b 37)

Celarent. Likewise, if A (is predicated) of no *B* but *B* of all *C*, (it is necessary) that *A* will belong to no *C*. (25 b 40)

Darii. Let *A* belong to all B, anti B to some *C*. Then if "predicated of all" means what was said at the beginning, it is necessary for *A* to belong to some *C*. (26 a 23)

Ferio. And if A belongs to no *B*, but B to some *C*, it is necessary that *A* does not belong to some *C*. (26 a 25)

Cesare. Let *M* be predicated of no *N* but of all *O*. Then, since the negative converts, *N* will belong to no *M*. But M was assumed (to belong) to all *O*; so that *N* (will belong) to no *O*; for this has been shown previously. (27 a j)

Camestres. Again, if *M* (belongs) to all *N* but to no *O*, neither will *N* belong to any *O*. For if *M* (belongs) to no *O*, then *O* (belongs) to no M; but *M* belonged to all *N*; therefore, *O* will belong to no *N*; for the first figure has been produced again. And since the negative converts, *N* will belong to no *O*. (27 a 9)

Festino. For if *M* belongs to no *N* but to some *O*, it is necessary for *N* not to belong to some *O*. For since the negative converts, *N* will belong to no *M*. But *M* was assumed to belong to some *O*, so that *N* will not belong to some *O*; for a syllogism in the first figure is obtained. (27 a 32)

Baroco. Again, if *M* belongs to all *N* but not to some *O*, it is necessary for *N* not to belong to some *O*. For if it belongs to all, and *M* is also predicated of all *N*, it is necessary for *M* to belong to all *O*. But it was assumed not to belong to some. (27 a 36)

Darapti. Whenever both *P* and R belong to all *S*, (it is true) that *P* will of necessity belong to some *R*. For since the affirmative converts, *S* will belong to some R, so that since P (belongs) to all *S*, and *S* to some *R*, it is necessary for *P* to belong to some R. For a syllogism in the first figure is produced. It is also possible to make the proof *per impossibile* and by *ekthesis*. For if both belong to all *S*, then if one of the *S*'s, *e.g.*, *N*, is taken, both *P* and *R* will belong to this, so that *P* will belong to some R. (28 a 17)

Felapton. And if *R* belongs to all *S*, but *P* to none, there will be a syllogism that of necessity P will not belong to some R. The same type of proof (mill work) by converting the *RS* premiss. It might also be shown *per impossibile*, as in the previous cases. (28 a 26)

Disamis. For if *R* (belongs) to all *S* and P to some, it is necessary ior P to belong to some R. For since the affirmative converts, *S* will belong to some P, so that since *R* (belongs) to all S, and *S* to some P, R will belong to some P. So that P (will belong) to some R. (28 b 7)

Datisi. Again, if *R* belongs to some *S* and *P* to all, it is necessary for *P* to belong to some R. For the same method of demonstration (will work). And it is also possible to demonstrate it both per *impossibile* and by *ekthesis*, just as in the previous cases. (28 b 11)

Bocardo. For if *R* (belongs) to all *S* and P does not belong to some, it is necessary for *P* not to belong to some *R*. For if to all, and R (belongs) to all *S*, P will also belong to all *S*. But it did not so belong. It is also proved without reduction, if one of the *S*'s to which *P* does not belong is taken. (28 b 17)

Ferison. For if P (belongs) to no *S*, but R belongs to some *S*, P will not belong to some *R*. For the first figure will be produced again when the *RS* premiss is converted. (28 b 33)

Fesapo and *Fresison*, premisses in reversed order. . . . such as, if *A* (belongs) to all *B* or to some, but B to no C. For when the premisses are converted it is necessary for *C* not to belong to some *A*. Likewise in the other figures: a syllogism always results from conversion of the premisses. (29 a 23)

There is some question as to how these formulas should be interpreted. Traditionally, "Aristotelian" syllogisms have been presented as arguments and not as conditional sentences. The well-known example of a syllogism in Barbara has the form of an argument consisting of two premisses and a conclusion:

All men are mortal.
All Greeks are men.
Therefore, all Greeks are mortal.

As J. Lukasiewicz emphasized, this cannot be obtained by substituting terms for variables in the Aristotelian formula. The difficulty is not only that Aristotle uses expressions like "*A* is predicated of all *B*" or "*A* belongs to all *B*" instead of "All *B* is *A*"; more important, nearly all of the Aristotelian formulas have the form of conditional sentences, and the word "therefore" almost never occurs. Thus, their instances cannot be arguments — at least, not of the usual type. On the other hand, however, Lukasiewicz himself is not very convincing when he argues that the "true" syllogisms are generalized conditionals; on this hypothesis Barbara, for example, would be:

For every *A*, *B*, *C*, if *A* is predicated of all B and B is predicated of all C, then A is predicated of all C.

It will be noticed that some of the Aristotelian statements approximate this form, but that others do not. Aristotle's formulations of Darii and Cesare are not conditionals, and his statement of Felapton is clearly metalinguistic. Further, the sense of the word "necessarily," which occurs in nearly every one of the formulas, is not adequately represented by the prefix "For every A, B, C." Anyway, there is no evidence that Aristotle ever used quantifiers; he seems rather to have thought of variables simply as letters standing in place of terms. Further, a number of passages seem to indicate that, for Aristotle, the syllogisms are *instances* of the formulas containing variables and do not themselves contain variables. All of these obstacles stand in the way of accepting Lukasiewicz' interpretation.

Another, and closely related, difficulty concerns the question whether terms are classes or the names of classes. There are many places in which it appears that Aristotle regards terms as constituents of sentences. the latter being clearly regarded as significant sounds. But there are equally many places where he seems to be thinking of them as classes. Thus, he says "for one thing to be included as a whole in another, and for the other to be predicated of all of the one, are the same." Probably the truth is simply that Aristotle did not honour our much-valued distinctions between the use and mention of linguistic expressions and between arguments and conditional sentences. In asking whether he "really" meant syllogisms to be arguments or conditionals, and whether he "really" meant his logic to concern classes or names, we may be asking questions to which there are no appropriate answers.

The moods of the syllogism are grouped into three figures. Aristotle says that if we want to prove syllogistically that A belongs (or does not belong) to B, we have to take something common in relation to both, and this can be done in three ways: by predicating either A of C and C of B, or C of both. or both of C. "These," he continues, "are the figures of which we have spoken, and it is clear that every syllogism must be in one of these figures." Accordingly. Barbara, Celarent, Darii. and Ferio belong to the first figure; Cesare. Camestres. Festino, and Baroco to the second; and Darapti, Felapton, Disamis. Datisi, Bocardo, and Ferison to the third. There has been much discussion as to why Aristotle did not anticipate his followers in mentioning a fourth figure: *i.e.,* why he did not consider the possibility of proving A of B by predicating C of A and B of C. Numerous answers, none completely convincing, have been given. In any case, it is probable that Aristotle did recognize the existence of such syllogisms. For he allows interchange of the premisses of a syllogism and says that the result of converting the conclusion of a syllogism is again a syllogism; applying these operations to Barbara. Celarent. and Darii we obtain the moods Bramantip, Camenes, and Dimaris of the fourth figure. The remaining valid moods in this figure, Fesapo and Fresison, are given explicitly, although with their premisses in reversed order.

As I. M. Bochenski observed. "the assertoric syllogism is probably the most important discovery in all the history of formal logic, for it is not only the first formal theory with variables, but it is also the first axiomatic system ever constructed." (I. M. Bochenski, *Ancient Formal Logic*, North-Holland Publishing Company. 1951.) Aristotle axiomatizes his syllogistic in several ways. In the first of these he chooses as axioms the syllogisms of the first figure. They are said to be "perfect," *i.e.,* intuitively evident. He then proves the validity of the syllogisms in the second and third figures by reducing them to syllogisms of the first figure. The reductions are of two sorts: direct reduction and *rcductio ad impossibile.* Direct reductions are made by converting one or more premisses of the syllogism to be proved, reversing their order if necessary, and then deriving the desired conclusion (or its converse) by means of the syllogism to which reduction is made. By this procedure Aristotle reduces Cesarc and Camestres to Celnrent; Festino. Felapton, and Ferison to Ferio; Darapti, Disamis, and Datisi to Darii. (*See* the translations above.) The other method proceeds as follows: from one of the premisses and the contradictory of the conclusion of the syllogism to be proved, one derives (using the syllogism to which reduction is being made) the contradictory of the other premiss, thus establishing that the conclusion follows from the premisses. Aristotle uses this method to reduce Baroco and Bocardo to Barbara. Then! after reducing all of the moods to those of the first figure, he further states that Barbara and Celarent alone would suffice as axioms. He proves this by showing how to reduce Darii and Ferio to syllogisms of the second figure and by reminding us that all syllogisms of the second figure are reducible to Barbara and Celarent. (We are told that Festino may be proved by a *reductio* ad *impossibile* to Celarent, as well as by a direct reduction to Ferio.) Elsewhere he observes that the moods of any of the three figures will serve equally well as axioms.

Aristotle arrives at the valid moods by a process of elimination. To show that there is no valid syllogism of a given type, he always produces a counter-example. He does this in a particularly expeditious manner, managing to deal with several possibilities at a time. We quote and explain a typical example.

> But if M is predicated of all N and O, there will not be a syllogism. Terms for the affirmative relation are substance, animal, man; for the negative relation substance, animal, number.

This is a condensed argument to show that in the second figure there is no valid mood of the form "If M is predicated of all N and O, then . . . ." It makes tacit use of the fact that any substitution of terms for variables which converts the premisses of a valid mood into true sentences will also convert the conclusion into a true sentence. Now suppose there were a valid mood with the indicated premisses and a negative conclusion. Then any substitution of terms for variables which makes the premisses true will also make this negative conclusion true. and will tlierefore make false the universal affirmative formula "N is predicated of all O," which is the contradictory of the particular negative and the contrary of the universal negative. But, as a matter of fact, substitution of the terms "substance," "animal," and "man" for "M," "N," and "O," respectively, makes the premisses and this universal zffirmative formula true. Therefore. there is no valid mood with the indicated premisses and a negative conclusion. Analogously, since substitution of the terms "substance," "animal," and "number" makes the premisses and the universal negative formula "N is predicated of no O" true, there cannot be an affirmative conclusion. Therefore, there is no valid mood of the type under consideration. Often Aristotle does even better than this, dealing simultaneously with two pairs of premisses and thus eliminating eight possibilities at once.

After sifting out the valid moods of the syllogism Aristotle proceeds to make certain general remarks about them. He notices that in every syllogism at least one of the premisses must be affirmative and at least one must be universal. He points out further that a universal conclusion occurs only when both premisses. are universal. while a particular conclusion may follow from premisses which are both universal or one of which is particular. Also, at least one of the premisses must be like the conclusion in being affirmative or negative. Many other less interesting points are made, such as that only Barbara has a universal affirmative conclusion.

We have confined our attention to the assertoric syllogism, *i.e.,* to such syllogisms as contain only assertoric components. Actually much the greater portion of *Prior Analytics* I is devoted to modal syllogisms, which contain problematic or apodictic premisses or both. Aristotle develops the theory of such syllogisms in a manner similar to that used for the assertoric syllogism. However, his treatment is incomplete and contains many errors; and the already complex subject is further complicated by the fact that he uses the modal operators "necessary" and "possible" in a number of different senses. some of which are very difficult to grasp. His contribution to modal logic is undoubtedly important, but a great deal of work remains to be done before it can be regarded as well understood.

The remainder of the *Prior Analytics* and all of the *Posterior Analytics* are devoted primarily to subjects which are not relevant to logic as presently conceived. The same is true of the *Topics* and the *Sophistical Refutations.* In the *Posterior Analytics* Aristotle investigates the nature of scientific knowledge. The *Topics* attempts to lay down rules for arguing dialectically, *i.e.*, for establishing desired conclusions syllogistically from generally accepted premisses, and the Sophistical *Refutations* consists of a laborious discussion of fallacious arguments. Yet throughout these works there occur incidental remarks mhich, as Bochenski has shown, reveal that Xristotle was aware of many non-syllogistic laws of logic, including examples from what would now be described as the theory of identity and the calculi of predicates, relations, and propositions. Indeed, the science of logic has very few branches of which the beginnings, albeit sometimes faint, cannot be found somewhere in his writings.

2. Theophrastus.—Theophrastus, Aristotle's successor as head of the Peripatetic school, was evidently a logician of tonsiderable ability. Unfortunately, we possess only a few fragments of his logical works, and in many of these his name is linked with that of his successor, Eudemos. These fragments, however, suffice to show that his work consisted mainly in the development and correction of Aristotelian doctrine. We know but few details. To the first figure of the assertoric syllogism he added five moods which, when the order of their premisses is reversed, are seen to be precisely the five moods of the fourth figure. (Lukasiewicz conjectures that he was led to do this by defining the first figure as that in which the middle term is the subject of one premiss and the predicate of the other.) He expressly identified the indefinite sentences with the particular. He objected. for some reason or other, to Aristotle's use of "A does not belong to some *B*" and "Not: A belongs to all *B*" as synonymous. Further, it may be conjectured that he used something like the Euler diagrams for the syllogism, since he paraphrases "No *S* is *P*" as "S is separate from P."

However, Theophrastus' most significant contributions were in the field of modal logic, where, according to Bochenski, he made two major changes: (1) the interpretation of "possible" as "not self-contradictory" instead of "contingent"; (2) the affirmation and consistent application of the principle that the conclusion always follows the weaker premiss. It is also likely that his investigations into hypothetical syllogisms anticipated, to some extent, the Stoic logic of propositions.

3. Stoics and Megarians.—In many respects ancient logic reached its zenith in the writings of the Stoic and Megarian logicians. The Megarian school was founded by Euclid. one of the followers of Socrates. Among his pupils were Eubulides, to whom the Liar paradox is ascribed: Ichthyas. the successor of Euclid as head of the school; and Thrasymachus of Corinth. the teacher of Stilpo. The best-known pupil of Stilpo was Zeno (c. 350–260 B.C.), founder of Stoicism. Zeno's successors were Cleanthes and Chrysippus, the latter of whom was the most productive logician of the school. ("If there had been no Chrysippus. there would have been no Stoa"; "If there is any logic in heaven, it is the logic of Chrysippus.") Another important branch of the Megarian school consisted of Eubulides, Apollonius Cronus. Diodorus Cronus. and Philo. Unfortunately, the writings of all these men have been lost, and it is therefore necessary for us to depend upon fragments quoted by later authors. The best of our sources are Sextus Empiricus and Diogenes Laërtius, although we also get bits of information from Cicero, Gellius, Galen, Boethius, Apuleius, Alexander and the other Greek commentators, Origen, Proclus, Stobaeus, Epictetus, Seneca and a few others. Of these, only Epictetus and Seneca were favourably inclined toward Stoicism, and they were not interested in logic. The result is that our knowledge of the Stoic-Megarian logic has to be obtained principally from persons nho were trying to show that it was of no value.

Nevertheless, the picture which can be pieced together from these fragmentary sources is one of a relatively sophisticated and formalized logic quite different from that introduced by Aristotle. It is a logic of propositions. nhile the syllogistic is a logic of classes or terms: *i.e.*, the values of the Stoic variables are propositions; those of the Aristotelian variables are terms or classes. Further, it is a logic of valid inference schemas, while the Aristotelian formulas are usually propositional forms of conditional type. Stoic-Negarian logic is very modern in a number of important respects. The usual sentence connectives are interpreted truth-functionally, as is customary nowadays, and various possibilities of defining them in terms of one another are noticed. Arguments are sharply distinguished from the corresponding conditional propositions. The inference schemas which make up the calculus are never confused with the meta-rules for their reduction to one another. The whole logic is conceived in terms of a semantic distinction very similar to G. Frege's distinction between the sense and the denotation of linguistic expressions. In general, it is drawn upon lines very familiar to modern students of the subject.

Stoic semantics rests upon a fundamental distinction among three things: (1) the linguistic sign or sound, *e.g.*, the name "Dion." (2) the existent object denoted by the sign, which in this example would be Dion himself, and (3) the meaning of the sign. The first two of these three things are always bodies. say the Stoics, but the third factor is not a body. It is what Greeks but not Barbarians are able to grasp when they hear Greek words spoken. The technical term for these meanings or senses is "Lekta." On the Stoic view, it is with Lekta, and not with the linguistic expressions thereof. that logic is concerned.

The Lekta are classified in great detail. First, they are divided into deficient and complete. The deficient Lekta are subjects and predicates, a subject being the sense of a proper or class name, while a predicate is the sense of a verb. Complete Lekta are propositions, questions. imperatives. oaths, salutations: etc. Of course, the interest of logic is confined to propositions. which are defined as complete Lekta which are assertoric. They are elsewhere differentiated from other complete Lekta by the property of being true or false. A proposition is the sense of a declarative sentence; if atomic (see below) it is somehow composed of the subject and predicate nhich are the senses of the components of the sentence.

Propositions are divided into atomic and molecular. An atomic proposition is composed of subject and predicate without the help of a logical connective. A molecular proposition always contains at least one connective and consists either of two occurrences of a single proposition (as in "If it is day, then it is day") or of different propositions (*e.g.*, "If it is day, then it is light"). Atomic propositions are either definite (*e.g.*, "This man is walking"), indefinite (*e.g.*, "Somebody is walking"), or intermediate (*e.g.*, "Socrates is walking"). Types of molecular proposition include the negation, conditional, conjunction, disjunction, and several others. The negation of a proposition is said to be formed by prefixing "not," and emphasis was placed upon "prefix." (What this spatial terminology can mean when applied to propositions, as contrasted with sentences, is not explained.) Thus, they said, the correct negation of "It is day and it is night" is "Not both: it is day and it is night." which is of course quite ditierent from "It is day and it is not night." A conditional proposition is one that is formed from two occurrences of a single proposition or from different propositions by means of the connective "if" (*e.g.*, "If it is day, then it is light"). The part immediately following the "if" is the antecedent, and the other part is the consequent, even when the conditional is stated backwards. *e.g.*, "It is light if it is day." A conjunction is a molecular proposition compounded by means of the connective "and." *e.g.*, "It is day and it is light." Similarly, the parts of a disjunction are joined by "or," *e.g.*, "It is day or it is light."

There was a great controversy among the Stoics and Megarians about the meanings of conditionals. Callimachus reports, "Even the crows on the rooftops are discussing the question as to mhich conditionals are true." Sextus states and illustrates the four main proposals. He arranges these from the weakest (material implication) to the strongest, at each step cleverly producing an example which is true in all the preceding senses but false in the sense at hand.

For Philo says that a true conditional is one which does not have a true antecedent and a false consequent; *e.g.*, when it is day and I am conversing, "If it is day, then I am conversing"; but Diodorus defines it as one which neither is nor ever was capable of having a true antecedent and a false consequent. According to him, the conditional just mentioned seems to be false, since when it is day and I have become silent, it will have a true antecedent and a false consequent; but the following conditional seems true: "If atomic elements of things do not exist, then atomic elements of things do exist," since it will always have the false antecedent. "Atomic elements of things do not exist," and the true consequent, "Atomic elements of things do exist."

And those who introduce "connection" or "coherence" say that a conditional holds whenever the denial of its consequent is incompatible with its antecedent; so that, according to them, the above-mentioned conditionals do not hold, but the following is true: "If it is day, then it is day." And those who judge by "suggestion" declare that a conditional is true if its consequent is in effect included in its antecedent. According to these, "If it is day, then it is day" and every repeated conditional probably will be false, for it is impossible for a thing to be included in itself.

It will be noticed that Philo has defined what is now called "material implication." This definition seems to have been the one which found the greatest favour with the Stoics. It occurs in many of the fragments. sometimes even in what amounts to truth-table form:

Since, then, there are four possible combinations oi the parts of a conditional—true antecedent and true consequent, false antecedent and false consequent, ialse and true, or conversely true and false—they say that in the first three cases the conditional is true (*i.e.*, if the antecedent is true and the consequent is true, it is true; if false and false, it again is true; likewise, for false and true); but in one case only is it false, namely, whenever the antecedent is true and the consequent is false.

The view of Diodorus is not as clear as that of Philo, but from his definition of the "possible" as "that which either is or will be true" we can determine that a conditional holds in the Diodorean sense if and only if it holds *at all* times in the Philonian sense. For example. "If it is day, then it is light" holds in the Diodorean sense provided that for every value of t the propositional form "If it is day at time t, then it is light at time t" is a true Philonian conditional. The third sense mentioned in Sextus' list is what is now called "strict implication"; the fourth is nowhere taken up again.

Two basic types of disjunction were recognized by the Stoics: exclusive and inclusive. Exclusive disjunction was most used, and it is the only type of disjunction involved in the Stoic calculus of propositions. An exclusive disjunction is true if and only if exactly one of the disjuncts is true! *e.g.,* "It is day or it is night." For inclusive disjunction we possess no clear truth-functional definition, but there are illuminating examples, such as "Socrates is walking or Socrates is conversing." There seem also to have been non-truth-functional definitions: according to one of which a disjunction is not true unless the disjuncts are incompatible. As to conjunction, the case is simpler. A conjunction is true if and only if both parts are true. A negation is true if and only if what is negated is not true.

Chrysippus, in reference to the statement "If anyone is born under the Dog Star, then he will not drown in the sea," recommends that it be expressed as follows: "Not both: someone is born under the Dog Star and he will drown in the sea." thus showing that he knew how to express material implication by means of negation and conjunction. There is also some evidence that the Stoics knew how to define exclusive disjunction in terms of negation and equivalence.

As with Aristotle's syllogistic, however, the most interesting aspect of the Stoic logic of propositions is its arrangement into a deductive theory. The elements of the Stoic theory are arguments: not propositions, where an argument is regarded as a system of propositions containing premisses and a conclusion. Arguments of five types are taken as basic, and all others are declared provable in terms of these. The basic types are represented by the following five schemas:

I. If the first, then the second.
The first.
Therefore, the second.

II. If the first, then the second.
Not the second.
Therefore, not the first.

III. Not both the first and the second.
The first.
Therefore, not the second.

IV. The first or the second.
The first.
Therefore, not the second.

V. The first or the second.
Kot the first.
Therefore, the second.

For an example of a proof in the system, consider the following schema:

1. If both the first and the second, then the third.
2. Not the third.
3. The first.

Therefore, not the second.

The Stoic proof given by Sextus makes use of the following meta-rule: "If we have premisses which yield a conclusion, then we have in effect also the conclusion among the premisses, even if it is not explicitly stated." From 1 and 2, by a basic argument of type II, we get

4. Not both the first and the second.

which. according to the meta-rule, can now be considered as one of the premisses. From 3 and 4 we then obtain the conclusion by a basic argument of type III.

We know that there were four meta-rules by means of which such proofs were to be carried out. Unfortunately, we possess only two (or possibly three) of these rules. The first was "If from two propositions a third is deduced, then either of the two together with the denial of the conclusion yields the denial of the other," and the third was "If from two propositions a third is deduced and there are propositions from which one of the premisses may be deduced, then the other premiss together with these propositions will yield the conclusion." Perhaps the rule used in the example above is another version of this one. The Stoics seemed to think that their system was complete, *i.e.*, that every valid argument in the calculus could be reduced to a chain of arguments of the five basic types. Without knowing all four of the meta-rules we are not in a position to evaluate this claim.

Examples of Stoic proofs are very few in number. However, numerous arguments are mentioned and schematized without proof. For instance, there is the schema

Either the first or the second or the third.
Kot the first.
Not the second.
Therefore, the third.

Chrysippus said that even dogs make use of this sort of argument. For when a dog is chasing some animal and comes to the junction of three paths, if he sniffs first at the two paths down which the animal did not run, he will rush off down the third path without stopping to smell. Another schema is

If the first, then the second.
If the first, then not the second.
Therefore, not the first.

A Stoic example of an argument of this type is

If you know that you are dead, then you are dead.
If you know that you are dead, then you are not dead.
Therefore, you do not know that you are dead.

The Stoic and Megarian logicians, like logicians of all times, were greatly interested in paradoxes, the most famous of which was the Liar. This important antinomy was the subject of much writing in antiquity, including perhaps 28 books by Chrysippus alone. In fact. there is an ancient epitaph which says that Philetas of Cos died from spending his nights thinking about it. The Liar appears in several forms. Alexander gives "The man who says 'I am lying' is both telling the truth and lying." Cicero's version is "If you say that you are lying and tell the truth. then you are lying." Gellius asks, "When I am lying and say that I am lying, am I lying or telling the truth?" A closely related paradox, often called "the Epimenides." first appears in the Apostle Paul's *Epistle* to *Titus*. Paul there reminds Titus that even the Cretan prophet (identified by commentators as Epimenides) said that all Cretans were liars, gluttons. and evil beasts. He adds that what Epimenides said was true! No clear solution to any of these formulations is to be found in extant ancient literature.

4. The **Last** Period.—The history of ancient logic after Chrysippus is a subject still awaiting exploration in the second half of the 20th century. In the imperfect state of knowledge it appears that there were no logicians worthy of being mentioned in the same breath with Aristotle, Diodorus and Chrysippus. The period was not a creative one, new problems and methods being entirely

lacking, and what literature there was consisted primarily of commentaries and compendiums. In this connection, the contemporaries Galen and Apuleius (c. A.D. 150), whose handbooks are extant, deserve mention. Among the commentators, Alexander of Aphrodisias, a Peripatetic of the 3rd century A.D., was clearly a competent logician. His commentary on the *Organon* remains down to the present as perhaps the best exegetical account of this work. Of the later Greek commentators on Aristotle, Simplicius must be listed as one of the few who wrote intelligently about matters of logic. Martianus Capella, author of a Latin handbook of great importance for the transmission of ancient logic to later times, should also be mentioned.

Anicius Manlius Severinus Boethius (c. A.D. 480–524), the last Roman philosopher, was not a very good logician but is nevertheless highly important because of his influence on the middle ages. He wrote a number of books on logic, including De Syllogismo Hypothetico, De Syllogismo Categorico, and the commentaries on De *Interpretatione*. In these works we find Aristotelian logic presented in a terminology and manner now known as "traditional." Thus, the syllogisms are stated as arguments and not in conditional form. The Square of Opposition appears in its usual form, and many other details of classical logic occur for the first time in Boethius.

In the De Syllogismo Hypothetico we find a number of formulas best interpreted as theorems or rules of the propositional calculus. Some of them appear to be absurdly erroneous, but Van den Driessche has shown that Boethius occasionally used "if" in the sense of material equivalence. In the light of this explanation, such formulas as

If not-a, then b implies c: but
b implies c; therefore, not-a.

are seen to be valid, after all.

With Boethius, ancient logic comes to a close.

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II. LOGIC IN INDIA

1. Origins.—The origins of formal logic in India lie in exegesis and debate. By perhaps the 4th century B.C. the school of exegetes or interpreters of Vedic texts (mimamsa) began to furnish technical terms and a few basic concepts that were to be used later in logic. Actual logical operations are first found in the patterns of debate, called in some schools nyaya, which crystallize about the 2nd century B.C. The opening argument of the Buddhist *Kathavatthu* of this period falls into such a formal pattern. It contains a refutation that may be summarized thus:

If my first statement (a) was true, then you should consent to my second (b). You are wrong to say that a is true but b is not true. If b is not true, then a is not true. You are wrong to say that a is true but b is not true.

This is certainly an approach to propositional logic, as Stanislaus Schayer has pointed out. But it is consistent with the practical nature of such texts that while logical operations are actually performed no general rules are yet given for their performance.

These patterns of debate were often very lengthy, their form being chosen for psychological or rhetorical effect. According to the Jain author Bhadrabahu (1st century B.C.) the best pattern is one of ten members, which he lists as follows: (1) general thesis, (2) particular thesis, (3) general reason, (4) particular reason, (5) counter-argument, (6) denial of the counter-argument, (7) example, (8) doubting the example, (9) laying the doubt, (10) conclusion. It is from such a pattern as this that the classical Indian syllogism, likewise called nyaya, arises.

2. The Old **Nyaya (Pracina-nyaya)**.—The major school of Indian logic takes its name from the syllogism. The oldest writings of the school, the Nyayasutras, may go back to the time of Christ but acquired additions perhaps as late as A.D. 200. The early period of the school is characterized by intense and beneficial argument between orthodox (Hindu) and Buddhist logicians. Important contributions to logic were also made by the physicists (vaiseshika) in the early period and from the 5th century onward by the Jains.

The classical Indian syllogism is found in the earliest Nyaya texts. It consists of five members and shows clearly its origin from a pattern such as Bhadrabahu's (see above). It has become a syllogism by the expansion of the "example" to include a statement of universal concomitance or pervasion (*vyapti*). In the following example the particular argument is directed against the exegetes, who claimed that the word of the Veda is eternal.

1. Thesis: Word (is) non-eternal,
2. Reason: because (it possesses) the property of being produced.
3. Example: What possess(es) the property of being produced (is) seen to be non-eternal, as a pot. What possess(es) the property of not being produced (is) seen to be eternal, as the soul.
4. Application: It (viz., word) (is) like this (viz., possesses the property of being produced).
5. Conclusion: Therefore, word (is) non-eternal.

The original of the above contains no finite verb. According to commentators the last three members only are assertions. In the first two the terms are simply brought together without anything yet being asserted of the truth or falsity of the collocation.

This syllogism contains three parts (ansa) or terms. (1) The paksha (field), viz., the subject of thesis and conclusion. It is called a field because the other two parts occur (vartete) in it. In the above example paksha = word. (2) The hetu (reason proper). In the example hrtu = the property of being produced. (3) The sadhya (that which is to be proved). The early Nyaya argues about just what the sadhya is, *e.g.*, whether in the above example it is "the non-eternality of word" or "word-as-non-eternal" or, what was finally agreed on, simply "non-eternality."

This analysis shows how the classical Indian syllogism differs both from those of Aristotle, the terms of which are classes, and from the formulas of propositional logic. The paksha is normally a single individual; hetu and sadhya are regularly properties, expressible in Sanskrit by an abstract noun. The translation of the third member as "$F(x) \supset_x G(x)$" may refer to the same facts in a given instance as the Indian original, but the facts are not arranged in the Indian way. The letter F refers by an indissoluble expression to two notions which are quite distinct to the Indian logician: the hetu and the relation by which the *hetu* occurs. In the later development of Nyaya either of these notions may be qualified independently of the other.

The Buddhist Vasubandhu (4th century A.D.) distinguishes between inference for others (pararthanumana, *i.e.*, formal debate), which requires the presence of all five members, and inference for oneself (*svarthanumana*), which requires only the first three. The syllogisms of later textbooks are regularly given in the three-membered form. Prasastapada the physicist and the Buddhist Dinnaga (both c. A.D. 400) give systematic lists of fallacies.

Dinnaga is the first to give a "wheel of reasons" (hetucakra), that is, a systematic list of possible hetus. His list is based on the distribution of the hetu with respect to the *sapaksa* (objects other than the paksha but like it in being loci of the sadhya) and the vipaksa (objects other than the *paksha* and unlike it in not being loci of the sadhya). There are nine possible distributions, as the hetu may occur in all, part of, or none of either of these areas.

This wheel of reasons is vastly increased by Lddyotakara (c. A.D. 600) of the orthodox Nyaya, who gives 176 possible hetus. The increase is occasioned in the first instance by the addition of cases where sapaksha, vipaksha, or both simply do not exist. Thus, as an example of the third type: "Everything is eternal, because it (is) an object of knowledge." Other refinements of Uddyotakara are to distinguish cases where the *hetu* occurs in all, part, or none of the paksha itself, where the hetu is complex, *e.g.*, "Word (is) non-eternal, because while it (is) nameable it (is) an object of knowledge," etc.

The Buddhist Dharmakirti (7th century) propounds a further division of *hetus* into: (1) Those which possess a common nature with the sadhya, *e.g.*, "This is a tree, because it is a *Simsapa* (tree)." (2) Those which are an effect of the sadhya, *e.g.*, "This hill possesses fire because it possesses smoke." (3) Those which are cases of nonperception, *e.g.*, "There are no Simsapas here, because we perceive no trees." It is of this third class, which includes inferences from negative premisses and inferences leading to negative results, that Dharmakirti's analysis is most elaborate. He lists 11 varieties.

The Old Nyaya is summed up from an orthodox standpoint by Vacaspati Misra, who wrote his Nyayasucinibandha in A.D. 976. The date A.D. 841, given in many books, is due to an error in identifying the era.

3. The New Nyaya (Navya-nyaya).—Udayana (11th century) and others were instrumental in altering the Nyaya to the form which it assumes in the hands of Gangesa (14th century according to the evidence adduced by Dinescandra Bhattacaryya). Gangesa for the first time expressly refers to his school as the New Nyaya. In the centuries which followed, other schools also contributed to logic, notably the pluralistic Vedanta of south India (*e.g.*, Jayatirtha and Vyasatirtha), the neogrammarians (*e.g.*, Nagesa Bhatta), and the Jains. The following account is limited to the New Nyaya since its contributions appear to be the most important.

The chief innovations of the New Nyaya are three: a new method of universalization, rendered possible by the concept of limitation (avacchedakata); the discovery of a number of laws similar to the theorems of propositional logic; a new interest in the definition of relations and the use of these relations in operations of considerable complexity.

The method of universalization springs from a dissatisfaction which had always been felt with quantifiers. "All things which possess smoke possess fire" had troubled even the old logicians and for more reasons than one. There was the formal difficulty of binders. Mountain fire does not occur in a kitchen nor kitchen fire on a mountain. Deeper than this was a problem of knowledge. Even if interpreted without cross-connection. such statements refer to facts which the Naiyayikas claim are impossible to be known except by inference. And inference cannot serve as the basis for inference. What we perceive, say the Naiyayikas, are the generic principles (jati or vibhajakopadhi) that reside in the individual manifestations with which the senses come in contact. If a universal statement is to serve as the basis of inference, it should be phrased in accordance with the facts presented by perception. The New Nyaya method of so phrasing statements appears clumsy in English translation and can best be shown by a graduated example.

For "All that possesses smoke possesses fire" let us first substitute the equivalent expression "No case of smoke occurs in what is not a locus of fire." And for this let us substitute again: ('The absence of smoke which occurs in the locus of a generic absence of fire is a generic absence." The terms to be universalized are now (a) generic absence of fire and (b) generic absence (of smoke). Absence a is said to be such that its counterpositiveness (*pratiyogita*, the nature of the thing which it denies) is limited (*avacchinna*) by fireness (*vahnitvavacchinna-pratiyogitanirupitabhava*). That is to say, we are denying not this or that case of fire but any case you choose of an entity inhered in by fireness. Absence b is said to be an absence whose counterpositiveness is limited by smokeness.

Notice that in these substitutions, which sound so clumsy in English, the Sanskrit expression is a single compound word. The literal rendering of *vahnitvavacchinna-pratiyogitanirupitabhava* would be fireness-limited-counterpositiveness-described-absence. It is this syntactical peculiarity which allows the New Nyaya to operate with such terms somewhat as the modern logician operates with the symbols p and q or F and G where these symbols stand for whole propositions or functions. Accordingly, we find in the New Nyaya definitions of conjunction, disjunction, and implication which cover the facts referred to by sentence connectives as well as class connectives. One must bear in mind, however, that a translation of these definitions into logistic notation is never an exact one. The New Nyaya units are never precisely propositions or classes; they are the referenda of abstract nouns. New Nyaya techniques are parallel in many respects to those of modern logic: thus, where the western mathematician or logician speaks of a class of classes the Naiyayika speaks of the abstra-ct of an abstract; but parallel lines do not actually meet.

This New Nyaya method of universalizing by abstraction offers a quite satisfactory substitute for quantification so long as the number of terms and length of operations is not too great. Limits are imposed by human memory and corporeal breath but these limits are fairly wide. In formal debate Naiyayikas of the present day will use words that run to 300–400 syllables and take more than a minute each to pronounce.

As counterpositiveness is limited by an abstract determining the nature of the entity denied, so are causeness, effectness, etc.,' limited by abstracts which determine or show the precise selection of things caused or effected. A further step is taken by the technique of relational limitors. The counterpositiveness of absence limited by fireness is said to be limited also by the relation contact when we deny the presence of fire in a locus such as hearth, by a relation objectivity if we deny that fire is an object of knowledge, by identity if we deny that fire is water, etc. In this way the New Nyaya comes to investigate the relations between entities, and by simplifying all complex relations into chains of relations of two terms each, it is able to analyze situations of considerable complexity.

The New Nyaya reaches its height of analytical power with Raghunatha Siromani (c. 1475–*c.* 1550). This philosopher is as famous for the innovations he introduced in metaphysics, where he overthrew Nyaya tradition for a system much closer to Vedanta, as he is for his logic. Raghunatha constructs definitions of concomitance and pervasion (*vyapti*) that will fit cases of compound and complex *hetu* and sadhya. In his analysis of relations he comes on a discovery of the true nature of number. It is typical of his school that he does not distinguish abstracts or classes (*e.g.*, pairs, triples) from the corresponding cardinal numbers (*e.g.*, 2, 3). He distinguishes the relation by which twoness is connected with the components of pairs (the relation of inherence) from the relation by which twoness is connected with the pairs as abstracts. The latter relation, called *paryapti* (which may be translated literally by coining the phrase "circumtaining relation"), corresponds to what Frege in 19th-century Europe expressed by saying that a number belongs to a concept; it represents in another form Frege's insight that, *e.g.*, the number 2 should be attached to the concept, satellite of Mars, rather than to the concrete physical objects, Deimos and Phobos.

The creativeness of the New Nyaya, like that of all schools of Indian philosophy, declines from the beginning of the 18th century, but competent Naiyayikas and a few brilliant ones are still to he found in Benares, Calcutta, Mysore and in the district of Nadia in Bengal, the birthplace of Raghunatha.

See also INDIAN PHILOSOPHY.

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III. HISTORY OF SCHOLASTIC LOGIC

Medieval scholastic logic is characterized by its dependence on classical tradition, by its use of the Latin language and by the influence of Christian theology. While tradition and the Latin language had a more direct bearing on its formation and development, theology influenced it rather indirectly, partly by demanding a well-developed logic for the discussion of theological questions, partly by positing a few logical and semantical problems of its oun; for example, the problem of the truth or falsity of propositions concerning future contingent facts, or the problem of formality of logical discourse in terms of the divine Persons of the Holy Trinity. The Latin language. however, was of far greater importance than theology in the development of medieval logic. Essentially and entirely, the logic of the schoolmen was based on a "natural" language which, with the help of the grammarians (mostly Priscian and his medieval disciples like Elyas), was analyzed, reduced to rules and adapted to the needs of logic. Consequently the language of scholastic logic is richer, or rather more complicated and more involved in the subject matter, than the artificial languages of modern logic. But above any other factor, it mas tradition that guided the development of scholastic logic.

Primarily through Boethius and Apuleius, the early schoolmen believed themselves in uninterrupted contact with ancient logic; what they actually had. however, was but a fragment of the whole. It was only toward the end of the 12th century that the total body of Aristotelian logic became known; and at the same time the Arabian philosophers—notably Averroes, the great commentator on Aristotle—became available to the schoolmen, while elements of Stoic logic still continued, transmitted primarily from Cicero through Botthius and Apuleius.

By way of summary, it can be said that scholastic logic began to develop in the 12th century, reached maturity in the 14th and 1jth centuries, and declined rapidly from the 16th to the 18th centuries It is impossible to fill this bare outline with complete details. Modern scholars, thanks to the pioneer work of Jan Lukasiewicz, were at mid-20th century, only on the verge of bringing to light the highly developed logic of the 14th and 15th centuries—a logic that up to a few decades before had been completely lost.

1. Period of the **"Old** Logic" (**Ars** Vetus).—Fragments of ancient logic were transmitted to the scholastics through the works of the church fathers primarily St. Augustine The main sources, however, were Porphyry's *Isagoge,* or *Introduction to the Categories of Aristotle,* and the *Categories* and *Perihernzenias (De Interpretatione)* of Aristotle

Later, when other logical treatises of Aristotle became known, these three works were grouped together under the title of *Ars Vetus* (Old Logic), while the neuly discovered works were called *Ars Nova* (New Logic).

Another part of the logical heritage from antiquity was Cicero's *Topics,* to which must be added the commentaries of Boethius on the norks included in the *Ars Vetus,* his *Introduction to the Categorzcal Syllogism,* his treatises *On Topical Differences* and *On Hypothetical Syllogisms* and a few minor works, together with the *Perihermenias* of Apuleius of Madauros who also treated the categorical syllogism.

Thus the logicians of the early middle ages—thanks to Cassiodorus and the Benedictine monks who preserved what they could of ancient learning—had at their disposal a classification of terms; a theory of definition and division; an analysis of sentences; the truth and falsity both of simple categorical sentences and of modal sentences and a theory of their oppositions. a theory of the categorical syllogism and of the hypothetical (mostly conditional) syllogism; and a theory of dialectical or topical inferences. Through Cicero, Boethius, and Apuleius, fragments of Stoic logic were also available to the early scholastics, and Apuleius provided the additional help of a primitive systematization of logic The most conspicuous deficiency of early medieval logic, measured according to the standard of Aristotelian logic. was the lack of any treatment of the modal syllogisms and of any theory of demonstration.

The history of logic from the end of the ancient world up to the 11th century can be summarized in the one main fact that this partial legacy from antiquity was at least tenaciously preserved and slowly and thoroughly absorbed.

The real development of scholastic logic began with Peter Abelard (1079–1142) and his school. Although contemporary writers speak much of the great activity in logic during this time, and although many logical tracts are still extant in manuscript, little is actually known about the logic of the period, Abelard's *Glosses to Porphyry,* the *Categories* and *Perihermenias* are the only complete texts edited, and they deal more with semantical and philosophical problems (universals) than with logic. His *Dialectica,* substantial parts of which were published by Cousin, seems completely dependent on Boethius and Apuleius for its logic; in fact it amounts to little more than a systematization of the Boethian legacy.

There are five parts: (I) On the Parts of Speech *(Oratio),* On the Predicables, On the *Categories,* and On the Content of *Perihernzenias;* (II) On Categorical Propositions and Syllogisms, or the *Prior Analytics;* (III) Topics; (IV) On Hypothetical Propositions and Syllogisms, or the *Posterior Analytics* (!); and (V) On Divisions and Definitions.

It may be remarked in passing that Abelard was quite aware that it was his logic and his daring application of it to theological problems rather than the scandal of his private affairs that brought him into conflict with St. Bernard (*Odiosum me reddit mundo logica*).

John of Salisbury, a disciple of Abelard, and a great admirer of the *Topics* or *Dialectics,* gives in his *Metalogicon (Et quia logicae suscepi patrocinium, Metalogicon inscriptus est liber;* ed. by Clemens C. I. Web, p. 3, Oxonii 1929) many details about the enormous activity in logic that was then going on. He mentions Adam of Little Bridge *(de Ponte Parvo),* an Englishman named after the place where he taught in Paris, who also wrote a textbook, an *Ars dialectica* or *Ars discernendi.* He tells a remarkable story about one of Adam's disciples, William of Soissons, who apparently composed a *machina,* a calculus of logic. According to John of Salisbury, this man learned from Adam of Little Bridge certain quite remarkable consequential rules for the proof of which he used his "machine"; for instance: From one impossible (sentence?) every impossible follows. Although John refuses to accept this, it nevertheless seems to be the forerunner of the later scholastic consequential rule: From an impossible anything follows.

There were about 12 handbooks of logic in use at this time, but they seem to have been more or less of the same type. In any case none of them gained general recognition, and none is accessible to us in printed form.

2. Period of the "New Logic" (**Ars** Nova).—Around 1zoo, according to Alexander Neckam (d. 1217), the school at the Little Bridge in Paris required the reading of the *Ars Vetus,* and in addition, Aristotle's *Topics, Sophistical Refutations* and the two *Analytic~*these last constituting the *Ars* Nova. From then on the scholastics had at their disposal the entire *Organon* of Aristotle. They immediately began the work of assimilation, and it can be safely stated that around the middle of the 13th century the whole of Aristotelian logic had been completely absorbed and was being extensively used by the schoolmen, notably also by the theologians.

The process of assimilating the *Organon* was greatly helped by the influx of oriental literature into the Latin occident. Long before the scholastics became acquainted with the whole of the *Organon,* the Arabians, through the help of the Syrians, had absorbed Aristotelian logic. It is said that al-Farabi (d. 950), "the Second Philosopher" (Aristotle being "the First Philosopher," Xvicenna, "the Third"), directed his attention largely toward the logic of Aristotle and introduced it into the culture of Islam. He overcame the violent reaction of the Islamic theologians and paved the way for "the Third Philosopher," Avicenna (Ibn Sina, d. 1037 in Persia). The part of Avicenna's *Logic* that was translated into Latin toward the end of the 12th century is but an insignificant fragment of his well-developed treatise. His complete original work never directly reached the scholastics, and like the entire "hellenizing Arabian philosophy," as M. Horten calls it, remained foreign to orthodox Arabian philosophy and theology. Most important, as far as scholastic logic is concerned, was the work of Averroës (Ibn-Rushd, d. 1198 in Spain). His excellent and faithful commentaries — the scholastics used to call him simply "the Commentator" — for which he in turn exploited the earlier Greek commentaries — appeared in the first half of the 13th century at Paris and Oxford.

As far as logic is concerned, it seems that the influence of the Jewish philosophers on the scholastics was nil or at most negligible. Even the classical definition of truth as conformity of thought with reality (adequatio rei et intellectus), which Thomas Aquinas attributed to Isaac Israeli, is actually not to be found at all in Israeli's Book of Definitions. The formula is of Arabian origin.

Thus, through acquaintance with the culture of the east, the schoolmen obtained access to a wealth of material which they used extensively and well. But parallel to this opening up of sources from Arabian philosophy went the direct contact with the Greek sources of Aristotle and his commentators. Thus the revival of the ancient Aristotelian logic was complete. This abundance of newly acquired material was brought together in the voluminous work of Albertus Magnus. He wrote no sum of logic, to be sure, but he paraphrased the whole *Organon* of Aristotle, including also the additions made by Boethius, by drawing from the Arabian sources. How far he went independently beyond this scope is difficult to say at present. His logic: as far as syllogistics and the modal logic is concerned, is essentially that of the Aristotelian commentators.

Several near-contemporaries of Albertus Magnus also made important contributions to the development of logic. Robert Grosseteste (d. 1253), bishop of Lincoln, wrote a commentary to the Posterior Analytics which had great influence and was widely used. St. Thomas Aquinas (d. 1274) wrote an important commentary to Perihermenias, making use of the translations from the Greek furnished by William of Moerbeke. One of his followers, Giles of Rome (d. 1316), composed valuable commentaries to all the works of the *Organon*. Robert Kilwardby (d. 1279), the fellow Dominican and opponent of St. Thomas, also produced commentaries to logical writings, as did Duns Scotus (d. 1308) and the so-called Averroists such as Boethius of Dacia (c. 1285).

It is not easy to state just how far these logicians went beyond the matter they had at hand. Clearly, their commentaries did not simply repeat or explain, but sifted and developed as well. The confusing state of the Aristotelian logic of modalities, which was keenly felt by some logicians, was to a certain extent overcome by the distinction of Theophrastus' sensus divisus or the modality of the thing, and the sensus *compositus*, or the modality of the dictum. A similar advance can be noted in syllogistics in general. From Averroës the schoolmen learned to enumerate all possible combinations in each figure and to eliminate the invalid moods. Beyond this, nothing definite can be said until further research has been completed.

It is worthy of note, however, that these commentaries to the classical treatises strictly followed the line of development presented in the treatises themselves, taking little or no cognizance of the current of Terministic logic that finally absorbed the Aristotelian. This is true even of those commentaries written by logicians who also wrote original tracts completely in line with Terminism.

3. Rise of Terministic Logic. — Genuine scholastic logic did not originate from the revival of Aristotelian logic, but rather had its roots in earlier tradition, inaugurated by Boethius and Apuleius and developed by Abelard and his successors in constant contact with grammar. It was the logic of speech (scientia *sermocinalis*), in differentiation from, though not in opposition to, the logic of second intentions. This was the logic that remained basic not only in the sense that it was obligatory for beginners, but also in the sense that it was the starting point for an enormous and original productivity in logic. This logic of the Terminists or Summulists took definite shape, as far as is kno n at present, toward the middle of the 13th century, and was given its classical form by Petrus Hispanus (Peter of Spain, later Pope John XXI, d. 12 77), whose famous textbook remained in use until the 17th century. Terminism was developed primarily by the artists (philosophers) rather than by the theologians, who were relatively late in taking the leading part in it; there are, however, traces of Terministic logic in all the great theologians of the 13th century, beginning with Alexander of Hales (d. 1245).

Terministic logic led its own life, was in constant contact with the logic of the commentators, and was confined neither to the Realists nor to the so-called Nominalists, for it was indifferent to metaphysical implications.

Of the numerous summulae composed during the 13th century, only two have been printed in modern times — those of William of Shyreswood (d. after 1267) and Peter of Spain — and a few others have been described. Their relation to Apuleius is evident from the fact that all of them start with a discussion of propositions (Perihermenias) and include compound propositions. Their indebtedness to the grammarians is obvious from the introduction of semantical problems; their character as textbooks is likewise evident from the introduction of mnemonic verses, some of which have survived up to the present (for instance, Barbara celarent), and the discussion of sophismata. The pattern of these textbooks for beginners is essentially the same. They open with a tract on propositions, then deal with terms (at least with the five predicable~of Porphyry), then with the categorical syllogism, followed by topical rules and ending with fallacies. However, within this framework and sometimes scattered throughout, as in Peter's *Summulae,* there is found a group of additional tracts which constitute the most important contribution of the Summulists. They were called in the middle ages the Parva Logicalia, or the tracts on the properties of terms. These properties are the semantical relations of terms in the context of propositions: suppositio, *copu*latio, appellatio, ampliatio, and restrictio, to which are added *distributio* and the corresponding properties of relative terms. *Sup*positio is the use of a term that stands for something in a proposition. According to the older, Realist, logicians, a term signifies that for which it is instituted by convention, that is, for a concept or for a nature; but it stands for (*supponit*) that for which it is actually used in a proposition. Hence suppositio is the most general property of a term. The predicate term calls for (appellat-appellatio) verification for the time indicated by the tense of the verb; the verb itself and true adjectives have copulatio (binding) ; a term may be restricted (restrictio) in its scope by the tense of the verb or by the adjectives, or enlarged (*am*pliatio) in a similar way, and may be distributed (distributio) by quantifiers, and refer back to another term when it is a relative pronoun. Thus in the sentence: "Every white man was an animal," the terms "white" and "was" have copulatio; "animal" has *suppositio,* for it stands for the nature "animality" in every man; and it also has appellatio, since it calls for existing men, but only according to the form of the verb — that is, at some past time it must have been true to say: "This white," pointing at a man who is now or was white, "is an animal." The term "man" is restricted by the adjective "white" to stand for fewer individuals than it is able to stand for alone, and the term "white man" is distributed for every individual man who is white.

Of all these properties, it was suppositio that received the fullest treatment and the most extensive development. The *supposita* (individuals in a broad sense) for which a term can stand are, according to the Realists, either individuals, or the nature signified by the term. or the term itself. In the first case it is called personal suppositio, in the second, simple suppositio, and in the third, material suppositio. The first two apply to terms in use, the latter to terms in mention. Further distinctions are made, such as common suppositio (of a common term) and discrete (of a singular term or its equivalent) ; natural suppositio (the standing of a common term for anything it can stand for), and accidental *sup*positio (the standing of a common term for that which the context requires). Accidental suppositio is either simple or personal, and personal *suppositio* is further subdivided into confused and distributive (when a term stands for every individual), determinate (when a term stands for at least one individual), and confused only (when a term is bound or "immobilized" by the essence signified by another term).

It is obvious that semantical and intensional considerations prevailed among the Summulists, although the foundation for an extensional interpretation was laid and to a certain extent developed. It remained for the following period to develop this fully.

The Summulists' interest in semantical relations also led them to study the syncategorematic terms as distinct from the categorematic, which distinction probably goes back to the Stoics. While categorematic terms have a definite object that they signify by convention, syncategorematic terms (*e.g.,* the conjunctions "and," "or," "if-then," etc., the signs of negation and predication such as "no" and "is," etc., the quantifiers "every," "none," "some," etc.) have signification only with categorematic terms, but not alone. This led the Summulists already to understand them as logical operators or functors (*officiales*), and thus they advanced from a semantical to a syntactical interpretation of them. The great interest of the Summulists in these terms is apparent from the fact that they treated them extensively in several independent tracts, and also by the fact that they gave considerable attention to another type of logical literature, the Sophismata, which dealt mainly with the same matter. Sophismata (which seem to have originated in the school of Abelard) are not always false arguments; they are rather ambiguous sentences that owe their ambiguity precisely to the syncategorematic terms contained in them. In the medieval texts they are always treated in the same manner; the positio of the sophisma (one sentence) is followed by the *probatur* (it is proved) etc.. and the improbatur (it is disproved) etc., and terminated by the *solutio* of the probatur or of the *im*probatur or of both. The study of such tracts was an excellent means of obtaining practice and skill in the application of logical rules.

It may be well to add here that for the same reason—for practice in logic—the so-called Obligatio was introduced and developed. Obligatio has almost the same meaning as axiomatics in the modern sense, for the Respondens binds himself to the acceptance of a proposition and its consequences, and has to guard against the contradictions in the original sentence (the positio or petitio) or its opposite (the depositio), and in the consequences assuming pertinent or impertinent sentences. One kind, the impositio, deals with the use of symbols (for propositions or terms) and its limitations.

4. Classical Period of Scholastic Logic.—The classical period of scholastic logic which began, roughly speaking, *c.* 1300, achieved the synthesis of the entire Aristotelian logic with the Terministic logic and systematized that synthesis on the basis of consequential rules. It is impossible to mention the names of all those who deserve credit for this splendid accomplishment, but at least a few of the greatest among them require some comment.

It is becoming more apparent, as research progresses, that the main impetus of the new movement came from Oxford—or in any case from England—with Roger Bacon (d. after 1292) as a forerunner. Sutton, perhaps the Dominican Thomas Sutton (c. 1300), composed a tract on consequential rules which was quoted and commented on later by Albert of Saxony. Judging from Albert's comments, the tract was marked by a high degree of formality. The two outstanding men of this period, however, were the so-called Nominalist, William Ockham (Occam), and the Realist, Walter Burley. They had immediate followers among equally great logicians, partly at Oxford, where the Mertonians (William Heytesbury; Richard Swineshead, "the Calculator," who mas highly praised by Leibniz; John Dumbleton; Ralph Strode; and Richard Ferabrich) held sway; and partly at Paris, where Jean Buridan and Albert of Saxony were leaders.

Ockham (c. 1300–1349) composed three sums of logic, two of which are still unedited. The first and longest is known as the Summa Logicae. It is written not for beginners, but for theological students, and as such is a work of maturity. In the spirit of the Terminists. Ockham arranges the entire *Organon* of Aristotle into three parts: (I) On Terms; (II) On Propositions; (III) On Argumentation (the syllogism in general, the demonstrative syllogism, the Topical rules the fallacies). To the first section are added the Parva naturalia; to the second. a discussion of compound propositions; to the third, after the Topical rules, a tract on Obligatio is added. Ockham gives only brief mention to hypothetical syllogisms, but he treats in *extenso* of modal syllogisms and mixed syllogisms in a manner that leads far beyond Aristotle. Although he formulates the general consequential rules in the section dealing with the Topical rules, he speaks of them in all three parts of the *Summa,* clearly implying that he considers them the basis of syllogistics.

The step that made Ockham's implication explicit was taken by Walter Burley (c. 1275–1345), a staunch adversary of Ockham in many respects but one with him in the purely formal treatment of logic. The bulk of his De puritate *artis* logicae was written after Ockham's Summa. As far as is known, this is the first work in the history of logic that places the consequential rules first and reduces syllogistics to a subdivision thereof.

Of the continental logicians, one of the most important was Jean Buridan (c. 1295–1366), who rewrote the *Summulae* of Petrus Hispanus, revising the theory of suppositio and putting it before the treatment of syllogistics, and adding a tract on demonstration.

Buridan's disciple, Albert of Saxony (c. 1316–go), rector of the University of Paris and afterward of the newly founded University of Vienna, and later archbishop of Halberstadt, integrated in his Perutilis *Logica* Burley's concept of logic (whom he often quoted in his other works). with Buridan's improvement. into the system of William of Ockham. Thus was finally completed a system of scholastic logic which would seem to be unsurpassed by that of any other schoolman. This highly condensed and nevertheless complete logic contains six tracts. The first deals with terms; the second, with *suppositio* (adding many rules) ; the third, with propositions; the fourth, with consequential rules; the fifth, with fallacies; the sixth, with *Insolubilia* (insolvables, antinomies) and *obligatio.* In the first three tracts. Albert follows Ockham closely as to arrangement and content. though the second part is much better organized and considerably extended. The fourth tract, however, combines the thought of Ockham, Burley and Buridan, welding together in an ingenious system (and in this order) the general consequential rules of simple categorical propositions, of modal propositions, the consequential rules of categorical, hypothetical, modal and mixed syllogisms and the topical consequential rules. Again syllogistics is subordinated to a general theory of consequential rules.

In this work, as in all the others of the period and of subsequent periods, it is characteristic that the theory of consequential rules is treated as of primary importance. Two other dominant characteristics are a mainly extensional interpretation of the theory of suppositio in combination with a perfect sense for the formality of logic.

This character of the formality of logic is clearly and succinctly expressed by Albert. following Burley. The syncategorematic elements of discourse are the form; they are the skeleton of logical discourse and are clearly understood as being the constants on which the formal validity of inferences rests. The categorematic terms are understood as the material elements; variables are used for them and the rule of uniform substitution applied. Thus the inference: "A man is running, therefore an animal is running," is not valid. For the substitution made in: "If a is b, then c is b," not by alman, *b*/running, *c*/animal (which would yield the true inference), but by *a*/man, *b*/running cltree, will make it a false inference. However, the inference, "If a is *b*, then what is b is a," is formally valid It is also expressly stated that the position of terms or propositions belongs to the form. Hence it is not the same to say: "Socmtes ab homine *differt*" ("Socrates differs from a man") and "Socrates *differt* ab homine" ("Socrates differs from man"). The former is true and the latter false. To be "formally true," "logically true" and "universally true" are interchangeable expressions. Since the syncategorematic terms as the syntactical constants of logical discourse are fixed by definition, though not by a definition of a thing (quid rei) but of the meaning of the term (*quid* nominis), because there is nothing corresponding to them in the object world, the famous and much misunderstood distinction between that which is true because of the expression (de *virtute* sermonis) and that which is true according to the intention of the author, calls for a rigorous analysis of ordinary speech and its reduction to exact language. In fact, it was one of the main tasks of scholastic logicians to codify laws for the complicated Latin language in order to make it a vehicle for valid inferences.

The negation of terms (yielding infinite nouns and verbs), of simple and modal categorical propositions, and of compound propositions (called hypothetical), is consistently carried through. The contradictory opposite of an expression or a sentence is always obtained by adding the sign of negation to the term itself or to the principal element of the proposition. In the latter case, this is either the verb or the modality or the main statement-connective. Lacking adequate symbolism—only term and proposition variables are used—the scholastics scrupulously insisted that the sign of negation must precede that which it is supposed to deny. Hence, a typical negation of a conditional sentence would be: "Non, si a est b, b est c."

It was partly through this device for negation and partly because of their interpretation of the "vel," the "or-conjunction," that the schoolmen, long before Augustus De Morgan, formulated the laws that bear his name. It seems that England discovered them, just as it rediscovered them; for Ockham and Burley are both in complete and perfect command of them as understood by modern logicians—that is, as applying to unanalyzed propositions. According to Burley. the negation of: "a et *b*" ("a" and "*b*" being proposition variables) is "non: a et *b*," and this is equivalent to: "non a vel non b"; and the negation of: "a vel *b*" is "non: a vel b," and this is equivalent to: "non a et non b."

In a surprisingly extensive form, the conditional propositions and inferences between them were studied during this period and developed into a whole system. Sometimes they were united in tracts usually entitled: De Consequentiis, of which the earliest seems to be that of Thomas (?) Sutton. Others were written by Ralph Strode and Jean Buridan—at least there is a printed text attributed to him. These tracts contain the basic theses or laws of modern propositional calculus and some of the theory of quantification, but they are not formulated as laws or theses—though sometimes used as such—but are rather formulated in a metalanguage and as rules for inferences, using as names for variables or substitutions for them "antecedent" and "consequent."

The term "consequence" can be equated with "conditional proposition," though some logicians restrict it to mean logically, that is formally, valid inference. The *officialis* or operator "*si*" (if-then) is understood sometimes in the Diodorean, sometimes in the Philonian, sense; in the latter sense definitely by John of Cornwall (Pseudo-Scotus), most probably also by Ockham. Lately Ernest A. Moody devoted a special study to consequential rules and formulated more than 60 of them, corresponding to the rules given by the scholastics, and corresponding also to theses of the propositional calculus in *Principia Mathematica* and in C. I. Lewis's system of strict implication (Lewis and Langford, *Symboiic* Logic). If to these are added the modal consequences, the number goes far beyond 100, and if the syllogistic consequences of all forms are added, the number goes far beyond 1,000.

Though all the classical scholastic logicians speak of syllogistical consequences, at least one of them was aware that a syllogism in the form received from the Aristotelian commentators is not a consequence, that is, not a conditional proposition, but a juxtaposition of categorical propositions. And since as such a syllogism is neither true nor false, the denial of the conclusion of a syllogism does not infer the denial of the premisses. In order to make the rule: "From the denial of the consequent follows the denial of the antecedent" applicable to syllogisms, we must transform them into compound conditional propositions of which either the antecedent or the consequent is composed of two categorical propositions joined by the connective "and."

The theory of consequential rules deeply penetrates the entire theory of suppositio. The definition of various forms and subdivisions of suppositio are given by formal consequences which are called "descent." The scholastics made use of four different quantifiers which are defined as follows: The universal quantifier ("every") allows the descent from a common term to copulative propositions in which the common term is particularized (*singularizatio*), and all individuals are enumerated for which the common term stands. In a similar way the particular quantifier ("some") allows the descent to a disjunctive proposition, the collective quantifier ("all") to one proposition, in which the term is singularized and its elements joined by "and"; the disjunct or confused quantifier to one categorical proposition in which the term is singularized and its elements joined by "or." For example: "Every man is an animal" is equivalent to: "This man is an animal, and that man is an animal:" and so on for every individual man that is an animal. "Some man is an animal" is equivalent to: "This man is an animal or that man is an animal, etc." "All Apostles are twelve" is equivalent to: "This Apostle and that Apostle and so on for all the Apostles, are twelve." "Every man is an animal:" is equivalent to: "Every man is this or that or that, etc., animal." Later scholastics also studied the relations between the various quantifiers.

During this period, and certainly beginning with Ockham, a semantical definition of truth and falsity on the basis of the theory of suppositio was elaborated. In its simplified form it runs: "A proposition is true if subject and predicate stand for the same or do not stand for the same as is denoted by that (affirmative or negative) proposition." Hence the proposition: "A man is white" is true if, and only if, there is a thing of which it can be said that this is a man and this same is white.

The theory of suppositio also solves the problem of the so-called existential import. Hardly any of the scholastics understood a categorical universal affirmative proposition as equivalent to a conditional proposition, although they understood the latter as a consequence from the former. A scholastic universal proposition is simply invested with existential import and in order to make the conclusio ad subalternatam valid, it is not necessary to add an existential proposition. Later scholastic logicians added a conditional to the descent, for instance: "Every man is an animal, therefore this man, if he exists, is an animal, etc." Or they added the so-called constantia, that is, the proposition: "and these are all . . ." However, since the scholastics were keenly aware of the problem and moulded their theory of suppositio accordingly—which theory varied, for the Realists admitted the existence of universal things and the Nominalists denied it—and since many admitted the suppositio naturalis which was often understood as being of necessary matter, they paid attention to the problem of the conversion of propositions, and were extremely cautious about the conversion by contraposition and in the use of infinite terms (that is terms like "not-man," "not-stone").

The various and varied discussions of the logical antinomies can only be hinted at here. No more than passing mention can be made even of Raimon Lull (c. 1232–1315), whose Ars Magna and his method of combination (mixtiones) so deeply influenced Leibniz, for there is no authentic interpretation of the work of this challenging thinker who was both mystic and logician.

5. Decline of Scholastic Logic.—Toward the end of the 14th century, the decline of scholastic logic set in. The ravages of Black Death, the wars between France and England, the western schism, all acted unfavourably on the scientific culture of the late middle ages. Yet it is remarkable that especially scholastic logic managed for more than a century to maintain its high standard. Its worst enemies arose from the ranks of the Humanists who preferred classical style, poetry, and rhetoric to the rigour of the "barbaric" Latin of scholastic logic. Nevertheless it was Italy, the centre of Humanism, that produced the best logicians of the period. Paul of Venice (d. 1429), an alleged Averroist but certainly of the school of the Nominalists, composed a *Logica* Magna and Parva. The former is a truly monumental work, not only in regard to its size, but in the thoroughness of its formal treatment of logic as well. Paul admits only simple conversion as formally valid, applies quantification also to material suppositio, and has a most interesting discussion of the semantical antinomies. A more succinct and highly systematized logic, composed entirely in the form of theses, was produced by his disciple, Paulus Pergulensis (d. 1451).

During this time many commentaries were written, mostly on the *Summulae* of Petrus Hispanus, or on Buridan (for example, the very important commentary of Dorp). Some writers also commented on the Logica Parva of Paul of Venice, and on a few others of lesser importance. These commentaries are of value for historical notes. It seems that the Realists; during this period, confined their activities to writing commentaries, although toward the turn of the 1 jth century they began to produce original tracts, largely based on the revised order of the *Summulae* of Petrus Hispanus. Of the Scotists, mention should be made of the commentaries of Johannes Magistri (c. 1400), of Johannes de Monte (c. 1450) and especially of Petrus Tartaretus (rector at Paris. 1490), who also composed an excellent little tract on the Descent. Of the Thomistic tradition, the logic of St. Vincent Ferrer (written 1372) merits attention, and the more extensive work of Chrysostom Javellus (d. 1538), both of which continue the realistic Terminist logic.

Under the impact of the Reformation and the new philosophies, the so-called Nominalistic logic, and in general the extremely formalized logic of the 14th and 1 jth centuries, disappeared from the scene. With the Counter Reformation, toward the end of the 16th century, a kind of scholastic renaissance took place, but it disregarded much of the former achievement, going back primarily to the philosophy of St. Thomas and Duns Scotus. Johannes a Sancto Thoma (1589–1644) composed a logical tract that has dra n some attention from modern scholars; and the works of Silvester Maurus, S.J. (1619–87), and Bartholomew Mastrius, O.F.M. Conv. (1602–73), have also won the notice of recent writers.

The 17th century saw the complete disintegration of scholastic logic. Subsequent degeneration was so rapid that by the middle of the 18th century it was dead to all practical purposes.

See also the separate articles on many of the logicians mentioned in this section.

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IV. MODERN LOGIC

In this section we outline the development of deductive logic from the 16th to the middle of the 20th century. The history of inductive logic is treated in the articles INDUCTION; PROBABILITY; and SCIENTIFIC METHOD.

1. Ramée.—Pierre de la Ramée, or Petrus Ramus, whose anti-Aristotelian position was widely influential. is perhaps the first of the post-scholastic logicians who deserves mention here. One of the earliest noteworthy works on logic in a modern language is his *Dialectique* of 1555, though other works are in the traditional Latin. His *Dialecticae Libri Duo* of 1 j j6, long used as standard (John Milton's *Artis* Logicae *Plenior Institutio*, 1672. is. e.g ,but a revised edition of it). has a much modified and abbreviated version of the older logic, omitting the immediate inferences altogether and greatly simplifying the rules of the categorical syllogism. In an altered classification into moods or kinds, a special place is provided for syllogisms having two singular premisses, including not only the two moods of the expository syllogism (see LOGIC) but inferences involving a singular predicate, such as: Octavius is heir of Caesar, I am Octavius, therefore I am heir of Caesar; Judas that wrote the Epistle was the brother of James, Judas Iscariot was not the brother of James, therefore Judas Iscariot was not the Judas that wrote the Epistle.

Propositions with singular predicates had been treated by Ockham, Pseudo-Scotus, and other scholastics—as well as the expository syllogism, by some as confined to the third figure, so that the singular middle term occurs only as subject, but by others as admitting moods also in other figures. And indeed Pseudo-Scotus already maintained that syllogisms with singular premisses should be brought into the Aristotelian form by rereading in the following way: Everything which is Octavius is heir of Caesar, everything which is I is Octavius, therefore everything which is I is heir of Caesar. The Ramistic treatment of these singular inferences as non-Aristotelian was later countered on similar grounds by Thomas Spencer (*The* Art of Logick delivered in *the* precepts *of Aristotle and Ramus*, London, 1628) and, more sharply, by the mathematician John Wallis (*q.v.*) in his Cambridge thesis of 1639, published in 1643, and in his *Institutio Logicae* of 1687. Wallis reached the conclusion that singular propositions are to be assimilated to universal propositions for purposes of the syllogism, on the ground that the predicate of a singular proposition and of a universal proposition are alike predicated of all, of the whole rather than a part of the subject. Following, not necessarily Wallis, but earlier writers generally, the authors of the Port-Royal Logic (see below) give a similar account of singular propositions, so that it is said that all propositions can be reduced to the four forms *A*, E, I, *O*. And this remained the generally accepted doctrine until the traditional point of view was superseded by the development of modern logic in the 19th and 20th centuries.

2. Jungius.—Joachim Jungius, in his Logica *Hamburgensis* of 1638, brought forward and discussed a number of forms of inference that are not reducible to the traditional immediate inferences and syllogisms. Relations especially are involved in these, and if widespread attention and study had been given to the matter, the logic of relations might have been developed two centuries in advance of the actual event. But Jungius remained without important influence. except upon Leibniz, and his contributions to logic were ignored by his successors or (*e.g.*, by Wallis) dismissed as reducible to the tradiiional doctrine.

One of these forms of inference which Jungius considers is that of the so-called oblique *inferences*, which had already been treated by Aristotle. An example is: The square of an even number is even, 6 is an even number, therefore the square of 6 is even. The significance of this, as it appeared in the light of much later developments, may be seen by attempting to reduce to traditional syllogistic form as follows: Every even number has an even number as square, 6 is an even number, therefore 6 has an even number as square. In this way the conclusion has 6 as its subject. And if we wish then to infer, in another syllogism, that 36 is the square of 6 and therefore 36 is even, we must first transform the conclusion so that it will have as its subject, the square of 6. The inference which is missing from the traditional catalogue of forms is the immediate inference (if we wish to call it that) from the proposition, 6 has an even number as square, to the proposition, the square of 6 is an even number.

To make the issue clearer we may put the inferences into modern notation, using e (~)to mean that x is even, and s (~y,) t mean that the square of x is y. The first inference is then from the premisses $e(x) \supset_x . s(x, y) \supset_y e(y)$ and e(6) to the conclusion $s(6, y) \supset_y e(y)$, and the second inference then uses the additional premiss $s(6, 36)$ to draw the conclusion $e(36)$. Relational inferences of this sort—here illustrated in a case so simple as to be almost trivial—are as a matter of fact essential to nearly all important mathematical reasoning.

Other examples of Jungian relational inferences are the following. A circle is a figure, therefore who draws a circle draws a figure: $c(x)$ >, $f(x)$, therefore $c(x)$ A, $d(x, ?)$ >, . $f(x)$ A, $d(x, y)$. A reptile is an animal, therefore Who created every animal created every reptile: $r(x) \supset_x a(x)$, therefore $a(x) \supset_x C(x, y) \supset_y . r(x) \supset_x C(x, y)$. David is the father of Solomon! therefore Solomon is the son of David; *i.e.*, upon supplying a tacit premiss, $F(x, y) \supset_{xy} s(y, x)$, F (S, D). therefore $s(D, S)$. (This last had been considered also by Galen.)

3. Geulincx.—Arnold Geulincx published in 1662 Logica *Fundamentis Suis*, a *quibus hactenus collapsa fuerat, Restituta*. Though the title indicates the author's intention to restore neglected fundamentals, this is not just a reproduction of the scholastic logic but an original work. Following are some points of special interest. The doctrine of *suppositio*, largely ignored by other logicians of the period, is here reproduced in altered terminology and with some alteration in content; the possibility of using the same term with different kinds of *suppositio* is treated as being (with a suitable exception to allow for syllogistic inferencej a form of equivocacy, and the device is mentioned in particular of underlining in manuscript or using a distinct style of type in print, to distinguish "grammatical" (*i.e.*, material) *suppositio* and "logical" (*i.e.,* simple) *suppositio* from others. It is argued that negation may be applied only to propositions, and not to terms. Detailed rules (not new except in viewpoint) are given for the reduction of negations, including what are now known as the De Morgan laws of the propositional calculus, the law of double negation, and such reductions as that of not all not to some, *i.e.,* of $\sim(x)\sim$ to $(\exists x)$. Treatment of the categorical syllogism is brief but adequate, and is supplemented by mention of the inference known as the antisyllogism (example: Peter is not an animal, therefore either Peter is not a man or some man is not an animal). What would now be called valid inferences of the propositional calculus are especially well handled, in spite of the handicap of doing it entirely in words, without the aid of special symbols other than the use of capital letters to stand for propositions. Disjunction is explained clearly as inclusive, and *modus ponendo tollens* is rejected (in contrast with the uncritical acceptance of this inference by Ramus and by the Port-Royal Logic). The copulative syllogism (see LOGIC) is treated by use of the appropriate De Morgan lam to reduce it to *modus tollendo ponens*. No reduction of the negation is given in the case of conditional propositions, but negations of such propositions are considered, and the following inferences are allowed: from $\sim . A \supset B$ to $\sim . \sim B \supset \sim A$; from $B \supset C$ and $\sim . A \supset C$ to $\sim . A \supset B$; from $A > B$ and $\sim . A \supset C$ to $\sim . B \supset C$; from $A \sim B$ to $\sim . A \supset B$.

Geulincx considers at one point the inference: Every white man is white, every white man is a man, therefore some man is white. He notes that the premisses are necessary, but the conclusion contingent. And he rejects the inference on the ground that the word "white" is used equivocally—in the conclusion to refer to the present time, and in the premisses absolutely, *i.e.,* without reference to time—so that the syllogism has four terms. The weakness of this is that there are still only three terms in the premisses, and on the traditional doctrine a conclusion should follow in Darapti. But it remained for Leibniz some decades later to give more serious consideration to the problem of existential import.

4. Port-Royal Logic.—Port-Royal Logic or *La Logique* ou *l'Art* de Penser, the original title, was written by Antoine Arnauld and Pierre Nicole, possibly with the collaboration of some others, and was first published in 1662. It was, like Ramus, long and widely used (both Latin and English translations appeared in England) and though the authors follow Ramus in the fourfold division of logic into idea, judgment, reasoning and method, they restore the Aristotelian-scholastic treatment of opposition, conversion and the categorical syllogism.

An important original contribution of the Port-Royal Logic is the distinction between comprehension and extension—of ideas, as the authors say—or of concepts, or of terms, as is more usually said by later writers. The comprehension of a concept consists namely of all those attributes which are contained in it and cannot be removed from it without destroying it—as, *e.g.,* the authors say, the idea (concept) of a triangle contains extension, figure, three sides, three angles, the equality of the sum of these three angles to two right angles, etc. And the extension of a concept consists of the subjects to which it extends, or of what were traditionally called the inferiors of a general term—so that, *e.g.,* the extension of the concept of a triangle consists of all the different species of triangles: isosceles, right, obtuse, etc. This distinction was widely adopted by later writers and became a standard part of the traditional logic. Along with Mill's connotation and denotation of names it may be thought of as a forerunner of Frege's distinction of sense and denotation (see SEMANTICS IN LOGIC; CONNOTATION; and DENOTATION).

The Port-Royal Logic also contains the first publication of the ideas of Blaise Pascal (*q.v.*) about the nature of definition. Namely it was Pascal who first observed that every demonstrative science must begin, not only with unproved propositions (see AXIOM, and POSTULATE) but also with undefined terms, or termes *primitifs* as they are called in the Port-Royal Logic. Pascal also restricts definitions in mathematics to nominal definitions, *définitions* de nom, which consist merely in the giving of a name to something which has been clearly designated in terms completely known; the use and purpose of such definitions is the abbreviation of discourse; they are entirely free, and never subject to being contradicted; and, as Pascal wrote in a letter to Le Pailleur, one may equally well define something impossible as something actual. These ideas were taken up by the authors of the Port-Royal Logic, who lay great emphasis on the need for careful definition as a means of avoiding confusion of thought. However they retain also the notion of a real definition, or *définition* de chose, as a proposition which explains the nature of a thing by means of its essential attributes, and which is therefore capable of being confirmed or disputed. And the idea, which arose much later, that primitive terms and axioms (or postulates) are, like nominal definitions, arbitrary, is not to be found in the Port-Royal Logic; on the contrary the authors demand, following Pascal, that primitive terms shall be completely known, and axioms completely evident.

5. **Saccheri.**—Giovanni Girolamo Saccheri's Logica *Demonstrativa* of 1697 and 1701 also requires mention, though the author is (deservedly) better known for the partial anticipation of non-Euclidean geometry in his Euclides *Vindicatus* of 1733 (see GEOMETRY). The Logica provides a treatment of the traditional logic in the form of a series of demonstrations based on postulates and definitions, in the manner of works on geometry. Two points are emphasized which afterward played an important role in the Euclides Vindieatus, namely: (1) the law of Clavius (see LOGIC) and the associated method of proving a proposition by showing it to be a consequence of its own negation; and (2) the distinction between nominal definitions and real definitions, on the basis that the former merely state the meaning of a term, whereas the latter carry also the assertion of existence.

(1) is the consequentia mirabilis of 17th-century scholastic writers. Geronimo Cardano (*q.v.*) writes in his De *Proportionibus* of the striking character of this method of proof, which he thought to be his own discovery. Knowledge of the method came to Saccheri through Christopher Clavius. by whose name the law is sometimes known, and who, in commentaries on Euclid and on Theodosius, points to its use by Euclid, by Theodosius, and by Cardano. But Saccheri was the first to exploit this method of proof systematically—in his Logica and in Euclides Vindicatus.

Significant in (2) is that definitions are always of terminology, and real definitions are distinguished from nominal by the added demonstration or assumption of existence. Otherwise Saccheri had been anticipated by Pascal and in the Port-Royal Logic, in regard to the nature of nominal definitions and the fallacy of misusing a nominal definition in the role of a real definition. (But Saccheri, in his Latin terminology and in his notion of nominal definition, is evidently following Ockham and other scholastics rather than Pascal.)

6. **Leibniz.**—Gottfried Wilhelm von Leibniz (Leibnitz) (*q.v.*) brought forward already in a work published in his youth (*Dissertatio* de Arte Combinatoria, 1666) the project of constructing a universal exact system of notation, a symbolic language, in which all concepts would be so analyzed into their ultimate constituents, by the notation itself, that it would be the means for a fundamental knowledge of all things. This project of a lingua characterica *universalis* was partly based on the ideas of Lull, to whom Leibniz refers. Leibniz continued to advocate it throughout his life, later adding as an important part the project of a calculus ratiocinator, or calculus of reasoning. And though the total program of Leibniz, as just described, is no doubt not even theoretically fulfillable, the calculus ratiocinator remains an important forerunner of the logistic method in logic.

Leibniz's contributions to logic remained largely unpublished during his lifetime. The most important waited publication much more than a century. But Raspe's Oeuvres Phzlosophiques de Leibniz, published in 1765, contains a purely descriptive paper about the lingua characterica universalis, a paper which treats the difficulty concerning existential import, and the Nouveaux *Essais* sur *l'Entendement Humain.*

In the paper on existential import, Leibniz is led to hold that all four of the categorical forms A, E, I, *O* are to be understood on the basis of a tacit presupposition that the terms which enter are existent (are not empty). This Leibnizian solution of the difficulty has often been adopted since; and if class variables are used to formulate the traditional logic of categorical propositions, the solution may be put in the form of restricting the range of values of the variables to non-empty classes. There is, however, the objection that this seriously reduces the applicability of the traditional logic, as it may be impracticable to ascertain in advance that all terms are existent, and syllogistic reasoning may serve a substantial purpose even in cases in which it is possible or probable that some of the terms are empty.

In a passage in the *Nouveaux* Essais, Leibniz discusses the relational inferences of Jungius, correctly remarking that they cannot be reduced to any traditional syllogism except by a *changement* des termes which renders the total process of inference asyllogistic (see above).

The same work also contains a statement of the law of identity in the form, "A is *A*," or "All *A* is *A*." This law must not be credited exclusively to Leibniz—since Leibniz refers to its use by Ramus to treat the Aristotelian conversions as special cases of categorical syllogisms—and since indeed this possibility was known in the 13th century, and there is mention already by Boethius of uhat John Locke (in 1690) called "identical propositions." But it was Leibniz uho first ascribed to the law of identity a special status as a "primitive truth of reason."

In many of his works Leibniz seems to overestimate the importance of one or both of the laws of contradiction and identity. In the Nouveaux *Essais* Leibniz avoids saying that these laws are alone a sufficient basis for the whole of logic, and even may be thought to imply the contrary. But elsewhere he is less cautious, especially in writings that were not intended for publication. Thus in *Réflexions* sur *l'Essai* de *l'Entendement Humain* de *Mr.* Locke (published with Locke's letters in 1708) and in the reply to the first letter of S. Clarke (published in 1717 after Leibniz's death) it is said that the law of contradiction, so stated as to include the law of identity, suffices to demonstrate either all truths independent of experience or all principles of mathematics. It would seem that Leibniz at times really hoped that all necessary truths might be demonstrably reduced to these very simple ones—though indeed with the aid of certain principles of inference, especially the syllogism in Barbara (cf. the letter quoted by J. E. Erdmann, vol. 1, p. 81). But some of his successors made the idea into an unsupported and almost meaningless item of doctrine—see THOUGHT, LAWS OF.

Leibniz's actual attempts at the construction of a calculus ratiocinator were made in the period from 1679 to 1690 and are published, some in Erdmann's Opera *Philosophica* (vol. 1, 1840) and C. I. Gerhardt's *Philosophische Schriften* (vol. 7, 1890), the remainder in L. A. Couturat's *Opuscules* et Fragments *Inédits* (1903). These show beginnings from which the modern treatment of logic might well have developed. But their content remained unknown for 150 years, and historically only the generalities of Leibniz's program exerted any influence.

In the century following Leibniz there were many attempts at a logical calculus, of which the most widely known and discussed were those of Gottfried Ploucquet (in 1763) and of Johann Heinrich Lambert (*q.v.*) (in 1767, and in a number of fragments published in Lamberts *Logische* und *Philosophische Abhandlungen*, vol. 1, 1782). Lambert's are noteworthy as containing some beginnings of a logic of relations. But none of the attempts produced a satisfactory calculus, and the main trend of opinion was against this direction.

7. Euler.—Leonhard Euler (*q.v.*), in his Lettres *à* une *princesse d'Allemagne* (vol. 2, 1770), illustrated his treatment of the categorical syllogism by using the interiors of three circles to represent the minor term. the middle term and the major term. Thus $\mathbf{s}(x) \supset_x \mathbf{m}(x)$ is pictured by showing the circle for $\mathbf{s}$ entirely within that for m, and $\mathbf{s}(x) \supset_x \sim\mathbf{m}(x)$ by showing the two circles as non-overlapping, etc. This method of visually checking the validity of syllogisms was brought into general use through its adoption by Euler. and came to be known as the *Euler diagram,* though the device did not originate with Euler. Such circle diagrams had been employed in special cases by Johann Christoph Sturm (*Universalia Euclidea,* 1661); and they were used by Leibniz to treat the categorical syllogisms systematically, in a fragment not published until 1903; but their first systematic use for this purpose in a published treatise seems to have been by Johann Christian Lange (*Nucleus* Logicae Weisianne, 1712).

8. **Kant.**—Immanuel Kant (q v.) contributed little to logic. Indeed it was his opinion that logic had made no important step either forward or backward since Aristotle, and seemed to all appearance to be finished and complete (Kritik der *reinen Vernunft,* preface to 2nd ed., 1787). But his influence was great because of his reputation in other fields. In particular the general acceptance of the term, analytic, for propositions that are true on logical grounds alone is traceable to Kant, although Kant's own definition of the term would restrict it to a narrow subclass of such propositions, and although the term, analytic, and its opposite, synthetic, had been used already by Christian August Crusius in 1747. The now familiar contention that "existence is not a predicate" is due to Kant, who used it (op. *cit.*) as an objection against the so-called ontological proof of the existence of God; but a satisfactory positive analysis of the notion of existence had to await the introduction of the quantifiers by Frege and Mitchell.

9. **Hegel.**—Georg Wilhelm Friedrich Hegel (*q.v.*), in *Wissenschaft* der Logik (1812–16), denounces the Leibnizian project of a universal symbolic language as shallow and senseless, and singles out for special attack Ploucquet's recommendation of his calculus as making possible the mechanical performance of logical inference without danger of error if the rules of the calculus are followed. Hegel is similarly critical of the Euler diagrams, and even of the long-established formal treatment of the syllogism as it appeared in the traditional logic of his day. It is not without some justice that he reproaches the latter with being in an ossified and contemptible state. But Hegel represents, as an extreme example, the tendency which long prevailed to hold logic itself in low esteem and to devote the greater part of a work on logic to other subjects, especially to topics in epistemology and metaphysics that bear upon the traditional logic or are suggested by it.

10. **Bolzano.**—Bernard Bolzano's *Wissenschaftslehre* of 1837 contains many original contributions of which the importance was long overlooked, and its proper place in the history of logic came to be seen only in the light of much later developments. In this brief account we confine attention to a single point, Bolzano's treatment of the notion of analyticity.

Bolzano introduces notions of analyticity in a wider and in a narrower sense; but of these only the latter is free from serious objection, and will be described here. It will be convenient to state Bolzano's definition with respect to a formalized language, though it must be remembered that Bolzano did not have this means available, and such restatement of his definition gives it an appearance of greater rigour than was possible for Bolzano himself. We may take this language to be the set theory of Zermelo (see LOGIC), with a large number of individual constants added, corresponding to the words of various kinds that appear in an English dictionary, so that the language becomes (theoretically) usable for purposes of ordinary discourse as well as for expressing propositions of pure logic and of mathematics. Also we state the definition as for an analytically true sentence, although Bolzano deals rather with the proposition ("Satz an sich") expressed by a sentence; and we employ the terminology explained in the article LOGIC, instead of Bolzano's own. From any sentence let a corresponding propositional form be obtained by replacing every extra-logical constant (Bolzano says extra-logical concept) by a variable, two or more occurrences of the same constant being replaced always by the same variable, and different constants by different variables. A sentence is then analytically true (in the narrower sense) if either: (1) the corresponding propositional form is true for all values of the variables; or (2) the sentence can be reduced to one satisfying condition (1), by a series of steps which consist in replacing an occurrence of an individual constant by a synonymous constant or a well-formed part by a synonymous well-formed part.

This definition is not without its difficulties. In particular no explication is offered of the notions of synonymy and of being true for all values of the variables (or satisfied by all values of the variables—*see* SEMANTICS IN LOGIC), but these notions are taken for granted; indeed the notion of synonymy is not explicitly present at all, but is implicit in the treatment of propositions rather than sentences, and its role is indicated only by some examples. Bolzano himself calls attention to the possibility of dispute as to which constants, or concepts, shall be recognized as logical and which as extra-logical (though in the case of the particular language which we have here selected for the purpose of illustration, it might be possible so to control the vocabulary of added individual constants that all constants but A and ϵ would be clearly extra-logical). In spite of such difficulties, Bolzano must be credited with having proposed the first definition of a distinction between analytic and synthetic propositions that deserves serious consideration from the point of view of its logical adequacy.

A minor point is that Bolzano completed Kant's classification of propositions into analytic (analytically true) and synthetic by adding a third category of the analytically false.

11. Mill.—John Stuart Mill's A *System* of Logic, Ratiocinative and *Inductive* (1843) is remembered for its contributions to inductive logic, which are outside the scope of this article, and for its introduction of the distinction of CONNOTATION and DENOTATION, which is treated in the articles of those titles.

12. Algebra of Logic.—The algebra of logic had its beginning in publications of George Boole (*q.v.*) and Augustus De Morgan (*q.v.*) which appeared simultaneously in 1847. There are two main divisions.—The algebra of classes has three basic operations, the logical sum (or union) $F + G$ of two classes F and G, the logical product (or intersection) FG of F and G, and the complement F' of a class F. In the notation introduced in the article LOGIC, $F + G$ may be explained as meaning $\lambda x[F(x) \vee G(x)]$, FG as meaning $\lambda x[F(x)G(x)]$, and F' as meaning $\lambda x{\sim}F(x)$. The notation 0 was used for the empty class; and 1 for the universal class, *i.e.*, the class which coincides with the domain of individuals so that all individuals belong to it. And equations and inequalities were written. such as $G + H = F' + G'$ to mean that the logical sum of G and H is the same as the logical sum of the complements of F and G, or $FG \neq 0$ to mean that the logical product of F and G is not empty, or $F \leqq G$ to mean that F is contained in G in the sense that all individuals belonging to F belong also to G.—The algebra of relations has six basic operations, the logical sum $F + G$ of two relations F and G, the logical product FG, the contrary F' (or $-F$), the relative sum $F \dagger G$, the relative product $F;G$, and the converse F. These may be explained as meaning respectively $\lambda x\lambda y[F(x, y) \vee G(x, y)]$, $\lambda x\lambda y[F(x, y)G(x, y)]$, $\lambda x\lambda y{\sim}F(x, y)$, $\lambda x\lambda y(z)[F(x,z) \vee G(z,y)]$, $\lambda x\lambda y(\exists z)[F(x,z)G(z,y)]$, $\lambda x\lambda yF(y,x)$. The notation 0 was used for the empty relation. 1 for the universal relation, 0' for the relation of diversity (which holds between x and y if and only if x and y are different individuals), 1' for the relation of identity. And again equations and inequalities may be written.

The three basic operations of the algebra of classes, and the six basic operations of the algebra of relations, obey laws which are of much the same kind as familiar laws of the algebra of numbers (and in part coincide with them). By using these a formal algebra or calculus of classes may be set up, and an algebra of relations. These were the first successful calculi of logic. As treated by 19th-century writers, neither is yet a logistic system in the sense of modern logic, but a calculus in a less rigorous sense.

Various notations were used by different writers. And when the two algebras mere incorporated into Principia Matlzematica (see below) as parts of the logistic system of that work, the authors, partly following Giuseppe Peano, changed the old notations completely. In the algebra of classes the logical sum, logical product; and complement are expressed by $F \cup G$, $F \cap G$, and $-F$ respectively, and the notations 0, 1, $\leqq$ are changed to Λ, V, $\subset$ respectively. In the algebra of relations the same notations are used with a dot added, as $F \mathbin{\dot\cup} G$, etc.

The method of Boole, in 1847 and in 1854, is not an algebra of classes in the sense described above, but an application of ordinary numerical algebra to the logic of classes—as is possible if the logical sum of F and G is written as $F + G - FG$, and the complement of F is written as $1 - F$. Yet Boole was able to obtain in this way the essential results of the algebra of classes, and indeed worked them out more fully than De Morgan. In De Morgan's Formal Logic of 1847 are, however, some beginnings of the algebra of classes in the more proper sense, including in particular the De Morgan laws $(FG)' = F' + G'$, $(F + G)' = F'G'$ (it was only later that De Morgan's name came to be applied also to the analogous laws of the propositional calculus). From these beginnings the algebra of classes developed into its classical form through contributions by William Stanley Jevons (*q.v.*) (Pure Logic, 1864, and later works), Charles Sanders Peirce (in a series of papers beginning in 1867), Ernst Schroeder (Der Operationskreis des Logikkalkuls, 1877), John Venn (*Symbolic* Logic, 1881), and Platon Poretsky (in papers published in the period from 1884 to 1908).

The algebra of relations had its beginnings in publications by De Morgan (Syllabus of a Proposed System of Logic, 1860, and a paper in the Transactions *of* the Cambridge Philosophical Society, vol. 10, 1864) and received its major development at the hands of Peirce (in papers beginning in 1870) and Schroeder (in Algebra der Logik, vol. 3, 1895).

The standard reference work on the algebra of logic is Schroeder's three-volume Algebra der Logik (1890–1905). However, Schroeder's axiomatic basis of the algebra is deficient, and should be replaced, in the case of the algebra of classes by E. V. Huntington's (Transactions of the American Mathematical Society, vol. 5, pp. 288-309, 1904), and in the case of the algebra of relations by Tarski's (The Journal of Symbolic Logic, vol. 6, pp. 73-89, 1941).

There is a sense in which the algebra of logic has also a third division, the algebra of propositions, though not always clearly distinguished from the algebra of classes. Boole had already considered the alternative of interpreting the variables of his algebra as propositional variables instead of class variables. But the first true calculus of propositions appears in papers of Hugh MacColl, beginning in 1877; and in particular it was MacColl who rediscovered the so-called De Morgan laws of the propositional calculus (known already to the scholastics). The second volume of Schroeder's Algebra has a combined algebra of classes and propositions.

13. **Peirce.**—Charles Sanders Peirce (*q.v.*), besides the matters already mentioned, has the credit of having taken the first steps in many things which afterward became important in the development of logic. These include the first definition of the notion of simple order (1881); the first treatment of the propositional calculus as a calculus of two truth-values (1885); the definition of = (1885) which is given above in the article LOGIC (though this had been partly anticipated by Leibniz's informal definition, "Things are identical of which one can be substituted for the other with preservation of truth"); and the definition of finiteness (1885) which would be expressed in modern notation as follows: G is a finite class if $(F) \mathbin{.} F(x, y)F(x, z) \supset_{xyz} y = z \mathbin{:\supset:} F(x, z)F(y, z) \supset_{xyz} x = y \supset \mathbin{.} G(x) \supset_x (\exists z)[G(z)F(x, z)] \supset \mathbin{.} G(z) \supset_z (\exists x)[G(x) F(x, z)]$. Peirce also initiated in 1881 the method of treating the foundations of arithmetic which was afterward developed by (Julius Wilhelm) Richard Dedekind (Was sind und was *sollen* die *Zahlen?*, 1888) and Giuseppe Peano (Arithmetices Principia, 1889).

The *Insolubilia* were discussed by Peirce (1869, 1901) with direct reference to the medieval sources. It is quite possibly through Peirce that the Liar first came to the attention of Bertrand Russell, but it required the independent discovery of Richard's antinomy (see below) to make clear the importance of what are now known as the semantical antinomies or paradoxes.

In a paper of 1880, in treating the categorical syllogism, Peirce says that traditionally the affirmative (categorical) propositions imply that their subjects are existent, while the negative ones do not; but he will assume rather that particulzr propositions imply the subjects existent, universal propositions not. Indeed this change of the convention about existential import is strongly indicated from the point of view of the algebra of classes; it was implicit in a short note published by Arthur Cayley in 1871, but was first made explicit from this point of view by Peirce, and by Venn in 1881. It is true that under the changed convention, certain traditional inferences (*e.g.*, conversion per *accidens,* syllogism in Darapti) require an added existential premiss to validate them. But the convention which Peirce describes as the older one also renders some of the immediate inferences invalid without an added existential premiss, those namely (including contraposition) that involve obversion of a negative proposition.

14. Brentano.—Franz Brentano in his *Psychologie vom Empirischen Standpunkte* of 1874, made it a part of his psychology of judgment that every proposition can be reduced to an (affirmative or negative) existential proposition, so that, *e.g.,* "Some man is ill" and "All men are mortal" are said to have the same sense as "An ill man is" and "An immortal man is not" respectively. In modern notation the four categorical forms *A*, E, I, *O* thus become $\sim(\exists x) \,.\, s(x) \sim P(x)$, $\sim(\exists x) \,.\, s(x) P(x)$, $(\exists x) \,.\, s(x) P(x)$, $(\exists x) \,.\, s(x) \sim P(x)$. Hence quite independently of the algebra of logic (to which he was opposed) Brentano arrived at the same doctrine of existential import which was later introduced by Peirce as described above, and at the same modification of the traditional logic. including rejection of the syllogisms in Darapti, etc. But Brentano seems to defend his own revision of the traditional rules as the only right one, whereas Peirce sees more clearly that it is a matter of choosing the convention under which the formal treatment of logic can proceed most eiriciently.

An exposition of Brentano's logical innovations was published by J. P. N. Land in the first volume of the British periodical *Mind* in 1876. And a detailed treatment of immediate inference and the syllogism from Brentano's point of view is in Franz Hillebrand's Die *Neuen Theorien der Kategorischen Schluesse* of 1891.

15. **Frege.**—Gottlob Frege is the founder of modern logic in a sense in which neither Leibniz nor De Morgan and Boole can be so considered, and as such is unquestionably the greatest logician of modern times. The essential steps in the introduction of the logistic method were taken in his *Begriffsschrift* of 1879. In the same work there appear for the first time the propositional calculus in its modern (logistic) form, the notion of a propositional function, the use of quantifiers and the logical analysis of proof by mathematical induction in terms of the notion of a hereditary property—or hereditary class, as we shall here prefer to say.

This last was important in Frege's definition of an inductive cardinal number, and thus provided the basis for the derivation of arithmetic from logic which was described and defended in his *Grundlagen* der *Arithmetik* (1884) and carried through rigorously in the first volume of his *Grundgesetze* der *Arithmetik* (1893). To state the definition in the slightly modified form in which it was later used by A. 9. Whitehead and Bertrand Russell in *Principia Mathematica,* let us call two classes *G* and H similar if there is a one-to-one correspondence between them, *i.e.,* if $(\exists F) \,.\, F(x, y)F(x, z) \supset_{xyz} y = z \,.\, F(x, z)F(y, z) \supset_{xyz} x = y \,.\, G(x) \supset_x (\exists z)[H(z)F(x, z)] \,.\, H(z) \supset_z (3x)[G(x)F(x, z)]$. As the cardinal number of a class G, we might think to take the concept. or property, of similarity to *G*. But if a property is understood (as usual) in intension. this has the defect that the cardinal numbers of two different but similar classes will not be actually identical. Hence we are led to take the corresponding extension. *i.e.*, to define the cardinal number of *G* as the class of classes which are similar to *G*. The cardinal number of *H* is successor of the cardinal number of G if, for some class H, similar to H, $(3y) \,.\, H_1(y) \,.\, G(x) \equiv_x \,.\, H_1(x) \sim x = y$; a class of cardinal numbers is hereditary if all successors of cardinal numbers belonging to it also belong to it; the cardinal number of the empty class Λ is the number 0; and the inductive cardinal numbers (the non-negative integers) are those which belong to every hereditary class to which o belongs.

From an antinomy due to Georg Cantor, concerning the question of the greatest (infinite) cardinal number. Russell extracted the simpler antinomy which is now known by Russell's name (*see* ANTINOMY), and communicated it to Frege in 1902. As the antinomy can be put into the form of a demonstration of contradictory theorems from Frege's logical axioms, Frege felt that one of the foundations of his construction had been shattered. Indeed it must have seemed to Frege and his contemporaries that his great work was a failure. For although Frege's axioms can be amended to remove the inconsistency—and Frege himself made some suggestions in this direction in the Appendix to the second volume of his *Grundgesetze* der Arithmetik (1903)—it must then seem that the axioms have been artificially designed for a purpose. and it is less easy to maintain that they have been taken once for all from a realm of eternal truth. It is only in the perspective of time that we are able to see that Frege's positive contributions far outweigh the inconsistency of the particular system in which they were embodied.

Independently of Frege, the use of quantifiers was suggested also by O. H. Mitchell, to whom the idea is credited by Peirce in his paper of 1885.

Other important contributions of Frege are the distinction of sense and denotation (see SEMANTICS IN LOGIC), and the device of systematically employing quotation marks to distinguish the mention of a term, expression or symbol from its use. The latter distinction is in a sense obvious, and was already recognized among the medieval distinctions of *suppositiones;* yet failure to observe it has been the source of much confusion, in Frege's day and since.

16. Venn.—John Venn, besides contributions already mentioned! introduced in 1880 the *Venn diagram.* This is a modification of the Euler diagram (see above) in which the three circles are so drawn as to overlap in all possible ways, thus dividing their plane into eight regions; and to represent the given premisses, some of these regions are shaded as a sign that the classes they stand for are known to be empty. and others are marked with a star as a sign of non-emptiness. If an inference is to be dealt with (not necessarily syllogistic) that involves n basic classes, n > 3, the corresponding regions may be drawn as ellipses or other more complicated shape, instead of circles, and so placed as to divide their plane into 2^n regions; and then the same process of shading and starring is followed.

17. **Peano.**—Giuseppe Peano is important for his influence on Russell, and for his contribution in devising a scheme of logical notation which is more convenient than those of Peirce: Schroeder and Frege, and much of which (through its adoption by Russell) is still in use. Peano's postulates for arithmetic (see POSTULATE) are due to Dedekind in all but the point of view of taking them as postulates. His *Formulaire* de *mathématiques,* written with the aid of collaborators and published in five "volumes" (or editions) from 1894 to 1908, is intended as a compendium of mathematics; developed from its postulational beginnings with the aid of Peano's logical notation. His treatment of logic had begun to go beyond the algebra of logic but he did not yet have the logistic method.

18. **Burali-Forti.**—Cesare Burali-Forti stumbled upon the antinomy which now bears his name (*see* ANTINOMY), in a paper of 1897 in which he seems to have been not aware that he had revealed antinomy at all.

This antinomy and that of the greatest cardinal number were known already to Cantor but had not been published, and it was through Burali-Forti's paper that there first came to general attention the threat to the foundations of mathematics that is constituted by the antinomies.

19. **Russell.**—Bertrand Russell (*q.v.*) adopted Frege's thesis that arithmetic is a branch of logic, in the sense that all the terms of arithmetic can be defined with the aid of logical terms only (see the brief statement above as to how, in part. this is to be done), and all the theorems of arithmetic can be proved from logical axioms only. And the same thesis was extended by Russell to the whole of mathematics—a doctrine which later came to be known as *logicism.* The project of carrying this out is the subject of Russell's *The* Principles *of Mathematics* (1903). The theory of types as a means of avoiding the inconsistency of such a system as Frege's, though the idea of it was discussed in the *Principles,* was first put into satisfactory form by Russell in a paper of 1908, and on this basis the detailed logicistic development of a large part of mathematics is in the three volumes of Whitehead and

Russell's Principia *Mathematica* (1910–13). Thus Whitehead and Russell succeeded where Frege failed. But the theory of types compels the use of the axiom of infinity—which plays no role in Frege's work—and some have objected that this is not properly an axiom of logic.

The type theory of Principia is the so-called ramified theory of types (concerning which see MATHEMATICS, FOUNDATIONS OF). The reduction of this to the simple theory of types was mentioned by Leon Chwistek in 1921; independently of Chwistek, it was advocated more seriously by F. P. Ramsey in 1926. and thence came into general use through its adoption by Rudolf Carnap (Abriss der Logistik, 1929) and Kurt Goedel (1931).

Another major contribution of Russell is the device (1905) by which descriptive phrases such as "the 32nd president of the U.S.A." may be eliminated if desired (see SEMANTICS IN LOGIC). A technical improvement of Russell's device, important especially when it is employed in a formalized language, was introduced by W. V. Quine in 1940.

20. Zermelo.—Ernst Zermelo stated the axiom of choice in 1904—the use of which in mathematical reasoning had previously been tacit and unrecognized. The first formulation of axioms for set theory was by Zermelo in 1908. Zermelo's axioms involve, however, an unexplained notion of a "definite property." Different proposals for overcoming this difficulty were made by A. A. Fraenkel and Thoralf Skolem in 1922 and 1923, of which Skolem's has the advantage that it leads more directly to logistic formalization of Zermelo's verbally stated axioms. The axioms of set theory as given in the article LOGIC are obtained from those of Zermelo by Skolem's method, with addition of the axioms of replacement, due to Fraenkel, and the axioms of excluded infinite regress due to John von Neumann (later introduced independently also by Zermelo).

21. Richard.—Jules Richard published in 1905 the antinomy now known by his name. Semantical paradoxes related to Richard's were afterward proposed by various other authors, including the paradox of Kurt Grelling in 1908 (see SEMANTICS IN LOGIC).

22. Hilbert.—David Hilbert's contributions to logic arose from his work in the foundations of mathematics (see MATHEMATICS, FOUNDATIONS OF). Important among them are the program of proof theory and in particular of a metatheoretic consistency proof, dating from 1905, and in connection with this the sharp distinction between object language and meta-language (in Hilbert's terminology, between mathematics and metamathematics). *Grundlagen* der *Mathematik* (1934, 1939), a comprehensive treatise of modern logic containing Hilbert's ideas in their final form: was written in collaboration with Paul Bernays, to whom the detailed content of the work is largely due.

23. Brouwer.—Luitzen Egbertus Jan Brouwer is the founder of mathematical intuitionism (see MATHEMATICS, FOUNDATIONS OF; and THOUGHT; LAWS OF). His publications in this field began with his dissertation in 1907 and a paper on the law of excluded middle in 1908 and extended through 1954. The logistic formalization of intuitionism is, however, due to Arend Heyting (1930) and others.

24. Lewis.—Clarence Irving Lewis was led by the "paradoxes" of material implication (see LOGIC) to seek a notion of implication, strict implication, which shall correspond rather to the relation of logical consequence in the sense that, if $<$ is the sign of strict implication, and if **A** and B are any sentences. **A** $<$ **B** shall be true if and only if **B** is a logical consequence of **A.** Lewis's publications about the matter begin in 1912. But the first satisfactory formulation of a propositional calculus with strict implication was in 1920. The book of Lewis and C. H. Langford, *Symbolic*. Logic (1932), treating the subject at length, has become a classic in the field of modal logic, and the starting point of many more recent investigations.

25. Lowenheim.—Leopold Loewenheim in a paper of 1915 proved the theorem which is now known as Loewenheim's theorem (see LOGIC): and several other important results in the metatheory of the functional calculus of first order.

26. Skolem.—Thoralf Skolem, besides the contribution to set theory already mentioned, gave a new and better proof of Loewenheim's theorem, established the extension of this theorem which is stated in the article LOGIC. contributed results connected with the decision problem of the functional calculus of first order (some of which were later important in the proof of Goedel's completeness theorem), and discovered also the following metatheorem, that no set of postulates. finite in number or enumerably infinite. expressible in the notation of a simple applied functional calculus of first order can be adequate for arithmetic in the sense of characterizing completely the system of non-negative integers.

27. Post.—Emil L. Post's dissertation of 1920, published in 1921, contains the first comprehensive metatheoretic treatment of a logistic formalization of the two-valued propositional calculus. including proofs of consistency and completeness; also the first formulation of a many-valued propositional calculus from a point of view which is abstract in the sense of being concerned with the form of the calculus independently of any particular interpretation.

28. Lukasiewicz.—Jan Lukasiewicz, in a paper of 1920, introduced a three-valued propositional calculus based on Aristotle's doctrine of future contingents (see THOUGHT, LAWS OF). This was later generalized to an analogous n-valued propositional calculus, different from that of Post. Much important nork is also due to Lukasiewicz in the two-valued propositional calculus, and in the history of logic.

29. Tarski.—Alfred Tarski contributed extensively to two-valued and many-valued propositional calculus, taking his departure from the work of Lukasiewicz. However, his most noteworthy contributions. beginning in 1930, are to the general metatheory of logistic systems, a domain in nhich many important new ideas are due to him. Especially semantics, in the sense of the metatheoretic treatment of notions related to those of meaning and truth, is the creation of Tarski (see SEMANTICS IN LOGIC). Much of the more recent work of Tarski has been in the boundary region between logic and mathematics, or has applied methods and results of modern logic to special branches of mathematics.

30. Carnap.—Rudolf Carnap, in his Der *logische Aufbau* der *Welt* (1928), Testability and *Meaning* (1936–37) and many other publications, was a pioneer in the systematic application of the methods of modern logic in epistemology and philosophy of science—making in this a contribution to philosophic method which in the eyes of many exceeds in importance his support of a particular philosophical outlook (that of logical positivism, *q.v.*). Carnap's contributions to the study of the metatheory of logistic systems begin in his Logische Syntax der *Sprache* (1934, published, 1937, in English with some additions as *The* Logical *Syntax* of *Language*). In a paper of 1935, somewhat later than Tarski but independently (and in a different terminologyj, Carnap introduced the idea of syntactical definitions of the semantical notions of truth and satisfaction, and in particular was the first to make such definitions for the full simple theory of types, as distinguished from a functional calculus of finite order. And concerning Carnap's contributions to intensional semantics, see SEMANTICS IN LOGIC.

31. Herbrand.—Jacques Herbrand in his short life—he was killed in a mountain-climbing accident in 1931 at the age of 23—made extensive contributions to Hilbertian proof theory and to the metatheory of the functional calculus of first order. The most important of these cannot be stated here. But the deduction theorem of first-order functional calculus should be mentioned as Herbrand's.

32. Goedel.—Kurt Goedel proved the completeness theorem of the pure functional calculus of first order (1930), and the famous incompleteness theorem (1931). For statements of these, see LOGIC and (especially for the latter) MATHEMATICS, FOUNDATIONS OF.

The bearing of the incompleteness theorem on Hilbert's program of a metatheoretic consistency proof for mathematics is obvious: but more far-reaching is the consequence that no single logistic system, satisfying certain very general conditions, can tenably claim to embrace only logical truth *and* the whole of logical truth (if indeed the latter phrase has a meaning at all).

Also due to Goedel (1940) is the metatheorein that if the system of set theory with omission of the axiom of choice (see LOGIC) is consistent, it remains so upon addition of the axiom of choice or an axiom expressing the generalized continuum hypothesis or both. (For a statement of the continuum hypothesis *see* MATHEMATICS, FOUNDATIONS OF.) As Goedel pointed out. his result is applicable alike to various forms of set theory and to type theory.

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LOGICAL POSITIVISM, a philosophical doctrine first formulated in Vienna in the 1920s, according to which scientific knowledge is the only kind of factual knowledge and all traditional metaphysical doctrines are to be rejected as meaningless. The school differs from earlier empiricists and positivists (David Hume. Ernst Mach) in holding that the ultimate basis of knowledge rests upon public experimental verification rather than upon personal experience. It differs from Auguste Comte and J. S. Mill in holding that metaphysical doctrines are not false but meaningless—that the "great unanswerable questions" about substance, causality, freedom and God, are unanswerable just because they are not genuine questions at all. This last is a thesis about language, not about nature, and is based upon a general account of meaning and of meaninglessness. All genuine philosophy (according to the Vienna group) is a critique of language; and (according to some of its leading members) its result is to show the unity of science—that all genuine knowledge about nature can be expressed in a single language common to all the sciences. Philosophy is not a theory but an activity. The proper task of philosophers is linguistic—unless we add that it is their business also to persuade men to adopt a "scientific" attitude to moral and political questions.

The Vienna circle, which launched its first manifesto in 1929, had its origin in discussions among physicists and mathematicians before World War *I*. The general conclusion was reached that the empiricism of Mill and Mach was inadequate since it failed to explain mathematical and logical truths, or to account satisfactorily for the apparently *a priori* element in natural science. In 1922, Hans Hahn at Vienna university laid before his students the *Tractatus Logico-Philosophicus* of Ludwig Wittgenstein, published in the previous year. This work introduced a new general theory of meaning derived in part from the logical inquiries of Giuseppe Peano, Gottlob Frege, Bertrand Russell and A. N. Whitehead. *It* gave the Vienna group its logical foundation and drew in the philosophers hloritz Schlick. Rudolf Carnap, Friedrich Waismann, Otto Neurath and (at Berlin) Hans Reichenbach and Walter Dubislav. The group conducted its campaign in the journal *Erkenntnis* (Leipzig, 1931–40) and, after most of the members of the group had moved to the United States, in an elaborate *International Encyclopedia of Unified Science* (Chicago, 1938 *et seq.)*, published with the help of Charles Morris and other U.S associates. Carnap at Chicago, Reichenbach in California. Philipp Frank at Harvard, Waismann in England and many others, continued the work of the school in a series of systematic works and a stream of papers and monographs. In the meantime disciples had been found in many other countries: in Poland. among the mathematical logicians; and in England, where A. J. Ayer's *Language, Truth and Logic* (London, New York. 1936; rev. ed., 1946) provided an excellent introduction to the views of the group. In England, however, the direct influence of Ludwig Wittgenstein proved very much more powerful. Wittgenstein had come to England from Austria before World War I and had spent some time at Cambridge, discussing logic with Bertrand Russell. The *Tractatus Logico-Philosophicus* expresses and generalizes the conclusions that he had reached upon philosophical questions. In 1929 Wittgenstein returned to Cambridge and taught and worked there (with a few intermissions) until his retirement in 1947. During this later period Wittgenstein himself subjected the doctrines of the *Tractatus* to fundamental criticism and produced what was in effect a new account of philosophy. The later philosophy was disseminated by his students (and by copies of his own informal notes) and profoundly affected the course of English philosophical thought. His *Philosophical Investigations* (Ger. text with Eng. trans., Oxford, New York, 1953) appeared posthumously. While the name "logical positivism" is commonly applied to Wittgenstein's later philosophy as well as to the *Tractatus,* it is certain that a wide gulf separates it from the philosophy which the Vienna circle based in part upon the *Tractatus*.

Characteristic Views of the Vienna Circle.—The following views may be regarded as characteristic of the Vienna school:

Philosophy as a Critique of Language.—It is evident that some of the great philosophers (Locke, Spinoza) explicitly undertook the criticism of language, but it has generally been held that this was not their chief task. Philosophers have usually attempted to assert a view about the world; to state not only the limits of the possible, but also the nature of being or of the universe as we know it. Wittgenstein's *Tractatus* attempted to show that reality *as* a *whole* cannot be described and that the limits of the possible (or "of what can be said") are *shown* in the language as a whole. But what is shown in the language as a whole cannot itself be *said* in language. According to the Vienna school the traditional metaphysical philosophies purport to ask the questions that cannot be answered (*e.g.,* Can one really know material substances?). Here, although experimental evidence may seem to be relevant. it always proves to be beside the point. Metaphysical statements have no verification: metaphysical questions are *Scheinprobleme*. There are of course many questions which philosophers have asked (*e.g.,* about the physiology of perception) which concern particular matters of fact. These however belong to science and not to philosophy. The sole remaining task of philosophy is the analysis and clarification of language. This involves an account of "meaningful" and "meaningless." "true" and "false," "valid inference," etc. as these terms are applied to contingent and to necessary statements—to the propositions of science and history and to the theorems of logic and mathematics. An understanding of such matters will enable us to show how a given metaphysical question arose and why it is meaningless. It is characteristic of the Vienna group, as of the *Tmctatus*, that particular metaphysical puzzles are to be settled by reference to a general theory about language.

The Doctrine of Tautology.—This doctrine derives from the *Tractatus*. The only necessary propositions are those which are true by definition; which are so framed that they cannot be denied without inconsistency. Thus "All men are rational" is held to assert with regard to *anything* that either it is a man or it is not rational. But this follows from our actual use (or one actual use) of "man" and "rational." The necessary proposition cannot but be true since it asserts every possible state of affairs: it is true which-so-ever of its constituents are true and true which-so-ever of its constituents are false. There is a sense therefore in which all necessary propositions say the same thing—that is, *nothing at all.* And the Vienna group held that in general any necessary truth is derivable from some rule of language: its only necessity is its being prescribed by rule in a certain system. This was most easy to show in the case of mathematics, hut some attempt has been made to codify the physical sciences and even branches of biology. With regard to nontechnical necessary propositions (*e.g.,* "Whatever has a beginning in time must have a cause"; and "The same surface cannot be red'all over and blue all over at the same time") it mas recognized that our ordinary language is not itself capable of exact formulation as a calculus: but attempts were made to construct an artificial language in which all necessary statements could be demonstrated by appeal to formulas (*e.g.,* Carnap's *Der logische Aufbau der Welt*, Berlin. 1928).

The Verification Principle.—The fundamental purpose of language is the making of statements about the world. The earlier works of the logical positivists distinguish sharply between "atomic propositions," each of which refers to a single atomic fact, and derivative propositions or hypotheses, which assert some truth-functional combination of atomic facts (*e.g.*, a disjunction of two such facts, a conjunction of a set of such facts). An atomic statement is true if it corresponds to an atomic fact (by which was originally meant a simple observation); a hypothesis is true if the atomic propositions that it asserts are true and the atomic propositions that it denies are false. "The meaning of a statement is the method of its verification" (Waismann). The verification test does not require actual verification but only verifiability in principle, nor is complete verification envisaged in most cases: in all cases it must be possible to collect experimental evidence which determines the truth or falsity of some of the atomic propositions involved (*i.e.*, which tells for or against the hypothesis). The verification test excludes a hypothesis which asserts every possible combination of its atomic constituents: such a "hypothesis" is in fact a tautology or necessary statement. The same test excludes a hypothesis which denies every possible combination: such a "hypothesis" is excluded as being a contradiction or nonsense. But the test also excludes "hypotheses" which do not mean (*i.e.*, from which one cannot validly infer) any set of atomic statements. For where this is the case no evidence is available by which its truth or falsity can be shown. For example, Berkeley argued that the assertion of material substance is nonsensical, since it cannot be "cashed" in any statements about. ideas of sense: whereas the assertion that "a tree exists in the park" or "I have two hands" can be so "cashed."

Form and *Content*.—The earlier writers (especially Moritz Schlick;) were perplexed by the metaphysical problem of how it is possible to communicate at all if our genuine statements are really about our own experiences. How can I be sure, for example, that another person verifies my statement by reference to the same kind of experience as I do? Schlick attempted to avoid the difficulty by his doctrine of form and content: what we communicate by language is not experience but knowledge, and knowledge is the form of which experience is the content. This very difficult doctrine evidently refers to two striking facts about our common use of language: (1) users of a given language employ a common syntax and a common set of definitions: and (2) they also (generally speaking) apply descriptive words on the same occasions even when their experiences come to them through different senses (sight. touch, etc.). This, it is commonly held, one can know without beginning to know what experiences lead people to make use of the language. Schlick maintained that we understand what a man means (in the only sense in which meaning can be communicated; see also SEMANTICS IN LOGIC) if we know (1) the syntactical connections of his words with related expressions in the language (especially if we know *the* definition of his terms in terms which are simple or indefinable); and (2) if we know how he uses the simple terms (*i.e.*, on what occasions he would apply them). This communicable meaning is called form: for a given person, no doubt. it is the form of his own experience-content: but while it is nonsense to speak of community of experience, it is not nonsense to speak of community of structure.

Protocol-Statements. — The doctrine of form and content failed to satisfy. Carnap argued that the question of the relation of an expression to experience (or content) is either meaningless or tan be translated into a question about the relation of one expression (or type of expression) to another. Thus a question about how an empirical proposition is to be verified (or what it means) ought to be tackled by showing its connection not with experiences. but with statements of a peculiar and fundamental kind. the so-called *Protokollsätze*. Such statements would be described by other philosophers as an observer's account of what he actually perceives at a given moment: Carnap describes them by specifying the kinds of expression that can occur in them. Then the last word about the meaning of an empirical proposition is given in showing the kinds or classes of protocol-statements which (if they were made) would logically entail the truth or probability of the statement. This is also the last word about its truth, since, according to the theory, it makes no sense to add "provided that the protocol-statements were made truly." For the protocol-statements have to be taken as indubitable: science rests upon the reports actually made by observers. And Carnap improved the occasion by putting forward the general thesis that statements or questions about the relation of language to experience (which belong to the "material mode of speech") are always a source of metaphysical muddle and can always be replaced by statements or questions about the rules connecting one type of expression with another — statements in the "formal mode of speech." From this, Carnap passed later to the development of a hierarchy of languages.

Physicalism.—The doctrine of protocol-statements was subsequently modified. In the first place, the attempt to show the one-sided dependence of all empirical statements upon some set of protocol-statements came to be regarded as a quaint metaphysical survival: Neurath argued that real language knows no vocabulary of direct experience and that the reports which are actually employed in verifying empirical statements are framed in ordinary language. Second, protocol-statements are not indubitable: not only may we have to select between conflicting reports, we may also decide to reject a report rather than modify an empirical theory or generalization. Neurath preferred to view protocol-statements in the same sort of way as the indications of thermometers or measuring rods: that a thermometer records a high temperature and that an observer says he is getting very hot are both facts (if they are facts) about the physical world and expressed in "physical-object-language"; and either may need correction. Science is possible (it was agreed) because in fact the reports of different observers in the same circumstances do in general agree. and because reports made by the same or different observers upon the evidence of different senses (sight, touch. etc.) also in general correspond. Logical positivists (or many of them) thus passed easily from a quasi-phenomenalistic philosophy to a quasi-materialistic philosophy, and from a correspondence theory of truth to a coherence theory — modified in some cases by the introduction of arbitrary or conventional choice.

The Emotive View of Ethical *Expression*.—Having delivered philosophers and scientists from "the misery of metaphysics," the group proceeded to demolish all kinds of philosophical morality—except possibly their own. So-called statements about what things are right or good cannot be verified (in the manner explained above) and are therefore without meaning. They are simply expressions of attitudes and ought not to be regarded as conveying knowledge or even opinion. The characteristic value words may serve to move or to persuade: they cannot serve to convince us of facts, since they are indefinable in factual terms. This view, reminiscent of Hume, had already been put forward in England by C. K. Ogden and I. A. Richards (The *Meaning* of Meaning, 1922): it was more or less generally adopted by the Vienna group and their English and American disciples, although Schlick (Fragen der Ethik, 1930) argued at length for a typical hedonistic utilitarianism. The "logic" or methodology of persuasive argument was fully examined by Charles Stevenson (Ethics *and Language,* 1945) more from the point of view of the Cambridge analytical school than from that of the Vienna group.

Particular Doctrines of **Wittgenstein.**—In the foregoing account of the Vienna group emphasis has been put on Wittgenstein's *Tractatus Logico-Philosophicus;* undoubtedly the general doctrine of tautology and the doctrine that philosophy is analysis of language are to be found in the *Tractatus*. Two other doctrines to be found there received less attention from the Vienna group: (1) the account of how a simple statement means a simple fact — the "relation of representation" — and the general doctrine of how communication is possible by means of different kinds of signs; and (2) the doctrine that tautologies do not say, but only show, the structure of language — that the characteristic structure of language cannot be said in language. Wittgenstein admits a use for the tautological principles of formal logic — while asserting provocatively that contradictions would have served the same purpose—but is prepared to dismiss as nonsense all those philosophical statements in which the structure of language is elucidated or its limits traced. This self-denying ordinance was not taken seriously by the Vienna group, who attempted to circumvent it by the introduction of the "formal mode of speech" and the hierarchy of languages.

In his later discussions and in the Investigations, Wittgenstein denounced all attempts to build systems of philosophy — even negative systems: he declined to offer any general theory of meaning and was particularly mistrustful of theories which take mathematics or natural science as the ideal. It is possible to trace in his later writings analogues of logical positivist principles: for example, that philosophy is a critique of language. But the doctrines are only analogues, and no conclusion can be reached about his views from a study of the writings of the Vienna circle.

Logical positivism in the United States has found allies among the pragmatists and (naturally enough) among the logicians and scientists. The philosophy of Wittgenstein has been associated with the Cambridge school of G. E. Moore (the defense of common sense and of ordinary language) and has a very wide following in England. See also biographies of philosophers referred to above.

BIBLIOGRAPHY.—Reference should be made to the works mentioned above, especially to those of A. J. Ayer and to the volumes of *Erkenntnis* (1931–40); also to the periodicals *Journal of Philosoplzy, Philosophy of Science, Analysis, Mind* and *Australasian Journal of Philosophy. See* also two short works by R. Carnap, *The Unity of Science,* Eng. trans. (1934), and *Philosophy and Logical Syntax* (1935), as well as his massive *Logical Syntax of Language* (1937). M. Schlick, *Gesammelte Aufsätze* (1938), is of importance. Philipp Frank, *Modern Science and Its Philosophy* (1949), gives a history of the movement. *See* further J. R. Weinberg, *An Examination of Logical Positivism* (1936); and L. S. Stebbing, "Logical Positivism and Analysis," *Proceedings of the British Academy,* vol. xix. Gilbert Ryle, *The Concept of Mind* (1949), and John Wisdom, *Other Minds* (1952), show in contrasted ways the influence of Wittgenstein's later thought. (K. W. B.)

LOGISTICS. In U.S. military administration, a term loosely applied to a wide range of noncombatant activities, especially those connected with supply, transportation, construction and the care and evacuation of sick and wounded. In a nonmilitary sense, long archaic, logistics was the Greek science of computation (from logistikos, '(skilled in calculating"); it is also a branch of logic closely related to mathematics. The military application of the word has little currency outside the United States. and even there its widespread use hardly antedates World War II. Its nearest counterpart in British military terminology is "administration," an even broader term embracing all military activities not directly associated with strategy (*q.v.*) and tactics (*q.v.*). Though still defined in this sense in American military dictionaries, "administration" has been largely replaced by "logistics" in ordinary military usage in the U.S.; when used, "administration" generally has the layman's meaning of "management."

This article is divided into the following sections:

I. CHANGING USES OF THE WORD

In its military sense, the word "logistics" has been used so loosely, and in such a variety of specific and general applications, as to defy precise definition. For some writers in the late 18th and early 19th centuries it appears to have conveyed such disparate meanings as "strategy" and "philosophy of war." For others in the same period it had come to signify military staff work in general.

1. Jomini.—The first serious effort to define the word with some precision and to fix the place of logistics in the science of war was made by Baron Antoine Henri Jomini (*q.v.*), the celebrated student of Napoleon's campaigns and foremost authority on the military art in the first half of the 19th century. In his Precis de l'art de la guerre, published in 1836, Jomini divided the art of war into five branches — strategy, grand tactics, logistics, engineering and minor tactics. Logistics, the third branch, he defined as "the practical art of moving armies," by which he meant not merely the mechanics of transportation, but the staff work, administrative arrangements and even reconnaissance and intelligence involved in moving and sustaining organized military forces. Engineering, defined as the art of fortification, did not include, in Jomini's scheme, nontactical types of construction (building of roads, cantonments, etc.), which presumably came under the heading of logistics. Jomini thought of logistics, in fact, as comprising virtually all military activity, apart from combat and the planning of combat. involved in "the execution of the combinations of strategy and tactics."

In particular, Jomini associated logistics with the work of the military staff. According to him, the word had been derived from the title of the *maréchal* (or major *général*) des *logis* in French armies of the late 17th and 18th centuries, who, like their Prussian counterpart, the *quartiermeister,* had originally been charged with routine administrative arrangements for marches, encampments and troop quarters (*logis*). With the growing complexity of military administration in the 18th century, the more gifted of these officials (like Pierre Joseph de Bourcet, from whose campaign plans Napoleon later profited) had become the equivalent of chiefs of staff to the high-born and often inept commanders of the day, and had developed an efficient staff system along the lines of the modern general (or "capital") staff. Since Jomini's time! other writers have traced the origin of "logistics" to the title of the logista, an administrative official in Roman and Byzantine armies. The Greek word logistikos, mentioned above, also has an obvious functional relationship to it. Whatever the origin of the word, Jomini saw logistics as the central function of the commander's staff, which in his own time had come to play a crucial role in translating the commander's ideas and will into concrete action. Generalship, he insisted, was inseparable from good staff work, and a good general must also be a good logistician. For future generals Jomini left an engaging picture of Napoleon, his own logistician, sprawled on the floor, marking off with a pair of dividers on the map the marches of the several corps that were to converge on tomorrow's objective.

Despite the enormous influence of Jomini's writings on military thought during the long middle span of the 19th century, the word "logistics" gained only a limited currency in French (la logistique) and in English as a rather academic term used occasionally by the learned. German writers, including Jomini's great contemporary Karl von Clausewitz, used it not at all. Jomini's broad conception of the term was generally forgotten; in military parlance its meaning came to be restricted to supply, transportation and quartering of troops. In the 1880s Adm. A. T. Mahan introduced it into U.S. naval usage, and in the decade or so before World War I the navy's concern with the economic foundations of its expansion began to broaden the connotation of the word to include for the first time the processes of industrial mobilization and the functions of a wartime economy in supporting military operations, spheres of activity that in Jomini's day had seemed little related to the conduct of war.

2. Thorpe.—This broader conception of logistics was reflected in a little book published in 1917 by an obscure marine corps officer, George Cyrus Thorpe, under the title Pure Logistics. Thorpe argued that the whole sphere of mar-making fell naturallv into three subdivisions. strategy. tactics and logistics, and that since the first two by common understanding were concerned with the actual conduct of war by the fighting forces, the logical function of logistics was to provide all the means, human and material, for the conduct of war. It therefore embraced, Thorpe insisted, not merely the traditional functions of supply and transportation in the field, but also war finance, ship construction, munitions manufacture and other aspects of war economics.

Thorpe's conception of logistics did not win immediate acceptance, however, either in his own service or in the U.S. army, which also became involved in economic mobilization during World War I and was responsible during the 1920s and 1930s for planning for industrial mobilization in a future war. At the army's general services school at Fort Leavenworth, Kan., logistics was defined as late as 1926 in traditional terms as "that part of the military art which embraces the details necessary to the movement and supply of troops in military operations."

3. World War 11.—The word "logistics" came into sudden vogue in the U.S. during World War II at a time when paradoxically it had almost disappeared from military use in Europe. With wide usage came further confusion of meaning. The army service forces, comprising most of the army's supply and service agencies in the United States, defined logistics (largely in terms of its own functions) to include virtually all aspects of administration except training. During the war and after, in all the military services, the logistics label was attached indiscriminately to numerous staff and operating agencies exercisinp a variety of functions in the field of administration, and the army created several types of "logistical" field commands. Official definitions changed from year to year, and differed among the services. Army dictionaries belatedly recognized the term for the first time in 1944, in the traditional narrow sense; field service regulations did not follow suit until 1949. The navy, by contrast, before 1950 had embraced a conception of the term as broad as that propounded by Thorpe in 1917, even defining a separate sphere of "civil" logistics to cover industrial mobilization for war.

4. Postwar Definitions.— In 1948 the three unified military services agreed on an official definition that listed virtually all military activities dealing with the provision and a'dministration of matkriel, personnel and facilities. Two years later they added to the list training and welfare activities, and also the phrase "acquisition or furnishing of services." These additions seemed to give logistics a scope as broad as that of military administration itself, and marked the high point in the development of official interservice definitions of the word. After 1950 the trend was back toward narrower, more traditional conceptions. As defined in 19j8, logistics still included all aspects of transportation; the acquisition, construction and operation of military facilities; the entire range of matkriel functions. from design and procurement through distribution and final disposition; and services (still unspecified). But of the once long list of personnel functions only hospitalization and evacuation remained.

Official definitions have scarcely affected usage, which remains stubbornly inconsistent and loose. In its narrowest application, logistics may mean simply military supply and transportation. At the other extreme, it may comprehend the provision in the broadest sense of men and matkriel for military operations, including all the planning, administration and services therein involved. and reaching far back into the mobilization of the nation's economic resources for war. As one epigrammatic definition puts it. logistics is often likened to "the military element in the nation's economy and the economic element in its military operations."

Not all the specialists whose skills are thus blanketed consider themselves logisticians; however. To the radio operator or electronics technician, to the nuclear physicist or public information officer, to the personnel administrator, to the file clerk, even to the military engineer. logistics is likely to appear as a vague conglomeration of activities somewhere outside his own area of specialization. Most of the military specialists whose duties bring them in contact with or even within sound of combat feel a strong aversion to the label of logistics because of its traditional noncombatant connotations. The word belongs, in fact, primarily to the vocabulary of the staff planner, for whom it serves as a convenient symbol to apply to whatever combination of noncombatant activities happens to be under consideration at the moment. Even in the language of staff planning, where "logistics" has become a familiar and overworked word, it is likely to be paired with a more precisely definable one, producing such locutions as "logistics and administration," or, inexplicably, "logistics and supply." Rarely in working military parlance does the occasion arise to use the word in its broadest sense. Where logistics stops and something else begins is, in fact, a question of serious concern only to the military theorist and the writer of official definitions.

II. ELEMENTS OF LOGISTICS

Viewed historically and analytically, logistics consists of four principal elements. *Supply* and *transportation* form the hard core, the primary functions by which armed forces are enabled to exist and to perform their essential tasks of moving and fighting. In addition, men and matériel alike depend for effective performance on a variety of *services,* such as repair and maintenance of weapons and equipment. The fourth element, closely related to services. is *administration,* considered in its general meaning as the function of organizing, coordinating and managing military activities.

1. Supply. — Supply is the function of providing the material needs of military forces. (It does not include the provision of men, which ordinarily is not considered an aspect of logistics.) In a narrow sense, supply refers only to distribution and the related function of storage. Broadly construed, it covers all stages in the life of an item of supply or equipment except its actual use or consumption; it includes design and development. manufacture, procurement, storage, distribution, salvage and final disposition. With these go such services as testing, maintenance, repair, packing and packaging. warehousing and veterinary service. Supply is also a planning-administrative process, paralleling the physical processes listed above and including such activities as contracting, pricing, scheduling. allocation and control of raw materials, components, and facilities, industrial relations, conservation, inspection, stock control, administering of supply policies and procedures, requisitioning and the processing of requisitions. All these functions and processes fall into four broad phases: (1) production. in its non-technical sense, including all steps in the creation of finished items of matériel; (2) procurement or acquisition of finished items by the military authorities from producing agencies; (3) distribution through the channels of supply; and (4) dominating the whole, the balancing of supply and demand, *i.e.*, the determination of requirements and assets, and the scheduling of objectives in production and distribution.

While the character of military supply has varied with the changing technology of warfare, it has always had the basic aim of providing military forces the essential material means that enable them to live (food, water, clothing, shelter and medical supplies), to move (vehicles and transport animals, fuel and forage) and to fight (weapons, defensive armament and materials, other combat equipment and the expendables of fire or missile power). In all three categories are items such as clothing, vehicles and weapons, that are used repeatedly, and therefore need only be replaced when lost, destroyed or worn out; and materials such as food, fuel and ammunition: that are expended or consumed, and therefore must be continuously or periodically resupplied. From these characteristics are derived the classifications of *initial issue, replacement* and *resupply.* Other more technical classifications are used in various countries and services. The U.S. army uses five main classifications: (1) subsistence and forage; (2) equipment and other items issued to organizations and individuals on the basis of allowance tables; (3) fuels; (4) equipment and materials of irregular issue; and (j) ammunition. The British army recognizes two broad classes: (1) supplies, which include all the expendables except ammunition; and (2) stores, which include ammunition and military hardware in general.

2. Food, Forage and Fuel. — Historically, food and forage made up most of the bulk and weight of supply requirements until the 20th century, when with mechanization and the growth of air power forage largely yielded to fuel. The demand for food is unremitting and undeferrable; since man himself, as a consumer of food, has changed little or not at all, it is the one constant of logistics. While a man can live without food for as long as five weeks, he becomes militarily useless long before that limit is reached; if deprived of water he succumbs in four or five days. A man's daily ration makes a small package—the U.S army ration in World War II weighed only six pounds—but an army of 50,000 men may consume in one month as much as 4,000 tons of food.

Animals require much more: the standard grain and hay ration in the U.S. army in the 19th century was about 25 lb., and the daily forage for a corps of 10,000 cavalry weighed as much as the food for 50,000 men. Forage requirements tended, moreover, to be self-generating, since the animals needed to transport it also had to be fed. The number of animals accompanying armies varied widely. Napoleon described as an ideal, which he himself failed to attain, a supply train of no more than 500 wagons in an army of 40.000 men; with a corps of 7,000 cavalry, this would amount to about 10.000 animals. Northern armies in the Civil War, whose transport was probably more lavish than the historical average, commonly numbered half as many animals as soldiers. A force of 50,000 men thus might consume more than 300 tons of forage daily. This was more than twice the weight of gasoline that an equivalent force of three World War II infantry divisions, using motor vehicles exclusively, needed to operate for the same length of time In the latter case, moreover, fuel requirements diminished markedly when an army was not moving, uhile the premechanized force had to feed its animals whether moving or not. The expendables of movement in the 20th century, however. include fuel for rail and water transport as well as for motor vehicles and in addition the immense fuel requirements of modern air power. In World War II fuel and food made up more than half the total resupply and replacement needs of U.S. forces (not including fuel for transoceanic shipment), and almost 80% of their resupply of expendables. Food amounted to only 8% and 12%, respectively.

3. Ammunition and Equipment.—Before the advent of mechanization, complex weapons and massive firepower in the late 19th and 20th centuries, equipment replacement and ammunition resupply needs were relatively small. Missile power, in the ages before the invention of gunpowder, was limited by the difficulty of bringing large supplies of missiles to the battlefield. Much depended, in a protracted battle, on the speed with which spent arrows and javelins could be gathered up and turned against their original owners; the ancient slinger (effectively employed by Hannibal against the Romans) had an important advantage over the bowman in using a projectile that was both more portable and more readily obtainable.

For five centuries after the invention of gunpowder the provision of ammunition was not a major logistical problem. Not until the use of field artillery on a large scale in the 18th century, and the development of quick-firing shoulder arms in the 19th, did ammunition begin to constitute a substantial proportion of resupply needs. As late as 1864, in the Atlanta campaign of the American Civil War, Gen. William T. Sherman's average daily ammunition requirements amounted to only one pound per man, as against three pounds for rations; Confederate forces, according to their chief of ordnance. expended on the average only half a cartridge per man per day.

The immense increase of firepower in the 20th century upset the historic ratios. In World War II the average ammunition requirements of C.S. forces overseas amounted to 14% of their total resupply and replacement needs, and 21% of their expendables. Earlier, in World War I, and again in the Korean war ammunition expenditures were higher. Replacement requirements also climbed in the 20th century, particularly in the lavishly equipped U.S. army, but only moderately as compared with the smelling tonnages of expendable supplies. Replacement of equipment and miscellaneous non-expendables for U.S. forces in World War II absorbed only 13% of their total resupply and replacement requirements.

4. **Transportation.**—While strictly speaking a logistical service, transportation is usually considered an independent function of logistics because of the vital importance of movement (both of materiel and personnel) as a basic function of military forces. In the distribution phase of supply, transportation is, of course, the dominant element. (See TRANSPORT, MILITARY.)

For 5.000 or 6,000 years of organized warfare, before the development of steam propulsion and the internal combustion engine, armies depended for mobility on two sources of energy: the muscles of men and animals. and the force of the wind. On land they used men and animals to haul and to carry; on water they used oar-driven or sail-propelled vessels. Among these various modes the balance of advantage and disadvantage was often delicate. involving numerous variables. Movement by water was exposed to the hazards of storm and the vagaries of mind. Transports mere vulnerable to attack by enemy warships; they were also limited in their carrying capacity, and expensive to hire or buy. Large overseas expeditions could be undertaken only by comparatively wealthy states. unless, as in the case of the Scandinavian rovers of the 8th and 9th centuries, the warriors were themselves mariners and seafaring was rooted in the economy. Only rarely was a force transported over water powerful enough to overcome a strong land-based foe—as the Persian invaders of Greece learned at Marathon in 490 B.C.—and its subsequent support was likely to be precarious.

On the other hand, armies have usually been able to move faster by water' than by land. The natural roadway of the sea offers less friction and fewer obstacles to movement over its surface than even good roads, and military history contains few examples of good roads. In the 19th and 20th centuries construction of larger ships and the development of steam and other forms of propulsion made water travel largely independent of wind and weather, and made it possible to transport and sustain overseas larger forces than ever before. On land technological change mas also under way. More and better roads were built, particularly in Europe and the United States, and the railroad. after the mid-19th century. enabled whole armies for the first time to move long distances more rapidly than a man could walk. Motor vehicles and more road building in the 20th century extended the conquest of rough terrain. The airplane. finally, freed military movement, for relatively small forces and limited amounts of materiel, from bondage to earth altogether. Yet the costs of mobility on land—in equipment, materials and energy—were high and military movements, except by small forces with little impedimenta. were still confined to narrou ribbons of rail and road constructed in advance. In large parts of the world these were largely lacking. and the technology of military movement was still primitive. Even in the mid-20th century, in short, movement by water retained the advantages inherent in its nonresistant medium.

On land. the soldier himself has always been the basic and indispensable burden carrier. As a matter of simple logistical economy, he represents large available carrying capacity at no extra cost His equivalent, in an army of 50,000 men. would be 1.250 wagons drawn by 7,500 horses or mules; a difference of only five pounds in his individual load could add or subtract a requirement for 125 wagons and 750 animals. Since the days of the Roman legionary, the soldier's load has averaged. until recently, from 55 to 60 lb. Exceptions were few and conspicuous. Oliver Cromwell reduced the load of his New Model army to less than 40 lb. per man; the troops of revolutionary France endured physical discomfort and developed foraging into a system in order to discard most of the personal impedimenta that had burdened the typical 18th century soldier; "Stonewall" Jackson's foot cavalry in the Civil War carried only musket. ammunition, a blanket or rubber sheet, a frying pan. a few personal necessities and on occasion three days' rations. The ratio between armament and vital needs in the soldier's load has varied widely, but the modern soldier has tended to relegate most of his food to vehicle transport, while carrying a heavier burden of weapons and ammunition. Recent research has discredited the traditional practice of using augmented training loads to develop endurance, and has emphasized the necessity of reducing comhat loads to a minimum, since fear and fatigue both drain muscular power. In most armies following World War II the soldier's load was drastically reduced, in the C.S. army to about 40 lb.

Before the age of steam, armies supplemented the soldier's carrying capacity both with additional manpower and with animal power. Each had its advantages, but the balance was fairly even. A team of six horses ate about as much as 40 or 50 men, but the men could carry more on their backs than the horses could haul, and considerably more than the horses could carry. Men could negotiate rougher terrain, and they required less care. On the other hand, when men were used as carriers their loads had to be distributed in small packages, and men proved less efficient than animals when teamed to haul heavy and bulky loads. (The one-man cart, an ancient means of conveyance, was used to good effect by the Koreans and Chinese in the Korean war and has a significant role in the logistics of the Chinese and Soviet armies.) The horse and mule, besides, have less strength and stamina, though more agility than the ox, which through the ages has been the primary beast of burden. As a mount for the warrior, making the most of its speed and height. the horse has served a more useful function, and one with logistical aspects as well, since mounted troops, whether they fought as infantry or cavalry, could move rapidly for short distances. With such rare exceptions, however, as the far-ranging cavalry armies of the Mongols in the 13th and 14th centuries. large cavalry forces were shackled, like infantry, to their slow-moving transport and to their bases. In general, animal transport has predominated in the military experience of the Western world, where manpower has usually been scarce! while in the orient, where manpower is plentiful, men have been used even more than animals as military beasts of burden. Both forms of transportation continue to be used in the mid-20th century, wherever mechanical transport is insufficient or breaks down or runs out of fuel. In the Korean war the porter with his A-frame probably carried more tonnage than was carried by any other mode of land transport.

5. Services and Administration.— This is the shadow land where logistics merges into areas of military activity to which usage has generally not accorded the name. History and the activities themselves unfortunately recognize no line of functional demarcation that might suggest a distinction between logistical and nonlogistical services and administration. Even the ancient distinction between combat-related and noncombatant activities has grown fuzzy in modern warfare, where so many specialized and unviolent skills (artillery fire direction, for example) may enter into the process of killing.

Services may be defined as activities designed to enable personnel or matériel to perform their appropriate functions more effectively; administration may be defined as the managing and ordering (as opposed to the actual performance) of a function or process—hence also the operation of an organization or installation. Since services themselves must be administered, both purposes are usually combined in the same activity.

The list of military services and administrative activities in modern warfare is long. Those associated with supply have already been mentioned. Transportation, itself a service: involves a subordinate service, stowage of freight, as well as the administering of troop and freight movements, control of traffic and documenting of shipments. Seven other major service-administrative areas can be discerned: (1) communications; (2) the construction, repair and maintenance of facilities (housing, depots, railroads. etc.), including operation of utilities and leasing and disposal of real property; (3) personnel services (medical, spiritual, legal, personal, informational: recreational) and administration (recruitment, induction, classification, assignment, maintenance of records, separation); (4) dissemination of public information; (5) finance and fiscal management; (6) military justice and discipline; and (7) military government. Administration itself, finally, has its own related service: the study and development of improved methods of management.

Even though not all these activities fall within the sphere of logistics by current usage and definitions. they may be referred to collectively, for present purposes, as "logistical services." Most of them are of recent origin, reflecting both the complex technology of modern warfare and the institutional complexity of modern society. Over the long run of military history, the logistical services considered necessary to keep soldiers. animals and equipment in fighting trim were generally of a rudimentary sort. From the earliest times, however, they posed a serious logistical problem. First, they added to armies and their lines of communications substantial, sometimes immense, numbers of people whose primary business was not to fight and who, if not properly organized, often impeded fighting. The soldier seldom possessed the technical skills required to perform any but the simplest logistical services; in some ages. as a member of the warrior class, he was even prohibited by social prerogative from performing them. The classic accompaniment of armies, consequently, has been its long train of noncombatants, often far outnumbering the fighting men.

Logistical services also added to the baggage of armies a growing burden of specialized equipment, tools and materials required for performance of the services. Services tended to generate more services: service equipment itself had to be serviced, sometimes by additional equipment manned by additional technicians, and service personnel themselves required services. Logistical services thus meant more people to be fed, clothed and sheltered, and more people and baggage to be transported. This is the problem of what the British call the "administrative tail"; it is as old as military history.

III. POWER VERSUS MOVEMENT

The potential effectiveness of a military force lies in three attributes—*power*, mobility and *range*—*i.e.*, the ability to fight, to move freely and rapidly and to move far. Each depends on physical ingredients that must be provided and transported, and on logistical services that also place a burden on supply and transportation. Since logistical capabilities are almost always limited, power, mobility and range must compete for the available supply, transportation and services. This competition over the ages has tended to focus on transportation, which for an army in the field almost invariably determined the amount and kind of supplies that could be made available, as well as the scale of services that could be provided. at the time and place needed. Given a fixed amount of transport, the amount of supplies and services it can deliver to a force in the field depends in the main on the distance it must travel in performing these functions. Three methods have been used, in combination and with varying emphasis: (1) self-containment, in which all that the force needs is carried along with it; (2) local supply. in which supplies and services are obtained from sources nearby or along the route of march; and (3) supply from bases, in which supplies are brought as needed from more distant sources.

1. Self-containment.— The idea of complete independence from external sources of supply has always exerted a powerful fascination. For many a commander plagued by supply troubles the hard-hitting, fast-moving, streamlined, self-contained "flying column" was a glittering ideal, which somehow never quite materialized. Self-containment in equipment, service personnel and even ammunition or missiles was the historical rule until the great expansion of fire power and of replacement requirements in the last century. Even in the 20th century, replacement of equipment and resupply of ammunition has normally been intermittent rather than continuous. Few military forces have been able to operate for long without frequent resupply of food, forage and fuel. The disintegration of the French army after its defeat at Blenheim in 1704, and of Napoleon's Grande Armée in the retreat from Moscow in 1812, resulted largely from exhaustion of accompanying supplies and inability to subsist on the countryside.

By its nature, self-containment is the least economical of all methods of supply. The available transportation is fully loaded only once at the beginning of the movement, and serves thereafter as a rolling warehouse, which is steadily depleted as the force eats into its food and fuel or forage. Thus only a fraction of the available capacity is put to use. Self-containment, in fact, offers few advantages other than that of moving by an unpromising. possibly unguarded route. without delays or detours to replenish supplies. Hannibal gained this advantage when he crossed the Alps into northern Italy in 218 B.C., circumventing the Romans barring the easier coastal route—but in doing so he lost almost half his entire force. Gen. John Burgoyne's invasion of New York from Canada in 1777 with a virtually self-contained force bogged down in hostile country and ended in disaster at Saratoga. In general, self-containment requires the sacrifice of both fighting power and range of movement in a striving for mobility which may itself be defeated by the sheer weight of the expendable supplies that must be carried.

2. Local Supply.—Until modern times, supply from local sources (including captured stores) in the regions where armies operated was the most common method of resupplying food and forage and of providing labour and other simple services. In fertile country, an army could usually meet at least a large part of its immense cumulative demand for the major expendables, at low cost in transportation and without sacrificing power or range. When efficiently organized to reduce delays and diversions, local supply even permitted a high degree of mobility. Normally. however, an army living off the country tended to straggle and to load itself down with loot. If it moved too slowly or was pinned down by the enemy, it might sweep the region bare and starve. In winter or in desert mountains local supply offered meager fare. And a hostile population, as Napoleon discovered in Russia and in Spain, could bring disaster to an army that had to scrounge for its food.

Yet, even when the troops could be fed by other means. the animals usually had to shift for themselves: for the burden of transporting forage any considerable distance could be prohibitive. Local supply of forage was in fact almost universal throughout the centuries before the advent of mechanized transport. Moreover, cattle driven along with an army could transform forage into food for the troops—a supply technique as ancient as Biblical times and still common in the late 19th century. Unwieldy and slow-moving though it was, the accompanying herd had the great merit of transporting itself! and unlike the wagon train it dwindled as it was consumed. It was the forage requirement, far more than the problem of food supply, that served. as a general rule until recent times. to confine large-scale military operations to relatively settled. fertile regions and to the months of the growing seasons.

When mechanical transport replaced animals. one of the great continuities of military history was broken. Mechanized armies can operate in winter and desert areas as long as they have fuel. But when that is gone, they grind to a halt. for empty gasoline tanks cannot be replenished from fields and pastures. Mechanization closed the door to both self-containment and local supply as practicable logistical systems. Until power can be packaged in capsules or, like forage, gathered along the route of march, the door is likely to remain closed.

3. Supply From Bases.—The alternative to self-containment and local supply is continuous or periodic resupply and replacement from stores amassed in advance at accessible points. Each of these. or all together. constitute a supply "base," a term also applied to a whole area embracing an army's sources of supply. In the past, supply from bases oifered two main advantages over local supply: (1) bases were relatively secure from attack, and (2) they could be stocked with any desired quantity of war material. On the other hand. supply from bases involved, and still involves, three serious disadvantages. First. the movement of supplies over the routes. or iines of communications joining them to the army, may itself be interrupted or cut off by the enemy. and these supply lines, because of their length, are exceptionally difficult to defend. Second, an army shackled to its bases lacks flexibility and moves slowly, primarily because of the administrative friction and inertia involved in organizing a regular flow of supply from base to army. Finally, the transportation costs of maintaining the flow of supply even over short distances are heavy. These costs rise geometrically as the distance between army and base increases, since in order to deliver a load of supplies each vehicle must travel to the base and return, and additional food, forage and fuel must be carried for the personnel, animals and vehicles engaged in the movement. This geometrical increase in expendable requirements for moving up supplies over a lengthening gap between a base and an advancing army progressively encroaches upon and eventually cancels out the capacity to deliver supplies to the army, regardless of the amount of transport used. With animal-drawn transport. the point of no return is reached very quickly. General William T. Sherman, looking back over his experience in the American Civil War, concluded that an army thus supplied could not operate effectively more than 100 mi., or about five days' march from its base.

With mechanized transport, the theoretical operating radius is greatly extended. The U.S. army truck-and-trailer used in World War II, with $3\frac{1}{2}$ times the capacity of a Civil War-type army wagon. could travel as far on 100 lb. (13.3 gal.) of fuel as the horse- or mule-drawn wagon could travel on 750 lb. of forage. Thus, whereas in the Civil War as much as 75% of the transport used to sustain an army operating 100 mi. from its nearest base might have to be assigned to carry forage for the animals hauling the supplies, only 3% of the trucks used to supply a World War II army operating at the same range were needed to carry their own fuel. In both cases, the ultimate limit on the operating range of armies mas theoretically absolute. In practice, armies using animal-drawn transport could evade the limitation by resorting to local sources for part of their forage, while for the modern mechanized army the ultimate limit was so great—perhaps 3.000 mi.—that it never became operative.

IV. LOGISTICAL SYSTEMS BEFORE 1850

The combination of local supply for food and forage and of self-containment in hardware and services appears often in ancient history as the logistical basis for operations by forces of moderate size. Three of these operations are familiar to every schoolboy—the 4,000-mi. march of Xenophon's Ten Thousand, the even longer campaign of Alexander the Great from Macedonia to the Indus arid Hannibal's campaigns in Italy. The larger armies of ancient times —like that of Xerxes in the invasion of Greece in 480 B.C.—seem to have been supplied by depots and magazines along their routes of march. The Roman legion combined all three methods of supply into a marvelously flexible system. The legion's ability to march fast and far owed much to superb roads and to an efficiently organized supply train; which included mobile repair shops and a service corps of engineers, artificers. armourers and other technicians. Supplies were requisitioned from local authorities and stored in fortified depots; labour arid animals were drafted as required. At need, the legion could carry in its train and on the backs of its soldiers up to 30 days' supply of provisions. In the first Punic War a Roman army marched an average of 16 mi. a day for four weeks.

One of the most efficient logistical systems ever known was that of the Mongol cavalry armies of the 13th century. It rested mainly on self-containment and local supply; supplemented by bases. In normal movements the Mongol armies divided into several corps and spread widely over the country, accompanied by trains of baggage carts. pack animals and herds of cattle. Routes and camp sites were carefully selected for accessibility to good grazing and food crops; food and forage were stored in advance along the routes of march. On entering enemy country, the army abandoned its baggage and herds, divided into widely separated columns and converged upon the unprepared foe at great speed from several directions. In one such approach march a Mongol army covered 180 mi, in three days. Commissariat: remount and transport services were carefully organized. The tough and seasoned Mongol warrior could subsist almost indefinitely on dried meat and kurds. supplemented by occasional game: when in straits, he might drain a little blood from a vein in his mount's neck. The Mongol pony, bred on the steppe, could dig for forage through a light snow. Every man had a string of ponies; baggage was held to a minimum; equipment was standardized and light.

In the early 17th century Gustavus Adolphus of Sweden and Maurice of Nassau restored to European warfare a mobility not seen since the days of the Roman legion, mainly by careful organization of supply. The Swedish armies were based on pre-stocked magazines. but they also had compact supply trains with well-organized services, a flexible tactical organization and light, standardized artillery. An important feature of Gustavian logistics was a system of orderly requisitioning that contrasted with the indiscriminate looting and devastation characteristic of the warfare of the day.

The forinalized warfare of the 18th century was based on an elaborate and ritualistic system of logistics that sacrificed both range and mobility. This was the period of the rolling magazine. and of intricate systems of fortified depots and defended lines of communications. The growing size of armies, increasing use of artillery and greater attention to the creature comforts of a mercenary soldiery, all combined to place heavier burdens on transport. The retinues of baggage and servants accompanying higher officers assumed monumental proportions. At the same time. a widespread revulsion against the depredations and inhumanity of the religious wars in the preceding period brought sharp curbs on looting and other abuses; local supply took the form of carefully regulated requisitioning administered through municipal and provincial authorities under terms often defined by treaty. Since soldiers were expensive, there was a tendency to avoid battles (which, when they occurred, were bloody), and campaigns tended to degenerate into sluggish maneuvers with the primary aim of threatening or defending bases and lines of communications. War became an appendage of logistics in which, as Frederick the Great remarked, "the masterpiece of a successful general is to starve his enemy."

The era of the French Revolution and the Napoleonic domination of Europe (1789–1815) brought back both mobility and range to European military operations, along with an immense increase in the size of armies and the destructiveness of narfare. Logistics became simpler and in many respects cruder. French armies. operating on the principle that "war must support war." largely abandoned the rolling magazine, the elaborate system of supporting depots of the preceding period and even the requisition system. Baggage trains were pared down to the essential needs of fighting power and mobility. The soldier was often heavily burdened with weapons, ammunition and necessities formerly carried by the train; his greatcoat, for example, now served as his tent. Even so, he marched faster and farther (partly by virtue of an accelerated march cadence) than his opponents and predecessors. The system leaned heavily on the willingness of the patriotic citizen soldier (who in a few years became a veteran) to scrounge for himself, to do without and to suffer and die for lack of the rudiments of medical care. Napoleon himself avowedly counted on a brief campaign climaxed by a resounding victory to solve most of his logistical problems. The system, such as it was, tended to degenerate. Baggage trains grew larger; in the invasion of Russia in 1812 they were unable to keep up with the pace of advance and left the troops dependent upon a devastated countryside. In Spain too the logistics of local supply and self-containment broke down.

V. LOGISTICS IN THE INDUSTRIAL ERA (1850–1950)

1. The Revolution in Warfare.— Between 1850 and 1950 the conditions and methods of logistics were transformed by a revolution in warfare more fundamental than any that had occurred in the preceding 6,000 years. The revolution had four facets: (1) the mobilization of mass armies; (2) a revolution in weapons that vastly increased firepower; (3) an economic revolution that provided the physical means needed to feed. munition and transport mass armies; and (4) a revolution in the techniques of management and organization, which enabled nations to mobilize their economic and human resources and to coordinate their use in a war effort often referred to, in the 20th century, as total.

These interrelated developments did not occur all at once. Armies of unprecedented size had appeared in the latter years of the Napoleonic wars. But for almost a century after 1815, the world saw no similar mobilization of military manpower except in the American Civil War. Meanwhile. however, the rapid growth of populations (in Europe, from 188,000,000 in 1800 to more than 550,000,000 in 1950) was creating a virtually unlimited reservoir of manpower. By the latter part of the 19th century most nations were building up large standing armies backed by even larger reserves, and the great 20th-century wars saw the mobilization by each major power of armies numbering many millions.

The revolution in weapons had also started earlier! with a series of inventions and scientific developments dating at least back to the latter part of the 18th century. Its impact upon armaments. in the form of weapons in widespread use, was not felt until about the middle of the 19th century. The rifled percussion musket, rifled and breech-loading artillery, heavy ordnance of very large calibres and steam-propelled and armoured warships were all coming into general use in the 1850s and 1860s. The details of the technological revolution, which proceeded with gathering momentum thereafter, cannot be summarized here. Each successive conflict brought forth a fresh crop of new and deadly weapons, but it remained for mass armies in the 20th-century world wars to realize the full potentiality for destruction that the new technology embodied.

By the mid-19th century the industrial revolution had already given a number of industrialized nations—especially Great Britain, France and the United States—the capacity to produce munitions, food, transport and many other items in quantities no commissary or quartermaster had ever dreamed of. In the American Civil War, the abundant munitions output of the still budding and only partially mobilized industrial economy of the Northern states dimly suggested the latent capabilities that might have been realized. But in general the wars of the 19th century hardly scratched the surface of the immense war-making potential already in being. The generally limited character of all the conflicts between 1815 and 1914 can probably be attributed to the distribution of pomer and the nature of the international rivalries in this period. But even had these factors not tended to limit war objectives and to curb the mobilization of latent military power, it may be doubted whether managerial knowledge and techniques then in existence would have sufficed to carry out such a mobilization. It was, in fact, only in the crucible of World War I at the cost of colossal blunders and waste of effort that these techniques began to be learned.

Thus the full implications of the revolution in warfare were not revealed until the 20th century. Long before 1914, however, new instruments and techniques of logistics had begun to emerge.

2. Transportation and Communication.— The railroad, the steamship and the telegraph had a profound impact on logistical method during the last half of the 19th century. From the Crimean War on, telegraphic communication was an indispensable tool of command, intelligence and operational coordination. particularly in controlling rail traffic. In the 20th century it yielded to more efficient forms of electronic communication—the telephone, radio, radar, television and telephotography.

Railroads spread rapidly over western and central Europe and the eastern United States between 1830 and 1860. They were used. mainly for troop movements, in the suppression of the central European revolutions of 1848–49, on a considerable scale in the Italian War of 1859, and extensively in the American Civil War, where they also demonstrated their capacity for long hauls of bulky freight in sustaining the forward movement of armies. One of the revelations in this conflict was the speed with which torn up or blown up track could be repaired, and this remained true even after rail lines and junctions became prime targets for air bombardment in the 20th century.

In Europe, from 1859 on, the railroads shaped the war plans of all the general staffs, the central feature of which was the rapid mobilization and concentration of troops on a threatened frontier at the outbreak of war. In most countries railroad building was planned with this end in view. Germany's strategic rail net in the centre of Europe enabled her to exploit to the full the advantage of interior lines. In 1870 she was able to concentrate 350,000 troops. 150,000 horses and 6,000 pieces of artillery on the French border in 21 days. and her recognized efficiency in mobilizing influenced the war plans of all the European powers in 1914. In both world wars Germany's railroads enabled her to shift troops rapidly between the Russian and the western fronts.

In the 19th century, steam propulsion and iron ship construction also introduced new logistical capabilities into warfare—the latter by breaking down earlier limitations on the size of seagoing ships. the former by freeing sea-borne transportation from the vagaries of the wind. Steamships moved troops and supplies in support of overseas operations in the Mexican War of 1846–48 and on a much larger scale in the Crimean War of 1854–56; river steamboats played an indispensable logistical role in the American Civil War.

The complement of the railroad was the powered vehicle that could travel on ordinary roads and even unprepared surfaces, within the operating zones of armies, forward of railhead. This was a 20th-century development, a combination of the internal combustion engine, the pneumatic tire and the endless track. Motor transport was first used on a large scale in World War I, along with animal-drawn transport, and in World War II it became, next to the railroad. the dominant means of land movement. Another innovation was the pipeline, used to move water in the Palestine campaign of World War I, and extensively in World War II to move oil and gasoline to storage points close to the combat zones. More revolutionary was the development of air transportation. In World War II, units as large as a division were carried in one movement by air over and behind enemy lines, and resupplied by the same means. Cargo aircraft maintained an air lift for more than three years from bases in India across the Himalayas into China; during the last eight months of operation it averaged more than 50,000 tons per month—an air line of communications for a whole theatre of operations. But the fuel costs of such an operation were exorbitant. Despite the development of gigantic cargo aircraft, air transportation remained primarily a means of emergency movement when speed was an overriding consideration.

3. The Growth in Quantity.—The most conspicuous logistical phenomenon of the great 20th-century wars was the enormous quantity of matériel used and consumed. One cause was the growth of firepower. which was partly a matter of increased rapidity of fire of individual weapons, partly a higher ratio of weapons to men—both multiplied by the vast numbers of men now mobilized. A Civil War infantry division of 3,000 to 5,000 men had an artillery complement of up to 24 pieces; its World War II counterpart, numbering about 15,000 men; had 328 artillery pieces all capable of firing heavier projectiles far more rapidly. A World War II armoured division had an armament of nearly 1,000 pieces of artillery. Twentieth-century infantrymen, moreover, were armed with semiautomatic and automatic weapons instead of the single-shot muzzle-loaders used by most troops in the Civil War.

The upward curve of firepower was reflected in the immense amounts of ammunition required in large-scale operations. Artillery fire in the Franco-German War, and in the Russo-Japanese War, for example, showed a marked increase over that in the Civil War. But World War I unleashed a firepower whose existence had hardly been hinted at in the previous conflicts. In this holocaust British and French forces expended during one average month more than twice as much artillery ammunition as did the Union forces during the entire four years of the American Civil War, and in the seven-days battle of the Somme in 1916 British artillery fired about 4,000,000 rounds, or roughly 125 times as many as the Union artillery in the three-days battle of Gettysburg. In World War II the U.S. procured only about 4 times as many small arms as it had in the Civil War, but 43 times as much small-arms ammunition. The Confederacy fought through the four years of the Civil War on something like 5 000 or 6.000 tons of gunpowder; American factories in one average month during World War I turned out almost four times this quantity of smokeless powder. Again, in one year of World War II; 7,000,000 tons of steel went into the manufacture of tanks and trucks for the U.S. army, 4,000,000 tons into artillery ammunition, 1,000,000 tons into artillery and 1 500,000 tons into small arms—as contrasted nith less than 1 000 000 tons of pig iron used by the entire economy of the northern states during one year of the Civil War. To the ammunition expenditures in the 20th-century world wars were added, moreover. the immense tonnages of explosives used in air bombardment. It must be remembered, finally, that ammunition and explosives remained a relatively small item among the military expendables; the neight of fuel and food was perhaps four times as great.

With growth in quantity went a parallel growth in the complexity of military equipment. The U.S. army in World War II used some 60 major types of artillery above .60 calibre, from the 20-mm. automatic aircraft cannon to the 16-in. coast artillery gun. For 20 difierent calibres of cannon there were some 270 types and sizes of shells. The list of military items procured for U.S. army ground forces added up to almost 900,000, and each end item contained many separate parts; fire control instruments for some anti-aircraft guns contained as many as 25,000 precision-made parts. To convert and expand a nation's peacetime industry to the production of such an arsenal posed staggering technical problems. Manufacturers of automobiles, refrigerators, soap, soft drinks, bed springs, toys, shirts and microscopes had to learn how to make guns, gun carriages, recoil mechanisms and ammunition.

4. The Determination of Requirements.—To design and manufacture a weapon in quantity took from 18 months to two years or more, the so-called "lead time" of logistical planning. The operation in which the iveapon was used was rarely planned in detail more than six months in advance. From this circumstance was derived the central problem of logistical planning: how to predict, without operational plans, what would be needed to carry on a war, in time to produce and make the matériel available when needed. In World War II the U.S army developed elaborate administrative processes for accomplishing this feat, involving hundreds of statisticians and technical experts, electrical computing machinery and an army of clerical personnel.

Fundamentally the method ivas simple. Instead of "guestimating" the needs of all possible future operations not yet planned or conceived, requirements were calculated item by item for the army as a ivhole. on the basis of general expectations as to its composition, rate of expansion and overseas deployment, and the areas where it would operate. Requirements were grouped under the following headings: (1) initial equipment for each soldier and troop unit that the army expected to mobilize; (2) replacement equipment to cover expected losses in use and in combat, as indicated by analysis of past experience; (3) consumption and expenditure requirements for expendable supplies, also based on past experience: and (4) distribution requirements for both equipment and supplies needed to "fill the pipeline" in the army's world-wide system of supply (*i.e.*, quantities stocked in depots, in transit, and iost in transit), and thus ensure ready availability when and where needed. Reserves were also provided to cover unforeseen needs, and specific bills of requirements added for planned operations and for certain projects (*e.g.*, the reconstruction of a port) that could be foreseen. In general, the aim of the system was to provide a diversified fund of war material of all kinds. from which. it was hoped, specific needs could be met as they arose. The British in World War II used a somewhat different method which emphasized the calculation of requirements for forces in each theatre of operation.

5. The System of Staged Resupply.—Long before mechanization relegated local supply to a minor role in the support of modern armies, growing supply requirements had made armies dependent on more or less continuous resupply from bases. The *étappen* system of the Prussian army in 1866 was essentially a modification of the rolling magazine of the 18th century. Behind each army corps trailed a series of supply trains. shuttling continuously between the advancing troops and the nearest magazines in the rear. The magazines were repeatedly moved forward to keep within one or two days' march of the advance. and were in turn replenished by a lengthening chain of magazines extending back as far as the railhead. Only a small train accompanied the troops, carrying a basic load of ammunition, rations and baggage; each soldier carried three days' emergency rations. The system was geared to a steady, slow advance on a rigid schedule and a predetermined route, and the individual soldier was still heavily laden. Yet no alternative method seemed possible, since in 1366 and again in 1870–71 Prussian forces were able to obtain no more than a third of their supplies locally.

Staged; continuous resupply became the basic logistical system for all armies in the industrial era. and for large, well-equipped forces sustained reliance on self-containment and local supply virtually disappeared. Accompanying loads were limited mainly to fighting equipment and a small reserve of fuel and ammunition, and soldiers carried a day or two of emergency rations. The administrative "tail" of magazines and shuttling transport stretching far back to the army's sources of supply became a regular feature of modern land warfare. In World War II, supplies moving to U.S. armies overseas normally passed through seven or eight major stages, besides numerous intervening ones: from a depot in the U.S. to a port of embarkation, to an overseas port, to a rear-area depot and perhaps to an intermediate or advanced depot, to a regulating station, to an army-area supply point, to a division or regimental supply point and finally to the troops.

Under this system, even though it was frequently described as a "pipeline," supplies never flowed continuously from ultimate source to consumer. The object was to stock reserves of material as far forward as safe and practicable, making possible regular supply of food and fuel, and immediate provision of ammunition, replacement equipment and services when needed. Before any major operation, large reserves had to be accumulated close behind the front; the build-up of American war matériel in the British Isles preceding the Normandy invasion of 1944 went on continuously over a period of two years, and involved the shipment of 16,000,000 tons of cargo across the Atlantic from the Cnited States. In essence, the system strove to convert supply from bases into an approximation of local supply, by moving the bases close to the troops.

Behind the armies: in the continental European theatre in World War II, spread the rear-area administrative zone, a vast complex of depots. traffic regulating points, railway marshalling yards, troop cantonments and rest areas, repair shops, artillery and tank parks. oil and gasoline storage tanks, airfields and headquarters—through which ran the lines of supply stretching back to ultimate sources. In the Pacific: the administrative zone covered vast reaches of water, and most of the bases were on islands. Communication and movement in this theatre depended largely on shipping, supplemented by aircraft, and one of the major logistical problems was moving forward bases and reserves as the fighting forces advanced. Late in the mar, supply ships often sailed all the way from the U.S. west coast, bypassing intermediate bases, to forward areas where they were held as floating warehouses until their cargoes were exhausted.

The system of staged resupply gave modern armies considerable range of movement and sustained offensive power, but it crippled their mobility. The natural habitat of the system was the creeping or sealed front of World War I, though many offensives on the western front bogged down, after gaining a few miles, through failure of supplies to keep up with the advance. World War II brought back maneuver and rapid movement. but mobile forces remained tied to their bases; they could move only so far and so long as their supplies could be carried to them. Both the capabilities and limitations of the system were dramatically demonstrated when the U.S. 3rd army plunged across France in the summer of 1944, only to halt after four weeks because the racing armoured spearheads had outrun the capacity of their methodically shuttling transport. Even though used on a lavish scale, motor vehicles could not keep them supplied with the immense quantities of fuel required.

One of the striking lessons of World War II, often obscured by the tactical achievements of air power and mechanized armour, was the great power that modern logistics gave to the defense. In 1943 and 1944 the ratio of superiority enjoyed by Germany's enemies in output of combat munitions was about $2\frac{1}{2}$ to 1; the whole apparatus of Germany's war economy was subjected to relentless attack from the air, and had in addition to make good the enormous losses of material resulting from a succession of military defeats. Yet Germany was able, for about two years, to hold its own, primarily because its waning logistical strength could be concentrated on sustaining the firepower of forces that were stationary or were retiring slowly toward their bases, instead of on the immensely expensive effort required to support a rapid forward movement.

6. Logistical Specialization. — For many centuries the soldier was a fighting man and nothing else; he depended on civilians to provide the services that enabled him to live, move and fight. Even the more technical combat and combat-related skills, such as fortification, siegecraft and the service of artillery, were traditionally civilian. After the mid-19th century, with the rather sudden growth in the technical complexity of warfare, the military profession faced the problem of assimilating a growing number and variety of specialized noncombatant skills. Many of the uniformed logistical services date from this period; examples are the British army's transport corps (later Royal army service corps), hospital corps, and ordnance corps and the U.S. army's signal corps. In the American Civil War the Union army formed a railway construction corps, largely civilian in composition and operation but under military control. Prussia a little later created a railway section in the great general staff and a combined military-civilian organization for controlling and operating the railroads in time of war.

Not until the 20th century, however, did organized military units performing specialized logistical services begin to appear in large numbers in the field. By the end of World War II, what was called "service support" comprised some 45% of the total strength of the U.S. army. Only three out of every ten soldiers had combat functions, and even within the ranks of a combat division, one man out of four fell into the noncombatant category. Even so the specialized services that the military profession succeeded in assimilating were only a small fraction of those on which the combat soldier depended. Throughout the vast administrative zones behind combat areas and in the national base, armies of civilian workers and specialists manned depots, arsenals, factories, communications centres; ports and the other apparatus of a modern society at war. Military establishments employed a growing number of civilian administrators, scientists, management and public relations experts and other specialists. Within the profession itself, the actual incorporation of specialized skills mas limited, in the main, to those directly related (or exposed) to combat, such as the operating and servicing of military equipment, though even here the profession had no monopoly. Soldiers also served as administrators and supervisors over civilian specialists with whose skills they had only a nodding acquaintance. On the whole, the fighting man at mid-20th century belonged to a shrinking minority in a profession made up largely of administrators and noncombatant specialists.

LOGISTICS IN THE NUCLEAR AGE

The dropping of the first atomic bombs in August 1945 and the subsequent emergence of nuclear and thermonuclear weapons systems employing long-range missiles as well as manned aircraft inaugurated a new era in warfare, which promised to demand radical changes in logistics and logistical systems as well. But the new weapons were not immediately used in war; the limited conflicts of the 1950s employed, in the main, the weapons and logistical methods of World War II.

1. Korean War. — The major conflict in this period, the war in Korea (1950–53), was reminiscent in many ways of the positional warfare in Italy in World War II. For U.S. forces, the near-disastrous retreat to the Pusan perimeter at the outset of the war recalled the tragedy of Bataan early in 1942. In many other respects, the war seemed an extension of World War 11—even to the stocks of munitions left over from that conflict without which the UN operations of the first year could hardly have been supported. Late in the war, American forces began to use new model trucks, but they represented no new departure in design. Weapons were also mostly World War II models, in some cases improved versions.

UN forces had an excellent base in nearby Japan, whose factories made a major contribution by rebuilding American World War II matériel. Both Japan and South Korea's major port of entry, Pusan, were free from Communist air attack throughout the mar. Chinese bases north of the Yalu enjoyed a similarly immunity from UN air raids. This curious circumstance greatly simplified the supply problems of UN forces, enabling them to funnel through Pusan supply tonnages comparable to those handled by the largest ports in World War II, and to concentrate depots and other installations in the Pusan area to a degree that would have been suicidal without complete air superiority.

The expenditure of artillery ammunition by UN forces at times soared above the highest levels attained in World War II, and the available supply often fell dangerously low. Output of ammunition in the U.S. was meager, owing to the long lead time needed to reach quantity production and to the expectation that the war would not last long. Actual shortages on the firing line were primarily a result of inadequate transportation facilities in Korea. UN forces also suffered at the beginning of the winter of 1950-51 for lack of winter clothing which had not been moved forward soon enough. The numbers of service troops never seemed to be adequate, although they were considerably greater than was normal in World War II, and were supplemented by large numbers of Korean labourers — more than 150,000 in the fall of 1951. Korean porters made a major contribution to the UN transport service in rugged terrain which trucks could not negotiate.

Communist supply lines, though heavily bombarded by UN air forces, functioned remarkably well; troops and supplies mere moved by night. local labour and transportation were used extensively and the Chinese soldier proved, as he had often done during World War II, that he could endure an incredible amount of privation, subsist on very little food and still fight well. The Communist logistical system, technically primitive, enabled the Communist forces to mount heavy offensives, but they could not be sustained for more than three or four days. On the U S side, the most brilliant logistical exploit was the "amphibious operation in reverse" by which the X corps was evacuated from Hungnam in Dec. 1950. In a period of two weeks, under constant enemy attacks, some 105,000 troops, 98,000 Korean civilians, 17,500 vehicles and 350,000 tons of cargo were loaded in 193 vessels.

By World War II standards, the Korean war was a limited conflict (except for the two Korean belligerents, on whose soil it was fought). It involved only a partial. or "creeping" economic mobilization in the U.S., the major UN participant, and a modest mobilization of reserve manpower. Yet this was no small war. During the three years that it lasted, about 37,200,000 measurement tons of cargo were poured into the South Korean ports, or more than three-fourths of the amount shipped to U.S. army forces in all the Pacific theatres from Dec. 1941 to Xug. 1945. And the combined UN forces reached a peak strength of almost 1,000,000 men. of whom more than a third consisted of U.S. and other non-Korean contingents. Communist forces were considerably larger.

(See also KOREAN WAR.)

2. Management. — Logisticians were much concerned in the post-World War II period with improvements in management aimed at greater economy and efficiency. This was no new trend, for World War II had seen a major effort, especially in the service forces and air forces of the U.S. army, to bring order and reasonable economy into operations which, because of their unprecedented magnitude, tended to breed waste and duplication. In the postwar years the slashing of military appropriations, the increasing cost of military hardware in a period of rapid technological change and growing international tensions all combined to put heavy pressure on the armed services to squeeze more military strength from the defense dollar — to get, as the saying went, "more bang for a buck."

To a considerable extent, the methods adopted to improve management in logistics were those used in the business world, though in many cases they had actually developed, and in some cases had their origin, in the military establishments. Civilian management firms, hired to survey these establishments, gave a strong impetus to the organization of logistical activities along "functional!' line , as opposed to the traditional organization by commodity groups with headquarters of the general-staff type--though the attempt to do so was successfully resisted in many quarters. Under the unified military establishment in the U.S., all activities were grouped into major and subsidiary "programs," with orderly schedules of objectives which were continuously matched against performance. Unification also spurred efforts to break down the uneconomical compartmentation of logistical activities under each armed service. Large groups of related functions (*e.g.,* military transportation by land, water or air, or procurement of subsistence, clothing or medical supplies) were placed under the control of one of the armed services or a single interservice agency. In overseas commands certain logistical activities were also "unified" for all three services.

In the technology of logistical administration, an innovation of revolutionary implications was the introduction of completely automatic electronic data processing machinery. Applied to such large-scale operations as the processing of supply requisitions and control of inventories, this development held promise of reducing to small proportions the factor of time in many areas of logistical activity, of centralizing control to an unprecedented degree and of slashing administrative manpower requirements.

Another significant development was "operations research" or "operations evaluation," a form of scientific study and investigation which used advanced mathematical techniques in the analysis of repetitive operations, particularly those involving the use and performance of military hardware, with a view to developing more efficient methods and procedures.

Operations research was applied to many areas of military and business operations, but proved especially productive in the analysis of logistical activities.

3. Logistics in Nuclear War. — For logisticians, however, the fundamental dilemma posed by the "quantum jump" in weapons technology after World War II was the absence of any comparable development in the apparatus or methodology of logistics. No technical innovation perfected and applied during this period, in transportation, supply or administration had an impact upon the conduct of war remotely comparable to that produced in the 19th and early 20th centuries by the railroad, the telegraph, the internal combustion engine or mass production. On the other hand, the new weapons, with their immense destructiveness and range, threatened to sweep away every vestige of the logistics developed to meet the demands of the industrial era. None of the elaborate apparatus of rear-area administration, lines of communications or even sources of supply required in the two world wars of the 20th century seemed likely to survive the firepower that could now be brought to bear against it, and no effective defense against this firepower had yet appeared.

The problem was. indeed, under attack from many angles. New logistical doctrine stressed dispersion, and much study went into the determination of how small a concentration of personnel or structures constituted a "profitable target." In the future war, the communications zone would be wide and deep; installations would be small. widely dispersed, duplicated on a large scale to avoid irretrievable loss, and, as far as possible mobile; depot stocks would be mixed instead of specialized; automatic data processing machinery would permit rapid supply action by remote control; a variety of small, mobile cargo carriers would be available, combining the functions of storage and movement, and capable of travelling on any terrain; cargo would also be carried by helicopter and aircraft that could use water runways; "roll-on-roll-off" seagoing and submersible carriers would discharge their cargoes rapidly on small beaches and immediately put out to sea; all movements of troops and cargo would be spread among numerous alternate routes.

Combat units, small, mobile, lean, stripped down to the bare essentials of equipment and services, would resupply themselves from small dispersed magazines, or be resupplied by aircraft and fast-moving supply columns.

Yet all this, by 1960, was still hardly more than a planner's vision. At best. it held promise of reducing to some degree the inherent vulnerability of the surface-bound installations and transport on which military forces in the foreseeable future were likely to depend for most of their logistical support. Dispersion and duplication were enemies of economy and efficiency, and the more advanced new means of movement, storage and handling were expensive, intricate and difficult to produce in quantity. The net effect could only be to increase the costs of logistical support and to diminish the yield in delivered supplies and services.

The central problem of logistics in the nuclear era, as before, was one of weight and bulk — the historic barriers to mobility and range, and the primary causes of vulnerability to the new firepower. With substantial reductions in weight and bulk of impedimenta and supplies, the pace of supply movements would quicken, armies could thin out the density of their rear-area installations and lines of communications, and the self-contained, hard-hitting "flying column" might return to warfare. Some promise of a real breakthrough in this area was offered by the application of atomic energy to transportation. Atomic-powered vehicles, whether on land, on the sea, under water or in the air, would consume virtually no fuel, and in World War II fuel had accounted for from two-thirds to three-fourths of the weight of all supply requirements. The first atomic-powered submarines and surface vessels appeared in the 1950s, and nuclear submarines, by the end of the period, had become a regular component of the U.S. navy. A further reduction of transportation requirements was inherent, too, in the new weapons themselves, which replaced many times their own weight and bulk in the older types of explosives and delivery instruments.

The growing range of firepower, moreover, involved a corresponding diminution of the distances over which the ingredients of firepower and logistical support had to be transported. Intercontinental missiles and bombers, based in a nation's home territory, theoretically could eliminate altogether the need for advanced air and missile bases, along with the defending forces, lines of communications and administrative establishments that supported them. By 1960 all the major powers had to reckon with the possibility that the sources of logistical support might, in any case, be wiped out, and lines of communication rendered inoperable by the initial strikes and counterstrikes of an all-out nuclear war. In such a case, the ensuing "broken-backed" conflict, if hostilities continued at all, would have to be waged by surviving farces in being with whatever weapons, supplies and transport remained. It could readily be envisaged that warfare under these circumstances might eventually revert to more primitive pre-industrial forms.

Logistical planners still had to reckon, however, with the probability of limited wars, with or without nuclear weapons, and with such present realities as limited budgets and interservice competition for funds and priorities. Development of new tools for logistics lagged behind the development of new weapons. The motor vehicles, ships, railroads and air transports in general use by 1960 were not significantly different from those used in World War II. Despite plans for dispersion, mobility and automated supply procedures, military forces remained dependent on the system of staged resupply from bases, elaborate service support and ponderous administration that had characterized the logistics of the industrial era.

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LOGOGRAM AND SYLLABARY. Under this heading are included systems of writing that utilize logograms, or signs for words, and syllabograms, or signs for the syllabic components of words. (For systems of writing that utilize letters or signs for the smallest elements of language, namely phonemes, *see* ALPHABET.)

The systems of writing that utilize logograms and syllabograms may be divided into two classes: (1) logosyllabic writing, which utilizes in about equal measure signs both for words and for syllables; and (2) the syllabic writing, which either contains only signs for syllables or utilizes syllabic signs more than logographic signs.

Logosyllabic Systems.—This term includes full systems of writing, which represent actual units of language, such as words and syllables. They are to be distinguished sharply from primitive systems, which express vaguely defined ideas or meanings. The latter are called pictographic, ideographic or semasiographic systems and are forerunners of writing. (*See* WRITING; PICTOGRAPHY.)

Full systems of writing originated in the vast mass of land extending from the eastern shores of the Mediterranean sea to the western Pacific. In this large area seven original systems of writing developed. all of which could claim independent origin: (1) Sumerian in Mesopotamia. 3100 B.C.–A.D. 50; (2) proto-Elamite in Elam, 3000–2200 B.C.; (3) proto-Indic in the Indus valley, c. 2200 B.C.; (4) Chinese in China, 1300 B.C.–present; (5) Egyptian in Egypt. 3000 B.C.–A.D. 400; (6) Cretan in Crete and Greece, 2000–1200 B.C.; and (7) Hittite in Anatolia and Syria, 1500–700 B.C.

New systems of writing come to light from time to time through the efforts of excavators. The proto-Armenian inscriptions, which have been discovered in great numbers in Armenia, are too little known to warrant their addition to the list. The undeciphered Phaistos and Byblos writings are most likely syllabic and thus fall under the classification of syllabic writings. The mysterious Easter Island inscriptions, on which much effort has been spent by many imaginative minds, probably represent pictorial concoctions for magical purposes. Finally, the Amerindian systems of the Mayas and the Aztecs do not represent full writing, since even in their most advanced stages they never attained the level of development characteristic of even the earliest phases of the seven systems.

Sumerian System.—The home of cuneiform writing was in Mesopotamia. in the basin of the Tigris and Euphrates rivers. The term cuneiform means literally "wedge form," from Latin *cuneus*, "wedge." plus *forma*, "form," and ones its origin to the medgelike appearance of the little strokes. The decipherment of cuneiform was initiated in the first half of the 19th century by Georg Friedrich Grotefend and Henry Creswicke Rawlinson; by the end of the century it was possible to read with relative ease the various forms of cuneiform in which many languages of the ancient near east were written. Chief among these were Sumerian, spoken in southern Mesopotamia by a people of disputed ethnic and linguistic affiliation. and Akkadian. a Semitic language spoken in all of Mesopotamia, which included two main dialects. Babylonian and Assyrian. Toward the end of the 3rd millennium B.C. the Sumerian language died out, giving way to Akkadian.

Throughout its history the material par excellence of Mesopotamian writing was clay. As the rounded forms of pictures could not easily be incised on clay with a stylus, the signs acquired an angular form consisting of a few separate strokes of the stylus. The natural pressure of the stylus on one of its corners produced the appearance of wedges. Cuneiform was later used on other materials, such as stone and metal.

The Mesopotamian cuneiform system included about 600 logograms, out of which about 100–150 signs, depending on time and area, were used syllabically. The normal Mesopotamian syllabic writing contained signs of the type *ta*, *tu*, *tam*, *tum*. At no time did any of the Mesopotamian syllabaries contain signs for all the possible syllables in the languages for which they were used. The attempt to express linguistic forms with the fewest possible signs resulted in various economizing measures. No Mesopotamian system distinguished between voiced, voiceless and emphatic consonants in the case of signs ending in a consonant. Thus, the sign IG had the value ig, ik and iq, just as the sign TAG might have stood for *tag*, *tak* and *taq*. In addition, some older systems. such as Old Akkadian and Old Assyrian, did not even distinguish the quality of the consonant in signs beginning with a consonant. Thus, in these systems the sign GX had the value of *ga*, *ka* and *qa*. In all cuneiform systems many signs ending in i might stand also for those ending in *e*, as in the sign LI with the values *li* and *le*. Syllables which were not represented by a sign in the syllabary might be represented by signs with similar consonants, as, for instance, in expressing the syllable rin with the sign which had a normal value *rim.* When there were no signs with similar consonants. a syllable was written in Sumerian in a way not paralleled in any other syllabic system; the syllable ml, for which no separate sign existed, was written as *ra-al,* while in other known syllabic systems this syllable would be written *ra-l(a)*. ra-lie) or the like. (See also SUMERIAN LANGUAGE; AKKADIAN LANGUAGE.)

Egyptian System.—The name of the hieroglyphic writing of the Egyptians is derived from the Greek *hieroglyphika* gvammata and owes its origin to the belief that it was used chiefly by the Egyptians for sacred purposes (*hieros*, "sacred," *glyphein,* "to incise"). By 1822 the hieroglyphic writing was successfully deciphered by the Frenchman Jean François Champollion. chiefly on the basis of comparison with the Greek inscription on the Rosetta stone (*q.v.*). The hieroglyphic form of writing, used chiefly for public display purposes. was not the writing of everyday practical life. For such purposes the Egyptians developed two forms of cursive writing, first the hieratic and then the demotic. The Egyptian system consisted of about 700 signs, of which about 100 were used syllabically. The syllabary consisted of about 24 signs, each with an initial consonant plus any vowel, such as the sign m^x with the values m^a, m^i, m^e, m^u and $m^{(x)}$, and of about 80 signs, each with two consonants plus any vowel(s), such as the sign t^xm^x with the values t^am^a, t^im^i, t^em^e, t^um^u, t^am^i, t^em^i, $t^am^{(a)}$, $t^em^{(e)}$, $t^{(a)}m^a$, etc. This characterization of the Egyptian nonlogographic writing as consisting of signs expressing one or two consonants plus any vowel is in disagreement with the views of many Egyptologists. who say it is simply consonantal or even alphabetic. (See I. J. Gelb, *A* Study of *Writing,* pp. 76–81 [1952].) (*See* EGYPTIAN LANGUAGE; HIEROGLYPHS.)

Hittite System.—The decipherment of the Hittite hieroglyphic writing was achieved in the 1930s through the combined efforts of several scholars. Knowledge of Hittite has not reached the level of Sumerian or Egyptian. The term hieroglyphic was taken over from Egyptian writing. and it simply implies that Hittite writing, like Egyptian, was picture writing; it does not imply that the Hittite hieroglyphic system was borrowed from the Egyptian hieroglyphic or that it was in any way related to it. Hittite hieroglyphic writing was in use from about 1500 to 700 B.C. in a large area extending from central Anatolia to northern Syria. Its language was related to, but by no means identical with, cuneiform Hittite, a language preserved in the cuneiform writing borrowed from Mesopotamia. Both of these languages and writings were used simultaneously in the Hittite empire, but while cuneiform Hittite was limited to the area around Bogazkoy. the capital of the empire, and died out soon after 1200 B.C., hieroglyphic Hittite was used throughout the empire and continued as a living tongue up to about 700 B.C. Hittite writing consisted of about 450 signs, of which about 60 were used syllabically. The syllabic signs were of the type ta, ti, te, *tu,* each representing a syllable beginning with a consonant and ending in a different vowel. (See HITTITES.)

Chinese System.—Of the four main systems of writing. Chinese is the only one which did not have to be deciphered in modern times; because knowledge of it was passed from generation to generation, Chinese writing made its appearance about the middle of the 2nd millennium B.C.. during the Shang dynasty. as a fully developed phonetic system. In its outer form the writing has changed greatly during its long history, but the inner characteristics of the oldest inscriptions hardly differ from those of recent times. The oldest Chinese inscriptions are the oracle texts on animal bones and tortoise shells, and some short texts on bronze vessels, weapons, pottery and jade. The signs in the Shang period were limited in number, no more than about 2.500, and in the majority of them the pictorial character is still clearly recognizable. But the signs developed a linear form, and in later writings it is impossible to recognize the pictures they originally represented.

Chinese writing does not have a full syllabary comparable to the syllabaries in the other three (major) systems. As the words of the Chinese language are regularly expressed by word signs, it is only in writing foreign words and names that the necessity arose to use word signs in a syllabic function. Thus; "Jesus" is written as Yeh-su, "English" as *Ying-chi-li,* "French" as *Fa-lan-hsi,* "telephone" as te-li-feng. There are no set word signs for certain syllables, as there are in the near eastern systems; for example, "Jesus" might also be written Ya-su; "telephone," te-lu-fung. The characteristic tendency of Chinese toward abbreviation may be noted in the use of *Ying* for "English" (besides *Ying-kuo-jen* for "Englishman." that is, "English-country-man"), Fa for "French" (besides *Fa-kuo-jen*) or Lo for "Roosevelt" (besides *Lo-ssu-fu*). Frequently words spelled out syllabically acquired a logographic spelling; for example, the above-mentioned te-li-feng, "telephone," is now usually written as *tien-hua,* "electricity talks." Chinese writing is said to consist of about 50 000 signs, of which an unspecified number are used in a syllabic function This extraordinary development of Chinese logography constitutes a unique phenomenon in the history of writing. (See CHINESE LANGUAGE.)

Proio-Elamite, **Proto-Indic** and Cretan Systems.—All these systems are either completely or largely undeciphered. The proto-Elamite writing first dppeared at Susa. the capital of ancient Elam. and can be dated roughly to the so-called Jemdet-Nasr period after 3000 B.C. The earliest examples are found on several hundred clay tablets, perhaps business records Not even one of the several hundred signs can be read certainly. Some number signs and the existence of a decimal system have been determined with some assurance. A more developed form of proto-Elamite writing, also undeciphered, occurs on about a dozen stone inscriptions from the Old Akkadian period around 2200 B.C. The later type of writing consisted of a very limited number of signs (only 55 have been discovered) differing greatly in form from those of the previous period.

Seals with peculiar signs, which have aroused intense interest throughout the world, have been found sporadically during the 20th century at various sites in the Indus valley. In 1924 the archaeological department of the government of India undertook the first systematic excavation of the ancient sites today called Harappa and Mohenjo-Daro, and a considerable number of texts were discovered. More inscriptional material of the same nature was uncovered at Chanhu-Daro. At these sites cultures of great antiquity were unearthed. about which, strangely enough, Indic tradition says nothing. The still undeciphered writing consists of about 250 signs found on short seal inscriptions, pottery and copper tablets. The relative chronology of this proto-Indic writing was established by comparative stratigraphy with the help of Mesopotamian finds. The writing made its appearance in the second half of the 3rd millennium B.C. and, after a few centuries, disappeared as suddenly as it had appeared.

The origin and development of the Cretan writing are best illustrated by the epigraphic finds made at the beginning of the 20th century by Sir Arthur Evans at Knossos, in Crete. Other sites in Crete (Mallia, Hagia Triada) and in Greece (Mycenae, Orchomenus. Pylos, Thebes. Tiryns), as well as in the Aegean islands, have yielded epigraphic material that supplements the knowledge derived from the Knossos material.

The tuo major classes of Cretan writing are the Hieroglyphic and Linear. The undeciphered Hieroglyphic A and B are probably of the standard logosyllabic type. Linear B is predominantly syllabic, as is the still undeciphered Linear A system. (See MINOAN LINEAR SCRIPTS.)

Syllabic Systems.—Four syllabic systems developed from the logosyllabic systems discussed above: the cuneiform syllabaries from the Mesopotamian cuneiform; the West Semitic syllabaries from the Egyptian; the Aegean syllabaries from the Cretan; and the Japanese syllabary from the Chinese.

Cuneiform Syllabaries.—Mainly during the 2nd millennium B.C. the cuneiform writing of the Sumerians and Akkadians was borroned by many peoples surrounding Mesopotamia. such as the Elamites of Iran, the Hurrians of northern Mesopotamia and Syria, the Hittites of Anatolia and the Urartaeans of Armenia. Only the Hittites took over the Mesopotamian logosyllabic system in approximately the form it had at its original home. All others simplified their cuneiform writings considerably by limiting their systems to syllabic signs plus a small number of logograms for the most common nouns.

West Semitic Syllabaries.—In contrast to the East Semitic group of languages, represented only by Akkadian, all other Semitic languages, such as Phoenician, Hebrew, Aramaic, Arabic and Ethiopic, belong to the West Semitic group. This linguistic grouping is paralleled by a grouping based on graphic considerations. The Akkadians used cuneiform writing, while all other Semites used writing that was first developed on the Egyptian model in the middle of the 2nd millennium B.C. in the Syro-Palestinian area and reached its climax about 1000 B.C. in the Phoenician writing of Byblos, from which it spread to the surrounding West Semitic peoples.

All the West Semitic writings used a limited number of syllabic signs, 22 to 30. each of which expressed an initial consonant plus an inherent but unindicated vowel. With the development of separate vocalic signs in the first centuries A.D., the originally syllabic signs of the West Semitic writings became alphabetic, and the West Semitic writings became alphabets. (See also SEMITIC LANGUAGES.)

Aegean Syllabaries. — Under the syllabic writings of the Aegean area can be included the still undeciphered Cypro-Minoan and the deciphered Cypriote syllabaries of the island of Cyprus, the undeciphered syllabary of the disk of Phaistos in Crete and the undeciphered syllabary on about ten stone and metal inscriptions from Byblos.

The number of syllabic signs used in the Aegean systems varies from 56 to 90, and the signs are regularly of the type ta, te, ti, *tu*, to, that is, an initial consonant plus a different vowel. The difference between voiced, voiceless and aspirated consonants is not indicated in the writing. This type of syllabic sign is found in the Cretan, as well as in the hieroglyphic Hittite, writings discussed above.

Japanese Syllabary. — After a few centuries of cultural and commercial contact between China and Japan, the Chinese system of writing seems to have made its appearance in Japan in the 5th century A.D. The Chinese word signs were simply taken over by the Japanese and read not with their Chinese values but in Japanese. Thus, for example, the Chinese word sign *nan*, "south," was read in Japanese as *minami*, "south." The Chinese writing may have been well suited to a monosyllabic and isolating language in which grammatical forms are normally expressed by syntactical position rather than by special formatives. However, such writing was not suited to Japanese, which is polysyllabic and agglutinative and expresses grammatical forms by means of special formatives. Therefore, some of the Chinese word signs soon came to be employed as syllabic signs expressing the grammatical formatives of the Japanese language. Originally, the choice of the syllabic signs was unsystematic, and it was not until about the 9th century that a stable syllabary with 47 signs was developed, each expressing a consonant plus a vowel, with the difference in voice being fully indicated. In introducing a full syllabary the Japanese have never given up the logographic apparatus borrowed from Chinese, which they use along with their syllabary. See JAPANESE LANGUAGE.

Writings of Modern Primitive Societies. — Several systems. such as those of the Cherokees and Alaska Eskimos in America and of the Vai and Bamum Negroes in Africa, were developed in modern times under the influence of white men. Starting as a primitive logography, they passed through a logosyllabic stage. ending with syllabaries consisting of 85 (Cherokee) to 226 (Vai) signs.

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LOGOGRAPHI, in Greek logographoi, writers of logoi or compositions of any sort, especially in prose. In Attic Greek the word signifies "professional speech writers"; in modern usage (since G. F. Creuzer. Die *historische Kunst* der *Griechen* in *ihrer* Entstchung und Fortbildung, 1803) it refers to pre-Herodotean writers of chronicles, from the doubtfully historical Cadmus of Miletus (*q.v.*) to Pherecydes. All these make extensive use of mythology, but their attempts at systematization and criticism are primitive. Their dialect is Ionic. Mention may be made of the following: Hecataeus of Miletus (*q.v.*); Acusilaus of Argos, who paraphrased in prose (correcting the tradition where it seemed necessary) the genealogical works of Hesiod; Charon of Lampsacus (c. 450), author of histories of Persia, Libya, and Ethiopia, of annals of his native town, and of the chronicles of Lacedaemonian kings; Xanthus of Sardis in Lydia (*c.* 450), author of a history of Lydia; Hellanicus of Lesbos (*q.v.*); Hippys and Glaucus, both of Rhegium, the first the author of histories of Italy and Sicily, the second of a treatise on ancient poets and musicians; and Damastes of Sigeum, author of genealogies of the combatants before Troy (an ethnographic and statistical list), and of short treatises on poets, sophists and geographical subjects. The work of Stesimbrotus of Thasos "On Themistocles, Thucydides and Pericles," though belonging to the same period, did not belong to the same category. It was really a political pamphlet, the first known of its kind, directed against the democratic imperialism of Athens.

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LOGOS, a common term in ancient philosophy and theology. It expresses the idea of an immanent reason in the world, and, under various modifications, is met with in Indian, Egyptian and Persian systems of thought. But the idea was developed mainly in Hellenic and Hebrew philosophy, and the term is significant in the Gospel of St. John in the New Testament.

THE HELLENE LOGOS

To the Greek mind, which saw in the world a *kosmos* ("ordered whole"), it was natural to regard the world as the product of reason, and reason as the ruling principle in the world. So a Logos doctrine was more or less prominent from the dawn of Hellenic thought to its eclipse. It rises in the realm of physical speculation, passes over into the territory of ethics and religion and makes its way through three well-defined stages. These are marked off by the names of Heraclitus of Ephesus, the Stoics and Philo.

Heraclitus.—The idea of Logos acquires its first importance in the theories of Heraclitus (6th century B C), who, trying to account for the aesthetic order of the visible universe, broke away to some extent from the purely physical conceptions of his predecessors and discerned at work in the cosmic process a logos analogous to the reasoning power in man On the one hand the Logos is identified with gnome and connected with dike, which latter seems to have the function of correcting deviations from the eternal law that rules in things. On the other hand it is not positively distinguished either from the ethereal fire, or from the *heim armene* and the ananke according to which all things occur. Heraclitus holds that nothing material can be thought of without this Logos, but he does not conceive the Logos itself to be immaterial Whether it is regarded as in any sense possessed of intelligence and consciousness is a question variously answered. But there is most to say for the negative. This Logos is not one above the world or prior to it, but in the world and inseparable from it. Man's soul is a part of it. It is relation, therefore, as Friedrich Schleiermacher expresses it, or reason, not speech or word. And it is objective, not subjective, reason. Like a law of nature, objective in the world. it gives order and regularity to the movement of things and makes the system rational.

The failure of Heraclitus to free himself entirely from the physical hypotheses of earlier times prevented his speculation from influencing his successors. With Anaxagoras a conception entered which gradually triumphed over that of Heraclitus, namely, the conception of a supreme, intellectual principle, not identified with the world but independent of it. This however was *nous*, not Logos. In the Platonic and Aristotelian systems too the theory of ideas involved an absolute separation between the material world and the world of higher reality, and though the term Logos is found the conception is vague.

With Plato the term selected for the expression of the principle to which the order visible in the universe is due is *nous* or *sophia,* not logos. It is in the pseudo-Platonic *Epinomis* that logos appears as a synonym for *nous.* In Aristotle again, the principle which sets all nature under the rule of thought, and directs it toward a rational end, is *nous,* or the divine spirit itself; while logos is a term with many senses, used as more or less identical with a number of phrases, hou *heneka* ("final cause"), energeia, *entelecheia,* ousia, eidos, *morphe,* etc.

The Stoics.—In the reaction from Platonic dualism, however, the Logos doctrine reappears in great breadth and is a capital element in the system of the Stoics (*q.v.*). With their teleological views of the world they naturally predicated an active principle pervading it and determining it. This operative principle is called both Logos and God. It is conceived of as material and is described in terms used equally of nature and of God. There is at the same time. the special doctrine of the logos *spermatikos,* the seminal Logos, or the law of generation in the world, the principle of the active reason working in dead matter. This parts into logoi *spermatikoi,* which are akin, not to the Platonic ideas, but rather to the "material" logoi of Aristotle. In man too there is a Logos which is his characteristic possession, and which is *endiathetos,* as long as it is a thought resident within his breast, but *prophorikos* when it is expressed as a word. This distinction between Logos as ratio (reason) and Logos as oratio (oratory), so much used subsequently by Philo and the Christian fathers, had been so far anticipated by Aristotle's distinction between the "outside" logos and the logos "in the soul." It forms the point of attachment by which the Logos doctrine connected itself with Christianity. The Logos of the Stoics is a reason in the world gifted with intelligence, and analogous to the reason in man.

(X.)

THE LOGOS IN JUDAISM AND CHRISTIANITY

The problem of the Logos in the New Testament is that the fourth evangelist, in opening his Gospel with the statement, "In the beginning was the Word" (Logos), is undoubtedly recalling the opening words of Genesis, "In the beginning God created the heaven and the earth, ... And God said . . . ." but, in using the Logos absolutely to denote a divine hypostasis, is employing the term in a manner which is without parallel in the Bible and cannot be derived directly from the Old Testament.

The Hebrew Logos.—In the Old Testament "the word of the Lord" is another way of saying "God speaks," and means any communication of God to man, especially through a prophet (II Sam. xxiii, 2). "The word of the Lord came to . . ." can stand at the head of a prophetic book. In Hebrew thought the word carried with it the idea of activity and power. The word does not describe or comment, but effects what it utters (Isa. lv, 10–11). It judges, destroys and delivers (Jer. v, 14; Ps. cvii, 20). It is thought of as having a quasi-independent existence and an inherent power, especially in blessing and cursing (Zech. v, 3–4).

Alongside the word in the prophets, which is occasional, appears later the word in the Law, which is authoritative for all Israel for all time (Deut. xxx. 11 ff.). Later still the activity of the word in revelation is extended to cover the work of creation (Ps. xxxiii, 9). Subsequently Judaism sought to avoid anthropomorphism and stressed the transcendence of God over His creation, but maintained His contact with the world and His activity in creation and revelation by postulating divine agents, Wisdom, Word and Torah (Law). In the successive stages of the Wisdom literature a doctrine of Wisdom (grammatically feminine in gender) is developed. She has some sort of independent existence, is the divine artificer and draws men to God (Prov. viii, 14 ff.); she is identified with her supreme manifestation among the nations, namely the Torah possessed by Israel (Ecclus. xxiv, 7–23); and she is herself the presence of God, is before all light and is identified with the word of God (Wisdom of Solomon vii, 22–30, ix, 1–2, xviii, 15). The identification of Wisdom with Torah was particularly the work of the rabbis, who speak of the Law in personal terms as divine and pre-existent with God, as light and life and as the source of truth. It is possible to parallel most of the statements about the Logos in the Johannine prologue with almost identical statements made either about Wisdom in the Wisdom literature or about the Torah in the rabbinic writings. While these agencies are to a greater or lesser degree personified, Jewish thought stopped short of hypostatization, and they are not conceived as independent metaphysical entities. The Johannine Logos is such an entity and would therefore appear to have its origin in a wider sphere than the Old Testament or orthodox Judaism. Its introduction in the prologue without explanation indicates that readers were expected to be familiar with it and that it had a considerable currency. Such a currency would correspond with the philosophical eclecticism and religious syncretism of the period.

Philo and Hellenistic Religion.—A notable example of such syncretism from the Jewish side was the Alexandrian Jew Philo (*q.v.*). He was not an original thinker but a compiler and. to judge from signs that he has incorporated material from predecessors in the same field. is the sole survivor of a widespread Jewish "philosophy" centred on, but not confined to, Alexandria. It aimed at converting the Greek world by presenting Judaism as the true philosophy by means of an allegorical and speculative interpretation of the Old Testament. (See JEWISH PHILOSOPHY.)

In Philo's voluminous works the term Logos occurs about 1,300 times, but it is impossible to harmonize the bewildering variety of his statements about the Logos into a single and consistent doctrine. At times he is dependent on Stoicism (*e.g.,* for such concepts as "the seminal Logos" and the "immanent and expressed Logos") but, unlike the more consistent type of Stoicism, differentiates the Logos from God as His work or image (De *specialibus* legibus, i, 81). He is dependent on Platonism when he identifies the Logos with the *kosmos* noefos or intellectual universe as a model for creation, or with the *topos* ("place") of the ideas considered as expressions of the mind of God. In general, Philo's Logos is a cosmological principle and, despite its frequency, hardly plays a living part in his theology, being an accommodation to Greek thought with the purpose of distinguishing between God as existing in Himself and God as acting toward the cosmos. Although he speaks of it in personal terms (*e.g.,* as first-born son), the Logos can hardly be said to be personified, except where, in exposition of Old Testament texts, it is identified with figures such as Aaron and Melchizedek. The Logos is divine but not God, is with God, is light (De *somniis,* i, 75), water (De posteritate *Caini,* 127), manna (Legum allegoriae, iii, 172 ff.) and shepherd (De *agricultura,* 51). Thus there is a close similarity of symbolism between Philo and the fourth evangelist, and they move in the same world of thought; but a comparison of their writings makes any direct dependence highly improbable. Philo speaks generally of "the divine Logos" or "the Logos of God" rather than of "the Logos" absolutely.

The evidence of syncretistic religion outside Hellenistic Judaism is difficult to assess. being found in, or deduced from, sources which are widely different in character and of disputed date (*e.g.,* the *Hermetica* and the Mandaean literature), are generally later than the 1st century A.D. and may in some cases be Christian or have been exposed to Christian or to Jewish influence. Moreover, fresh material, as it becomes available, tends to modify previous judgments. Thus the view that the Aramaic *memra* ("word") in the Targums on the Old Testament provides no parallel to the Johannine Logos is certainly correct, since the *memra* in the Targums is not a divine hypostasis but a theological device for avoiding the mention of the divine name; yet the "Gospel of Truth" discovered in the Jung codex contains elaborate speculation on the divine name as a divine hypostasis, which may go back to a 1st-century Judaism of a more heterodox kind than that of the Targums. Second-century Gnostic systems exhibit a mythological figure under various guises: such as Son of God, Image of God, *Nous, Anthropos,* among which is Logos. This figure has a cosmological function as mediator between the unknowable God and the world, brings gnosis to men and, in some cases, rescues men from a hostile world. The fourth Gospel has this element of emphasis on the function of Logos as Saviour in common with such systems, as well as a general similarity of language and ideas, but lacks their speculation or polemic on the origin of the world or of darkness, and is not likely to be dependent on them. In Gnosticism Logos is one among many aeons, while the Johannine Logos is the one and only mediator.

The New Testament. — The affinities of the fourth Gospel may thus be various, but the clearest allusions are to Genesis, Wisdom and the Torah. Such polemic as there is in the prologue concerns the relation between the Logos and the Torah. This is evident from the conjunction of the statements that the incarnate Logos was "full of grace and truth" and that "the law was given by Moses, but grace and truth came by Jesus Christ" (i, 14–17). The character and functions of the Torah as pre-existent with God. as the source of life and the illumination of men, are transferred to Jesus. and thereby the Logos is for the first time fully personified. The term Logos will then owe less to current philosophical and religious speculation than to Christian theological reflection upon the person of Christ. The same path was trodden by other New Testament writers to the point where they might well have used the term itself. For St. Paul the Gospel is the word of God, which is also the word of Christ (II Cor. ii, 17; Col. iii. 16), which is Christ Himself, in whom the fullness of the Godhead dwells (Col. i, 25–27, ii, 9) and who is the agent of creation (I Cor. viii, 6). In the Epistle to the Hebrews Jesus, who qualifies by an earthly career for an eternal priesthood, is presented as the author and sustainer of the universe and as the image of God (Heb. i, 1–4); and the author of the Apocalypse (Rev. xix, 13) identifies the exalted Christ with the Word of God, which elsewhere in his book means the revelation of God through Christ. The fourth Gospel represents the climax of such theological reflection. In this Gospel outside the prologue *logos* is used of individual statements made by Jesus (ii, 19–22); these are not, however. sporadic statements, but constitute together a single *logos* or message, which conveys truth and eternal life (v, 24, viii, 31, 43) and which is itself the *logos* of God (xiv, 24, xvii, 14). Further, for the evangelist this *logos* is not simply that which Jesus proclaims, but is inseparable from His person; He is the content of His own message and is Himself the light, life and truth which He gives. Thus the identification of Jesus with the Logos is a short and almost inevitable step and will have been taken, not by way of applying current metaphysical thought to the Gospel, but in order to present in its widest cosmic significance—no doubt by means of a term which would be widely recognized—the person of Christ as Son of God and revealer of the Father.

Although the title Logos is confined to the prologue this does not imply that the prologue is an afterthought loosely attached to the Gospel, since what is predicated of the Logos in the prologue, viz., that he is pre-existent, life, light, is rejected by his own and gives grace and truth to those who receive him. is predicated of Jesus in the Gospel.

The Early Church. — The Logos doctrine which played a major, and in some respects an unfortunate, role in the earliest attempts of the primitive church to state Trinitarian belief mas not a further development of the thought of the fourth Gospel but represents an importation from current philosophical thought and terminology. This was due to the apologists, whose aim in the face of a hostile world was to make the divinity of Christ intelligible to that world, to claim the world for Christ as its creator and to set forth Christianity as superior to, or the heir to, all that was best in pagan philosophy. Christ as the pre-existent Logos (1) reveals the Father to men and is the subject of the Old Testament manifestations of God; (2) is the divine reason in which the whole human race shares, so that Socrates and others who lived with reason were Christians before Christ; and (3) is the divine will and word by which the worlds were framed. Theophilus borrows the Stoic terms "immanent" and "expressed" Logos to denote Christ first as pre-existent with God before creation and then as uttered or generated for the purpose of creation; and the same idea is present in Athenagoras.

The apologists tended to start with Christ as a cosmological figure rather than as the revealer of the Father or as redeemer, and it was impossible for them to avoid an impersonal conception of Him as an attribute or function of God, or as a thought in the mind of God, which acquired self-expression and personality only in being uttered for the purpose of creation. They therefore inevitably subordinated him to God. Justin describes the Logos as flame derived from fire and as "numerically another thing." Subordination was carried further by Origen, who starts from a Greek philosophical conception of God as passionless and incomprehensible and, in attempting to do justice to such passages of Scripture as "the Father that sent me is greater than I," differentiates God as "cause" from the Logos as "caused" and calls the latter "a creature." although this was mitigated by his doctrine that the Son is eternally generated by the Father. Arianism pushed one side of Origen's thought to extremes and, working almost exclusively with the pagan idea of God as the immutable absolute and concentrating entirely on the cosmic function of the Logos, declared that since the Logos was susceptible of suffering he could not be God and that there was a time when he did not exist. Meanwhile there was another doctrine of the Logos in the church which was eventually able to escape the dangers of subordinationism. The Logos does not appear to have figured greatly in Gnosticism until Basilides, Valentinus and Heracleon, who were under Christian influence. It was possibly in opposition to their systems that St. Irenaeus and Tertullian developed a doctrine which started from Christ as the Son who reveals the Father through incarnation and redemption and used the term Logos for the more limited purpose of relating Christ as Son to the universe as its creator. It was this tradition in Athanasius and his followers which, when combined with Origen's doctrine of the eternal generation of the Son, led to the defeat of Arianism and ultimately to the conclusion that the scriptural and specifically Christian understanding of the Godhead was better expressed in terms of the relation of an eternally begotten Son to the Father than in terms of the relation of a pre-existent Logos to God.

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LOGOTHETE, originally the title of a variety of administrative officials in the Byzantine empire; *e.g.,* the official who was practically the equivalent of the modern postmaster general; and the logothete of the military chest. Gibbon defines the great logothete as "the supreme guardian of the laws and revenues" who "is compared with the chancellor of the Latin monarchies." From the eastern empire the title was borrowed by the west, though it only became firmly established in Sicily. where the *logotheta* occupied the position of chancellor elsewhere, his office being equal if not superior to that of the *magnus cancellarius.*

LOGROÑO, an inland province of northern Spain, the smallest of the eight provinces formed in 1833 out of Old Castile; bounded north by Burgos, Álava and Navarre, west by Burgos, south by Soria and east by Navarre and Saragossa. Pop. (1950) 231,010; area, 1.946 sq.mi. The portion skirting the Ebro forms a spacious and for the most part fertile undulating plain, called La Rioja. In the west the Cerro de San Lorenzo. the culminating point of the Sierra de la Demanda, rises 7,421 ft., and in the south the Pico de Urbion reaches 7,310 ft. The products of the province are chiefly cereals, good oil and wine (especially in the Rioja), fruit, silk. flax and honey. Large tracts of country are covered with vines and olive groves. Iron and argentiferous lead are mined in small quantities. A railway along the right bank of the Ebro connects the province with Saragossa. and from Miranda there is railway communication with Madrid, Bilbao and France. Besides Logrofio and Calahorra (*qq.v.*) the only municipalities with over 6,000 inhabitants are Haro (8,594) and Alfaro (8,097).

LOGROÑO, the capital of the Spanish province of Logrofio, on the right bank of the Ebro river and on the Saragossa-Miranda de Ebro railway. Pop. (1950) 50,080 (mun). The district was in ancient times inhabited by the Berones or Verones of Strabo and Pliny. and their Varia is identified with the modern suburb of the city of Logroiio now known as Varea. Logrofio nas named by the Romans Juliobriga and afterward Lucronius. It was unsuccessfully besieged by the French in 1521, and occupied by them from 1808 to 1813. Nationalists captured it during the civil war of 1936–39.

Logroño is an ancient walled town, finely situated on a hill 1,204 ft. high. Its bridge of 12 arches across the Ebro was built in 1138, but has frequently been restored. The crooked but picturesque alleys of the older quarters are in striking contrast with the broad avenues and squares laid out in modern times. Commercial centre of the fertile plain of the Rioja, Logroño has an important trade in wine.

LOGROSCINO (or Lo Groscino), **NICOLA** (1700?–1763?), Italian musical composer, who is remembered for his comic operas, mas born at Naples and was a pupil of Francesco Durante. In 1738 he collaborated with Leonardo Leo and others in the hasty production of *Demetrio;* in the autumn of the same year he produced *L'Inganno per inganno,* the first of a long series of successful comic operas.

He went to Palermo, probably in 1747, as a teacher of counterpoint; as an opera composer he is last heard of in 1760, and is supposed to have died about 1763.

LOGUE, MICHAEL (1840–1924), Irish ecclesiastic, was born at Kilmacrenan, County Donegal, on Oct. 1, 1840. He was appointed professor of theology and belles-lettres at the Irish college in Paris, where he was ordained a priest in 1866. He became bishop of Raphoe in 1879, archbishop of Armagh in 1887 and in 1893 was raised to the cardinalate. During World War I he deprecated participation by the clergy in Sinn Fein agitations, but in 1918 opposed conscription on moral grounds. In 1919 and 1921 he rigorously denounced campaigns against the police and the military, at the same time criticizing severely the policy and methods of the British government. He died at Armagh on Nov. 19. 1924.

LOGWOOD, a dyestuff for fabrics made from fibres of vegetable origin. Logwood comes into commerce in blocks which are hard and dense and possess a brown-red colour. It was imported into Europe soon after the discovery of South America, and mas cultivated in Jamaica from 171j. Logwood is the heartwood of the *Haematoxylon campechianum* (family Leguminosae), a tree distinguished by its peculiar ribbed appearance. It has been largely employed for the production of black and compound shades on woolen material, mainly in conjunction with a chromium mordant, and for the black dyeing of silk.

"Logwood extract." obtained by lixiviating the freshly cut wood with water and evaporating the solution *in vacuo,* and manufactured in the neighbourhood of the plantations, was exported for dyeing purposes.

Logwood contains the colouring principle haematoxylin, $C_{16}H_{14}O_6 \cdot 3H_2O$, which was first isolated by M. E. Chevreul in 1810. This, which is not a dyestuff, when oxidized readily passes into hematein, $C_{16}H_{12}O_6$, the true colouring matter. Such an oxidizing process has been applied to logwood extract, and the so-called hematein paste is a product of this character. Unaged extracts can, however, also be employed for dyeing when an oxidizing mordant is employed. The constitution of haematoxylin and hematein was elucidated by W. H. Perkins, R. Robinson and their pupils. (A. G. P.)

LOHENGRIN, the knight of the swan, hero of the German version of a legend widely known in literature from the middle ages onward. The legend assumes different forms in different literatures. but the common framework, the oldest part of which probably derives from the fairy tale "The Seven Swans," is the story of a mysterious knight who arrives in a boat drawn by a swan to protect a noble lady in distress, defeats her enemy and marries her, forbidding her, however, to ask his origin or his name; she later forgets her promise, and he leaves her, never to return.

The original home of the legend is unknown. The earliest known reference to it occurs in the 12th-century history of the crusades by William of Tyre, the source of the French version. In this *Roman du chevalier au cygne,* one of the *chansons de geste* (*q.v.*) based on the first crusade, the knight of the swan is called Hell-as. He is the son of King Oriant of Lillefort, and the story of his brothers' metamorphosis into swans and his own escape from this fate follows the tale of the seven swans persecuted by a wicked grandmother. Helyas marries Beatrix of Bouillon in circumstances parallel to those in which Lohengrin marries Elsa of Brabant *(see* below). Their grandson, Godfrey, becomes ruler of Jerusalem: and from this historical event stems the adaptation of the whole story to the glorification of the house of Bouillon.

In English, a late 14th-century alliterative romance, *Chevalere Assigne,* retells the first part of the *Roman du chcvalicr au cygne* and takes over the explanation that one of the knight's brothers did not regain human shape but remained a swan, accompanying his brother Enyas (the "Chevalere Assigne") on his travels. The same story is told in the opening of *Helyas— Knyght of the Swanne,* a prose romance adapted from the French by Robert Copland in 1512, which relates the history of the knight, his brother the swan and his marriage into the Bouillon family.

The German story first appears at the end of Wolfram von Eschenbach's epic *Parzival* (c. 1210). Elsa, a young princess of Brabant, refuses all offers of marriage, saying that she will only give herself to a man sent by God. From the temple of the Holy Grail arrives a knight in a boat pulled by a swan, and he is hailed by the princess as her God-sent husband. He marries her. but makes her promise that she will not ask his name or origin. She pledges her word but some years later asks the forbidden question. The swan returns, and the knight goes back to the Grail castle. His name was Loherangrin, the son of Parzival. king of the Grail.

The story is expanded into an epic of some 760 strophes in the anonymous Middle High German *Lohengrin.* This was the main source used by Wagner for his opera. The opening is in a Thuringian dialect but most of the poem is the work of a Bavarian poet who gives the story a historical context in the age of the German king Henry the Fowler (876?–936) and elaborates the realistic content at the expense of the romantic legend. *Lohengrin,* composed between 127j and 1290, is related to the contemporary poem known as the *Wartburgkrieg:* here the story is put into the mouth of Wolfram von Eschenbach who is made to recite it during the famous singers' contest at the Wartburg, seat of the Thuringian landgraves: certain gaps in the story of the *Wartburgkrieg* can be filled from passages in *Lohengrin;* and the ten-line stanza known as *Klingsors Schwarzer Ton* is common to both morks. Other medieval German versions of the story, which ultimately rest on the same passage from Wolfram's *Parzival,* include Konrad von Wiirzburg's *Schwanritter* (based on a French model) and the anonymous 15th-century epic *Lorengel,* which still uses *Klingsors Schwarzer Ton.*

Through its alignment with a specific historical period, its integration into the Wartburg story and its association with the Holy Grail and thence with the Xrthurian legend, the Lohengrin story has become part of German popular tradition. In particular it has become linked with the town of Cleves, whose rulers took the swan as their crest, and where the *Schwanenturm* on the castle and a statue of the knight and his swan perpetuate its memory.

See R. Jaffray, *The Two Knights of the Swan* (1910); *R.* Heinrichs, *Die Lohengrindichtung und ihre Deutung* (1905). Both contain details of text editions and further critical studies. (Rd. J. T.)

LOIN, that part of an animal lying between the upper part of the hipbone and the last of the false ribs on either side of the backbone; hence the butcher's term for a piece of meat cut from that part of the body. The upper part of a loin of beef is known as the "surloin," commonly corrupted into "sirloin." In the plural the word is a term for the lower part of the human body at the junction with the legs. It is more or less synonymous with flank, or that portion of the body bounded by the lower ribs, the backbone and the pelvis.

LOIRE, a department of central France, made up in 1793 of the old district of Forez and portions of Beaujolais and Lyonnais, all formerly included in the province of Lyonnais. Population (1954) 654,482. Area 1,853 sq.mi. It is bounded north by the department of Saône-et-Loire, east by those of RhBne and Isère, south by Ardèche and Haute-Loire and west by Puy-de-Dôme and Allier. From 1790 to 1793 it constituted, along with that of RhBne, a single department (Rhône-et-Loire). The Loire river rises in the department of Haute Loire to the south but traverses the department of Loire from south to north, and that department reaches west to the Mts. du Forez and east to the hills edging the Rhône valley, going beyond these to reach that river just south of Vienne. The valley floor in the south is the basin of Forez, an ancient lake floored by Tertiary strata, and the Loire, after subsequently passing through narrow defiles, enters the smaller basin of Roanne, also an old lake basin similarly floored. The hill frame is mainly formed of Archaean and Carboniferous rocks set in north-east to south-west lines to form the Mt. Pilat (4,705 ft.), Mts. du Lyonnais, Mts. du Beaujolais and Mts. du Charolais on the east, and the Mts. du Forez (Pierre sur Haute, 5,381 ft.) on the west. The climate on the heights is cold and healthy, it is unwholesome in the marshy plain of Forez, mild in the valley of the Rhône. The annual rainfall varies from 39 to 48 in. on the Forez mountains, but only reaches 20 to 24 in. in the vicinity of Montbrison. The plains of Forez and Roanne produce wheat and rye, and some oats, barley and colza. The vine is cultivated in the valley of the Rhône, on the lower slopes of the Forez mountains and on the hills west of the plain of Roanne. The forests of Mt. Pilat and the Forez chain yield good-sized pines and wood for mining purposes. The so-called Lyon chestnuts are to a large extent obtained from Forez; the woods and pasture lands of Mt. Pilat yield medicinal plants, such as mint. The pasture lands of the plain and mountains of Forez support live stock, notably the famous Charolais oxen. Poultry-rearing and bee-keeping are considerable industries. The department is rich in mineral springs, the waters of St. Galmier, Sail-sous-Couzan, St. Romain-le-Puy and St. Alban being largely exported. The chief wealth of the department lies in the coal deposits of the basin of St. Étienne (*q.v.*), the second in importance in France; quarrying is also active. Metal-working industries are centred in the south-east of the department, where are the great manufacturing towns of St. Étienne, Rive-de-Gier, St. Chamond and Firminy. At St. Étienne there is a national factory of arms, in which as many as 10,000 were employed; it makes cycles, motorcars, dynamos and accessories for electric lighting, apparatus for making acetylene gas, locks, edge-tools, common cutlery, chain cables for the mines, files, rails, etc. The glass industry is carried on at Rive-de-Gier and St. Galmier. St. Étienne and St. Chamond are centres for the fabrication of silk ribbons, elastic ribbons and laces, and the dressing of raw silks. The arrondissement of Roanne manufactures cotton stuffs, muslins and the like. That of Montbrison produces table linen. The department has numerous dye-works, flour-mills, paper works, tanyards, brickworks, silk-spinning works and hat factories. It is served by the P.L.M railway, Roanne being the junction of important lines from Paris to Lyon and St. Btienne. Within the department the Loire is hardly used for commercial navigation; there are canals from Roanne to Digoin (13 mi. in the department), and from Givors to Rive-de-Gier (7 mi.) and the Rhone (7 mi.).

Loire comprises three arrondissements—St. Étienne, Montbrison and Roanne—with 32 cantons and 338 communes. It is in the region of the XIII army corps (Clermont-Ferrand) and the *diocèse* and *académie* (educational division) of Lyon, where also is its court of appeal. St. Étienne is the capital, other leading towns being Roanne, Montbrison, Rive-de-Gier, St. Chamond, Firminy and Le Chambon. St. Bonnet-le-Château, besides old houses, has a church of the 15th and 16th centuries, containing paintings of the 15th century; St. Rambert and St. Romain-le-Puy have priory churches of the 11th century; and at Charlieu there are remains of a Benedictine abbey founded in the 9th century, including a porch decorated with fine Romanesque carving, old houses, etc.

LOIRE, the longest river of France, rising at 4,500 ft. in the recent volcanic peak of Gerbier de Jonc on the central plateau, and flowing north and west to the Atlantic. After a course of 18 m. it follows a picturesque channel along the foot of the basaltic rocks of Le Puy district, through narrow gorges and small plains. At Vorey, it is joined by the Arzon (left) and becomes navigable for rafts. The north-westerly direction of the Loire and its affluent the Allier is due to a tilting of the central plateau of France in Tertiary times so that the river valleys are filled with Tertiary deposits, on to which the Loire flows after passing the gorges of St. Victor. It again penetrates the hills of Carboniferous rocks before reaching the plain of Roanne. In this course it is joined by a large number of streams, the most important being the Coise (right), the Lignon du Nord and the Aix (left). Below Roanne the Loire is accompanied by a canal to Digoin (35 m.), thence by the so-called "lateral canal of the Loire" to Briare (122 m.).

At Digoin the Loire receives the Arroux, and gives off the canal du Centre (which utilizes the valley of the Bourbince) to Chalon-sur-Saône. Before reaching Nevers the Loire passes off the central plateau and on to the Jurassic rocks which form the rim of the Paris basin, over which rocks it flows in a northerly direction. Just beyond Nevers it is joined by the Allier (left); this river rises 30 m. S.W. of the Loire and follows an almost parallel course. Above Nevers the Loire is joined by the Aron (right), along which a canal proceeds northward, and below the confluence of the Allier gives off the canal du Berry to Bourges. Near Sancerre the river leaves the Jurassic rocks and has worn a valley through the Cretaceous uplands. At Briare it gives off a canal northward to the Seine. Between Gien and Blois the river flows in a wide arc across the Tertiary rocks of the Paris basin, passing Orléans, whence the canal d'Orléans, following the river Cens, communicates with the Briare canal. Passing Blois the Loire receives (right) the Cisse, and, after passing Tours, the three important left-hand tributaries of the Cher, Indre and the Vienne. Below Saumur it is frequently divided by long sandy islands fringed with osiers and willows; while upon arriving at Les Ponts-de-Cé (south of Angers) it is split into several distinct branches and studded with islands. At Angers it passes off the Cretaceous and on to the Palaeozoic and Archaean rocks of the Armorican massif.

The principal tributaries are: left, the Thouet at Saumur, the Layon and the Evre; right: the Authion, and, most important tributary of all, the Maine, formed by the junction of the rivers Mayenne, Sarthe and Loir. It receives the Erdre (right) at Nantes and the Sèvre-Nantaise (left), and farther on the canalized Achenau (left) and the navigable Etier de Méan (right) near St. Nazaire. Below Nantes, between which point and La Martinière (below Pellerin) the channel is embanked, the river is known as the Loire Maritime and widens out between marshy shores, passing Paimboeuf on the left and finally St. Nazaire, where it is $1\frac{1}{2}$ m. broad. The length of the channel of the Loire is about 625 m A lateral canal, known as the Maritime canal of the Loire, between Le Carnet and La Martinière enables large ships to ascend to Nantes. It is $9\frac{1}{2}$ m long, and $19\frac{1}{2}$ (capable of being increased to 24) ft. deep. At each end is a lock 405 ft. long by 59 ft. wide. The canal de Nantes à Brest connects this city with Brest.

The Loire is navigable only in a very limited sense. During the drought of summer thin and feeble streams thread their way between the sandbanks of the channel; while at other times a stupendous flood submerges wide reaches of land. When the flood waters of two or more tributaries arrive serious inundations result. Attempts to control the river began at a very early date, and in the middle ages the bed between Orléans and Angers was enclosed by dykes 10 to 13 ft. high. In 1783 a double line of dykes 23 ft. high was completed from Bec d'Allier downwards. In modern times embankments, aided by dredging operations extending over a large number of years, have ensured a depth of 18 ft. in the channel between La Martinière and Nantes Several towns have constructed special works to defend themselves against the floods; Tours, the most exposed of all, being surrounded by a circular dyke; and in the upper Loire reservoirs have been constructed to store flood waters.

LOIRE-INFÉRIEURE, a maritime department of France, made up in 1790 of a portion of Brittany on the right and of the district of Retz on the left of the Loire, and bounded west by the ocean, north by Morbihan and Ille-et-Vilaine, east by Maine-et-Loire and south by Vendée. Pop. (1936) 659,428. Area 2.695 sq.mi. The department consists of flat land on each side of the estuary of the Loire, and its suriace is varied oniy by the presence of weak ribs running west-north-west and east-south-east and continuing those of Brittany; the northernmost one, on the borders of Ille-et-Vilaine, reaches 377 ft., the *Sillon* *de Bretagne* stretching on the right bank of the estuary from Nantes towards the Vilaine hardly exceeds 250 ft. Seaward from the *Sillon,* and behind St. Nazaire, are peat-bogs including Grande Brikre which recently supplied old trees for joiners' work; near the coast are large salt-marshes, with Guérande as a salt-refining centre. The district south of the Loire lies equally low; its most salient feature is the lake of Grandlieu, covering 27 sq m., and surrounded by low and marshy ground, but so shallow (6½ ft. at most) that drainage would be comparatively easy. Canals are an important feature of the department, and the Nantes to Brest canal uses the Erdre up to within four m. of Nort, where it crosses to a tributary of the Vilaine. The south side of the Loire estuary has been canalized from Le Pellerin to Paimboeuf, and vessels drawing over 21 ft. can reach Nantes The climate is equable and drier than that of Brittany. At Nantes the mean annual temperature is 54·7°, the annual rainfall being 25.6 inches.

Horse, mule and cattle raising prospers. Good butter and cheese are produced. Poultry also is reared, and there is a good deal of bee-keeping. Much wheat, oats, buckwheat, potatoes and root-crops are grown, also leguminous plants, especially near Nantes. Vines and cider apples are grown. The woods are of oak in the interior and pine on the coast. Some iron is extracted in the department. North-west of Ancenis coal is obtained The granite of the sea-coast and of the Loire up to Nantes is quarried. Steam-engines are built for the navy at Indret, below Nantes; the forges of Basse-Indre are famous for their iron; and large quantities of lead are smelted at Coueron. There are considerable foundries at Nantes, Chantenay and St. Nazaire, and shipbuilding yards at Nantes and St. Nazaire. Pickles and preserved meats are prepared at Nantes, sardines cured at Le Croisic, which is the centre of the fishing industry, and in the neighbouring *communes,and sugar, brushes, macaroni and similar foods, soap and chemicals are made at Nantes, and paper, sugar and soap at Chantenay. The department is served by State railways, the Orleans company and the Western company. The department is divided into the three arrondissements of Nantes, Châteaubriant and St. Nazaire. There are 46 cantons and 220 communes. The appeal court is at Rennes, where is also the centre of the *académie* (educational division), to which it belongs. It is in the region of the XI army corps (Loire. Inf.) (Nantes), and forms the bishopric of Nantes under the archbishop of Tours.

The principal places are Nantes, the capital, St. Nazaire and Chbteaubriant. On the west coast the town of Batz, and neighbouring villages, are inhabited by a small community with a distinct costume and dialect, claiming descent from a Saxon or Scandinavian stock. Guérande has well-preserved ramparts and 15th century pates, a church dating from the 12th to the 16th centuries and other old buildings. At St. Philbert-de-Grandlieu there is a church with portions belonging to the beginning of the 11th century. Cisson has a 13th century castle and a market-hall built of wood. There are many megalithic monuments in the department.

LOIRET, a department of central France, made up of the three districts of the ancient province of Orléanais—Orléanais proper, Gâtinais, and Dunois. It is bounded north by Seine-et-Oise, north-east by Seine-et-Marne, east by Yonne. south by Nièvre and Cher, south-west and west by Loir-et-Cher and north-west by Eure-et-Loir. Area, 2,630 sq mi. Pop. (1936) 343,865. The department is a plain drained by the Loire from east to west, receiving the Loiret in the west on its left bank; this stream is only a few miles long, but so large that it is supposed to be an underground branch of the Loire. Towards the north the drainage is to the Seine by the Essonne and the Loing. The Sologne *(see* LOIR-ET-CHER) and the Beauce *(see* EURE-ET-LOIR) extend into the department on the south-west and north-west respectively. In the east is La Gâtine (capital Montargis), a region of wildernesses producing saffron and honey. The historic forest north of Orléans is slowly giving place to arable land. The lateral canal of the Loire from Roanne stops at Briare, from which town the *canal de Briare* connects with the Seine by the Loing valley, which is joined by the Orléans canal below Montargis The mean temperature is a little above that of Paris; the rainfall varies from 18·5 in. in the exposed Beauce to 27·5 in. in the well-wooded Sologne. Hailstorms cause destruction in the Loire valley and the neighbouring regions.

Sheep, cattle, horses, pigs, poultry, especially geese, and bees are reared. The chief cereals are wheat and oats, rye, barley, meslin, buckwheat; potatoes, beetroot, colza and forage plants and vines are grown, largely for vinegar. The woods consist of oak, elm, birch and pine; fruit trees thrive in the department, and Orleans is a great centre of nursery gardens. Gien is an important centre for the manufacture of faience. Porcelain buttons and beads are made at Briare. There are iron and copper foundries, which make agricultural and other implements. There are wool-spinning and wool manufacture carried on. The two arrondissements are those of Orleans and Montargis, with 31 cantons and 349 communes. The department forms part of the *académie* (educational division) of Paris. It forms also the bishopric of Orléans under the archbishops of Paris. It is in the military region of the Xth Army Corps (Orléans); and has its court of appeal at Orléans. The churches of Cléry (15th century), of Ferrières (13th and 14th centuries) of Puiseaux (12th and 13th centuries) and Meung (12th century) are interesting. At Germigny-des-Prés there is a church built originally at the beginning of the 9th century and rebuilt in the 19th century, on the old plan and to some extent with the old materials. Yèvre-le-Châtel has an interesting 13th century chbteau, and Sully-sur-Loire the fine mediaeval château rebuilt at the beginning of the 17th century by Maximilien de Béthune, duke of Sully, the famous minister of Henry IV. There are remains of a Gallo-Roman town (perhaps the ancient *Vellaunodunum)* at Trigukres and of a Roman amphitheatre near Montbouy.

LOIR-ET-CHER, a department of central France, formed in 1790 from a small portion of Touraine, the Perche, but chiefly from the Dunois, Vendômois and Blésois, portions of Orléanais. It is bounded N. by Eure-et-Loir, N.E. by Loiret, S.E. by Cher, S. by Indre, S.W. by Indre-et-Loire and N.W. by Sarthe. Pop. (1936) 240,908. Area, 2,479 sq.mi. The department stretches from the river Cher in the south through the one-time marshy Sologne, now largely drained, and across the Loire to the south-east corner of the hills of Perche, rising in the department to 840 ft., and draining to the Loir which flows westwards to join the Maine above Angers. Between Loir and Loire is the southern part of the Beauce *(see* EURE-ET-LOIR). In the tufa walls here and there in the valleys of Cher and Loir dwellings have been excavated, as at Les Roches in the Loir valley. The Sologne is famous for hunting and fishing. The Loire and, with the help of the Berry canal, the Cher are navigable. The climate is temperate and mild, though that of the Beauce tends to dryness and that of the Sologne to dampness. The mean annual temperature is between 52° and 53°. The department is primarily agricultural. The northern region of the department yields abundant wheat and oats, besides rye and potatoes. Vines thrive on the valley slopes, the vineyards falling into four groups—those of the Cher, which yield fine red wines, the Sologne, the Blésois and the Vendômois. In the valleys fruit-trees and nursery gardens are numerous; the asparagus of Romorantin and Vendôme is well-known. The Sologne supplies pine and birch for fuel, and there are extensive forests around Blois and on both sides of the Loir. There is good pasture in the valleys. Sheep are the chief stock; the Perche breed of horses is famous for lightness and strength. Formerly the speciality of Loir-et-Cher was the production of gun-flints. Stone-quarries are numerous. The chief industries are cloth-manufacture, leather-dressing, glove-making, lime-burning, the manufacture of "sabots" and boots and shoes, hosiery and linen goods. The department is served chiefly by the Orléans railway.

The arrondissements are those of Blois, Romorantin and Vendôme, with 24 cantons and 297 communes. Loir-et-Cher forms part of the educational division (académie) of Paris. Its court of appeal and the headquarters of the Xth army corps, to the regions of which it belongs, are at Orléans. Blois, the capital, the seat of a bishop under the archbishop of Paris, Vendôme, Romorantin and Chambord are the chief towns. In addition to those of Blois and Chambord there are numerous fine chbteaux in the department, of which that of Montrichard, with its 11th-century dungeon, that of Chaumont (15th and 16th centuries), and that of Cheverny (17th century) in the late Renaissance style are the most important. Those at St. Aignan, Lassay, Lavardin and Cellettes may also be mentioned. Churches wholly or in part Romanesque architecture were built at Faverolles, Selles-sur-Cher, St. Aignan and Suèvres. In the village of Trôo, close to ancient tumuli, was built a 12th-century church, and other surviving remains include those of a lazar house of the Romanesque period. There are several megaliths in the department.

LOISY, ALFRED FIRMIN (1857–1940), French Catholic theologian, was born at Ambrières in French Lorraine of peasant parents. The boy was sent into the ecclesiastical schools of St. Dizier, without any intention of a clerical career; but he decided for the priesthood, and in 1874 entered the Grand Séminaire of Chblons-sur-Marne. He was ordained priest in 1879. After being curé successively of two villages in that diocese, Loisy went in May 1881, to study and take a theological degree, to the Institut Catholique in Paris, where he ultimately became professor. He was dismissed from his professorship in 1893 in consequence of an article on "La Question biblique et I'inspiration des Ecritures" contributed by him to his bi-monthly review, *L'Enseignement biblique*. The promulgation of the papal bull *Providentissirnus Deus* by Leo XIII led him to discontinue the review. Meanwhile he had brought his *Les évangiles synoptiques* down to the confession of Peter. Loisy then became chaplain to a Dominican convent and a girls' school at Neuilly, but he soon resigned these appointments to continue his critical work in seclusion at Bellevue. A paper on "La Religion d'Israël" *(Revue du clerge' français,* Oct. 1900) was condemned by Archbishop Richard and by the pope. Loisy then began to lecture on biblical criticism at the École des Hautes Études Pratiques. Meanwhile he made a European reputation by his *L'Évangile et l'église* (1902, Eng. trans., 1903), which was a Catholic answer to Adolph von Harnack's *Wesen des Christentums.* The book was condemned by the archbishop, but Leo XIII declined to condemn the *Etudes évangéliques,* which appeared about the same time. But after the accession of Pius X, both these books, mith *Autour d'un petit livre* (1903) and *Le Quatrième Évangile* (1903), were placed on the Index. Loisy made a partial submission, which was regarded as unsatisfactory at Rome; he retired first to Dreux, then to his home in Lorraine.

But in 1908 he published the now completed *Les Évangiles synoptiques,* embodying the results of the "higher criticism" followed by *Simples Réflexions sur le décret Lamentabili et sur l'encyclique Pascendi.* The Holy Office pronounced the major excommunication on Loisy on March 7, 1908. From 1909 to 1932 Loisy was professor of church history at the Collège de France. His works include *L'Évangile selon Saint Marc* (1912); *Les mystères païens et le mystère chrétien* (1914); *Les actes des Apôtres* (1920); *L'Apocalypse de Jean* (1923). Loisy died June 1, 1940.

The Loisy controversy attracted great attention throughout Europe, and the literature is extensive. *See* Loisy's own *Autour d'un petit livre* (1903); A. Houtin, *La Question biblique au XIX^e Siècle* (1902); C. A. Briggs and F. von Hügel, *The Papal Commission and the Pentateuch* (1907).

LOJA (formerly written *Loxa),* a town of southern Spain, in the province of Granada, on the Granada-Algeciras railway. Pop. (1950) 30,056 (mun.). Loja, which has sometimes been identified mith the ancient *Ilipula*, or with the *Lacibi (Lacibis)* of Pliny and Ptolemy, first emerges in the Arab chronicles of 890. It was taken by Ferdinand III in 1226, but was soon afterward abandoned, and was not finally recaptured until 1486. The narrow and irregular streets of Loja wind up the sides of a steep hill surmounted by a Moorish citadel; many of the older buildings. including a fine Moorish bridge, were destroyed by an earthquake in 1884, although two churches of the early 16th century remained intact. An iron bridge spans the Genil river. which flows past the town on the north. Local products consist chiefly of coarse woolens. silk. paper. leather and salt.

LOKEREN, an important industrial town of Belgium between Ghent and Xntwerp (in East Flanders on the Durme). Pop. (1955 est.) 25,985. It lies at the southern point of the district called Waesland. It is sometimes called the "Garden of Belgium." The clayey-gravel nature of the soil and the dampness of the atmosphere are favourable to the cultivation of flax. Root crops have been grown there with great success since the 18th century. Industries include the spinning of wool, flax and hemp, and the manufacture of linen, canvas, etc.

LOKOIYA: *see* LOATUKO.

LOLLARDS, in late medieval England, a name given to holders of certain religious tenets deriving from the teachings of John Wycliffe (*q.v.*). The term comes from Middle Dutch *lollaerd*, "a mumbler" or "mutterer"; it had been applied before Wyclifie's time to the Flemish Beghards and other continental groups suspected of combining pious pretensions with heretical belief. As early as 1382 it was used in an anti-Wycliffite sermon by the Irish Cistercian Henry Crump, while in 1387 the bishop of Worcester, Henry Wakefield, gave it official currency in a mandate against five heretics.

Early History.—The earliest Lollard group consisted of the Oxford scholars who showed allegiance to Wycliffe's doctrines *c.* 1380; they were headed by Nicholas Hereford of Queen's college, to whom is attributed the first Lollard translation of the Scriptures. His associate Philip Repingdon, an Augustinian canon of St. Mary-in-the-Fields, probably carried the movement to Leicester. where by 1382 William Swinderby led a group of lay adherents and went forth to preach in neighbouring towns. Though Wycliffe himself was still writing at Lutterworth, no solid evidence supports the tradition that he personally sent out "poor preachers." In Nov. 1382 Archbishop William Courtenay assembled convocation at Oxford and there forced the academic Lollards into submission. Repingdon conformed with enthusiasm and ultimately, as bishop of Lincoln, became an active persecutor. Hereford was excommunicated, fled to Rome and appealed in vain against his sentence; arrested on his return, he recanted and by 1393 had also become a champion of orthodox belief. In 1390–92 Swinderby was still being pursued by authority and sheltered by sympathizers in the Welsh marches. At this stage the prime agent was Wycliffe's former secretary John Purvey, who probably compiled the second translation of the Bible, one far more attractive and idiomatic than that by Hereford. Despite Courtenay's apparent triumph, the sect continued to multiply among townsmen, merchants, gentry and even among the lower clergy. Several knights of the royal household gave their support, while vociferous partisans, concerned especially to disendow the church, emerged in the house of commons.

Lollard Beliefs.—The most complete statement of early Lollard teaching appears in the *Twelve Conclusions,* drawn up, originally in English, to be pressed upon the parliament of 1395. They began by stating that the church in England had become subservient to her "stepmother the great Church of Rome." The present priesthood was not the one ordained by Christ, while the Roman ritual of ordination had no warrant in Scripture. Clerical celibacy occasioned unnatural lust, while the "feigned miracle" of transubstantiation led men into idolatry. The hallowing of wine, bread, altars, vestments and so forth was related to necromancy. Prelates should not be temporal judges and rulers, for no man can serve two masters. The *Conclusions* also condemned special prayers for the dead, pilgrimages and offerings to images; they declared confession to a priest unnecessary to salvation. Warfare was "express contrarious to the New Testament, the which is a law of grace and full of mercy." Vo s of chastity by nuns led to the horrors of abortion and child murder. Finally, the multitude of unnecessary arts and crafts pursued in the church encouraged "waste, curiosity and disguising."

Though no particular manifesto ever commanded general adherence, the *Twelve Conclusions* cover all the main Lollard doctrines except two: that the prime duty of priests is to preach, and that all men should enjoy free access to the vernacular Scriptures. The movement's obvious attraction lay in this last provision and in its argument that the wealth, pride, ritualism and coercive powers of the church stood at variance with the recorded practices of Christ and the apostles. Its weaknesses sprang from bibliolatry and the vagaries of uninstructed private judgment. Though modern knowledge of Lollard extremist fundamentalism derives largely from such hostile writers as Bishop Reginald Pecock and Thomas Netter, the movement inevitably acquired a fringe of cranks. From its early days it also tended to discard the scholastic subtleties of Wycliffe, who probably wrote few or none of the popular tracts in English formerly attributed to him.

Fluctuations During the 15th Century.—The personal opinions and political needs of the Lancastrian kings induced them from the first to support the bishops in a campaign to obliterate the heresy. In March 1401 Archbishop Thomas Arundel forced Purvey into submission and induced convocation to condemn William Sawtre (Sawtrey), who was in fact burned a few days before parliament passed the statute *De haeretico comburendo*. This measure stipulated that a heretic convicted by the spiritual court and refusing to recant, or relapsing after recantation, must be handed over to the civil power and suffer burning. The persecution, though reinforced in 1407 by Arundel's new purge at Oxford, failed to stifle Lollardy or to abash the boldness of its supporters in parliament. In 1410 these latter openly sought to modify the law of heresy, to dispossess the church and to endow the crown, together with many new earls, knights, esquires, universities and hospitals, from the spoils. Foremost among the lay converts mas the distinguished soldier Sir John Oldcastle (*q.v.*), who was indicted in March 1413 for maintaining Lollard preachers and opinions. Arraigned before Arundel, he denied transubstantiation and the confessional. In October he escaped from the Tower of London and proceeded to organize a great march upon London by Lollards from many parts of the kingdom. On Jan. 9–10, 1414, Henry V assembled troops in St. Giles's fields and dispersed the rebels with little fighting. Though the elusive Oldcastle avoided arrest and execution until 1417. his rising resulted in a roundup of leaders and suspects so complete as to shatter the overt political influence of Lollardy. Driven underground, it operated henceforth chiefly among tradesmen and artisans, supported by a few clerical adherents. Between 1424 and 1430 over 100 Lollards were arraigned in the diocese of Norwich, while cases also proved common in Somerset and in parts of the diocese of Lincoln. Early in the century Scottish Lollards were being persecuted by the inquisitor Laurence of Lindores, yet the sect persisted there until the Reformation.

In the spring of 1431 a fresh Lollard plot came to light; its ramifications proved surprisingly extensive, and it aimed at no less than the overthrow of the government and the disendowment of the church. The subsequent decline in the number of prosecutions may indicate merely a slackening of official pressure. Despite a few martyrs, Lollardy was neither demonstrative nor heroic; it flourished upon quiet evasion, and most of its adherents submitted tamely when brought into the ecclesiastical courts. In 1455 Reginald Pecock issued his *Repressor* of *Overmuch Wijting [Blaming] of the Clergy,* a powerful attack upon Lollard beliefs and especially upon their misuse of biblical texts. His analysis indicates that the emphases of Lollardy had not substantially altered since the time of the *Twelve Conclusions.*

Lollardy and the Reformation.—There can be little doubt that a Lollard revival began about 1500. Much of the detailed evidence comes from John Foxe, *Acts and Monuments* (1563), yet it is highly circumstantial and finds support elsewhere. In the London diocese, especially in Essex, Bishop Richard Fitzjames prosecuted about 50 Lollards in 1510 and about as many again in 1518. In Dec. 1514 the murder of the Lollard merchant Richard Hunne in the episcopal prison at St. Paul's immensely intensified anticlerical feeling in the city. Between 1527 and 1532 the bishops Cuthbert Tunstall and John Stokesley caused at least 218 heretics to abjure in that diocese; with few exceptions these heresies remained purely Lollard. Another major focus lay in the Chilterns, especially around Amersham and Buckingham, where in 1506–07 about 45 cases were presented to Bishop William Smyth of Lincoln. In 1521 Bishop John Longland occasioned in that area 50 abjurations and 5 burnings, and he continued active for another decade. The region was connected through a number of scattered communities in the Thames valley with others in Berkshire, Wiltshire and the Cotswolds. At Newbury about 140 heretics are said to have abjured together sometime during the early years of the century. Yet another centre lay in the Kentish clothing towns of Tenterden, Cranbrook and Benenden, where in 1511 about 46 Lollards were denounced to Archbishop William Warham, 5 being burned, the rest abjuring. Between these various areas active liaison existed; for example, Thomas Man, burned at Smithfield in 1518, had moved about instructing communities in East Anglia, the Chilterns. the Thames valley and Newbury.

Before 1530 the old Lollard and the new Protestant forces had begun to merge. Early Lutheran missionaries, like Robert Barnes, sold William Tyndale's New Testament to Lollard communities. When the writings of Luther began to enter England, Bishop Tunstall wrote to Erasmus, "it is no question of pernicious novelty; it is only that new arms are being added to the great band of Wycliffite heretics." The list of proscribed doctrines compiled by convocation in 1536 still retained a high proportion of characteristically Lollard beliefs, and even the conservative north was affected by the revival. Research into the archives of the diocese of York revealed proceedings against about 32 heretics under Henry VIII and against 45 others during the reign of Mary I. The uneducated majority of these offenders evinced neither Lutheran nor Zwinglian beliefs. Both before and after the advent of continental Protestantism, they attacked, on a Lollard basis, saint worship, images, relics. holy bread, holy water. sacred buildings and objects, and, above all, the doctrines of confession and transubstantiation. Nearly all these cases fail to appear in the actual registers of the archbishops of York but emerge from day-to-day court books, which in most other dioceses have been lost for that period. Hence it is not possible to estimate accurately the scope of the movement or even the number of trials. Yet this resurgence of an inveterate Lollardy, however negative and confused, undoubtedly amplified those complex undercurrents of dissent and anticlericalism that disturbed English society under Henry VIII. Late Lollardy coloured proletarian criticism of the church outside as well as inside the small Lollard communities; it facilitated the spread of Lutheranism, predisposed opinion in favour of the king's anticlerical legislation and, since it persisted beyond mid-century, may have helped create the psychological bases of popular nonconformity.

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LOLO: *see* Yi.

LOMAS DE ZAMORA, Argentine city and important suburb of greater Buenos Aires, located 10 mi. directly south of the federal district. Pop. (1960) 275,219. Its name and origin date from the end of the 16th century, when several of the low hills in the region were given in a grant to a Spaniard named Zamora who accompanied Juan de Garay in the second and permanent founding of Buenos Aires. The town developed as a residential area and with the growth of Buenos Aires merged into the suburban area of greater Buenos Aires. After 1940 it became a major industrial area with chemical, electrical and cement factories. (Js. R. S.)

LOMBARD, PETER (Petrus Lombardus) (*c.* 1100–1160). theologian and bishop, best known as "Master of the Sentences" *(Magister Sententiarum),* was born about 1100. Little is known of his life. After early schooling at Bologna he went to France to study first at Rheims, then at Paris. From 1136 to 1150 he taught theology in the cathedral school of Notre Dame. He was present at the Council of Rheims in 1148. In 1159 he was named bishop of Paris. He died in 1160. Besides the *Books of Sentences* (*sententiarum libri IV*), Peter Lombard wrote commentaries on Holy Scripture, sermons and letters. No special importance attaches to these writings. The *Sentences,* however, established his reputation and subsequent fame.

This work, written between 1148 and 1151, is a collection of teachings of the church Fathers (sententiae *Patrum*), plus some opinions of medieval masters, arranged as a systematic treatise on sacred doctrine. Lombard takes due cognizance, throughout, of the role of reason in theology. His work marks the culminating point of a long tradition of theological pedagogy, and until the 16th century it was the official textbook of theology in the universities. Hundreds of scholars wrote commentaries on it (180 in England alone).

The contents of the Books of Sentences are as follows: book I deals with God, the Trinity, providence, predestination, evil; book II with angels, demons, the Fall, grace, sin; book III with the incarnation, the redemption, virtues, the Ten Commandments; book IV with the sacraments in general, the seven sacraments in particular, the four last things (death, judgment, hell, heaven).

The author shows originality in choosing and arranging his texts, in utilizing various currents of thought, in avoiding the extremes of both dialecticians and authoritarians, and above all in crystallizing the theology of the sacraments. He asserted that there are seven sacraments and that a sacrament is not merely a "visible sign of invisible grace" but also the "cause of the grace it signifies."

Peter Lombard's teachings encountered opposition during his lifetime and after his death. Later theologians rejected a number of his views. One opinion he held was officially censured, an opinion derived from Abelard's teaching that, in Christ, God is not man, but has humanity. This formula smacked of "christological nihilism" (a term applied to the heresy of adoptionism, according to which the Man, Christ, was not God's true Son, but his adopted son), and in 1177 Pope Alexander III condemned this error.

Notwithstanding, Peter Lombard was never regarded as unorthodox. Efforts to have his works condemned were unsuccessful. The fourth Lateran council (1215) even prefaced a profession of faith with the words "We believe with Peter Lombard. . ."

Peter Lombard's collected works may be found in J. P. Migne, Patrologia *Latina,* vol. 191 and 192. The best edition of the Books *of* Sentences (no English translation), is that by the Franciscans at Quaracchi, Libri quattuor *sententiarum,* 2 vol. (1916).

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LOMBARD, a village in Du Page county, northeast Illinois, U.S., 21 mi. W. of the Chicago "loop," is located on gently rolling terrain at an altitude of 700–750 ft. It was named for Joseph Lombard, a Chicagoan, who platted the site in 1868. Incorporated as a village in 1869, it is still classified as such, even though it has a population of about 20.000.

Known as the "lilac village," Lombard has six parks, covering more than 100 ac Lilacia park, bequeathed by Col. William Plum who collected lilacs as a hobby, has notable varieties of these flowering trees and shrubs. Lombard was one of the first communities in Illinois to give women the right to vote.

Lombard is mainly a residential suburb of Chicago and has little local industry.

For comparative population figures see table in ILLINOIS: *Population.* (D. A. Pr.)

LOMBARD LEAGUE. The attempt of the emperor Frederick I to re-establish imperial power in Italy led to a coalition, formed in March 1167, between the cities of Cremona, Mantua, Bergamo and Brescia. This league was soon joined by other cities. among which were Milan. Parma. Padua, Verona. Piacenza and Bologna, and the allies began to build a fortress near the confluence of the Tanaro and the Bormida, which. in honour of Pope Alexander III, was called Alessandria. During the absence of Frederick from Italy from 1168 to 1174, the relations between the pope and the league became closer, and Alexander became the leader of the alliance. The decisive struggle began when Frederick attacked Xlessandria in 1174, but the historical importance of the war is due to the defeat inflicted on the emperor by the league at Legnano. May 29,1176. The peace of Constance (June 25, 1183), which ended the struggle, left only a shadowy authority to the emperor in Italy. In 1226 the league was renewed against the emperor Frederick II and was one of the principal forces opposed to the Hohenstaufen thenceforward until their final overthrow.

LOMBARD0 (or LOMBARDI), the name given to a family of Lombard origin uho practised in Venice in the 1jth and 16th centuries as sculptors and architects, and who were largely responsible for the formation of the Venetian Renaissance style. Its most notable members were Pietro Lombardo *(c.* 143j–151j) and his sons Tullio (*c* 14j5–1532) and Antonio (c 1458–1516). The son of Tullio Lombardo, Sante (1504–1560), also practised as an architect.

PIETRO LOMBARDO was born at Carona about 1435, and is first heard of in Padua, where he was active in 1464–67. There he executed the Roselli monument in S. Antonio (1467) and the Casa Olzignani. About 1467 he transferred his studio to Venice, where he worked for the remainder of his life, producing a long succession of buildings and sepulchral monuments. The Roselli tomb derives from Florentine humanist monuments, and the earliest of his buildings in Venice, the church of S. Giobbe (after 1470) is also markedly Tuscan in character. Thereafter he developed a more individual architectural style, of which the first evidence is found in the church of Sta. Maria dei Miracoli (completed 1489). With its harmonious proportions and rich marble incrustation, this is one of the most distinguished Venetian churches of the early Renaissance.

In sculpture Pietro Lombardo also worked his way forward from the Niccolb Marcello (d. 147j) monument in SS. Giovanni e Paolo to the more complex and more typically Venetian Pietro Mocenigo monument in the same church (1476–81). In 1482 he executed the tomb of Dante for Ravenna and in 148j began work on his most distinguished monument, the Zanetti tomb in the cathedral at Treviso, where the carving was in large part carried out by his sons. From 1498 until his death in June 1515 he served as *capomaestro* of the ducal palace in Venice.

TULLIO LOMBARDO, the elder of Pietro's sons, was born in Venice, probably about 1455. He is mentioned with his brother Antonio by the humanist Collaccio in 147j, and assisted his father in work on the Pietro Mocenigo monument in SS. Giovanni e Paolo. The figure sculpture in his most important work, the Vendramin monument from Sta. Maria dei Servi, now in SS. Giovanni e Paolo, is the peak of Venetian classicism; a beautiful figure of Adam from this tomb is now in the Metropolitan museum, New York. In 1525 he executed his best-known work, the recumbent figure of Guidarello Guidarelli at Ravenna. His last dated work is the Bellati monument in the cathedral at Feltre (1528). Tullio was also active as an architect, designing the Cappella dell'Argento for the cathedral at Ravenna (1515) and the cathedral at Belluno (1517) and working in this capacity at Mantua (1527). He died on Nov. 17, 1532.

ANTONIO LOMBARDO, the younger of Pietro's sons, seems to have been born about 1458 and was already active by 1475. He assisted his father and brother in Sta. Maria dei Miracoli, on the Zanetti and Vendramin monuments, and on the façade of the Scuola di S. Marco (for the reliefs on which he and Tullio were jointly responsible). In 1501 he received the commission for two reliefs for the chapel of St. Anthony in S. Antonio at Padua, only one of which was completed (1505). This reveals Antonio as a more restrained and in some respects more sensitive sculptor than his brother Tullio. Between 1504 and 1506 he worked on the tomb and chapel of Cardinal Zen (d. 1501) in St. Mark's, Venice. This was the first major work in bronze executed by a Venetian sculptor and was completed by Paolo Savin.

In 1j06 Antonio Lombardo transferred his workshop to Ferrara, where he was employed by the Este and where he is last mentioned in 1516. There he was responsible for the carving of the celebrated Camerini d'Alabastro (alabaster chambers) in the Castello, which were decorated with mythological and other reliefs. An important group of carvings from this complex is in the Hermitage at Leningrad.

See P. Paoletti, *L'Architettura e la scultura del Rinascimento a Venezia (1893)*; L. Planiscig, *Venezianische Bildhauer (1921).*
(J. W. P.-H.)

LOMBARDS or LANGOBARDI, a Suevic people who appear to have inhabited the lower basin of the Elbe and whose name is believed to survive in the modern Bardengau to the south of Hamburg. They are first mentioned in connection with the year A.D. 5, when they were defeated by the Romans under Tiberius, afterward emperor. In A.D. 9, however, after the destruction of Varus' army, the Romans gave up their attempt to extend their frontier to the Elbe. At first, nith most of the Suevic tribes they nere subject to the hegemony of Maroboduus, king of the Marcomanni, but they revolted from him in his war with Arminius, chief of the Cherusci, in the year 17. We again hear of their interference in the dynastic strife of the Cherusci some time after the year 47. From this time they are not mentioned until the year 165, when a force of Langobardi, in alliance with the Marcomanni, was defeated by the Romans, apparently on the Danubian frontier. It has been inferred from this incident that the Langobardi had already moved southward, but the force mentioned may very well have been sent from the old home of the tribe, as the various Suevic peoples seem generally to have preserved some form of political union. From this time onward we hear no more of them until the end of the 5th century.

Shortly before this time the Langobardi appear to have taken possession of the territories formerly occupied by the Rugii whom Odoacer had overthrown in 487, a region which probably included the present province of Lower Austria. At this time they were subject to Rodulf, king of the Heruli, who, however, took up arms against them. The result was the total defeat of the Heruli by the Langobardi under their king Tato and the death of Rodulf at some date between 493 and 508. By this time the Langobardi are said to have adopted Christianity in its Arian form. Tato was subsequently killed by his nephew Waccho. The latter reigned for 30 years, though frequent attempts were made by Ildichis, a son or grandson of Tato, to recover the throne. Waccho is said to have conquered the Suabi, possibly the Bavarians, and he was also involved in strife nith the Gepidae, with nhom Ildichis had taken refuge. He was succeeded by his youthful son Walthari, who reigned only seven years under the guardianship of a certain Audoin On Walthari's death (about 546?) Audoin succeeded. He also aas involved in hostilities uith the Gepidae. In these quarrels both nations aimed at obtaining the support of the emperor Justinian, who, in pursuance of his policy of playing off one against the other, invited the Langobardi into Noricum and Pannonia, where they now settled.

A large force of Lombards under Audoin fought on the imperial side at the battle of the Apennines against the Ostrogothic king Totila in 553, but the assistance of Justinian, though often promised, had no effect on the relations of the two nations, which were settled for the moment after a series of truces by the victory of the Langobardi, probably in 554. The resulting peace was sealed by the murder of Ildichis and Ustrogotthus, and the Langobardi seem to have continued inactive until the death of Audoin, perhaps in 565, and the accession of his son Alboin. It mas about this time that the Avars entered Europe, and with them Alboin is said to have made an alliance against the Gepidae under their new king Cunimund. The Avars did not take part in the final battle. in which the Langobardi xere victorious. Alboin, who had slain Cunimund in the battle, took Rosamund, daughter of the dead king. to be his wife. In 568 Alboin and the Langobardi, in accordance nith a compact made with Baian, recorded by Meander, abandoned their old homes to the Avars and passed southnard into Italy, mhere they were destined to found a new and mighty kingdom (F. G. M. B.)

The Lombard Kingdom in Italy.—Alboin's reign in Italy was brief. In 572, according to Lombard tradition, he fell a victim to the revenge of his nife Rosamund, the daughter of the king of the Gepidae, whose skull Alboin had turned into a drinking cup. But in these few years the Lombards had established themselves in the north of Italy, from mhere in the next decade they frequently raided Frankish territory beyond the Alps. Chiefs were placed, or placed themselves, first in the border cities, like Friuli and Trent, which commanded the northeastern passes, and then in other principal places; and this arrangement became characteristic of the Lombard settlement. Its principal seat was the rich plain watered by the Po and its affluents, which was in future to receive its name from them; but their power extended across the Apennines into Liguria and Tuscany, and then southward to Spoleto and Benevento. Ticinum (Pavia), the one place which had obstinately resisted Alboin, became the seat of their kings.

Alboin was succeeded by a Lombard noble named Cleph who reigned for only 18 months. For the next ten years (574–584) no noble was able to obtain recognition as king. In the latter year, threatened by a Frankish invasion, the Lombards chose as king Authari, the son of Cleph, to whom is principally due the consolidation of Lombard power in Italy. Under him the independence of the dukes was reduced and something was done toward their transformation into royal officers. The dukedoms of the northern marches, Trent and Friuli, with the dukedom of Turin, long retained the independence natural to a border government in early times. Benevento, in the south, with its neighbour Spoleto, threatened at one time to be a separate principality, and to the last resisted the full claims of royal authority at Pavia.

The kingdom of the Lombards lasted from Alboin (568) to Desiderius (774), but it was never complete in point of territory. Throughout the greater part of this period there were three capitals in Italy—the Lombard Pavia; the Latin Rome; the Greek Raven,,. It was, moreover, long before the Lombards became amalgamated with the Italian population, and the process was far from complete when the kingdom came to an end. The Lombards were profoundly influenced by Italian civilization. They ultimately accepted Catholic Christianity, and they allowed the subject Italian population to live under Roman law; their charters are full of formulas derived from the phraseology of the Roman private deed. Nevertheless throughout this period the Lombards were essentially aliens in Italy. They threatened the independence of the papacy. and it was hostile. The new element they introduced into the Italian complex of races was never strong enough to dominate Italy as the Franks dominated northern Gaul.

Authari married Theodelinda, a daughter of Garibald, duke of the Bavarians. She played an important part in Lombard history as the mediator between the Lombards and the Catholic Church. Authari died shortly after his marriage (591), but Theodelinda had so won the Lombard chiefs that they bid her as queen choose the one among them whom she would have for her husband and for king. She chose Agilulf, duke of Turin (592–615), who remained an Arian but was favourably disposed both to peace and to the Catholic Church. The Arian and Catholic bishops went on for a time side by side; but the Lombard kings and clergy gradually yielded to the influences around them. Gregory the Great recognized that the empire could never expel the Lombards, and tried to promote peace between the Italians and Agilulf. Under these conditions the pope and the king of the Lombards naturally became the two real powers in the north and centre of Italy.

Agilulf was followed, after two unimportant reigns, by his son-in-law, the husband of Theodelinda's daughter, King Rothari (636–652), the first Lombard king to issue a body of law in his own name. From Rothari (d. 652) to Liutprand (712–744) the Lombard kings strove to enlarge their boundaries, and contended with the aristocracy of dukes inherent in the original organization of the nation. Their old enemies the Franks and the Slavs or Huns, ever ready to break in on the northeast, and sometimes called in by mutinous and traitorous dukes of Friuli and Trent, were constant and serious dangers. By the popes they were always looked upon with dislike and jealousy; with the Greek empire there mas chronic war. In the last phase of the kingdom it produced two rulers of unusual ability. Liutprand, who destroyed the independence of the great southern duchies, Benevento and Spoleto, and Aistulf who threatened Rome itself. Their success led directly to the events which brought the Lombard kingdom to an end. The popes, thoroughly alarmed, and hopeless of aid from the east, turned to the family which was rising into power among the Franks of the west, the mayors of the palace of Austrasia. Pope Gregory

III applied in vain to Charles Martel. But with his successors Pippin and Charles the popes were more successful. In return for the transfer by the pope of the Frankish crown from the decayed line of Clovis to his own, Pippin crossed the Alps, defeated Aistulf and gave to the pope the lands won by the Lombards from the empire, Ravenna and the Pentapolis (754–756).

Finally. invited by Pope Adrian I, Pippin's son Charlemagne once more descended into Italy. As the Lombard kingdom began, so it ended, with a siege of Pavia. Desiderius. the last king. became a prisoner (774), and the Lombard power perished. Charlemagne, with the title of king of the Franks and Lombards, became master of Italy.

For the subsequent history see the article ITALY. For the Lombard league see the articles under that title and COMMUNE: Mediaeval. See also T. Hodgkin. Italy and Her Invaders, vol. v and vi, 2nd ed. (1916) and bibliography in V. Chevalier, *Répertoire* des Sources *Historiques* du Moyen Age (1905). (R. W. C.; X.)

LOMBARD'S KOP, BATTLE OF: see SOUTH AFRICAN WAR, 1899–1902.

LOMBARDY, a region of northern Italy, bordered north by Switzerland, west by Piedmont, south by Emilia and east by the Veneto and Trentino-Alto Adige. It covers an area of 9,191 sq.mi. and is the fourth largest region of Italy.

Physical Features. — Physically, it may be divided into three zones: a northern, mountainous zone; a median, hilly zone; and a southern, flat zone. The northern zone is divided into the Alpine and pre-Alpine zones. The Alpine zone, where crystalline rocks prevail, comprises part of the Lepontine and the Retiche Alps, the Orobie Alps, the Ortles and the Adamello. In the Bernina it reaches a height of 13,304 ft. and has many glaciers. The pre-Alpine zone. mostly calcareous, though also dolomitic, attains less elevated heights, although it occasionally rises above the 8,000-ft. line, but it is particularly beautiful at some of its massifs, such as the Grigne. The hilly zone, partly composed of a morainic material with some morainic amphitheatres, is gently undulating. The alluvial plain, sloping northwest-southeast. is divided into high and low areas; the former has a gravelly soil, poor in superficial water; the latter. nith plentiful moisture content, is separated from the former by the "spring line." where the waters, hidden in the subsoil at the higher level, gush out.

Lombardy has many rivers, all tributaries of the Po. The principal are the Ticino; the Adda, with its affluents the Brembo and Serio; the Oglio, with its affluents the Mella and the Chiese; and the Mincio. The Valtellina, and the valleys Brembana, Seriaria, Camonica, Trompia and Sabbia, traversed by these rivers, are among the most beautiful in Italy. Lombardy has many Alpine, pre-Alpine and inframorainic lakes: part of Lake Maggiore and Lake Lugano, both shared with Switzerland; Lakes Como and Varese; the Lakes of the Brianza (Pusiano, Annone, Alserio, Segrino); Lake Iseo; Lake Idro; and Lake Garda, the largest Italian lake.

The climate, though in the main continental, is variable, because of great differences of height and the presence of large water areas; it is most continental on the lower plain at Milan, Pavia and Cremona. The rainfall, not less than 24 in. annually in the area near the Po, reaches 80 in. in the mountainous regions.

Population.—Lombardy has a larger population than any other Italian region. In 1951 it had a population of 6,566,154, which had increased to an estimated 6,721,767 by Dec. 31, 1954. Of the total population of Italy, therefore, 14% lived in Lombardy, which covers only 6.9% of the total area, with a density of 276 inhabitants per square kilometre, only surpassed in Campania and Liguria. The density is greatest in the pre-Alpine zone and on the plains, which accounts for the intense economic, agricultural and industrial development of the region.

A table giving area and population of the various provinces will be found in the article ITALY.

Agriculture, Industry, Communications. — Agriculture, especially in the plains, is industrialized, and high productivity is achieved by scientific use of fertilizers and by irrigation. Grasslands, where grass is mown up to eight times a year in the *marcite* (flooded meadows), cereal growing (rice, wheat and maize) and sugar-beet cultivation are characteristic of the low plains; the higher plains grow cereals, green vegetables, fruit trees and mulberries. The hilly zone has fruit and chestnut trees; the climate and soil around the lakes are specially suitable for olive trees and limes; in the pre-Alpine zone vines grow at altitudes as high as 2,400 ft above sea level; and on the Alps there is excellent grazing. In the alpine hamlets cattle breeding is scientifically practised and there is a livestock production of 1,700,000 head, of which half are milk producing; there are 500.000 pigs and 100.000 sheep, bred for wool and meat. Honey is another important product. Lombardy ranks third, after Veneto and Friuli, for production of silk cocoons.

A national park, of about 350 sq.mi., for the preservation of the indigenous fauna, was set up at Stelvio in 1935.

The development of industry began earlier in Lombardy than in any other Italian region; metal. paper, textile and leather industries were started at a remote date. Despite the necessity for importing many raw materials (metal, cotton, etc.) the great modern industries (engineering, metallurgical, electrical, chemical, textile, etc.) and flourishing crafts include 16% of all Italian firms and employ 25.2% of the working population. Installed motive power — electricity and methane gas—is 30% of the total production. The state draws from Lombardy 25.7% of its revenue; Lombardian savings constitute 20% of the national total.

There are excellent road and rail communications, the latter radiating from Milan (pop., 1951, 1,260,609). Other towns with over 100.000 estimated population are Brescia and Bergamo.

For the history of Lombardy, see LOMBARDS and ITALY. (A C.)

LOMBOK, one of the Lesser Sunda Islands, Indonesia, lies due east of Java, with the island of Bali between it and the Javanese coast, the Lombok strait separating it from Bali. Lombok has an area of 1,825 sq.mi It is very mountainous, being divided for nearly its whole length by two mountain chains, separated by a valley, which slopes upward, gradually, in terrace formation, and is broken in the centre by a ridge of low hills. The southern chain, which runs from southeast to south-southwest. does not exceed 1,000 ft., but the northern chain, beginning with Gunong Wangsit, 11½ mi. N. of Ampenam, rises eventually to 12,224 ft. in Gunong Rinjeng or Rinjani (the Peak of Lombok) one of the highest volcanoes of the Malay archipelago. Lower peaks flank the mountain, united by a plateau 7,200 ft. in height, and containing a fine lake, Danu (Segara Anak). Of the many small rivers none is navigable. The coast is very bold in places, with cliffs rising precipitously from the sea, but there are good anchorages in bays on the west and east coasts.

The flora includes, among the palms usual to the tropics, a great palm, a species of Corypha, which is a striking feature of the plains, and several Australian forms. The fauna comprises monkeys (*Macacus* cynomolgus), deer and wild pigs and many beautiful birds, large green pigeons, eight kinds of kingfishers, a ground thrush (Pztta concinna), grass-green doves, little crimson and black flower peckers, large black cuckoos, king crows, golden orioles and fine jungle cocks, and dragon flies abound.

For the scientist, Lombok possesses particularly great interest, in that it is the most westerly point of a former Australian or Pacific continent which must have broken up before Java, Sumatra, Bali, etc., were separated from Asia, and probably before the extreme southeastern portion of Asia was raised above the waters of the ocean.

Lombok strait, which has depths exceeding 600 fathoms, marks the edge of the Asian continental shelf. Alfred Wallace (1823–1913) (*q.v.*) drew a line from the strait northward, between Celebes and Borneo, and then passing eastward, between the Sangir Islands and Mindanao, into the Pacific ocean, to denote the frontier between the Asian and the Australian regions, which has been known since as the Wallace line. It is supported by the fact that there are marked differences between the flora and fauna of Bali and Lombok, the barbets, fruit thrushes, and woodpeckers of the former being practically unknown in the latter, while the cockatoos, honeysuckers and mound builders (Megapodidae), of Lombok are equally foreign to Bali.

Later observations, however, established that some intermingling of species is taking place.

The population of Lombok (1957 est.) was 1,252,157, composed largely of Sasaks, the indigenous inhabitants of the island, of Malayan origin and akin to the indigenous population of the neighbouring island of Sumbawa, with some Balinese who confine themselves mostly to the northwest. The Sasaks, who are Muslim, built villages and houses after the Balinese pattern, and followed customs resembling those of the Balinese under whose domination they came. Sasaks use the Balinese script for writing, and their literature consists of Javanese and Malayan translations. Clothes and mats are woven, and there are workers in gold, silver and iron. The people also cultivate rice and coffee.

Mataram, the chief town and trade centre, is a short distance inland from Ampenam, the chief port of Lombok, which is on the western coast; the port of Labuan Hadji is on the east coast.

As early as 1640 Lombok was regarded by the sultan of Macassar as being under his rule, and when his power was shattered by the Dutch in 1667–68, a Sumbawa chief, signatory to the Bongay contract, endeavoured to impose his sovereignty on the island, in which the Dutch assisted, peacefully. Civil war in Sumbawa left Lombok the prey of first pirate adventurers from Macassar and later of the Balinese who planted colonies in north Lombok and set about establishing their rule. Balinese intervention commenced about 1692, and eventually the Balinese succeeded in establishing four kingdoms in Lombok: Mataram, Karang Asem, Pagasangen, and Pagutan.

In 1843 Mataram entered into a contract with the Dutch, agreeing to acknowledge Karang Asem in Bali as the suzerain power. In 1849 the Dutch were at war with Karang Asem and Klungklung in Bali, and were assisted by Mataram, which, as a reward, was given Karang Asem (Bali), as a fief. But in 1872, Mataram refused to send its regular embassy to Batavia and, in 1891, interfered in the domestic politics of Bali.

At the same time it cruelly oppressed the Sasak population of Lombok, so that the latter made ineffectual attempts to throw off the Balinese yoke, finally invoking Dutch aid. This was given, and in 1894, after one expedition had met with disaster, a second was successful in overthrowing the government of Mataram. Lombok was made a division of the residency of Bali and Lombok, under an assistant resident at Ampenam, and was divided into two districts, East and West Lombok; a third district, Central Lombok, was created in 1898, the capitals of the three districts being at Mataram, Praja and Sisi. During World War II Lombok was occupied by the Japanese. It became part of the republic of Indonesia after the war. (E. E. L.)

LOMBROSO, CESARE (1836–1909), Italian criminologist, whose interests centred on the relation between mental and physical disorders, was born on Nov. 18, 1836, at Verona. He studied at Padua, Vienna and Paris, and in 1862 became professor of psychiatry at Pavia, then director of the lunatic asylum at Pesaro and later professor of forensic medicine and of psychiatry at Turin, where he eventually filled the chair of criminal anthropology.

He held that the criminal population exhibits a higher percentage of physical and mental anomalies than noncriminals; and that these anomalies are due partly to degeneration, partly to atavism, or reversion to a primitive evolutionary stage. He contended that criminals can be identified by certain "stigmata" or physical characteristics. Although most of Lombroso's theories were discredited, he worked in a practical way for a more humane and constructive treatment of convicts. *(See* CRIMINOLOGY.)

His *Crime, Its Causes and Remedies* was translated by Henry P. Horton (1911). Lombroso died at Turin on Oct. 19, 1909.

See also T. L. Ferrero, *Criminal Man According to the Classification of Cesare Lombroso* (1911); M. E. Paul (trans.), *C. Lombroso, a Modern Man of Science* (1911).

LOMÉNIE DE BRIENNE, ÉTIENNE CHARLES DE (1727–1794), French politician and ecclesiastic, was born at Paris on Oct. 9, 1727, of a Limousin family, dating from the 15th century. After a brilliant career as a student he entered the church. In 1752 he was appointed grand vicar to the archbishop of Rouen, in 1762 bishop of Condom, and in 1763 archbishop of Toulouse.

In 1770 he became an academician. He was on three occasions the head of the *bureau de jurisdiction* at the general assembly of the clergy; he addressed to Turgot a number of *mémoires* on political and social questions, one of them, treating of pauperism, being especially remarkable. As president of the assembly of notables (1787) he attacked the fiscal policy of Calonne, whom he succeeded as head of the *conseil des finances* on May 1, 1787. He made the *parlement* register edicts dealing with internal free trade, the establishment of provincial assemblies and the redemption of the *corvée*. To crush opposition to the stamp duty and the proposed new general land tax the *parlement* was exiled to Troyes (Aug. 15, 1787), and only returned to Paris on its agreement to an alternative plan prolonging for two years the tax of the two *vingtièmes* (a direct tax on income). But a further attempt to force the *parlement* to register an edict for raising a loan of 120,000,000 livres met with determined opposition.

The struggle of the *parlement* against the incapacity of Brienne ended on May 8 on its consenting to an edict for its own abolition; but with the proviso that the states-general should be summoned to remedy the disorders of the state. Brienne, who had been made archbishop of Sens, now had to face almost universal opposition; he was forced to suspend the *Cour plénière* which had been set up to take the place of the *parlernent,* and himself to promise that the states-general should be summoned. On Aug. 29, he had to retire, leaving the treasury empty. On Dec. 15 following, he was made a cardinal, and spent two years in Italy. After the outbreak of the Revolution he returned to France, and took the oath of the civil constitution of the clergy in 1790 *(see* FRENCH REVOLUTION).

He was repudiated by the pope, and in 1791 had to give up the biretta at the command of Pius VI. Both his past and present conduct made him an object of suspicion to the revolutionaries; he was arrested at Sens on Nov. 9, 1793, and died in prison, on Feb. 16, 1794.

The chief works published by Brienne are: *Oraison funèbre du Dauphin (1766)*; *Compte-rendu au roi* (1788); *Le Conciliateur,* in collaboration with Turgot (Rome, Paris, 1754). *See* also J. Perrin, *Le Cardinal Loménie de Brienne . . . épisodes de la Rdvolution* (Sens, 1896).

LOMOND, LOCH, the largest and most beautiful of Scottish lakes, situated in the counties of Stirling and Dunbarton. It is about 24 mi. long; its width varies from 5 mi. toward the south end to $\frac{1}{3}$ mi. at the north; the greatest depth is 623 ft. It is only 23 ft. above sea level. It contains 30 islands, the largest of which is Inchmurrin, with the ruins of Lennox castle, and 24 of which form an archipelago at the widest part of the loch. From the west the loch receives the Inveruglas (where is the powerhouse of a hydroelectric scheme), Douglas, Luss, Finlas and Fruin rivers. In the south it discharges through the Leven to the Clyde. From the east it receives the Endrick, the Blair, the Cashell and the Arklet. From the north it receives the Falloch. The narrow northern end of the loch lies between Ben Vorlich on the west and Beinn a Choin and Stob-an Fhainne on the east, but Ben Lomond (3,192 ft.), on the east but farther south, dominates the landscape. A good road follows the western shore and another leads from the Trossachs to the eastern shore at Inversnaid.

LOMONÓSOV, MIKHAIL VASILIEVICH *(c.* 1711–1765). Russian poet and man of science, was born in the village of Denisovka (the name of which was afterwards changed in honour of the poet), situated on an island not far from Kholmogorî, in the government of Archangel. His father, a fisherman, took the boy into his trade at the age of ten, but he had a passion for learning, and made his way to Moscow when he was 17. There he obtained admission into the Zaikonospasski school, and in 1734 he was sent from Moscow to St. Petersburg (now Leningrad). There he was chosen as one of the young Russians sent to complete their education in foreign countries. He studied metallurgy at Marburg; he also began to write poetry, imitating German authors, among whom he is said to have especially admired Günther. His Ode *on the Taking of Khotin from the Turks* was composed in 1739. On his return to Russia he was made professor of chemistry in the university of St Petersburg;

he ultimately became rector, and in 1764 secretary of state. He died in 1765.

In the history of Russian letters he is above all important as the man who reformed the Russian language and helped to make it an effective literary medium by his Rhetoric, his Russian *Grammar*, and his essay *On the Use* of *Sacred* Books in the *Russian* Tongue. His task was to find a middle course between the complicated Slavonic language used in the church services, with its elaborate syntax derived from Greek, and spoken Russian. Not only did he fix the literary language, but he wrote magnificent verse which had an enduring effect on later Russian poetry.

LONDON, JACK (JOHN GRIFFITH LONDON) (1876–1916), U.S. novelist. was born at San Francisco, Calif.. on Jan. 12. 1876. He soon moved to Oakland, Calif., where, as he recounts in his autobiographical *John* Barleycorn (1913), he quit school at 14 to escape poverty and gain adventure. In his sloop he explored San Francisco bay, alternately stealing oysters and working for the law, as told in Tales *of* the Fish Patrol (1905); he roamed as far as Japan as a sailor on a sealing cruise; and he saw much of the United States as a member of Kelly's Industrial army (a protest group, born of the panic of 1893, that originated in California and staged a march on Washington) and later as a railroad tramp, riding the rods as described in The *Road* (1907). Observation of depression conditions, fortified by a prison term for vagrancy, turned him in 1894 to Marxian socialism. a doctrine he supported for most of the rest of his life. Rebelling against becoming "a work beast," he crammed high school into one year, took a semester's work at the University of California, and energetically set out to write, supporting himself with odd jobs as narrated in *Martin* Eden (1909).

A winter in the Klondike during the gold rush of 1897 gave London his real start as a writer and supplied him with material for much of his best fiction. Combining his experience with ideas concerning evolution absorbed from Darwin and Spencer, and narrative techniques learned principally from Kipling, he gained a wide audience with his first book, *The Son* of the *Wolf* (1900). During the remainder of his short life he produced steadily. completing 50 books in 17 years. As his writing rested partly on reportorial elements. he constantly sought new scenes and experiences; thus, he lived in the London slums to get material for The People of *the* Abyss (1903); he served as a correspondent in the Russo-Japanese War; and he sailed a ketch to the South Pacific, telling of his adventures in The *Cruise* of the *Snark* (1911) and using the locale in many stories. In 1910 he settled on a large ranch near Glen Ellen, Calif.. where he experimented with farming techniques and built his grandiose "Wolf House," which burned before completion. He died at his ranch on Nov. 22, 1916.

Though his writing was uneven. London produced a number of forceful novels and short stories. Besides those mentioned above. the following are outstanding: *The* Call of the *Wild* (1903). *White* Fang (1906) and *Burning Daylight* (1910), in which he dramatized in turn atavism, adaptability and the appeal of the wilderness; and The Sea-Wolf (1904), The Iron Heel (1907) and *The* Valley of the *Moon* (1913), in which he combined adventure with theories about the Nietzschean superman, the future of socialism and the plight of the city worker. respectively. An enthusiast for social progress, he reflected the hopes, conflicts and frustrations of his period.

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LONDON, a city of Ontario, Can., the seat of Middlesex county, is 115 mi. S.W. of Toronto, at the forks of the Thames river, 21 mi. N. of Lake Erie and midway between Lakes Ontario and St. Clair. Pop. (1961) 166,818; metropolitan area 178,409. London is a financial, ecclesiastical, medical. educational, military and manufacturing centre; its coat of arms incorporates a locomotive, attesting the continuing importance of transportation in the economy of the city. It is served by all major Canadian railroads and has rail service to Chicago, Ill., and to Detroit, Mich.; there are also excellent highways and a municipal airport.

The name London was first applied to the site when it was chosen, in 1792, for the capital of Upper Canada, but the plan was not acted upon, and there were no buildings until 1826, when the first settlement was made. London was incorporated as a village in 1840, as a town in 1848 and as a city in 1855. This rapid growth was due to its interlake position, its early development as a transportation centre and the excellence of the surrounding land. In 1840 Dundas street, a plank and gravel road, from near Hamilton, was extended to London. and in 1853 the first railroad, the Great Western (now the Canadian National Railways main line), arrived. Thereafter the city grew steadily as a manufacturing, distributing and financial centre. In the 1960s there were over 500 diversified manufacturing industries producing a wide range of goods, including breakfast cereals, biscuits, beer, wine, flour, brass and steel goods, abrasives, diesel locomotives, refrigerators, textiles, hosiery and boxes. There were also printing and lithographing industries.

London is the seat of the Anglican diocese of Huron and the Roman Catholic diocese of London. The University of Western Ontario, with its affiliated medical school, is located there.

(G. FN.)

LONDON, the capital and largest city of the United Kingdom and the centre of the Commonwealth of Nations, is the largest port and industrial town in England. Its ancient heart is the City; a county corporate with an area of 677 ac. and a resident population of 4.771 in 1961. The county of London (excluding the City) consists of 28 metropolitan boroughs and covers an area of 115.9 sq.mi. with a population of 3,190.343 in 1961. Together, the City and the county of London make up the administrative county of London, with a population in 1961 of 3,195,114 and an area of 117 sq.mi., around which is a ring of suburbs conterminous with the Metropolitan Police district. The whole of this area, known as Greater London, covers 721.6 sq.mi. and had a population of 8,171,902 in 1961; it includes the county of Middlesex and parts of Essex, Kent, Surrey and Hertfordshire. The 28 metropolitan boroughs, each of which is noticed in a separate article, are:

1. *North* of *the Thames*.—The following, commencing on the west. lie on the river: Hammersmith, Fulham, Chelsea, Westminster (the City). Stepney and Poplar; north of these, and adjoining the northern boundary, are: Kensington, Paddington, Hampstead, St. Pancras, Islington, Stoke Newington and Hackney; and between these two groups are St. Marylebone, Holborn, Finsbury, Shoreditch and Bethnal Green.

2. *South* of the *Thames*.—Wandsworth, Battersea. Lambeth, Southwark, Bermondsey, Deptford. Greenwich and Woolwich (these touching the river and two small parts of Woolwich being on its north bank). Camberwell and Lewisham.

Geographical Situation.— London is situated in the London basin. which is drained by the lower Thames. The basin is formed by a downfold in the chalk, which underlies all the area between the North Downs and the Chilterns. This downfold is floored with very thick deposits of London clay, an impervious, sticky, water-holding deposit, upon which are scattered remnants of later coverings of sands and gravels.

The general relief of the land is low, the ground rarely rising above 400 ft. There are, nevertheless, two outstanding features. These are, first, the flood plain of the Thames, about 3 mi. wide, rising gently from the river to about 25 ft. (ordnance datum), covered with gravel and alluvial deposits. among which river silt, fine sand and peat predominate. Largely because of the shrinkage of the previously water-logged peat and silt, which took place as a result of embanking and the consequent drying out of these softer elements. the gravels lie generally several feet above the level of the alluvium. Here and there the drop from one to the other can be distinguished in the low relief. Both gravel and silt, however, lie mainly below the level of high tide today, and but for the embankments would be more or less submerged at every high tide and would revert to marshland; the gravels in the neighbourhood of the Thames are saturated with water every time the tide rises.

The second feature consists of two low, undulating plateaus rising above the flood plain to north and south in a couple of usually well-marked terraces covered with gravel. The rise of the southern plateau is continuous with that of the North Downs beyond London. except in the southwest, where a broad, gravel-floored valley, once, possibly, occupied by a precursor of the river Mole, links the Thames at Kingston with the Wandle valley at Merton and isolates the hills of Richmond and Wimbledon. On the north the land rises steadily to the hills of Hampstead and Highgate, and beyond to Finchley and Hendon, but drops steeply to the broad trench of the Lea valley in the east, and more gently to the broad clay valley of the Brent in the northwest. The lower terrace of the plateau, known as the Taplow terrace, lies between 50 and 100 ft. above sea level and drops somewhat steeply to the flood plain 25 ft. or so below. It may be easily distinguished in the steep descent from the Strand to the Embankment, or from Upper and Lower Thames street to the river, or in the drop from St. Giles's to Charing Cross. Above this terrace a higher one may be distinguished, generally referred to as Boyn hill terrace. It lies between 100 and 150 ft. above sea level; gravels which represent its floor form the greater heights of Richmond hill and Putney common and cap the spur of Islington hill.

The Thames winds in broad, tidal meanders between the edges of the flood plain, cutting now into the northern, now into the southern rim. Before its regulation and confinement between embankments. backwaters and ancient channels surrounded many sandy islands along its course. The names of some of them are perpetuated in the districts of Battersea, Bermondsey and Chelsea. A group of such islets filled the angle that the river makes at Lambeth, the most northerly being the famous Thorney, on which the Abbey of St. Peter (the predecessor of Westminster abbey) was founded. The broad, shallow course of the Thames as it crossed the flood plain from Lambeth toward Charing Cross was probably a fordable reach in Roman times, and there has been much conjecture as to the probability of the crossing of the Roman road in the neighbourhood of Westminster (or even of Lambeth) bridge. before its diversion to pass through the City. The northern section of the Watling street seems to trend toward a crossing there. and rhe alignment of the road along the edge of the Tyburn valley could be laid out from the high ground west of the Darent, south of the Thames, near the known end of the southern section of the street. But the remains of Roman occupation are so few at Westminster that it is unlikely that the Watling street ever crossed the Thames by ford or ferry there.

Just below Westminster and Whitehall the river takes a sharp bend to the east and flows for a couple of miles at the foot of the Taplow terrace, leaving a great stretch of reclaimed marsh to the south, occupied now by Lambeth, Southwark, Bermondsey and Rotherhithe. As a result of the set of the current against the northern shore in this reach, the river is deeper and narrower than at Westminster or—farther downstream—at the Isle of Dogs, where it is relatively broad and shallow. Across the brink of the gravel terrace which there directly overlooks the Thames, several small tributary valleys have been trenched, cutting the terrace into low hills which drop abruptly about 40 or 50 ft. to the river, and slope steeply to the side valleys that separate them.

Two of these small hills appear to have formed the site of the earliest London. which, according to one widely held theory, began its existence with the construction of a bridge across the Thames by the Romans. The selection of the site by the Romans would be based on the practicability of an approach and crossing as far downstream as possible. As regards approach there is no place on the north bank except this stretch between the Tower of London and Waterloo bridge where the 50-ft. contou- line approaches the river, until Staines is reached. This steep bank washed by relatively deep water would facilitate approach from the north and by river, but the crossing of the flood plain from the south must always have presented difficulties. It is this great expanse of marshland south of the City that lends support to a theory that London arose, not as a river crossing, but as the river port of Verulamium (St. Albans) with which it communicated by the ridgeways between Colne and Lea and by the two tributaries themselves. The Thames and the flood plain have afforded ample evidence that the river was a highway from earliest times, and that it formed a line of communication with the continent and the numerous small riverside settlements long before the Roman invasion. The steep edge which the two hills present to the deep river at London and to the stream valleys that isolate them, must have made defense of the site relatively easy. The gravel that covers the hills provided London's earliest water-supply, for the banks of the small tributaries oozed with springs. Many of these were important throughout mediaeval times and their names are still household words—St. Bride's well, Clerkenwell, St. Clement's well and Holywell, for instance; the Roman bath in Strand lane is still fed by water percolating through the gravels. Apart from ease of access and capability of defense, other physical conditions conducive to settlement would be the abundance of food and building materials. Fish, including salmon, was plentiful in the Thames; game, as well as timber—invaluable both for constructional purposes and as fuel—flourished in the great forest of Middlesex, behind, while the Taplow terrace was covered with brick earth which provided a light, rich soil as well as material for brickmaking.

The later growth and development of London was strongly influenced by the distribution of the terrace gravels. Settlement only advanced into the flood plain where embankments provided protection from flooding or where small hummocks of gravelly material caused a slightly greater elevation. Outside London it was the Taplow gravels and the Upper Tertiary and Drift gravels remaining in scattered fragments on the London clay that determined the settlement in villages. Apart from the bridgehead at Southwark, it was not until water could be brought from a distance and distributed widely in pipes, and until scientific drainage and sewerage were introduced, that settlement of any density was possible on the flood plain or on the London clay; even today large areas of the latter and of the alluvial marshland remain untenanted. Apart from the Thames gravel terraces, which have played so important a part in the site and expansion of London, and the small patches of gravel that provided sites for villages in the low-lying clay valley of the Brent, the sands and gravels of the London basin, where they cover large areas, have not been conducive to settlement, for they provided but poor soil. Much of the land became common grazing land and has been preserved as open common, for it is to these sandy and gravelly patches that London owes many of the high open spaces which are such an asset to the modern metropolis.

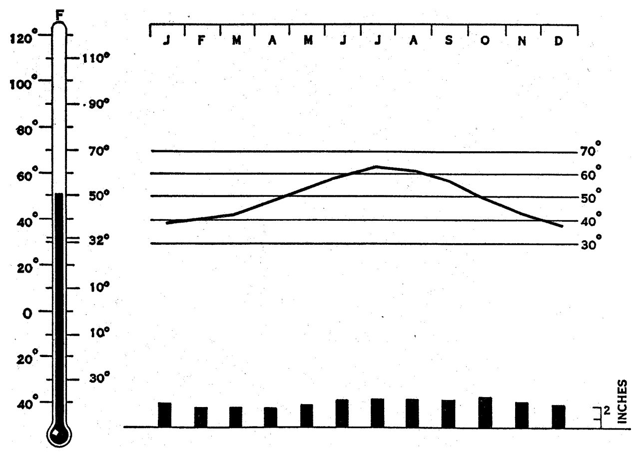


FIG. I.—WEATHER GRAPH OF LONDON. THERMOMETER SHOWS NORMAL ANNUAL MEAN TEMPERATURE; THE CURVE, MONTHLY MEAN TEMPERATURE AND THE COLUMNS. NORMAL MONTHLY PRECIPITATION

Climate.—The climate of London is equable and the weather variable because of the steady indraught of warm moisture-laden winds from the Atlantic and the frequent passage of cyclones, whose southern quadrants usually cross the London basin. Prevailing winds are from the southwest. As a result of the shelter afforded by the Chilterns and the North downs, and occasional inclusion within continental climatic influences in winter, London has a smaller rainfall than the Wealden or Chiltern areas. It

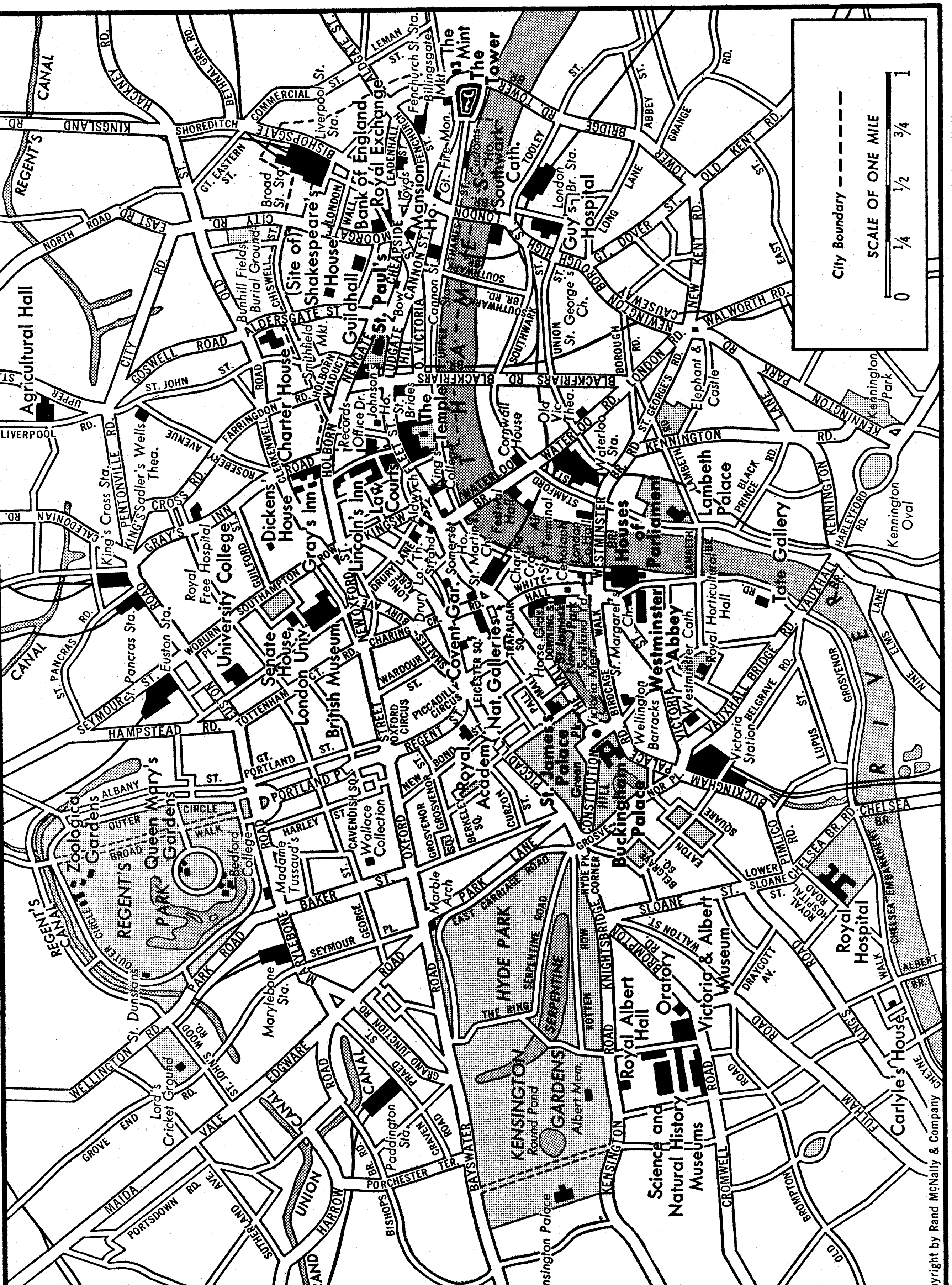


FIG. 2.—MAP OF THE MAIN DISTRICTS OF LONDON SHOWING LOCATION OF PRINCIPAL STREETS, RAILWAY STATIONS AND BUILDINGS, AND BOUNDARY OF THE "CITY"

has also a greater range of temperature and would experience more sunshine but for the pall of smoke that sometimes shuts out the sky in the winter half of the year. The mean annual temperature is 50° F.; the mean annual rainfall is about 23½ in. (H. OR.)

London's Lost Rivers.—Four northern tributaries of the Thames helped to form the physical site of London, and two of them determined the situation of the first town of which there is reliable historical record. From east to west these tributaries are the Walbrook, the Fleet, the Tyburn and the Westbourne. They are all lost rivers in the sense that none of them reaches the Thames above ground, and there are streets or thoroughfares named after all except Tyburn, that sinister name having been lost when the Marble arch moved to its present site in 1851.

The Walbrook rose in the marshy ground near Finsbury circus, pierced the Roman wall through a culvert, received one or more feeders in the region of the Mansion house and became a tidal stream slightly west of the streets named Walbrook and Dowgate. There can be no doubt of the antiquity of the name (the earliest mention of Walbroke street is in a charter of Henry III, 1236) nor of its early importance for shipping; the small vessels of the day were sailed or warped up it as far as Bucklersbury. Moreover the banks of the Walbrook were a favourite site for the houses of well-to-do Romans or romanized Britons.

Nevertheless excavation in 1953 showed that the mapping of an estuary with a wide mouth in the *Roman London* volume published by the Royal Commission on Historical Monuments has little relation to the ascertained facts. The Walbrook had three bridges across it; by John Stow's time (c. 1525–1605) it had become choked up and was hardly discernible. Today its valley is marked by a slight dip in Cannon street near the station.

The Fleet now flows into the Thames through two large sewers to be seen under Blackfriars bridge at low tide. It comes from the Highgate ponds. Stow's identification of the upper part of the stream as the River of Wells, mentioned in a charter of William I, is doubtful; its course is not. The stream flowed through Kentish Town. Camden Town and Somers Town to Battle bridge (subsequently King's Cross) and then through a deep channel in the gravel under what is now Holborn viaduct, Farringdon street and New Bridge street to the Thames. The tidal portion only was known as the Fleet (Flete ditch, 1278; Fleote, 1311; with other forms). Three bridges crossed this tidal part; and Seacoal lane, near Holborn viaduct, preserves the memory of wharves and shipping (first mentioned 1228). One of these bridges was Fletebrigge, crossing the stream at Ludgate circus. It gave its name to the modern Fleet street (Fletestrete, 1274).

The Tyburn—a Saxon name at least as old as the reign of King Edgar, whose charter to the monks of St. Peter, Westminster, calls it Theoburnan—gave its name to the gallows at Tyburn Tree (see TYBURN). At present the stream provides the beautiful stretch of water in Regent's park. Its source was in Hampstead near Swiss Cottage, and it flowed west of Primrose hill to Regent's park, took the course followed still by Marylebone lane (hence the latter's windings) and crossed Piccadilly near Half Moon street (where a dip can still be seen). Thence it flowed across the Green park and to the Thames (this stretch is now in a sewer) a little west of Vauxhall bridge. This little stream formed the marsh now drained and covered by Buckingham palace.

The Westbourne, Kilburn or Bayswater brook collected its waters from tributaries on the southern and western flanks of Hampstead hill. Kilburn High road follows part of its course, after which it diverged southwestward, crossed the Bayswater road at Marlborough gate; its bed formed the course which was widened into the Serpentine in the 1730s by order of Queen Caroline. The stream flowed under the Knight's bridge. where the highway was often flooded. and gave London another modern name. Pipes still carry the water across Sloane square station and can be seen from the platforms. From there the waters formed a marshy area near Ebury bridge.

A succession of streams enters the Thames from the south of London and drains an area between Deptford and Croydon. The Ravensbourne, Effra and the Wandle are the best-known, and their waters supply ponds or ornamental waters at Catford, Dulwich and south Wimbledon; only one of them, however. the Effra, qualifies as a "lost river" by reason of a partially underground course.

Thames Embankments.—The Victoria embankment, from Blackfriars bridge to Westminster and commonly known as "the Embankment," was opened in 1870 by the prince of Wales (later Edward VII). It had taken six years to construct, and 373 ac. of mud was reclaimed for public gardens, a roadway 100 ft. wide and the District railway underneath. The project originally arose from the necessities of main drainage; it was found that an embankment would cost no more than to run the pipes along the foreshore; accordingly these are installed behind the river wall. Before the embankment was made, the river front was disfigured by dilapidated buildings and offensive mudbanks. The Chelsea embankment, a mile long and providing for a roadway of 70 ft., also accommodates main drainage; it reclaimed 9½ ac. of foreshore. This embankment, which runs from west of Chelsea bridge to Battersea bridge, was opened by the duke and duchess of Edinburgh in May 1874. Together the Victoria and Chelsea embankments—with Grosvenor road, constructed at the same time—provide a continuous riverside communication (broken only between Lambeth bridge and Westminster) of about 4½ mi. The Albert embankment. on the south side opposite the houses of parliament, was opened in Nov. 1869 and had its origin in the need for flood prevention; 8½ ac. of foreshore was reclaimed and on this St. Thomas's hospital was built and a 70-ft. promenade constructed. A fourth embankment in front of the County Hall was opened in 1910. In 1951 this was extended to Waterloo bridge, and gardens were laid out on land denuded of buildings during World War II.

Bridges and Tunnels.—From Roman times until the 18th' century London bridge was the only bridge across the river Below London bridge (1) and on the seaward side of the Pool are now (2) the Tower bridge, completed in 1894. Upriver, within the county of London, are (3) Southwark bridge, the old "Iron bridge," begun in 181j, being replaced by the existing bridge, opened in 1921; its northern approach mas damaged in World War II; (4) Blackfriars bridge, opened in 1769, rebuilt between 1865 and 1869 and widened 1907–09 for tramways; (j) Waterloo bridge. opened 1942 replacing a celebrated bridge erected by John Rennie in 1817; (6) Westminster bridge, erected between 1854 and 1862 to replace a bridge, built between 1739 and 1750, which had become unsafe; (7) Lambeth bridge. opened 1932, replacing a suspension bridge of 1862; (8) Vauxhall bridge, opened 1906, replacing one built just before the battle of Waterloo; (9) Chelsea bridge, opened 1937. replacing a bridge of 1858; (10) Albert bridge, opened 1873, an ugly iron structure; (11) Battersea bridge, opened 1890 and replacing a picturesque timber bridge of 1773 renowned as the subject of a James Whistler picture; (12) Wandsworth bridge, opened 1873 and reconstructed between 1936 and 1940; (13) Putney bridge, 1884–86, widened in 1933, replacing a wooden toll bridge of 1729; (14) Hammersmith bridge, opened 1887 and repaired 1952, replacing a previous suspension bridge of 1827, the first of its kind across the Thames. All these are bridges carrying all kinds of traffic. To them must be added a 1jth, the Hungerford footbridge on the eastern side of Charing Cross railway bridge.

The Thames tunnel, opened 1843, between Shadwell and Rotherhithe, was an attraction to early Victorian Londoners nith its shops and stalls. and it was used as the starting-point of a walk into Kent by east London pedestrians. The tunnel never paid its way and now carries the electric railway service between Whitechapel and New Cross. The London County council (L.C.C.) maintains the Woolwich Free ferry (opened March 1889) and the following tunnels: Blackwall. opened 1897, 6 200 ft. long; Greenwich (foot passengers only) opened 1902, 1.21; ft. long; Rotherhithe, opened 1908, 6,833 ft. long; Woolwich (foot passengers) opened 1y12, 1,6jj ft. long. The L.C C. also controls more than 1.600 wharves and is responsible for flood precautions.

Central **London.**—No such expression is in use officially, but the postal districts W. (West), W.C. (West Central), E. (East)

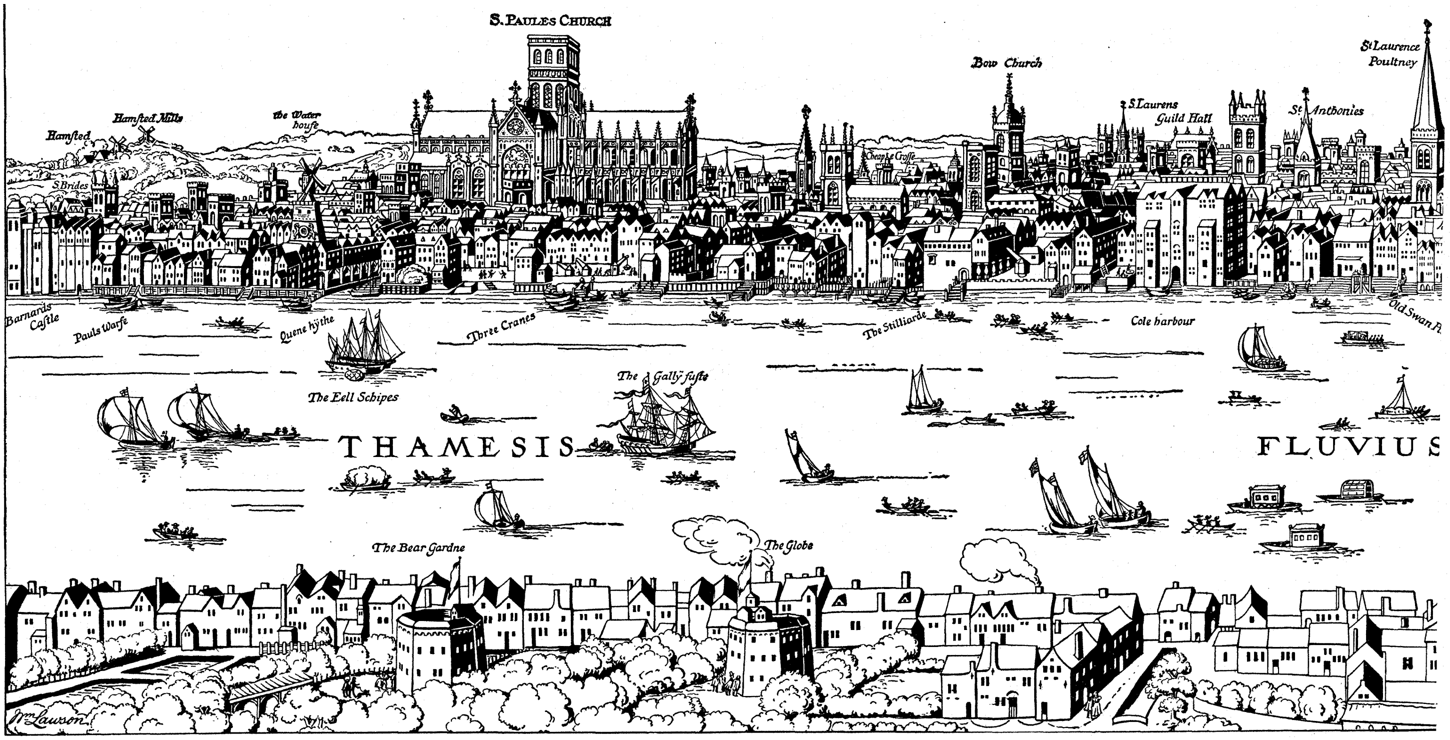


FIG. 3.— VIEW OF LONDON IN THE 17TH CENTURY. FROM THE SURREY SIDE OF THE THAMES, AFTER A DRAWING BY A CONTEMPORARY ARTIST, THE HIGHEST CHURCH IN EUROPE. BEING 520 FT. TO THE TOP OF THE STEEPLE. ON THE RIGHT IS THE ORIGINAL LONDON BRIDGE. BUILT BY A ARCHITECT WAS BURIED IN A CHAPEL ON THE BRIDGE. UNTIL 1750 IT WAS THE ONLY BRIDGE ACROSS THE THAMES. ABOVE THE GATE ARE SEEN

and E.C. (East Central) define the central area, though they exclude the region south of the river. The southwest postal district by exception groups a suburban district on the south'side with Westminster and much of what is known loosely as the West End. After 1955 Charing Cross was taken as the nodal point of modern London.

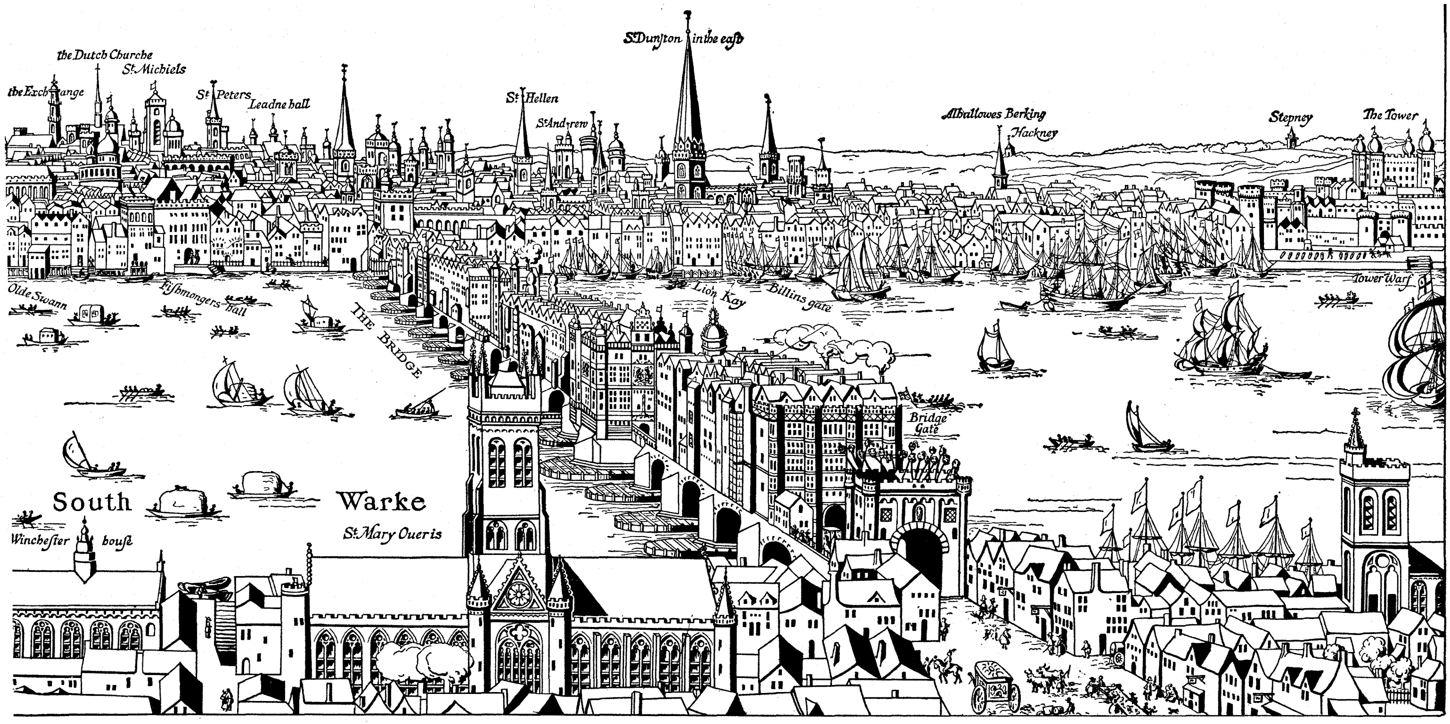
The City.—The antiquity of the City of London forms the background, but the background only, of a vigorous modern life. Within the small area between Temple Bar and Aldgate there are concentrated the Bank of England, the stock exchange! royal exchange, the Mansion house, the head offices of banks, financial houses and insurance offices, shipping companies, wholesale markets, Lloyds, the Baltic, the Wool, Iron and Steel and Coal exchanges, the general post office, telephone and cable headquarters, and the newspaper press and its accessories, the international news agencies and offices of overseas journals. The ratable value of the City in 1949 was £6,344,046 (it had been £507,372 in 1801); and the profits assessed to income tax of firms or persons carrying on business in the City was assessed in 1947–48 at £347,313,000. This was about one-sixth of the total for the United Kingdom. The day population was estimated at 500,000 in 1939 but may well be double that figure. At night the City is quieter than many villages. In 1951 the resident population was only 5,324. In 1563 it was 93,000; in 1801, 128,000; and in 1851, 129,000. By 1871 it had shrunk to 74,000 and has decreased ever since.

The Port of London.—From the earliest times the prosperity, and even the existence, of London depended upon its water-borne trade. This was carried on, however, mith no other docking facilities than were afforded by the two creeks of the Walbrook and the Fleet and two small havens of early construction at Billingsgate and Queenhithe. Billingsgate was mentioned in the De *Institutiones* Lundonie of King Aethelred II; Queenhithe appears under its older name of Etheredshyde in a charter of King Alfred; it became Queenhithe after its grant by Henry I to his wife, Queen Adelaide of Louvain. The Walbrook was used by vessels as far as Bucklersbury up to the 15th century; but it gradually filled up and its course was hardly to be seen at the end of the 16th. The Fleet was navigable to Seacoal lane (which tells its own story), first mentioned in 1287, but silted up, like the Walbrook. Its clearance and conversion into the New canal under William and Mary gave it only a brief renewal of life.

In 1661 the first dock was built at Blackwall and in 1700 the Howland Great Wet dock at Rotherhithe; but the modern system of docks was started only in 1802 with the West India dock, the first to be enclosed. There followed the London dock in 1805, the East India company's dock at Blackwall in 1806, the Surrey Commercial docks between 1807 and 1876, St. Katharine's (1825–28), Millwall (1868), the Royal Victoria (1855) and Royal Albert (1880). In 1886 the first Tilbury dock mas made, extending the port of London nearer the sea. Finally the Port of London authority (P.L.A.) came into existence in 1909, took over the old docks and embarked on a program of construction of which the King George V dock (opened 1921) is the largest. The group of Royal docks at Woolwich make up the largest expanse of impounded water in the world. The P.L.A. controls 69 mi. of river from Teddington lock to the sea. It is not necessary to visit the docks to see the port of London at work. Large vessels are unladen in the Pool of London, providing a continual spectacle; and another viewpoint is from the terrace in front of the Tower.

East London.—Londoners live in a metropolis which has extended in an ill-defined way. The unifying link is the Thames, and the complementary masses are the vague area of the West End and the East End belon London bridge. Unlike the West End, the East End has a precise frontier; it begins at Aldgate Pump. The two regions speak the same language, if with differing accents, and obey the same laws; to a large extent they are unknown to one another. They have the river in common. and without the river and all it means the West End would wither and decay. They differ in that the East End knows the Thames to carry the life and labour on its tides; the West does not.

This other London must be sought in such places as the Whitechapel road, in the ceaseless activity, curiosity and courage of the



VISCHER. ON THE LEFT IS SHOWN "OLD ST. PAUL'S," BUILT DURING THE 12TH AND 13TH CENTURIES AND DESTROYED BY FIRE IN 1666. IT WAS PRIEST. PETER OF COLE CHURCH; BEGUN IN 1176 AND FINISHED IN 1209, AFTER THE ARCHITECT'S DEATH. BY THREE LONDON MERCHANTS. THE HEADS OF CRIMINALS. IN THE 18TH CENTURY THE HOUSES WERE REMOVED. AND IN 1825 THE PRESENT BRIDGE WAS BEGUN

pavement, and the noise and vulgarity wherein resides the essence of the Cockney. Many Jewish, as well as Cockney. faces are to be seen in the Whitechapel road. East London has its Chinatown at Limehouse, and there is a Scandinavian quarter across the river at Rotherhithe. A blended odour hangs over East London. Such a name as Pickle Herring wharf gives a hint, picturesque but inadequate. The blend contains the individual odours of wooden packing cases and damp straw packing, tea, cheese, butter, bacon, rum and spices, vinegar and hot humanity, the shifting scents of ebbing and flowing tides. So with the names and the mingling of past and present: the Isle of Dogs, Bugsby's reach, Galleon's reach. Wapping Old Stairs, and the public houses, the Prospect of Whitby, the Artichoke Tavern and the Town of Ramsgate (where the mob caught Judge Jeffreys).

The West End. — Fashion began to move west from the City as early as the reign of Henry III, who gave the manor of Savoy (now the names of a royal chapel, a theatre and a hotel) to Peter of Savoy, who had married his niece Eleanor of Provence. By 1573 houses of bishops and nobility were continuous on both sides of the Strand, the bridle path along the bank of the river. Henry VIII had begun to demolish the leper hospital on the site of St. James's palace in the year he married Anne Boleyn (1533); and he had almost immediately moved to York house (which became Whitehall palace) on the fall of Thomas Wolsey in 1529. This was the origin of what became known as the West End—an indeterminate region focused on the court. The day of its splendour began after the Restoration, when Charles II walked with his courtiers, his ladies and his spaniels in Birdcage walk. In the 18th century Buckingham house in St. James's park was acquired by Queen Charlotte and was known as "the Queen's house" for some time afterward. The house became Buckingham palace after it had been reconstructed between 1825 and 1836. William IV disliked living in it, and the *Times* of the day criticized its unhealthy situation; but it became the London home of Queen Victoria and the prince consort and has since been the centre of the public life of the sovereign. The main front toward the Mall was refaced in 1912.

The West End embraces the four royal parks: St. James's, Green park, Hyde park and Kensington gardens (275 ac.)—a continuous stretch of lawn, trees, ornamental waters and laid-out gardens — which includes Kensington palace, where Queen Victoria was born. It includes Pall Mall and the clubs, Piccadilly and Piccadilly circus, Regent street, Mayfair, Park lane (no longer the home of multimillionaires but a place of luxury hotels); the houses of parliament and Westminster abbey and most of the great public art collections. Many of the large department stores are in the West End, and such streets as Bond street. Savile row, Regent street and Oxford street have an attraction of their own. Of the squares, big and little, some are highly fashionable, some going down in the world and being invaded by commerce, some with no social pretensions whatever, but all are beautiful, with matured and graceful trees and a general absence of the artificial. The eastern outpost of the West End may be taken as St. Martin-in-the-Fields, Trafalgar square, "the parish church of London" and the pioneer of broadcast services. When Charing was a village, St. Martin's stood among green meadows.

Soho, a cosmopolitan area with many restaurants and provision shops and peopled by Italians, Greeks, Cypriots and other foreigners, lies between Regent street and Charing Cross road and is bounded on the north by Oxford street. East of Piccadilly and particularly in Shaftesbury avenue and the Strand are most of the London theatres.

The Shopping Area. — Bargains are to be found in London, as in Paris and other great cities, in the byways rather than the highways; and part of the collector's pleasure lies in collecting little out-of-the-way shops. London contains some of the most famous shops in the world. The goods displayed are of good quality and any luxury or necessity for any climate or mode of life can be obtained somewhere in London. The chief shopping centres are in Bond street (a name which is almost a trademark for quality goods); in St. James's street and the Haymarket (with hatters and wine merchants dating from the 18th century); Jermyn street. Sackville street and Burlington arcade (for men's high-quality clothing); Piccadilly circus, Piccadilly and Regent street (with shops as well-known as the streets themselves); Victoria street. Knightsbridge, Sloane square and Brompton road. Westward of Oxford circus the region of large stores begins. These are matched or rivalled in Kensington High street and Queensway (formerly Queen's road). Bayswater.

William Whiteley (*q.v.*) was the pioneer of the universal store, Born near Wakefield. Yorks., in 1831, he was a draper's assistant there for four years and then for nine years in London. In 1863 he opened a small draper's shop in Westbourne grove; by 1876 he had 15 shops and 2.000 people working for him. He claimed that he could satisfy any demand and is said to have been tested by a request for an elephant. He came through the test. John Barker (later knighted) established an equally successful business in High street. Kensington, and before his death in 1914 saw it grow to a vast concern with several subsidiary shops. Harrod's. in Brompton road, grew out of a tiny grocery shop belonging in 1849 to Philip Henry Burden. Harry Gordon Selfridge established a well-known Oxford street store in 1909 with 130 departments. The suburbs of London and the East End also contain many thriving large stores and the multiple shop is to be seen nearly everywhere. In 1952 there were 111,742 retail shops in Greater London, representing 132.8 per 10.000 persons.

The Suburbs. — The spread of London westward from the City has already been noticed. The suburbs were a later and continuing development. encouraged and made possible first by the railway building of the 19th century, and later by the "tubes," the bus and electrified train services. Thus was created Greater London, covering a radius of about 16 mi. from Charing Cross. Of the population of Greater London (8,346,137 in 1951) a large number travel to their work in inner London every day. They sleep in "dormitory London." but their lives are concerned for five or six days a week with London proper.

In mediaeval London the word "suburb" was a synonym for "liberty." denoting a privileged area exempt from outside jurisdiction. Such were at first the outlying areas not included in the City walls; and the suburb par excellence was the district between Ludgate and Temple Bar. A charter of Edward III made a grant of land *apud* Flete *in Suburbio London.* Beyond "the suburb" were the villages swallowed up later by the insatiable appetite of the growing capital. A map of 1782 shows such villages as Islington, Hoxton, Stratford-le-Bow. Deptford, Camberwell, Newington, Battersea, Chelsea, Brompton and Paddington as separated from London; while a little farther out Kensal Green, Hampstead. Highgate, Kentish Town. Holloway, Lewisham, Dulwich, Clapham, Kensington and Hammersmith were in open country. Some of these, such as Dulwich, Hampstead and Highgate, still conserved something of their village atmosphere in the 1950s. Newer residential districts farther out and especially where there was an old village nucleus, possess attractive parks; and a notable permanent increase of bright flower beds was fostered by the festival year of 1951 and the coronation of 1953. Some of the suburban centres have grown up into the adult dignity of boroughs with mayors and corporations.

HISTORY

Conjecture and legend have built up a story of the origins of London which will not bear the scrutiny of history or archaeology. Much new material was brought to light about Roman London after World War II; but no structural evidence of a pre-Roman London was produced. The piles of early dwellings in such places as the bed of the Walbrook stream cannot be attributed to a "Celtic capital." A deep excavation made there in 1949 for a new building went down to the blackened piles supporting successive levels of London through 19 centuries. Its history became visible in three layers of burnt ashes representing the sack of London by Boudicca (Boadicea), a fire in Roman times and the Great Fire of London in 1666. On top of all were the rubble and ashes of World War II. The earliest traces of occupation were Roman, of the 1st century A.D. In another part of the City, just outside the Roman town hall near Cripplegate, postwar excavation showed that there had been occupation by a nomad community with primitive habits. It was tempting to guess, in the company of earlier historians, that these had been early London "lake-dwellers." the possible precursors of Celtic inhabitants: did they not live in a swampy region, their dwellings hardly raised above the surface of a region still known as Moorgate? But archaeology showed that they were squatters with gypsy habits and hardly earlier than the Norman conquest.

History is silent also. There are no relevant Celtic documents. The name alone is Celtic beyond dispute. But its earliest recorded form is the latinized *Londinium,* and the few references to it in classical literature relate to the years of Roman conquest or dominance. It has been asserted without any supporting evidence that the Celtic kingdom of Cunobelin or Cymbeline — which had its capital first at Verulamium and afterward at Colchester — possessed a port of entry on the Walbrook creek. Roman writers knew nothing of it. They might not have cared had they known. Archaeology does not admit such fictions, however picturesque.

Roman London. — With the Roman conquest historians are on firm ground. The unquestioned history of London begins with the Claudian conquest of A.D. 43. not with Julius Caesar's raids of 55 and 54 B.C. Caesar crossed the Thames somewhere below London, and he does not even mention it. The Claudian invasion was begun by Aulus Plautius, and the plain dictates of strategy determined the choice of the site of London as an advanced base for the subjugation of the island. His armies marched from four Kentish ports to Canterbury and from there along an ancient trackway which he converted into the first great military road. It cannot be doubted that the Thames was bridged in this advance; Roman generals and engineers had dealt with a far more formidable obstacle in the Rhine.

London's story thus began with the formation of a camp, which developed into a fort and then into a fortified town. It was already a busy port in A.D. 61 when it was put to fire and sword in the terrible vengeance of Boudicca, the legions having gone too far northwestward and left their rear exposed. Boudicca's rebellion provides the first recorded mention of London. There is none as yet of its walls or buildings. The excavations of 1950 and subsequent years however revealed portions of a substantial early fort covering 11 ac. This occupied an area within the later Wall south of Cripplegate. The fort was protected by a ditch and drawbridge; and modern and mediaeval streets within its area corresponded roughly with the pattern of a Roman "grid." The interest of this discovery — dated by finds and other evidence to the decade A.D. 70–80—is that it was constructed before the wall (which is not bonded into it) and while the conquest was still proceeding. The discovery seems to account first for an unexplained twist of the wall southwestward near the church of St. Anne and St. Agnes; and secondly for the enclosure within Roman London of an area remote from the main centre of Roman urban life between the Walbrook and London bridge.

Careful excavation there and elsewhere in the City became possible after extensive damage by fire and bombing had been done in World War II. Large areas were denuded of buildings and remained accessible to archaeologists as late as 1954. Earlier digging had proved the existence of a municipal centre on the site of the present Leadenhall market. An extensive range of buildings had been identified grouped around a forum. with a basilica or town hall, other public buildings, shops and commanding monuments, including the head of a colossal bronze statue of the emperor Hadrian (117–138). Elsewhere in the City have been found from time to time tessellated floors. hypocausts, decorated walls and other attributes of luxurious living. London, however, never became a capital in Roman times. In recognition of its wealth and importance it was officially renamed Augusta; but it reverted to London under various forms.

One monument has survived all changes. London Wall is still the name of a street. Modern street names recall the approximate if not the identical points where Roman roads pierced the wall—as Aldgate, Bishopsgate, Moorgate, Cripplegate, Aldersgate, Newgate and a doubtful Ludgate. The course of the wall is known from the Tower, where the remains of a bastion can be seen just southeast of the keep, to a point behind Stationers' hall. There and in other places fragments or sections can be seen above ground, though the visible masonry is often mediaeval or even later. Traces of hurried rebuilding near Aldersgate are taken with some plausibility as signifying raids of the Picts and Scots in the 4th century. A Roman galley, recovered from the Thames mud under County hall near Westminster bridge, preserves a memory of sea fights and perhaps of that between Allectus and Carausius in A.D. 293.

In 1954 an unsuspected Mithraeum, or temple of Mithras, believed to have been built about A.D. 150, was discovered in the course of a contractor's excavations for the foundations of a new building, about 1j ft. below the modern ground level on the west side of Walbrook (the street) but on the east side of the new course of the Walbrook stream or creek as determined by this excavation. The temple measured 60 ft. by 25 ft.; it had a projecting western apse and an entry from the east down steps in part remaining. The building was divided into a nave and aisles by two rows of columns, seven on each side, of which the bases remained. On the chord of the raised apse were two blocks of stone representing altars. The malls, built of squared stones and bonding tiles, stood shoulder-high. A timber-lined well was found, suggesting ritual lustrations, and other cult objects were a stone holy-water stoup and parts of two massive stone lavers. Among the sculptures discovered on the site, the most important was a head, and later a bust fitting into it, attributed to Mithra or Mithras. Other sculptures may have represented Serapis, the Ptolemaic god-of-all-purposes absorbed into the Mithraic cult, and various Graeco-Roman deities and temple attendants. The Mithraeum went out of use at some unknown date not much later than the end of the 4th century. Earlier in that century there had been a rehabilitation of pagan worship under Julian the Apostate; and it was thought that the temple might have been destroyed and its statuary hidden from Christian iconoclasts in the time of Constantine. It was found possible to arrange for its piecemeal removal and re-erection on a nearby site.

Rome rallied against barbarian onsets from the north and across the seas and established the forts of the Saxon Shore, some of which are still standing. But near the end of the 4th century rebellion became almost continuous; and the year 410, when the emperor Honorius recalled the legions, has been taken as the end of the occupation and thus of intercourse between London and the civilized outer world that had lasted almost four centuries.

Dark-age London. — London is hidden in the mist which settles on the whole island from the severing of the formal link with Rome to the coming of St. Augustine and his Latin monks. Little more can be discerned from the historical record than that London was the chief town of the East Saxons at the beginning of the 7th century and that its first bishop, Mellitus, built a church in honour of St. Paul on the highest ground within the city.

But what had happened since the departure of the legions? Did the urban life of the romanized British continue, with diminished resources. yet in substantial and often luxurious houses, with access to the sea and protection from the wild men of the north by a solid town wall? Was London deserted with the decline of trade and industry and the buildings left to decay? Or did their owners, as in many parts of the island, surrender to pillage, fire and murder if they could not escape? No firm answer can be given. Modern scholarship will not sustain the claim to a continuous city life; still less will it support the association of mediaeval London institutions with their Roman equivalents. The lord mayor bears a French title, while the sheriffs are Anglo-Saxon; the livery companies have no relation to anything known of Roman London. In fact it was administered by a procurator, responsible directly to the emperor.

The wall is the only link during the dark ages between Roman and Saxon London. Except in the instance already described of the newly discovered fort near Cripplegate, the Roman street plan cannot be reconciled with the mediaeval netaork of streets and courts. The line of Watling street and Bucklersbury may represent a road from the Roman bridgehead to Newgate, deflected from its direct course by St. Paul's. What is now Holborn and Oxford street is named Watling street on a pre-Conquest charter and was evidently recognized as a continuation of the road which emerged at Newgate (the only proved Roman exit). But Watling street is a Saxon name; all that can be said of it is that it seems to have been applied to well-made Roman roads still fit to use in Saxon times. These were London's only highways worth the name until the 18th century; and even in a derelict London one or two of them may have survived as through routes. When houses appear and can be plotted on a map, from the evidence of will and charters, they are found to bear little relation to any system of streets. They were placed irregularly, obliquely and often athwart the roadway.

Saxons and Danes. — The conquest of Britain by the Teutonic tribes of whom one, the Angles, ultimately gave its name to England, was a major event; its details are few and obscure. Modern historians permit us to accept Hengest (Hengist) and Horsa as real persons and the date of their landing on the Kentish coast as 449. But the record in the *Anglo-Saxon Chronicle* comes from a narrative compiled in more than one monastery, often long after the events described. Some of the dates are manifest guesswork. The mythical background provides an ancestor for the West Saxon kings in the heathen god Woden. The *Chronicle*, however. becomes factual and contemporary in the reign of Alfred and by Alfred's direction. This does not dispose of the fact that records of the conquest in the 5th and 6th centuries were meagre in the 8th and remained so.

The conversion of London to Christianity was precarious and premature. King Sebert of the East Saxons, under whom Mellitus had set up his London bishopric, was nephew of King Aethelbert of Kent, "lord over all the English races as far as the boundary of the flood Humber" (Bede). On Aethelbert's death Kent relapsed into heathenism; Sebert died at the same time; his sons refused to accept Christianity and Mellitus was banished. Two other bishops are named; but the stubborn paganism of the Londoners frustrated the attempt to found the first bishopric. Bede, writing in the 8th century, mentions London as the mart of many people coming by land and sea: but its possession passed to and fro between contending overlords until Ecgbert, king of Wessex, "conquered the kingdom of the Mercians and all that was south of the Humber."

A new epoch, for England and for London, begins with Ecgbert's grandson Alfred, who came to the throne in the thick of the fighting with the Danes. After his victory at Edington (878) a peace was arranged which restored Wessex to him and confined the Danes to the Danelagh in the east of England.

A new invasion took place in 884, the Norsemen being supported by the Danes of the Danelagh. Alfred beat them off by land and sea, pushed the frontier back in Essex and occupied London. Bishop Asser, in his contemporary biography, says that in 886 Alfred "after the burnings of cities and the slaughter of peoples, honourably restored the city of London and made it habitable," afterward entrusting it to the care of his son-in-la Aethelred, ealdorman of Mercia. The bishop adds that afterward all the Angles and Saxons who had been dispersed or were in captivity among the pagans turned of their own accord to submit themselves to the lordship of the king.

London was thus not yet the capital. It was a strong place and henceforth a rallying place outside the Danelagh. The capital was Winchester. London for the time being was a southeastern outpost of Mercia. The distinction between Mercia and Wessex (the only Saxon kingdoms which stood erect against the Scandinavian onslaughts) tended to break down with the relationship of their rulers and their common share in the task of reconquering the England of Ecgbert. The recovery of London implied the political unity of Alfred's kingdom, if Asser's record of submission to Alfred may be taken as more than a local affair between London and the Danelagh. From this day, since the London defenses aere never penetrated, the future capital became identified with its destiny. Excavations in 1952 near the London wall, behind the disused churchyard of St. Alphage, yielded evidence of continuous repairs above the Roman core. Both there and in other parts of the wall brought to light by bomb and spade the lower levels may safely be attributed to Alfred's initiative.

The 10th century. after Alfred's death, is in part a steady advance and consolidation of English conquests, in part a renewal of raids by the Norsemen. Remains of an important earthwork can be seen at Witham, Essex, raised soon after 911 as an obstacle to the Danish advance. London held firm, in spite of its siege by Olaf Tryggvesson and Sweyn Forkbeard with 94 ships in 994. An Icelandic saga relates how the long ships, unable to get past the bridge, were at last lashed together and carried forward by the force of the tide to break it down.

London was besieged by Canute in the short reign of Edmund Ironside. Canute cut a channel round the southern end of London bridge and blockaded the town. Edmund Ironside defeated a Danish army at Otford, near Sevenoaks, in Kent. but was afterward overwhelmed in battle in Essex on a site believed to have been Ashingdon. Peace was made on the basis of allotting Wessex to Edmund and the rest of the country to Canute. The men of London, now Canute's subjects, had to buy peace from the Danish army for a large ransom. Edmund died in Nov. 1016, and the men of Wessex submitted to Canute.

London was becoming a national capital in fact though not in name in the 11th century. Edward the Confessor was elected there by popular acclamation in 1042 after the failure of the Danish male line. London's growing importance is shown by meetings there of the witan, the old English council, eight times between 934 and 1055.

Harold II was elected king in London the day after the death of Edward the Confessor and reigned for nine months. The threat of invasion hung over the realm until Harold met, first the Norwegian assault of Harald Haardraade near York; and secondly the Norman host at battle near Hastings, in 1066. Duke William's victory was the end of the Anglo-Saxon era.

London after the Conquest. — Hastings was a decisive battle, but William had not conquered England until he had secured London. All the English leaders were not involved in the defeat at Hastings. William made a circuitous march on the city, burned Southmark and had half encircled London when Archbishop Stigand, leader of the aetheling's party, went to William at Wallingford and submitted to him. William received the Englishmen's oath of fealty at Berkhamstead, where London was represented by the city magnates. He was crowned king at Westminster in the midst of a tumult, never repeated in the case of his successors. Six months later, though the whole of England was not yet in his hands, he was able to leave for Normandy. He had not misjudged the importance of London.

William's charter greeted "all the burgesses within London, French and English, friendly," and promised the observance of the laws of King Edward the Confessor's day. The charter was addressed to William, bishop, and to Gosfrith, portreeve; it recognized. that is, a joint ecclesiastical and secular jurisdiction, or rather two jurisdictions side by side. William built the White Tower within, and partly upon, the Roman wall. A period of peace and increasing prosperity was interrupted but not brought to an end by a fire which in 1687-destroyed St. Paul's and a large part of the city.

William II (Rufus) strengthened the tower and built the great hall at Westminster. From the reign of Henry I, London assumed the character of a political capital; it obtained from Henry a charter of liberties, and in 1135 the citizens asserted their right to choose a new king on the death of the old. They refused to recognize Henry's daughter Matilda as queen, obtained the release of Stephen and finally drove her from the kingdom.

FROM THE MIDDLE AGES TO THE FIRE

London Under the Plantagenets. — The story of London between the Angevin monarchs and the Tudors is at the centre of national events. Pretenders to the crown had to secure the support of London, notably in the Wars of the Roses; and its money was required for the wars to conquer France, as under Edward III, Henry V and Henry VI. Its turbulent apprentices gave constant occupation to the city authorities; but they provided a ready-made defense force against an outside enemy.

The revolt under Wat Tyler (*q.v.*) in 1381, when the red dagger first appeared on the Corporation arms, and that of John (Jack) Cade (*q.v.*) in 1450, as later that of Sir Thomas Wyat against Queen Mary I in 1554, marked the relative ease with which rebellion was nipped in the bud during this period if the crown had the citizens' support.

The importance for London of the mediaeval centuries lies however elsewhere: in the assertion of the independence of the City, subject to fealty to the sovereign, in the creation of the mayoralty, in the rise of the guilds and in the growth of the great religious houses. The portreeve is the earliest official known to the documents. As mentioned above. he was addressed by name by William the Conqueror. This pre-Norman functionary, who had equivalents in several English as well as French cities, was one of a group of aldermen, who were territorial magnates whose estates gave their names to wards still existing. John Stow describes them as the knightengild. The idea of a commune or self-governing community forming a miniature republic was not English but French, as was the title of *maire* adopted for its head. London obtained its commune or self-governing corporation from John, acting as regent for his brother Richard I during his absence. On Oct. 8, 1191, John acknowledged the right of the citizens to combine in a sworn association, to take an oath to preserve the City and its liberties and to be obedient to its officers. This is taken as the recognition of the citizens as a corporation bound by corporate oath and replacing the looser association of wards, sokes and liberties. It is generally agreed that the mayoralty was established in connection with the granting of the commune. The precise date is uncertain. Henry FitzAilwin of Londonstone was the first mayor. He is mentioned without that title in Nov. 1191, as well as in later charters; but the oath of the commune in 1193 bound the citizens to accept the decisions of the mayor and others associated with him. The reasonable assumption is that the mayoralty dates from the year before, 1192. Its authority has never since been in dispute, and from the beginning of the 13th century the mayoralty is continuous through good and bad times. The dignity is supported by sheriffs and aldermen (these titles are Saxon), and by the livery companies (*q.v.*), whose power grew up with the growth of trade.

Trade called for a new bridge of stone, and in 1176 Peter of Colechurch began the new London bridge, which lasted until 1832. The Hanseatic merchants were settled on the banks of the Thames in 1157. Vessels drew up at the little ports of Billingsgate and Queenhithe (both of pre-Conquest origin) but also at wharves on both sides of the river. Close to the southern end of London bridge, St. Mary Overie (now Southwark cathedral) represented the importance of the ferry. By the 15th century the Thames side had assumed the picturesque appearance it bore in old prints up to the Great Fire of 1666. Great London merchants, such as Richard Whittington and John Pountney, had their homes (which were also their warehouses) near the river. The scene was dominated by the great spire of old St. Paul's (520 ft. high), with the silhouette of spires and towers below. This skyline survived the Great Fire and even to a large extent the bombing of World War II. For though the Reformation destroyed the religious houses the people clung to their parish churches, many of which were rebuilt through the genius of Sir Christopher Wren.

Late mediaeval London cannot be conceived without the great convents and priories which followed the coming of the friars in the 13th century. Blackfriars is still the name of a district. a bridge and a railway station. One formless mass of masonry is all that remains of the famous Dominican house, in the great hall of which the divorce proceedings of Henry VIII and Queen Catherine were heard. (Two Blackfriars playhouses, from 1576 to 1584 and from 1596 to 1655, were later set up there.) The Greyfriars, or Franciscans, had their church from 1306 on the north side of Newgate, on the site afterward occupied by Christ's hospital and Christ church. The Whitefriars, or Carmelites, from 1241 were on the south side of Fleet street between Bridewell and the Temple. Their conventual buildings ran down to the Thames, with a garden and a millhouse where Tudor street is now.

Other communities occupied the priory of St. Bartholomew (of which a noble fragment remains); the Charterhouse, or Carthusian priory of the Salutation, and the priory of St. John Clerkenwell (of which the gate still stands); the collegiate church of St. Martin-le-Grand; the Austin Friars, Old Broad street; and the priory of Holy Trinity, Aldgate, with the priory of Benedictine nuns in St. Helen's Bishopsgate. St. Helen's contains famous monuments in a mediaeval setting which dates from the 12th to the 15th century.

Tudor and Early Stuart London. — The modern history of England begins with the Tudors. The Reformation was the most permanent and is still the most controversial part of Henry VIII's legacy to the future. This involved the destruction of lovely buildings and venerable institutions. Moreover, his marriages left the succession in dispute long after his death. London was the spectator, or accomplice, in many evil deeds of this period. Tower hill was the scene of the execution of Queen Anne Boleyn (1536), of Margaret, countess of Salisbury (1541), of Queen Catherine Howard (1542), of Sir Thomas More and Bishop John Fisher (1535) and many others, including subsequently Lady Jane Grey (1554) and Robert Devereux, earl of Essex (1601). "The fires of Smithfield," chiefly executions of Protestants under Queen Mary, were the counterpart of the scaffold of her father. The victims burned there were altogether 43; a tablet on the wall of St. Bartholomew's hospital names John Bradford, John Rogers and John Philpot.

The spoils of the church were distributed for the most part to a new aristocracy. The sites of the convents were cut up into little streets and courts; new slums appeared in their place, with a great increase of the danger of fire. In Blackfriars what had been the prior's garden became the narrow Friar street. Holy Trinity priory, Aldgate, between Duke street and Leadenhall, possessed in the 15th century "a great garden," a second garden south of the convent church, a churchyard and a garden behind St. Katherine Cree church. Whitefriars had a Great Friars gate and a Little Friars gate on the south side of Fleet street, and its gardens stretched to the river. Bouverie street now cuts the convent lands in two. Some few fragments were spared. St. Bartholomew's hospital was refounded by Henry VIII after the destruction of the priory (except the nave of the church which was retained for parochial use). Henry also refounded St. Thomas's hospital in Southwark; and Edward VI gave his father's derelict Bridewell palace, with an endowment, for a hospital in the old sense of a refuge for the poor and infirm. London was swarming with beggars, cripples and an underworld hitherto dependent on the monasteries.

The livery companies also obtained halls. Edward VI converted the Greyfriars into Christ's hospital, for the maintenance and education of poor children; and the Charterhouse, though by no royal generosity, became in 1611 the home of 80 old pensioners and 40 boys. There had been a grim ending to the life of the convent. The Greyfriars had found it possible to assent to the act of succession but they could not bring themselves to swear that Henry was the head of the church. So resolving in their chapter house, they knew their doom: to be dragged on hurdles to Tyburn, there to be hanged and disembowelled.

Elizabethan London sprang from such a soil. Controversy was far from dead, and the axe had not yet finished its work; but a new spirit was stirring. About 1586 William Shakespeare came as a young man from Stratford to Blackfriars, where his first work, *Venus and Adonis*, was published in 1593. He was soon to be known as an actor and as a playwright. His career is closely associated with two theatres of which he was at one time joint proprietor — the Globe at Bankside and the Playhouse at Blackfriars. Both were outside the jurisdiction of the corporation of London. which was rigidly puritanical. Playhouse yard, just behind the *Times* office, preserves the memory of the entrance to the Blackfriars playhouse; the theatre itself is believed to have been on the site now occupied by a private house. That of the Globe is identified in the London County council *Survey of London;* it is shown in Wencel Hollar's bird's eye view of London as nearly opposite the quay of "Blackfreyars."

Jacobean London differed little from that of Elizabeth. Hollar's bird's eye view, just mentioned, was published in Amsterdam in 1647 but it was derived from sketches made just before the Great Rebellion. It shows many-gabled houses crowded together as in a mediaeval German city, but for the most part covered with tiles. Before war broke out, there had been some rebuilding and a beginning of planning. Inigo Jones erected the first Renaissance building in London in the church of St. Paul, Covent Garden, for James I, to whom is also due the New River company, providing the first supply of pure water.

The Great Rebellion left relatively few traces in the City. The centre of the drama was Westminster where Charles I met his parliament, his accusers and his death. The City was a parliamentary island, already with strong puritanical leanings, to be confirmed when Charles went in person in 1642 to Guildhall to demand the surrender of the five members of parliament accused of treason. Throughout the war a minority at least of the citizens was believed to stand behind the king; but London had the money, the men and the means of arming them. There was a moment after Edge Hill when swift decision might have changed the course of events. Charles had marched to Brentford but found parliamentary troops drawn up at Turnham Green. After a reconnaissance he retired to Reading and Oxford. London saw him no more until it flocked to the final scene at Whitehall on the cold morning of Jan. 30, 1649.

The Great Plague and the Great Fire. — "Late into December nights of the year 1664 London citizens sat up to watch a new blazing star, with 'mighty talk' thereupon" (Walter George Bell, *The Great Fire of London,* [London, 1951]). This was one of the portents (for in March a yet brighter comet was seen in London) that went before the Great Plague of London. Plague had been intermittent since the reign of James I; there had even been a "Great Plague" in 1625. That of 1665 was merely the worst. unexampled in its sudden spread and deadly effects.

The Great Plague began in St. Giles-in-the-Fields; the districts that suffered worst were Stepney, Shoreditch, the Borough, Bishopsgate, Aldgate, Whitechapel, Cripplegate and Clerkenwell. both sides of the Fleet ditch, both sides of Holborn and the crowded streets around Westminster abbey. The peak of 7,000 deaths in a single day was reached in September; after this the numbers declined to 500 in December and never rose above 300 a day thereafter. A return made to Charles II on Dec. 19 by the Company of Parish Clerks gave "the total of all the burials this year 97,306. Whereof, of the Plague 68,596."

The Great Fire followed before the plague had completely disappeared. Samuel Pepys, who had been to and fro during the plague, describes the beginning of the fire as seen by one of his maids from his house in Seething lane, near the Tower. at three o'clock in the morning of Sept. 2, 1666. It had started in Pudding lane near London bridge and seemed then a small affair. It was not arrested until practically the whole area of the city had been burned out; and the flames had spread beyond to the Temple and Holborn.

London within the wall was still a mediaeval city in appearance and much besides. when the fire broke out. Some rebuilding had taken place under James I and in the early years of Charles I; little under the Commonviealth; the main aspect was that now popularly recognized as "Elizabethan." Few of these timbered houses survive, and almost none in the actual fire area. The streets were almost impassable to wheeled traffic and would long ago have had to be widened, had not the Thames been the great highway. Nowhere did the timber-framed houses crowd more closely than by the river, where the outbreak began.

In Pudding lane — a dark, cobbled, narrow street sloping steeply to the Thames — John Farynor, the king's baker, had gone to bed at 10 o'clock after his day's trading was done. At 2 A.M. his man was roused by a choking sensation and found the house full of smoke. The baker, his wife, daughter and his man escaped over the roofs. The maid remained and became the first victim of the fire. Such was the origin of the fire in the opinion of Walter Bell, who wrote the standard work on the subject. At the time popular opinion demanded a culprit and fixed on papists and Frenchmen. The monument recorded from 1681 to 1685 and again from 1689 to 1830 the "perpetual remembrance of that most dreadful burning of this Protestant city, begun and carried on by ye Popish faction."

The fire spread slowly at first. A strong wind was blowing from the northeast. By eight o'clock London bridge and the houses on it were blazing. Live flakes were carried on the wind and the fire began to creep back from the river. That night all London saw such a glare as it had never known. The first day had carried the frontier of flame nearly to Queenhithe, on the river bank, and northward to Cannon street and East Cheap. On the afternoon of the second day the fire was raging about the Royal exchange, Lombard street and Cornhill, among the dwellings and shops of rich brokers and merchants. On the third day Guildhall was burning, the custom house and the Royal exchange were destroyed, and fire broke out on the roof of St. Paul's. The wind fell during the night, and the fire was out except for patches of flame on the fourth day. Its limit was in the Temple, where James, duke of York, had been put in command of soldiers and seamen.

The record on the north side of the monument states that the fire consumed 89 churches, 13,200 houses and 400 streets.

GROWTH OF THE MODERN CITY

Later Stuart London. — The Augustan age in English literature has long been recognized; but it was only after the upheaval of World Wars I and II that the architecture of Queen Anne's reign was fully appreciated. English baroque came to be compared with that of the Lon Countries, of Germany, of France and of Italy and to survive the comparison. Sir Christopher Wren (*q.v.*) actually began the rebuilding of St. Paul's cathedral under Charles II; it was finished in 1710, under Queen Anne. Wren's series of rebuilt City churches was completed under George I. The Great Fire destroyed or seriously damaged 87 out of the 101 churches in the City. Wren rebuilt or superintended the rebuilding of 51, as well as St. Andrew's, Holborn (not destroyed by the fire).

These churches formed a group unmatched for variety and attractiveness; among the most notable of Wren's towers and spires are reckoned St. Mary-le-Bow, Cheapside; St. Bride's, Fleet street; St. Vedast, Foster lane; and St. Michael, Paternoster Royal. Work began on these new churches in 1670; by 1687 the bodies of the earlier buildings and the lower stages of the towers were mostly completed; 17 were started in 1670, and 1700 saw them nearly finished.

Forty-four halls of City livery companies (*q.v.*) were also destroyed in the Great Fire. These did not form a group, as did the churches; they were scattered about the City, though they tended to concentrate near the river. After Guildhall they were the most important of the secular buildings. The earliest was the 14th-century Barbers' hall, near Cripplegate; the Merchant Taylors' hall, Threadneedle street, had a 15th-century hall and an earlier crypt; the Mercers' hall, Cheapside, had a private chapel which had formed part of the pre-Reformation hospital church of St. Thomas of Acon. Most of these buildings were restored or rebuilt soon after the fire. It has been claimed that some of them were designed by Wren. No evidence exists for this assertion. The companies employed their own surveyors; and these men, unknown outside the companies' records, designed some noble rooms and accessories. The wood carving of this period is seen at its best in St. Paul's; the City companies found other craftsmen, less well-known and not under royal patronage, to execute work which has never since been equalled.

The social quality of London was altering during the Restoration period and the earlier years of the 18th century. Fashion began to move out of the City under the influence of the court. Covent Garden and Lincoln's Inn fields were already fashionable under the first Stuarts; royalists returning with Charles II built themselves houses farther west; by the end of the reign wit and fashion had begun to follow the court toward Whitehall.

Hanoverians and the Regency. — The sturdy independent life of the City did not come to an end with its desertion by the aristocracy. Prosperous merchants and tradesmen alike lived over their warehouses and shops. Kings, ministers and parliaments had to look to the City of London or take the consequences. The declaration of allegiance to the prince of Orange, afterward William III, had been drawn up at Guildhall by the lords spiritual and temporal. The City supported "Wilkes and liberty" against parliament from 1769 onward and joined with him in challenging the right of parliament to prohibit the reporting of debates. The Gordon riots of June 1780 were the most formidable rising that the capital had known since Jack Cade and Wat Tyler. No police force existed. Soldiers had to be called in to prevent the spread of arson and mob terrorism, inspired by religious bigotry.

The sedan chair had come into use under Queen Anne. and it remained the most popular means of conveyance throughout the 18th century. Conveyance to Westminster was by river. This was safer, cleaner, quicker and pleasanter than to pass through ill-lit streets, cobbled, filthy, evil-smelling, undrained; with no footpaths and no protection for foot passengers except the iron posts along which Dr. Johnson felt his way. This was nevertheless the London of which James Boswell left such memories. Samuel Johnson wrote his *Dictionary* in Gough square; Oliver Goldsmith was living in the Temple; David Garrick after his marriage lived in Southhampton street, Strand; and Joshua Reynolds lived in Leicester square. The classical age of English portrait and landscape painting was soon to begin.

Georgian architecture came into being in quiet squares and streets, or in individual houses. Its merits were not to be recognized—it was indeed despised—until the 20th century was well on. For the most in brick, it was plain and austere, its decoration confined to a doorway or to a cornice; its beauty resided in its harmonious proportions. Display was reserved for the inside. Good portraits, good wine, good silver, good music and good company might be met there. The furniture had elegance and comfort.

The Regency introduced stucco to London—partly for reasons of economy during the Napoleonic Wars. Regent street and Carlton House terrace were the best-known examples until the Regent street quadrant wss rebuilt in Edwardian-Palladian between World Wars I and II. The regent himself impressed a vivid personality and a restless spirit of innovation on the society as well as the London of his day.

Victorian London. — London changed during the long reign of Queen Victoria from an insanitary, overcrowded and tortuous city to a spacious capital (outside the ancient City) which remained substantially unchanged until large areas of it were destroyed in World War II. A writer in the *Times* of July 28, 1853, said: "It does not take a very old man to remember when there was neither a gas-lamp, nor a cab, nor an omnibus, nor a steam-vessel, nor a plate-glass window, in a city of which these things are now essential ingredients." London at the beginning of the reign had only one railway terminus (Euston, line opened 1838), no underground or tubes, only the old palace of Westminster for the houses of parliament, no Trafalgar square, no Embankment, no Victoria street (Westminster) or Queen Victoria street (City), no Holborn viaduct or New Oxford street. Human rabbit warrens occupied the immediate region of Westminster abbey, St. Giles's circus and the sites of the later Aldwych and Kingsway. In the course of clearing these areas new slums were created by overcrowding elsewhere; but main arteries were driven through London from east to west. The Aldwych scheme was completed in 1905, soon after Queen Victoria's death; when she came to the throne the neighbourhood of Trafalgar square was known as Porridge Island, the National gallery was being built on what had been the king's mews, and behind it were barracks. Nelson's column, begun in 1840, did not receive its figure until 1843. Even the idea of a noble open space seemed ludicrous to contemporary opinion. The *Times* wrote of "this ill-fated square" and derided the lanterns of the National gallery as "pepper castors."

The Crystal palace (opened by Queen Victoria on May 1, 1851, in Hyde park) had also to undergo a fire of criticism in the press and in both houses of parliament. Popular criticism had changed into popular enthusiasm by the opening day of the Great exhibition, and the queen wrote of it in her journal: "This day is one of the greatest and most glorious days of our lives." The exhibition was an overwhelming success from the day of its opening to "the sad solemnity of the closing" (so described by Lord John Russell) on Oct. 11. It remained in the memory of Londoners long after the Crystal palace had been re-erected at Sydenham (1854); it left as permanent memorials the creation of a cultural and educational centre in South Kensington on an estate purchased out of its profits by the foresight of Prince Albert. The re-erected Crystal palace at Sydenham was burned down on Nov. 30, 1936.

World Wars I and II.—Edwardian London appears in retrospect as a prolongation of the Victorian scene; at the time a new reign seemed to inaugurate a new age. King Edward opened parliament in state to the delight of Londoners and brought back the colour and pageantry so long forgotten. The new Admiralty arch opened a dignified entrance to the processional way along the Mall; while Buckingham palace was refronted and a colossal statue of Queen Victoria erected. The statuary and architecture of the reign have not escaped criticism; they stamped it with an unmistakable signature needing no such identification as had been supplied by the word "Albert" to the Albert memorial.

The clouds of war were already beginning to gather when George V came to the throne in May 1910. When they dispersed in 1918, throne and people had been united more closely than ever before. World War I broke on a London unfamiliar with war, unprepared and incredulous. In April 1915 air raids on London became frequent, and Zeppelin attacks followed, causing a maximum of alarm; by the end of the war the Zeppelin had been superseded finally by the aeroplane; anti-aircraft defense had been developed, and London had shown its stout heart. A total of 355 incendiary and 567 explosive bombs was dropped in the City, killing 670 people, injuring 1,962 and causing damage estimated at £2,042,000.

World War II drew a red scar across the face of London. Figures give no indication of the facts in terms of human suffering except by comparison with those of World War I. Between 1939 and 1945 about 30,000 people lost their lives in air raids in London; more than 50,000 were injured. In the fierce attacks between Sept. 1940 and July 1941 between 45,000 and 50,000 bombs, excluding incendiaries, were dropped in the London region. Bombing continued for 57 nights between Sept. 7 and Nov. 2, 1940. What was justly called the second Great Fire of London occurred on the night of Dec. 29–30, when 1,500 fires were started. One night in September more than 40 fires were blazing on the Thames or in the docks. On another night Charing Cross bridge was damaged, all except one line; and on this suburban traffic ran again next morning. The damage to Westminster abbey and to the houses of parliament was done in a raid of May 10–11, 1941. Finally, after a long lull. the V-I, flying bomb, or "doodle-bug" as Cockneys called it. started a new series of air raids, more terrifying than the earlier ones, on June 13, 1944. The rocket, or V-2, followed on Sept. 8 (the first fell at Chiswick) and continued until March 1945 (the last at Smithfield, Stepney and Tottenham Court road). The London victims of the two V-weapons were 8.938 killed and 24,504 injured.

When World War II came to an end, the map of London showed wide areas of nearly complete destruction. In the City little was left standing between Cheapside and the Barbican. North of St. Paul's, Paternoster row had disappeared and almost every building as far as Newgate street. East of St. Paul's was another area of desolation extending from Cheapside to Upper Thames street. From the back of the Mansion house destruction had spread on both sides of the Walbrook to the Thames between Southwark bridge and London bridge. Another blitzed area lay round Fenchurch Street station and much of the area of Holborn circus, Gray's Inn road and Theobald's road was flattened.

St. Paul's cathedral was in continual danger from incendiaries but escaped save for the piercing of the choir rood and damage to the altar by a high-explosive bomb. The Temple church was badly damaged. calling for drastic restoration. The Middle Temple hall was badly damaged but the roof and screens—among the most precious survivals of later Gothic woodwork—were carefully restored to their original design. Ruin overtook many of Wren's most notable churches. These included St. Bride's, Fleet street; Bow church or St. Mary-le-Bow; St. Mildred, Bread street; St. Stephen, Coleman street; St. Alban, Wood street; St. Mary Aldermanbury; St. Augustine, near the east end of St. Paul's cathedral; St. Lawrence Jewry, near Guildhall; St. Nicholas Cole abbey; St. Swithin, opposite Cannon Street station and embodying London Stone; St. Vedast, Foster lane; and Christ church. Newgate street.

The steeples of many of these churches had escaped damage or were capable of restoration. Ultimately almost all were rescued for the future, though some are to be used for general rather than parochial purposes. Worship was carried on continuously in all cases, either in a vestry, a tower or a neighbouring church.

Treasures lost during World War II included many of the halls of the livery companies (*q.v.*). These were little known to the public but their interiors represented Restoration woodwork at its best; they contained notable portraits, and some of them incorporated mediaeval crypts or other early features. Of these halls 19 were completely destroyed or burned out; 11 were damaged less severely; only 2 remained substantially unharmed.

Excavation and Rebuilding.—The London Roman and Medieval Excavation council, formed while the war was still in progress. pursued patient research at many points in the City before rebuilding began. Part of the rebuilding plans provided for the permanent preservation of the wall near St. Alphage's church as an open space. Little churchyards belonging to churches never rebuilt after the Great Fire also found their place in rebuilding plans. Controversy delayed the building of the extension of the Bank of England east of St. Paul's; and the elaborate scheme for new alternative roads and bold planning to give better views of the cathedral was held up, despite increasing traffic problems. London's outdoor statues had been taken away for safety or had been protected on their sites: Charles I returned to his place at the junction of Charing Cross and Trafalgar square in 1946; Eros was poised again on his pedestal in Piccadilly in 1952.

Important changes on the south bank of the Thames were made in connection with a Festival of Britain held in 1951 to mark the centenary of the Great exhibition. A permanent memorial remained in the Festival hall, which was criticized for its frontage to the river but quickly became popular as a concert hall. Gardens were also laid out in part of the bombed area between the County hall and Waterloo bridge. Part became a helicopter station in 1954 and threatened the project of a continuous embankment and gardens from Westminster to Blackfriars bridge. River services were restarted in 1951 upstream to Kew and downstream to Greenwich and Gravesend. A new addition to the Embankment gardens was made in front of a huge new block of government offices west of Horse Guards avenue. In 1953 the coronation of Queen Elizabeth II brought unprecedented crowds into London; 30,000 people were counted outside Buckingham palace one night. In subsequent years permanent congestion of the streets seemed to threaten the continued life of historic London. (W. T. H.)

ARCHITECTURE

There is no definite evidence of a settlement on the site of the City of London before the Roman occupation. The Romans chose a site at the lowest point where the Thames could most easily be bridged. After the sack of London in A.D. 61 the walls were added and, though much rebuilt, they survived until the 18th century. Parts which include Roman work can still be seen at Tower hill, Monkwell street (east of Aldersgate street). St. Giles, Cripplegate, and the general post office. It seems that the City contained more stone and brick buildings at the end of the 1st century A.D. than at any other time until after the Great Fire. A hypocaust remains beneath the coal exchange, and there are mosaic pavements inside the Bank of England. Of the 330 ac. within the walls, only the eastern half appears to have been occupied by the Romans. There was also a small settlement at Thorney Island, where Watling street met the Thames at a ford—the nucleus of the present Westminster.

It is clear from early records that the City grew in strength and importance during the Saxon period. The predominance of early church dedications round the site of St. Paul's cathedral suggests that this western part of the space within the walls was the first to be used. During World War II Saxon work was uncovered at the church of All Hallows Barking-by-the-Tower A late Saxon rood panel remains at St. Dunstan's church, Stepney. King Canute made Westminster the site of a royal palace, thus initiating its separate existence as a court centre. Place names indicate considerable Danish influence in and around the City, (*e.g*, St. Clement Danes church, Strand). Immediately before the Norman conquest an impressive church was built at Westminster for Edward the Confessor, of which the Chapel of the Pyx and the monk's dormitory undercroft remain.

The Norman invasion resulted in major building activity in London, of which much is left. The Tower of London is outstanding, and contains the White Tower, an early Norman hall keep begun in 1078, with the well-preserved apsidal chapel of St. John projecting at its southeast corner. Many merchants' houses were built on vaulted stone crypts: houses surviving at Lincoln show the type. The wave of prosperity in the 12th century led to extensive rebuilding of churches in stone. Of these, the choir of St. Bartholomew the Great, Smithfield, founded in 1123 (nave completed in the 13th century) and containing the founder's tomb, still stands. The rotunda of Temple church (consecrated 1185) remains, though injured by restoration and bombing; and the crypts of St. John of Jerusalem, Clerkenwell (1140–85), and St. Mary-le-Bow (c. 1090) can still be seen.

Life in mediaeval London revolved round the central market area of Cheapside. The city government is traditionally associated with this area, in which stood the halls of the city companies and where Guildhall remains with much important mediaeval work (new roof by Sir G. G. Scott finished in 1954). As trade increased, much of the foreshore was reclaimed, the space within the walls was built over, and extramural building along the river bank began. The network of narrow streets which remains shows how overcrowded the City was; some idea of its appearance can be gained from study of the mediaeval streets of Chester and York, and in London itself from the timbered front of Staple inn, Holborn (late 16th century, but much rebuilt, latterly in 1950). About a quarter of the City was occupied by religious houses and their holdings. There were 106 churches, serving so dense a population that the present Bank of England covers the sites of two parishes. Records indicate continual rebuilding in City churches in the late middle ages, but much was lost in the Great Fire of 1666. Surviving mediaeval churches are St. Etheldreda, Ely place, Holborn (the only largely complete pre-Reformation church in England occupied by the Roman communion), built about 1300 as the private chapel of the bishop of Ely; Lambeth palace chapel (c. 1230) with undercroft (c. 1200); and, in the City, St. Helen, Bishopsgate (with Perpendicular arcade), St. Ethelburga, Bishopsgate (with early 15th century arcade), St. Giles, Cripplegate (14th century, rebuilt 1545; damaged by bombing), St. Andrew Undershaft (rebuilt 1532) and the Savoy chapel, Strand (1505 *et* seq.).

Mediaeval Westminster, on the other hand, centred round the ceremonial of court and abbey. Until the late 18th century the river was the chief means of transport, and the chain of great houses of the nobility along the Strand linked the City with Westminster. In Westminster some of the finest mediaeval architecture of London can be seen. Westminster hall was completed in 1097, but modified in 1380–1402 when the fine hammer-beam roof (designed 1380) was added—one of the earliest remaining in England. Westminster abbey was rebuilt for Henry III between 1245 and 1269; the eastern part, the north and south transepts and five bays of the nave are of this period. The cloister court (1245–50; 1344–70) and the chapter house (c. 1245–53; heavily restored by Sir George Gilbert Scott in the mid-19th century) are fine works; much of the monastic buildings of the mid-14th century remain. The rest of the nave was built between 1350 and 1420. At the extreme east end, Henry VII's chapel (1503–19) has a magnificent fan vault with pendants.

Southwark cathedral. though much restored (nave wholly 19th century), contains interesting 13th-century work (retrochoir, chancel, etc.). Several other mediaeval churches outside the City still stand. The best preserved is St. Margaret's, Westminster, a fine Perpendicular parish church. St. Mary, Stratford-le-Bow (Poplar), retains much 14th century work; good mediaeval west towers survive at the parish churches of Fulham (heavily restored), Lambeth and Putney (heavily restored). Two fine secular buildings can be seen: Crosby hall (1466–75), which was removed from the City and rebuilt in Chelsea in 1910, and Eltham hall, Woolwich, a splendid great hall of the late 15th century.

By 1600 most of the monastic property in and around London was occupied by laymen. Some churches were put to parochial use. After the dissolution of the monasteries the population of London increased, and the City began to assume its present-day pattern of life; streets grew up outside the walls. Brick came into wide use as a building material. The brick gateway of St. James's palace and some parts of Lambeth palace are of the late 16th century. What is now known as the St. John's institute, at Hackney, is a well-preserved early 16th century manor house. The Charterhouse. Finsbury, retains much 16th century work and some earlier fragments. The remnants of Well hall, Eltham, contain a range of brick buildings of 1568. The front of Sir Paul Pindar's Bishopsgate house, of about 1624, is preserved in the Victoria and Albert museum. Charlton house near Greenwich (1607) is a well-preserved Jacohean mansion (and with the demolition of Holland house in 1953–54, the only Jacobean house of first importance in London); number 17 Fleet street retains a Jacobean room ("Prince Henry's room"; 1610–11); the George inn, Southwark, has a galleried innyard of 1676, continuing the earlier mediaeval tradition; and Cromwell house, Highgate, of about 1637–40, has a fine staircase.

The 17th century saw the rise of the architect as an individual, and this century, which included the working lives of Inigo Jones and Sir Christopher Wren, gave to London some of its finest buildings. Inigo Jones initiated the use of a carefully worked-out classicism, which remained the dominant form in London architecture until the Gothic revival. He worked in the court circle and built, in the manner of Andrea Palladio, the Queen's house, Greenwich (1616–19; 1629–37) and the Banqueting hall, Whitehall (1619–22). Inigo Jones also designed Covent Garden piazza (begun 1630). Of the Lincoln's Inn fields scheme, begun about 1638 under the inspiration of Covent Garden, Lindsay house (possibly by Nicholas Stone) remains. The typical 18th-century London square derives from these two schemes. John Webb carried on in Jones's tradition and began work at Greenwich on a royal palace; his work comprises the eastern part of what is now called King Charles's block (1663–67) and the palace was continued, as the Royal Naval hospital, mainly by Sir Christopher Wren. The extramural expansion of London that had begun on a large scale in the Elizabethan age continued unchecked. At this time the speculative builder made his appearance. Noteworthy work of the period survives in the chapel of Lincoln's inn (1617–23; restored), built in an interesting revived Gothic style; a fine house, Ashburnham house (before 1662), remains in Westminster.

The Great Fire of London, 1666, destroyed four-fifths of the City. In the rebuilding the earlier street plan was followed in the main. In the interests of fire prevention, private houses were now built in brick and stone. Among the lost mediaeval works were most of the halls of the city companies. They were rebuilt in brick and stone on similar lines to the private houses. World War II again destroyed most of them; Skinners' hall and Vintners' hall still stand, with interesting woodwork, and Apothecaries' hall, which retains its courtyard, is valuable as an example of the former appearance of many City houses.

Before World War II, the 32 surviving examples of parish churches rebuilt, using the mediaeval ruins as foundations, under the supervision of Sir Christopher Wren formed an unrivalled group of works in the English Baroque style. The beautifully varied steeples formerly gave great charm to the City skyline. In many cases steeples have survived, including the two finest. St. Bride's, Fleet street (1702), and St. Mary-le-Bow (1683). The only churches to have survived the bombing intact are St. Benet, Paul's Wharf (1677–85); St. James, Garlickhithe (1674–87); St. Magnus the Martyr, London Bridge (1676–1705); St. Margaret Pattens (completed 1689); and St. Mary at Hill (1672–77); though some of the damaged churches were being restored in the 1950s. The major ecclesiastical monument of the City, St.

Paul's cathedral (1675–1710), a fine and characteristic work of Wren, is almost undamaged and still dominates the City. Other buildings by Wren in London are Greenwich observatory (1675–76), parts of the Royal Naval hospital. Greenwich (1696–1705); Chelsea Royal hospital (1682–92); and almost certainly Morden college, Blackheath (founded 1695); also work at Kensington palace (1690–1704).

In the early 18th century, the rapid growth of London continued. Gray's inn, Lincoln's inn, Inner Temple and Middle Temple were almost entirely rebuilt and retain the distinctive character of the period in spite of further modification and wartime damage. The squares, the most distinctive unit of Georgian town building, can be seen in the areas east and west of the City. Between 1710 and 1730 a number of fine churches built to serve these regions brought to prominence a new generation of architects following in the footsteps of Wren. Worthy of note are: St. Mary-le-Strand (1714–17) and St. Martin-in-the-Fields (1721–26), both by James Gibbs; St. Mary Woolnoth (1716–27), St. George, Bloomsbury (1720–30), and Christ Church, Spitalfields (1723–29), all by Nicholas Hawksmoor; and St. George, Hanover square (1712–24), by John James. In the City, the Mansion house was built in 1739–53 by George Dance the Elder on the site of a market. This was the first of the group of grandiose buildings marking the centre of activity in the City. Subsequent rebuilding there was in the same spirit. The ancient hospitals of London were rebuilt and several new ones constructed on the outskirts. Work by James Gibbs is to be seen at St. Bartholomew's hospital (begun 1730). William Kent designed the Horse Guards building before his death in 1748; it was executed by John Vardy, 1751–58.

In the second half of the 18th century the outward expansion of London was not as rapid, but some rebuilding was done, and several notable buildings resulted. Stylistically a move was made away from the earlier Palladianism. Robert Adam, probably the best-known 18th century architect, designed an important scheme. the Adelphi (begun 1768). of which the Royal Society of Arts building (1772–74) survives. Kenwood house. Highgate (1767–68), is a fine example of a large Adam country house. Adam's admiralty screen (1760) sets off Thomas Ripley's belatedly Wrenian admiralty building (1722–26). Robert Adam designed extremely graceful façades and delightfully varied interiors for his town houses, of which Chandos house, Chandos street, Cavendish square (1771), and 20 Portman square (1775–77), now the University of London Courtauld Institute of Art, remain in a good state of preservation. Adam's contemporary. Sir William Chambers, designed the first part of Somerset house (begun 1776), which survives in its riverside setting, with the arcaded terrace to the river front and a triumphal entrance on the Strand.

Sir John Soane's work is far more personal and daring than earlier architecture. The Bank of England (1792–1833) was his major work. The screen wall survives relatively unaltered, also some of the interior, though overshadowed by the rebuilding of 1925–39. Interesting work by him can also be seen in his own house (1812–14), number 13 Lincoln's Inn Fields (now Soane museum), and in the Dulwich art gallery and mausoleum (1811–14; destroyed 1944 but rebuilt from the original plans).

In the latter part of the 18th century important building projects were carried out on the great estates in the northwest of London. The most striking and best preserved is on crown land, the Regent's park-Regent street scheme (1811–23), designed by John Nash. The best surviving work is in the undamaged part of Park crescent. Portland place had already been laid out by Robert Adam's younger brother James, but very little is left. In 1821 St. James's park was redesigned on "picturesque" principles and Carlton House terrace was laid out. This scheme was meant to include Buckingham palace; and the Marble arch (1828, later moved to its present site at the top of Park lane) was intended for the park façade of the palace. Hyde park was laid out at the same time, and Decimus Burton designed (182; et seq.) the lodges to it, the excellent Ionic screen at Hyde Park corner and the Roman triumphal arch into Constitution hill, now somewhat dwarfed by the Quadriga placed on top in 1912. Three buildings of the early 19th century dedicated to learning can be compared: University college (1827–29) and the National gallery (1832–38), both by William Wilkins; and the British Museum (1823–47) by Robert Smirke. St. Pancras parish church (1818–22) by H. W. Inwood (with his father William Inwood) can be taken as a typical example of the church design of the period, with its antiquarian copying of classical details. Two interesting late Georgian theatre exteriors survive: Drury lane (1811), by Benjamin Dean Wyatt; and the Haymarket (1820–21), by John Nash.

In the 19th century London increased dramatically in area, and the administrative centre was largely, rebuilt. Early 19th century work is distinguished by the use of stucco, but brick returned to general use later. The new railway system called for a new type of building in the shape of the great termini. These display an interesting early use of cast iron and glass. The earliest, Euston (1839–40), by P. Hardwick, has a massive Doric entrance portico. King's Cross (1851–52) by L. Cubitt has a forthright brick faqade. The iron and glass train hall at Paddington (1854) is by the great engineer I. K. Brunel. Finally, there is Sir Gilbert Scott's St. Pancras station (1868–74): his complex Romantic Gothic exterior contrasts with the admirable train shed in glass and iron (1868) by W. H. Barlow. The use of iron frameworks became general. Buildings were made taller and the exteriors became ever more varied. All types of earlier architecture were copied. In the club houses of St. James's, as in the City warehouses, Italian Renaissance palaces were taken as models in the 1830s. In the early 1850s the copying of every kind of Gothic architecture began. For some time both styles were in use. The outstanding examples of Victorian Gothic in London are: the houses of parliament (1837–57) by Sir Charles Barry, assisted by A. W. N. Pugin; the Law courts, Strand (1874–82) by G. E. Street; the Albert memorial (1863–72) by Sir George Gilbert Scott; and Tower bridge (1886–94) by Sir John Wolfe-Barry and Sir Horace Jones.

During this century, particularly under Bishop Charles James Blomfield (bishop 1828–57), many new churches had to be provided for the ever growing metropolis. The most remarkable are those of William Butterfield (*e.g.*, All Saints', Margaret street, begun 1849), stridently original and wholly at variance with time-honoured standards of beauty. Pugin designed the Roman Catholic cathedral of St. George Southwark (1841, much damaged in World War II) and Scott rebuilt St. Mary Abbots', Kensington (1869–79), closer to mediaeval models. Other leading London church architects were G. E. Street (St. Mary Magdalene, Paddington, 1868–78), J. L. Pearson (St. Augustine. Kilburn, 1870–80) and G. F. Bodley (St. Michael, Camden Town, 1876–81). The great revival of domestic architecture and design, beginning in the 1860s under William Morris' leadership, is also well displayed in London, mainly in houses in Hampstead, Kensington and Chelsea—by now centres of artists and artistic people—designed by Philip Webb, Richard Norman Shaw, C. F. A. Voysey and their followers.

Throughout the 19th and the 20th centuries blocks of dwellings for working-class tenants were constructed. One of the earliest (of 1849) remains in Streatham street, Bloomsbury. In the late 19th and early 20th centuries a restated English Baroque was evolved and used on a number of monumental buildings. several of which are still on the river front. Examples are New Scotland Yard (1891) by Richard Norman Shaw, and County hall (1912–22) by R. Knott. Regent street and Piccadilly circus were redesigned in this style in the early 20th century and Bush house and the buildings of Kingsway continued this trend into the 1920s. Sir Aston Webb, a leading architect of the early 20th century, designed the Victoria and Albert museum (built 1899–1909) and the Buckingham palace main faqade (1913). Westminster cathedral (1895 *et* seq.) by J. F. Bentley is a fine neo-Byzantine building in red and white brick, with a tall campanile.

In the second and third decades of the 20th century enormous buildings in an unadorned, massively simple style were built. Outstanding examples are the Port of London Authority building, Tower hill (1922); Imperial Chemical house, Millbank (1929–36), by Sir. F. Baines; London Transport Executive headquarters, Westminster (1928–29), by Charles Holden; Broadcasting house (1930–31) by Val Myer; and the University of London senate house (1933 et seq.) by Holden.

But in the early 1930s a new trend appeared, under contemporary French and German influence (Walter Gropius and Eric Mendelsohn. the leading German architects were in London in the mid-1930s as political refugees and designed houses in Chelsea). Buildings were constructed of reinforced concrete, with much use of cantilever construction to permit larger unbroken window areas, and without the masking screens of decoration hitherto considered indispensable; for example, Sassoon House flats, Camberwell (1932), by E. Maxwell Fry; Simpson's store, Piccadilly (1936), by J. Emberton; Peter Jones's store, Sloane square (1936), by W. Crabtree and Sir Charles Reilly; the two Highpoint blocks of flats. Highgate (1936 and 1938), by B. Lubetkin and Tecton; and the Pioneer health centre, Peckham (1934–35), by Sir Owen Williams. Battersea power station (1933) by Sir Giles Gilbert Scott, is an impressive functional design in brick.

Postwar building continued in this style. Among outstanding works are Westminster Council flats, Ranelagh road (1946), by Powell and Moya; and the Royal Festival hall, South Bank (opened 1951), by R. H. Matthew and J. L. Martin. (K. Mn.)

POPULATION

The following table gives comparisons between certain census returns for Greater London and its chief component parts, namely, the City, the administrative county and Outer London (*i.e.*, the zone outside the county boundary but inside Greater London). All the figures before those of 1921 are adjusted to these areas.

Year	City	County	Outer London	Greater London
1841	123,563	1,825,714	286,067	2,235,344
1881	50,569	3,779,728	936,364	4,766,661
1921	13,709	4,484,523	2,995,678	7,480,201
1931	10,996	4,397,003	3,806,939	8,203,942
1951	5,324	3,347,982	4,997,801	8,346,137

In the above table it will be npticed that the population of Greater London has been increasing steadily and that since 1921 a decline in the population of the administrative county has been added to the long decline in that of the City. The increase in the whole London area since 1921 has taken place, therefore, entirely outside the county boundary, and of this increase the most striking feature is the rapid growth of Outer London. There have been two distinct population movements, one outward from the centre and one inward from the provinces.

As the population of London has been increasing, so has its character been changing. For centuries London has been one of the greatest seaports of the world and a great centre of commerce, but never before had it been a centre of manufacturing industry in the way it was becoming up to the outbreak of World War II; and a great part of the new development was in the outer ring.

One effect of this trend was to raise the proportion of the population born outside the area. through immigration that was to a great extent industrial in character. The peak of the immigration was in the 1930s and the proportion of "natives" was expected to rise again by the 1950s as those who had settled in London had locally born families. According to the sample analysis of the 1951 census, nearly three-quarters of the residents in the Greater London registration district were born in the London and south-eastern region. The numbers (in thousands) from other parts were as follows:

Rest of England	1,25j	Commonwealth	89
Wales	164	Colonies and protectorates	38
Scotland	142	Foreign	301 (of whom 120 were aliens)
Northern Ireland	38		
Eire	169		

GOVERNMENT

The Municipal Corporations act (1835) did not affect London. This was not so much a deliberate omission as that the commissioners on whose reports the act was based were baffled by the problems of the metropolis and failed to reach a definite conclusion about its future. The City of London, unlike other large towns, did not expand as the built-up area developed. It remained, as it still remains. within its historic "square mile" with little change from the middle ages. The rest of London was governed by the inhabitants of each parish in vestry assembled, save that in some instances parishes had elected select vestries under the provisions of the Vestries act, 1831. In neither case had the vestry powers of town management. To meet the needs of particular localities, commissioners or trustees having such powers had been from time to time created by local acts. In 1855 these local acts numbered 250. administered by not less than 300 bodies either self-elected, or elected for life, or both, and therefore in no degree responsible to the ratepayers. There were two bodies having jurisdiction over the whole metropolis except the City, namely, the officers appointed under the Metropolitan Building act of 1844, and the metropolitan commissioners of sewers. appointed under the Commissioners of Sewers act, 1848. Neither was responsible to the ratepayers.

Metropolitan Board of Works.—To remedy this chaotic state of affairs, the Metropolis Management act, 1855, was passed. Under that act a vestry elected by the ratepayers of the parish was established for each parish in the metropolis outside the City. The vestries for larger parishes became the local authorities; smaller parishes were grouped under district boards. A central body, the Metropolitan Board of Works, having jurisdiction over the whole metropolis (including the City) was also established, the members of which were elected by the common council of the City, the vestries and district boards and the previously established local board of Woolwich (*q.v.*). The board had a salaried chairman. The area of the metropolis for local government purposes was for the first time defined. Different areas were considered, including the police district, but that finally chosen was the district used by the registrar general for bills of mortality. The subsequent county of London was still virtually the same area in 1954. The Metropolitan Board of Works was given certain powers of supervision over the vestries and district boards, became the authority for main drainage and for the administration of the Building acts and subsequently had many additional powers and duties conferred on it. It completed the main drainage scheme; made a number of street improvements; constructed the Thames embankment; acquired 30 parks including Hampstead heath; and established the London Fire brigade. But like some of the vestries it also acquired an unfortunate reputation for corruption, which hastened its abolition when the general reform of county government in England began.

London County Council.—By the Local Government act (1888) a directly elected county council was established to administer the same metropolitan area as had been constituted in 1855. It took over the administrative powers of the justices of the peace as well as the functions of the Metropolitan Board of Works. By the Education (London) act (1903) the London County council took over the elementary education duties of the London School board. The Local Government act (1929) brought the transfer to it in 1930 of the poor law functions of the 25 boards of guardians, the Metropolitan Asylums board, the four boards of district school managers and the Central (Unemployed) body. Maternity and child welfare powers were transferred from the metropolitan boroughs under the National Health Service act (1946).

The act of 1888 left the vestries and the City unaffected. Over the next ten years there were several abortive bills to reform London government. Controversy raged between the "unifiers," who wished to amalgamate the City and the county council into a central corporation. and the "tenifiers," who wished to place local government in the hands of ten separate boroughs. In 1897 Kensington and Westminster petitioned to be created boroughs by the grant of charters under the Municipal Corporation acts. Instead the London Government act (1899) was passed. This interfered with neither the L.C.C. nor the City but kept fairly close to the structure adopted for the rest of the country in 1894. For the 40-odd vestries and district boards were substituted not 10 but 28 boroughs, each with a mayor and aldermen but with very much the same powers as the bodies which they succeeded.

In 1955 the London County council had 126 councillors, each parliamentary constituency returning 3 representatives. These councillors elect a chairman, who need not be already a member, and 21 aldermen. Councillors are elected every three years, the first postwar election being in March 1946. Aldermen hold office for six years, one half being elected by each new council. By convention the vice-chairman is chosen from the majority party and the deputy chairman from the minority. The standing orders also provide for a "leader of the council" and "leader of the opposition" who are entitled to attend and to speak but not to vote at the meeting of any committee or subcommittee of which they are not members.

For the first year of its life the council met at the City's Guildhall. It then moved into the premises of the Metropolitan Board of Works in Spring gardens, now known as Old County hall. The present County hall on the south bank of the Thames was opened in 1922. An annex including a conference hall was completed in 1933 and further office accommodations finished during World War II.

Corporation of the City of London. — The legislation of 1855, 1888 and 1899 left the government of the small area of the City in the hands of an unreformed corporation. Here the mediaeval system, in spite of any anomalies with respect to modem conditions. has resisted reform, and no other municipal body shares the traditions and peculiar dignity of the City corporation. This consists of a lord mayor, 25 aldermen and 206 (to be reduced to 159 by St. Thomas' day, 1959) common councilmen, forming the court of common council, which is the principal administrative body. The election of common councilmen, whose institution dates from the reign of Edward I, takes place annually, the electors being the ratepayers divided among the 25 wards of the City. An alderman (q v) of each ward (save that the wards of Cripplegate Within and Without share one) is elected for life. The lord mayor is now elected by the court of aldermen from two aldermen nominated in the court of common hall by the livery, an electorate drawn from the members of the ancient trade guilds or livery companies (*q.v.*), which, through their control over the several trades or manufactures, had formerly an influence over the government of the city which from the time of Edward III was paramount.

Metropolitan Borough Councils. — The metropolitan borough councils are elected every three years in May of the year after the county council elections. The councillors elect the aldermen who hold office for six years and are in the proportion of one to every six councillors. Councils vary in size; the tendency being to reduce the size when there is a reorganization. In 1954, 11 of the 28 boroughs had 60 councillors and 10 aldermen; the smallest had 30 councillors and 5 aldermen. Some wards return as many as nine councillors but the tendency is to standardize representation at three councillors for each ward.

Each borough has a mayor elected by the council. He need not be a member before he is elected but must be qualified to be one. Most councils also elect a deputy mayor from among their members. Each borough has its town hall. Some are modem buildings. but many are the old vestry halls, which have survived, with or without additional buildings, to meet expanding needs.

As an instrument for negotiation with central government departments and with the county council and for discussion of common problems, the borough councils established in 1912 a standing joint committee. This is made up of three representatives of the City and of each borough council, one of whom is usually the town clerk. It is assisted in its deliberations by advisory bodies of chief officers from the boroughs. In addition to its consultative work, the committee manages a union catalogue for all the public libraries in the county and provides an organization and methods service for those boroughs who wish to use it.

The 19th century provides a rich bibliography of royal commissions, select committees and abortive bills concerned with the reorganization of London government and its relation to the City. In the 20th century the more pressing problem has seemed to be the relation of the administrative county to the built-up areas beyond and the possibility of a unified local government for Greater London. A royal commission under the chairmanship of Viscount Ullswater sat from 1921 to 1923. The majority report was content to leave the structure as it was and proposed a London and home counties advisory committee to secure some common action. One minority report suggested a division of an area within ten miles of Charing Cross into county boroughs with a regional authority for some common services. Another proposed a directly elected Greater London council.

In 1945 a committee under the chairmanship of the marquess of Reading was established to examine London government within the county and the division of powers between the L.C.C. and the borough councils but dissolved without reporting.

The county of London was omitted from the reference to the Local Government Boundary commission which reported in 1947. The report excluded from consideration the Greater London area on the ground that it could not be treated independently of the future of the county itself. In 1949 a departmental committee under Clement Davies, set up to advise on machinery to implement the Greater London plan, pointed to the need for a regional authority and an "entirely new alignment of regional, county and local functions" and recommended reference to a Local Government commission.

The Central Government. — Apart from its control of the police, the central government has no greater administrative functions in the metropolis than in the rest of the country. The greater part of London was in 1954 in the standard administrative region V, London and southeastern. The ministry of housing and local government has a separate London region for the built-up metropolitan area.

The metropolitan police force was established by Sir Robert Peel in 1829. It is under the direction of a commissioner who is appointed by the crown and acts under the authority of the home secretary. Half the cost of the force is met out of central government funds and the other half by way of precepts levied on the borough and district councils. In addition to the ordinary police, operating in 22 divisions, there is a body of Thames river police and specialist services at headquarters in New Scotland Yard, available for consultation by provincial forces. The City of London force was established in 1839 and is under the direction of a commissioner appointed by the Common council.

As elsewhere, prison commissioners control the London prisons. All are used as local general prisons with additional special features. Brixton has accommodation for civil prisoners, Pentonville a small part reserved for recalcitrant prisoners. Wandsworth serves as an allocation centre for corrective trainees; Wormwood Scrubs as a corrective training and a young persons' prison as well as a reception centre for Borstal. Holloway is a women's prison. Feltham in Middlesex is a closed Borstal for boys and Latchmere house near Richmond a reception centre.

London has the judicial machinery of the rest of the country with certain peculiar features of its own. The principal courts for the trial of criminal cases are the central criminal court and the courts of quarter sessions. The central criminal court, taking the place of the provincial assizes, was established by an act of 1834 and sits at the Old Bailey, under a high court judge and two full-time judges, the recorder of the City of London and the common serjeant. It serves the counties of London and Middlesex and parts of Essex, Kent, Surrey and Hertford. The remaining parts of Greater London come within the southeastern circuit. London quarter sessions are held at Newington causeway.

In the administrative county, except for the northern part of Hampstead, the main courts of summary jurisdiction are the 12 metropolitan police courts, presided over by stipendiary magistrates. The chief magistrate's court is at Bow street. There are also stipendiary magistrates at West Ham and East Ham. In the City, the courts of summary jurisdiction are at the City of London justice rooms at the Mansion house, where the lord mayor or one of the aldermen sits and at the Guildhall where the aldermen sit in rotation. In the remaining parts of London, summary jurisdiction is exercised by the petty sessional courts of justices of the peace, who have concurrent jurisdiction where there is a stipendiary magistrate. The old petty sessional divisions were revised in 1953 and are now within the county of London.

Juvenile courts within the metropolitan police court area are in an exceptional position in that they are controlled by the home office. The home secretary appoints from among the London justices a panel of magistrates who sit in six courts, one for every two police court districts. The London Probation service is also under the control of the home secretary, advised by a committee of metropolitan magistrates and juvenile court justices.

The county court districts in London bear no relation to any local government areas. The mayor's and City of London court covers the City. Some districts are wholly within the county, some within the remaining part of Greater London and some fall partly within and partly outside London. The coroners' districts include one for the City and two franchise districts for the Tower liberty and the Queen's household. With these exceptions, the London coroners are appointed by the councils of the respective counties or county boroughs.

Parliamentary Representation.— The administrative county returns 42 members to parliament. The rest of Greater London is spread over about 50 constituencies. One metropolitan borough, Wandsworth, returns four members; three return three; five, two; and 14, one each. The cities of London and Westminster together return one member as do Shoreditch and Finsbury. Hackney returns one and one in conjunction with Stoke Newington; St. Pancras one and one with Holborn. Barons court is shared by Fulham and Hammersmith.

Finance, Rating, **etc.**—Before 1899 the duties of overseers in London had been performed by most diverse bodies. In that year the new borough councils were constituted in every case the overseers within their respective boroughs, except that the town clerk of each borough performs the duties of an overseer with respect to the registration of electors Again, with regard to rates. there were till 1899 three or four different rates leviable in each parish. These are now consolidated into a single rate, called the general rate. Every precept sent by an authority in London for the purpose of obtaining money which has ultimately to be raised out of a rate within a borough is sent to the council of the borough. The metropolitan borough councils make one general rate, which includes the amount necessary to meet their own expenditure, as well as to meet the demands of the county council and the metropolitan police. The total amount of rates raised in 1951–52 was £47,173,075, representing an average rate of 17*s.* 9*d.* in the pound (calculated on the basis of the net produce of a rate of a penny in the pound). Of this one-third was retained locally by the City corporation and the metropolitan borough councils.

The total expenditure of the local authorities, within the county, in 1951–52 was £109,683,703 when payments included twice had been deducted. This expenditure was divided mainly among the following bodies: London County council, £59,369,584; metropolitan police (proportion), £9,639,146; City of London corporation, £3,369,659; metropolitan borough councils, £32,114,983. Of the county council expenditure £27,625,832 went to educational services; £7,994,828 to housing; £6,015,965 to the metropolitan water board (proportion). Of the total expenditure of the boroughs, £5,041,652 went to highways and £4,605,810 to housing. From this gross expenditure £31,420,835 representing fees, rents and other receipts had to be deducted before reaching the amount to be met out of public funds. For example, nearly two-thirds of the expenditure on housing was met out of rents.

For certain services such as education and housing the central government makes a specific grant in aid. The total grants payable in this year were £27,171,650 or 24.8% of the gross expenditure. In addition to the grants in aid of specific services London received before 1929 the revenue from certain assigned taxes. Between 1929 and 1948 a block grant was paid to London in common with other local authorities, the amount being calculated according to a formula designed to take into account the comparative needs of different areas. After the Local Government act of 1948 the county of Essex and the county boroughs of East and West Ham were the only areas in Greater London to share in the new equalization grant. Instead of a central government grant, the administrative county introduced a new scheme for equalizing the rate burden.

This had long been a difficult and contentious question. A first step was taken by the establishment of the Metropolitan Common Poor fund in 1867; in 1894 an equalization rate of 6*d.* was levied over the county and distributed as a capitation grant. After World War I the situation became more acute, particularly with the growth of unemployment. It was brought to a head in 1921 by the refusal of the Poplar Borough council to pay the county precept, as a result of which the mayor and most of the council, George Lansbury among them, were committed to prison for contempt of court. In 1929 it was eased by the transfer of poor relief to the L.C.C. which meant that it was financed out of the general county precept. But there remained wide disparities between boroughs of high ratable value, such as Westminster and St. Marylebone, and those such as Poplar and Bethnal Green.

The purpose of the 1948 scheme was in broad terms to bring the ratable value per head of the poorer boroughs up to the average for the county. For the purpose of these calculations the population was weighted by the proportion that the net annual value bore to the ratable value. a weighting which took into account the effects of industrial derating. In order to bring a subnormal borough up to the average, additional ratable value had to be credited ta it. The rate in the pound payable on this credited ratable value was the amount of the grant paid out of the county funds.

Ecclesiastical Areas and Denominations.— The diocese of London founded in 314, covers the cities of London and Westminster, the county of Middlesex and the boroughs of the county of London north of the Thames. In the diocese are the bishoprics suffragan of Fulham, Kensington, Stepney and Willesden. The bishopric of Southwark was created in 1904, hdving been previously a bishopric suffragan in the diocese of Rochester. It contains the bishoprics suffragan of Woolwich and Kingston-upon-Thames. Greater London is also included in the dioceses of Chelmsford, Rochester, Canterbury, St. Albans and Guildford. Westminster is the seat of the Roman Catholic archbishopric in England, and Southwark and Brentwood are bishoprics. London is divided into six Methodist districts: north, northeast, northwest and south, southeast, southwest. The diocesan cathedrals in the county are St. Paul's and St. Saviour's, Southwark. The Roman Catholic cathedrals are Westminster and St. George's, Southwark. In 1903 the Wesleyans acquired the site of the Royal aquarium, near Westminster abbey, for the erection of a central hall. The Great Synagogue of the Jews is in Aldgate. The headquarters of the Salvation Army are in Queen Victoria street. City. There are numerous foreign churches, among which may be mentioned the French Protestant church in Soho square; the Greek church of St. Sophia, Moscow road, Bayswater; the German Evangelical church in hlontpelier place, Brompton road; and the Dutch Protestant church in Austin Friars.

PUBLIC HEALTH

London has separate health legislation from that of the rest of the country, the principal statute being the Public Health (London) act (1936). Public health bye-laws for London are made by the L.C.C. although in many cases administered by the metropolitan boroughs.

Sanitation.— Drainage is shared between the county and the metropolitan borough councils. The first act providing for a commission of sewers in London dates from 1531. Various works of a more or less imperfect character were carried out, such as the bridging over in 1637 of the River Fleet, which as early as 1307 had become inaccessible to shipping through the accumulation of filth. Scavengers were employed in early times, and sewage was received into wells and pumped into the kennels (channels) of the streets. A system of main drainage was inaugurated by the commissioners of sewers in 1849, but their work proceeded very slowly. It was carried on more effectively by the hletropolitan Board of Works (1856–88), and was transferred in 1889 to the newly created London County council, which completed and improved the system, covering the county of London, Willesden, Tottenham, Wood Green, West Ham, Brent area (Willesden), Leyton, Walthamstow, Ilford. Barking and Penge and parts of Acton, Croydon, Beckenham, Hornsey and East Ham. There are actually two distinct systems, north and south of the Thames, having separate outfall works on the north and south banks of the river. The sludge is taken out to sea by boat and the remainder discharged into the river. The borough councils provide and maintain the local street sewers, which discharge into the county trunk seners. The system takes both sew-age and rainwater, being supplemented by storm relief sewers which discharge storm water into the Thames. Outside the London drainage area, the borough and district councils are responsible, though there are a number of centralized disposal works administered by joint boards and committees. The collection and disposal of house refuse is the responsibility of the borough councils. Controlled dumping to reclaim waste land is the most common method of disposal.

The City of London is the port health authority. The City and the metropolitan boroughs undertake sanitary inspection and the inspection of food, slaughterhouses, offensive trades and rodent destruction, and the provision of baths and washhouses.

Cemeteries.—The cemeteries of London have developed from the old burial grounds of the different parishes. There are between 300 and 400 disused grounds, some of which are now open spaces. Most of the cemeteries now in use were opened in the 19th century. particularly in the 1850s, after the passing of the Burial act (1852). As these are filled, new ones have to be opened outside the county boundaries. The Brompton cemetery is the property of the government. Several are privately owned including the large Kensal Green cemetery. Most of the metropolitan boroughs have adopted the Burial act and provide municipal cemeteries inside or outside the county. The first crematorium in Greater London was opened in 1902 at Golders Green. The City opened one at Ilford in 1904. Metropolitan boroughs followed suit in the 1930s.

Hospitals.—The present hospital service in London represents a confluence of two very diverse channels. Most of London's best-known teaching hospitals were not under public management before 1948, such as St. Bartholomew's, the oldest, founded by Rahere in 1123, St. Thomas' (1200), Guy's (1724), St. George's (1733), St. Mary's (1845) and the London hospital (1740). At the end of 1936 there were 107 voluntary hospitals in the London county area, containing 15,443 beds. Some control over them was exercised by the King Edward's Hospital fund through its power to give or withhold grants.

Poor law hospitals go back to 1601 but the whole position was reorganized after the Poor Law Amendment act (1834), which created the unions and boards of guardians. In 1867 the Metropolitan Asylums board (M.A.B.) was established. This comprised some members appointed by the guardians and some nominated by the central government. Sickness of a general character was treated in the poor law infirmaries. The M.A.B. provided specialist hospitals for infectious diseases, tuberculosis and some other diseases. Mental hospitals were divided. Some came to the L.C.C. through the justices; some were established by the M.A B.

The 25 boards of guardians within the county and the M.A.B. were abolished by the Local Government act (1929) and in April 1930, 77 hospitals as well as 5 mental hospitals were transferred to the L.C.C. By 1948 the council maintained 100 hospitals with about 70.000 beds. On July 5 of that year, under the National Health Service act (1946) these were transferred to the regional hospital boards 'nhich also took over the voluntary hospitals, except for the teaching institutions which were nationalized under separate management. After 1948 the, county of London ceased to exist as a unit of hospital administration. There are four metropolitan hospital regions with regional boards, fanning radially from the Marble arch, but these stretch far beyond the boundaries of Greater London. In addition to these boards. there are governing bodies for 12 London undergraduate teaching hospitals and 14 graduate.

Maternity and child welfare became the responsibility of the metropolitan boroughs in 1918, though some councils continued to use the services of voluntary bodies. Ante- and post-natal clinics were provided with domiciliary supervision by health visitors. Before 1939 some boroughs provided lying-in hospitals in addition to the general L.C.C. and voluntary hospitals. Home helps were introduced as well as day nurseries, which were greatly increased during World War II. By the 1946 act these functions all passed to the L.C.C. Midwives came under the authority of the L.C.C. in 1936, as a municipal service. For the years 1896–1900 the death rate in London for babies under one year was 162 per 1,000 births. By 1938 it had fallen to 57. In 1953 it was 24. No borough in 1953 had an infantile mortality rate greater than 39.

The other branches of the national health service are under the London Executive council which covers the administrative county. The rest of Greater London comes under the executive councils of the appropriate counties and county boroughs.

WELFARE

London had the rudiments of a welfare system before the Poor Law Amendment act (1834). Under acts of 1647 and 1662 a Corporation of the Poor was established and by 1732 there were 45 workhouses in London. The act of 1834 set up boards of guardians for different parishes; these were joined in 1867 by the Metropolitan Asylums board. In the same year began the Metropolitan Common Poor fund which was the first attempt to spread the burden of maintaining the poor more evenly over the county. Subsequent legislation and administrative changes developed and modified the system.

Since 1948 responsibility for helping those without resources and those whose means, including national insurance benefits, were inadequate was placed on the National Assistance board (N.A.B.). Welfare, apart from financial assistance, remained with the county councils, who also received wider powers to care for children deprived of normal home life.

The N.A.B. followed the ministry of national insurance in dividing the standard London and southeastern region into two. The inner London region covers the counties of London and Middlesex with a small piece of Hertfordshire; the outer London region covers western Essex, Surrey, Kent and Sussex. Within these regions there are areas of which 26 are within the administrative county. For each county in the two regions there is an advisory committee; for London there are two, one for each side of the Thames. The county councils provide welfare homes and, on behalf of the N.A.B., manage reception centres in place of the old casual wards. Some of the homes are adapted from old institutions, others are smaller private houses taken over in order to provide smaller units. The L.C.C. has three lodging houses for men who, without being destitute, have no permanent home. There are also 11 hostels available for employed persons. A new and special problem is provided by those who, while not necessarily in financial difficulties, are unable to obtain housing accommodation. For them. accommodation is provided by the L.C.C. in homeless family units and in rest centres. There are four reception centres in the administrative county. The biggest of these, in Camberwell, accommodated (Dec. 1953) an average of j61 persons a night or a little more than one-quarter of those so accommodated in Great Britain.

In Nov. 1953 there were in the administrative county 8,719 deprived children in the care of the L.C.C. This was 11.3 per thousand of the population under 18 years. Of them 22% were boarded out. In Middlesex 5, and in Surrey 4.4 per thousand of the population under 18 were in care.

Voluntary Agencies.—The special social problems of a great urban area have led in London to the development of voluntary work parallel with that of the official system. In addition to the big national bodies, London has had its own organizations, which have grown up out of the spasmodic religious and philanthropic work of the 18th and early 19th centuries. In 1869 the Charity Organization society was founded to provide systematic help for those in need, working through branches spread through the county. Octavia Hill (*q.v.*) began her pioneer work in housing management in 1867 by acquiring houses in St. Marylebone. Later in the century came the settlements, of which the best known are Toynbee hall (1884) in Stepney, Oxford house in Bethnal Green and Cambridge house in Camberwell. In 189j the first hospital almoner began work at the Royal Free hospital. By 19j3 the Annual Charities Register and Digest gave particulars of 3,000 voluntary organizations available for citizens of the metropolitan area.

After World War II and the growth of publicly provided welfare services, the work of voluntary organizations moved away from various forms of material assistance to problems of personal adjustment, such as marital disharmony and behaviour problems in children. In 1946 this difference in emphasis was marked by the change of name of the Charity Organization society to the Family Welfare association. Family service units specializing in helping "problem families" established units in Stepney, Kensington and Islington. There was also a growth in specialist organizations. particularly for the care of the aged and the physically handicapped, such as spastics and paraplegics. The co-ordination of voluntary social work and the furtherance of community organizations is the special concern of the London Council of Social Service. In 1953 in Greater London there were 27 local councils of social service of which 5 were within the county.

PUBLIC UTILITIES

Electricity. — The Metropolitan Board of Works and the commissioners of sewers in the City began experiments with electric light. which was introduced in 1881 at the Royal Exchange and neighbourhood. At the close of the 19th and the beginning of the 20th century a large number of electric light companies came into existence, and some of the metropolitan borough councils and local authorities within Greater London also undertook the supply.

Under the Electricity Supply act of 1926, the London and Home Counties Joint Electrical authority, composed of representatives of the county councils and the electrical undertakings, was formed and made responsible for the supply over an area of 1,841 sq.mi., stretching from Guildford to Gravesend and from Hertford to Reigate. Since 1948 the London Electricity board has served an area of 253 sq.mi. This is the smallest of the country's distribution areas but has the largest population.

Gas. — From 1416, citizens were obliged to hang out candles between certain hours on dark nights to illuminate the streets. An act of parliament enforced this in 1661; in 1684 Edward Heming, the inventor of oil lamps, obtained a licence to supply public lights; and in 1736 the corporation took the matter in hand, levying a rate. Gaslighting was introduced on one side of Pall Mall in 1809, though it is said that Golden Lane Brewery and portions of Beech and Whitecross streets were lit by gas in 1807. In 1810 the Gas Light and Coke company received a charter and developed gaslighting in 'Clrestminster. Since 1948 the gas industry has been nationalized and managed by area boards.

Water Supply. — In the 12th century London was supplied with water from local streams and wells, of which Holy well, Clerk's well (Clerkenwell) and St. Clement's well, near St. Clement's Inn, were examples. In 1236 the magistrates purchased the liberty to convey the waters of the Tyburn from Paddington to the City by leaden pipes, and a great conduit was erected in West Cheap in 1285. Other conduits were subsequently built (cf. Conduit street off Bond street, Lamb's Conduit street, Bloomsbury); and water was also supplied by the company of water-bearers in leathern panniers borne by horses. In 1582 Peter Moris, a Dutchman, erected a forcer on an arch of London bridge. which he rented for 10*s.* per annum for 500 years. His works succeeded and increased and continued in his family till 1701, when a company took over the lease. Other forcers had been set up, and in 1609, on an act of 1605, Sir Hugh Myddelton undertook the task of supplying reservoirs at Clerkenwell through the New river from springs near Ware, Hertfordshire; and these were opened in 1613.

In 1630 a scheme to bring water from Hoddesdon on the Lea was promoted by aid of a lottery licensed by Charles I. The Chelsea Water company opened its supply from the Thhmes in 1721; the Lambeth waterworks were erected in 1783; the Vauxhall company was established in 1805, the West Middlesex, near Hammersmith, and the East London on the river Lea in 1806, the Kent on the Ravensbourne (Deptford) in 1810, the Grand Junction in 1811, and the Southwark (which amalgamated with the Vauxhall) in 1822.

In 1902 the Metropolis Water act constituted the Metropolitan Water board to purchase and carry on the undertakings of the eight then existing companies, and of certain local authorities. It consists of 66 members, appointed by the London county council (14), the City of London (2), the City of Westminster (2), the other metropolitan boroughs (27), the county councils of Middlesex, Hertfordshire, Essex, Kent and Surrey, the borough of West Ham, various groups of other boroughs and urban districts, and the Thames and the Lea Conservancies. June 24, 1904, was the date fixed on which control passed to the board, and by 1943 it was the largest water company in the world. It serves an area of 540 sq.mi. (42 mi. from north to south and 34 mi. from east to west). Roughly 60% of the water supplied by the board is taken from the Thames, next in importance being the Lea and New rivers. Water is regularly taken at the Laleham intake, 15 mi. above Teddington weir and intermittently from the Staines intake 4 mi. further upstream. The average amount of water supplied daily by the board was 49 gal. per head in 1952, and in 1953 there were 8.500 mi. of water pipes.

Fire Prevention. — In 1833 the fire insurance companies united to form a small fire brigade, the London Fire Engine establishment. Previously fire protection had been given by separate insurance brigades and by engines provided by parishes. In 1866, after the great Tooley street fire of 1861 had shown its inadequacy in relation to London's fire risks, it was taken over by the Metropolitan Board of Works, which also took over the fire escape stations that had been maintained since 1836 by the Society for the Protection of Life from Fire. In 1888 the Metropolitan Board of Works was superseded by the London County council. The last manual engine was used in 1899, and from 1906 the internal combustion engine was standard on all new London Fire brigade appliances. The brigade had been built up by two famous firemen, James Braidwood, the chief of the establishment. killed at the Tooley street fire, and Eyre Massey Shaw, chief officer from 1861 to 1891. It gained a great reputation for efficiency and courage. A number of other brigades were maintained alongside it by the local authorities of the Greater London area.

Under the Fire Services act (1947) the national fire service formed in World War II came to an end in 1948, and fire brigades became once again a local authority responsibility, but now of counties and county boroughs only. Greater London is therefore served by the brigades of the London County council. the county boroughs of Croydon, East Ham, West Ham and the counties included in the area; all of these have arrangements for mutual assistance when needed.

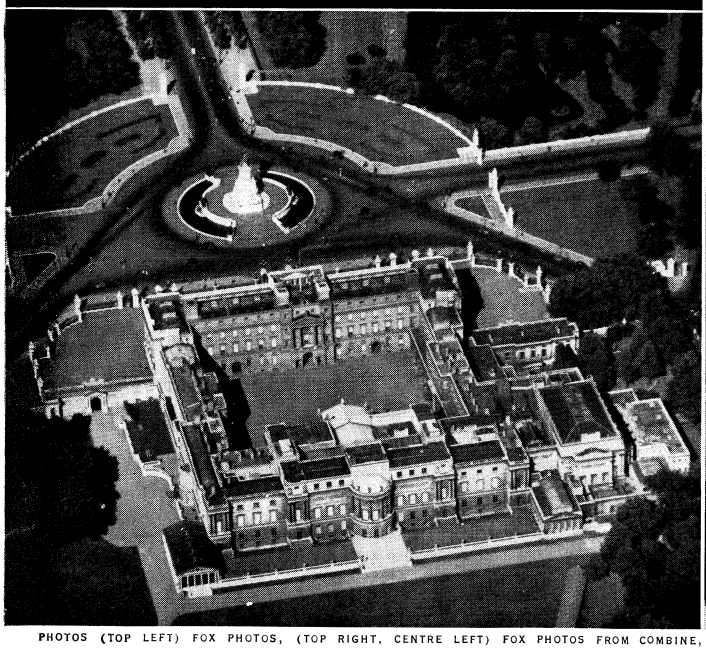
The London Fire Engine establishment began with about 80 men; in 1888 when the county Council took over, there were 581, and in 1952 there were 2,134.

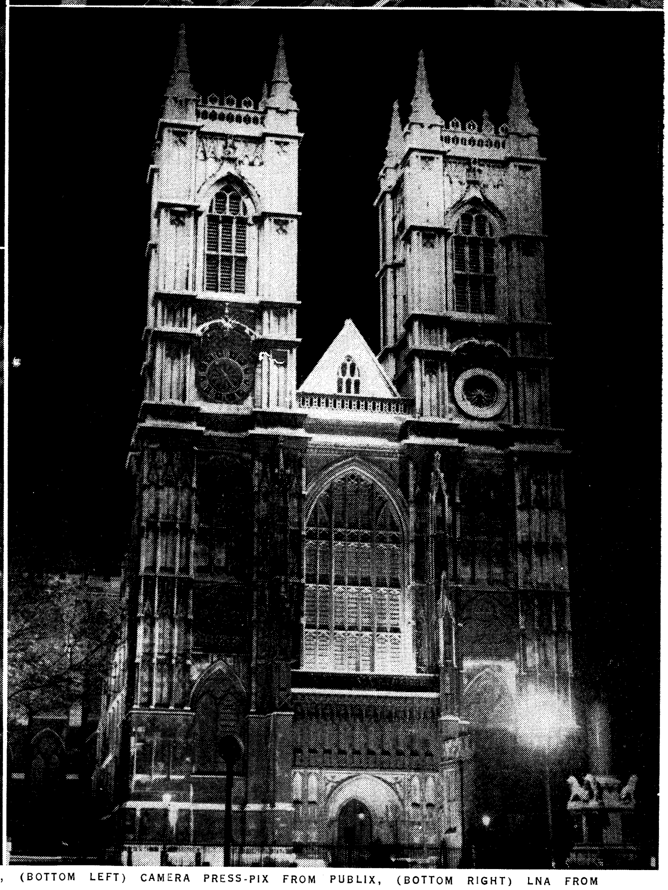
The London Fire brigade has normally available 58 motor pump escapes, which combine a pump and a 50-ft. escape in one appliance, and 51 motor pumps. Most of these are fitted with water tanks and hose reels. The brigade also has 16 mechanical turntable ladders, 3 fireboats and a number of specialized vehicles such as emergency tenders and a breakdown truck for special tasks. The brigade's cost is met from the county rates, after government grant and a contribution from the fire insurance companies have been credited. These companies also maintain a separate salvage corps.

HOUSING AND TOWN PLANNING

Responsibility for providing municipal housing for the county of London is shared by the county council and the metropolitan boroughs. The L.C.C. alone has power to build outside its own area.

The L.C.C. inherited its housing powers from the Metropolitan Board of Works, and the boroughs took over the public health duties of the vestries. Until World War I they were mainly concerned with clearing unhealthy areas, providing accommodation for people displaced by highway and similar improvements as well as building a little additional housing. After the first government housing subsidy in 1919 there began a new stage of striving to meet the shortage left by the war. Until 1934 the main emphasis was on additional housing. This was the period of the develop-





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PARLIAMENT BUILDINGS AND OTHER LONDON VIEWS

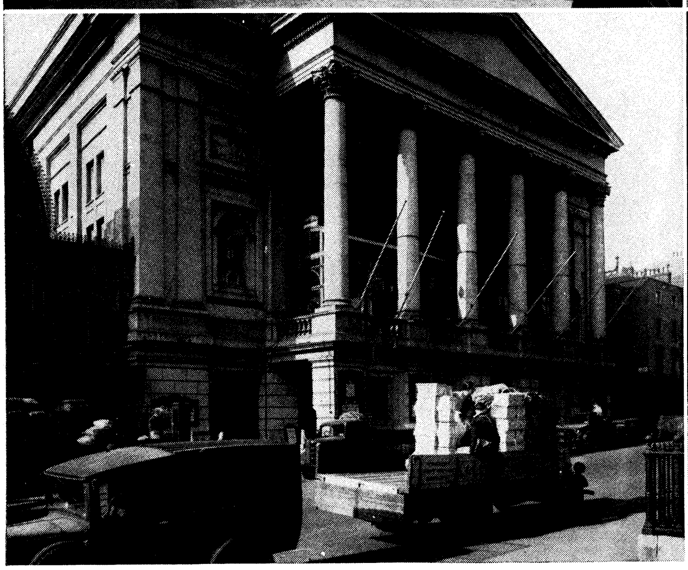
Top left: The houses of parliament and Westminster bridge, which spans the Thames. At right is the parliament clock tower containing Big Ben

Top right: The Tower of London buildings with Tower bridge in the foreground

Centre left: St. James's palace

Bottom left: Air view of Buckingham palace seen from the rear entrance. Facing the main entrance is the Queen Victoria memorial ana the Mail beyond, with St. James's park at right background

Bottom right: Westminster abbey



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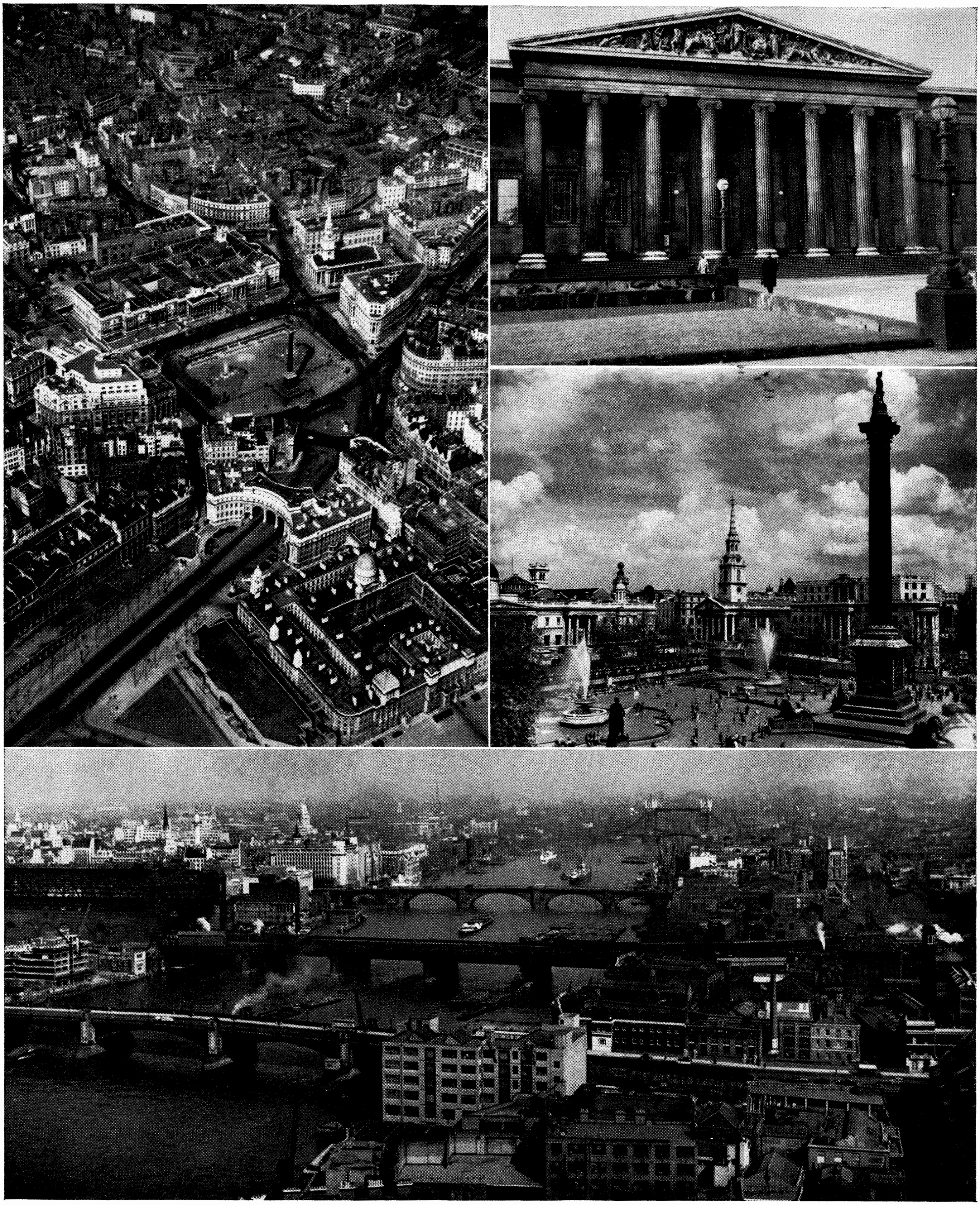
GENERAL VIEWS OF LONDON

Top left: London workers in the Embankment gardens during lunch time
Top right: Lincoln's Inn under a blanket of snow
Centre left: Looking toward St. Paul's cathedral and the Ludgate Circus end of Fleet street, centre of British newspaper publishing
Centre right: Piccadilly Circus, and Regent street at right. In the centre is the statue of Eros
Bottom left: Covent Garden market and opera house
Bottom right: Riders in Rotten Row, Hyde park



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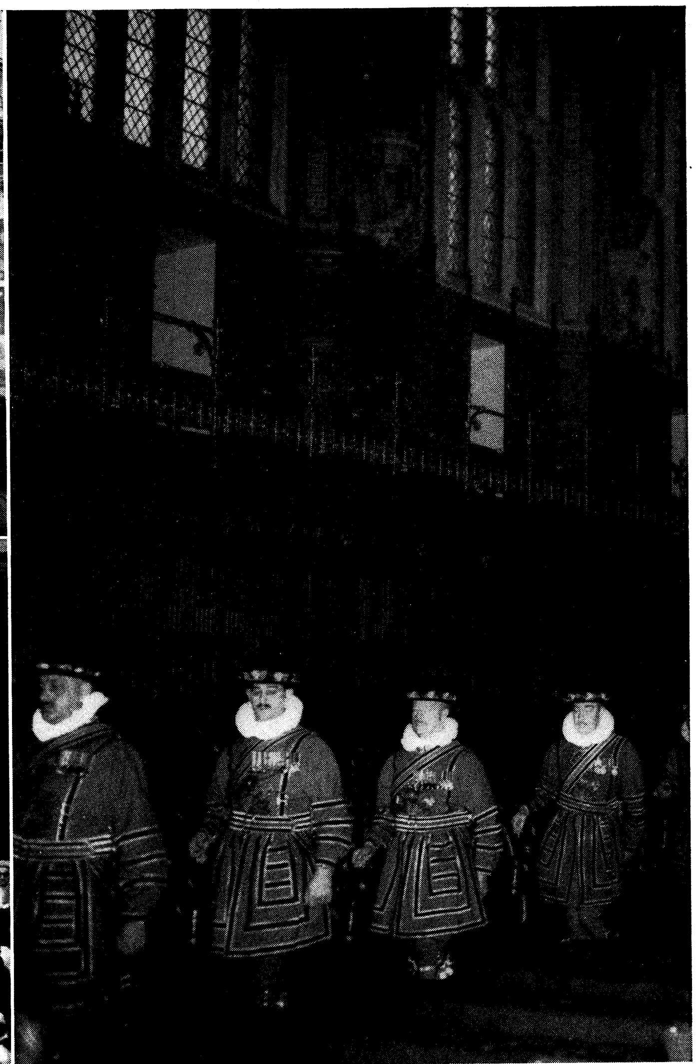
TRAFALGAR SQUARE, THE BRITISH MUSEUM AND LONDON BRIDGE

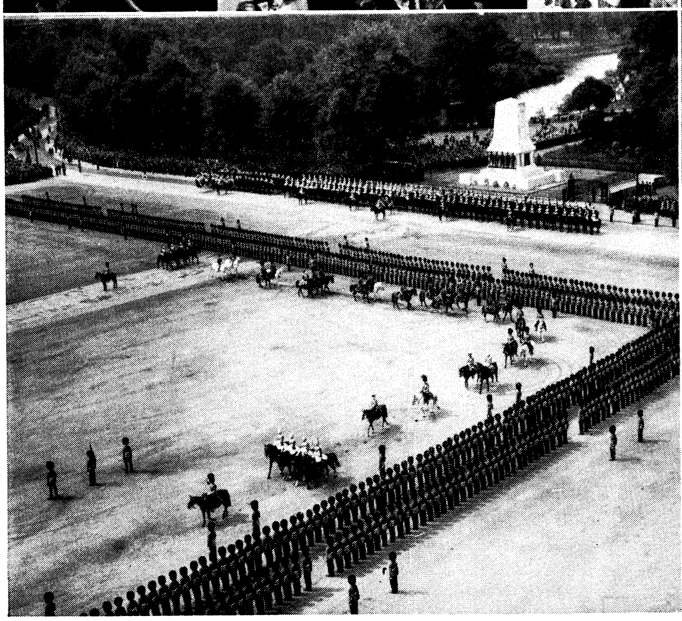
Top left: Air view of Trafalgar square and vicinity. Below the square is Admiralty arch and the Mall leading to Buckingham palace

Top right: The British Museum

Centre right: The Nelson monument in Trafalgar square. From left to right, bordering the square, are the National gallery, St. Martin-in-the-Fields church and South Africa house

Bottom: View of the Thames river with Tower bridge in the background and London bridge below it (third bridge from bottom)





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PAGEANTRY IN LONDON

Top left: The Changing of the Guard, at the Horse Guards, Whitehall

Top right: The queen's bodyguard of the yeomen of the guard, in Tudor costume, filing into the house of lords during the searching of the vaults. This ceremony precedes the state opening of parliament and dates from the 16th century when Guy Fawkes planted gunpowder beneath the house of lords in a conspiracy to blow up parliament

Centre left: The Lord Mayor of London's banauet in Guildhall

Bottom left: Trooping the Colour on Horse Guards parade in honour of the reigning monarch's birthday

Bottom right: Queen Elizabeth II leaving Buckingham palace for Westminster in the Irish state coach for the state opening of parliament

ment of great out-county estates such as Becontree (Essex, 2,784 ac.), St. Helier (Surrey, 825 ac.) and Watling (Middlesex, 386 ac.). After 1934 the state subsidy was confined to dwellings used for families displaced by slum clearance and in 1935 it was extended to housing required to abate overcrowding. More emphasis was placed on rehousing on cleared slum sites. and in most cases that meant the building of blocks of flats. World War II not only suspended all housing opeiations but caused serious damage. It was estimated that of approximately 790,000 dwellings in the county about 270,000 suffered war damage. Slum clearance was only slowly resumed. In addition to the repair of war-damaged property and the building of new permanent dwellings, nearly 8,000 prefabricated temporary houses were provided, and large houses were requisitioned for conversion into emergency accommodations for the homeless. At the end of 1951 there were 37,419 of these requisitioned properties, many of them accommodating several families. This record does not give a complete picture. Between the wars municipal housing accounted for some 42% of the total provision of houses in the administrative county and 15% in the rest of Greater London. From 1945 to 1953 the proportion in the administrative county was 92%. Some of the effect of these housing efforts could be seen from the change in the census between 1931 and 1951. The proportion of persons living more than two to a room fell from 13% to 2.5%. But there are three boroughs in which the proportion is more than 4%, or twice the proportion for England and Wales as a whole.

Town planning legislation began in 1909, but until the Town and Country Planning act (1932) there was little power to control built-up areas. By this act the L.C.C. became the planning authority for the county; the City and the borough and district councils in Greater London exercised the same powers. Some of these authorities at various dates combined to form joint planning committees. Those that were in the London traffic area (within a radius of about 25 mi. from Charing Cross) formed in 1937 a standing conference on London regional planning to make recommendations on planning matters of common concern. The L.C C. began to prepare a scheme to cover the whole of its area except the City. In 1935 was launched the Green Belt scheme, designed to acquire and preserve areas of recreational and agricultural land on the outskirts of London. Much of the green belt goes beyond Greater London. It is a joint undertaking in which the cost is shared by the L.C.C. and the other county councils concerned. In 1943 a County of London plan was prepared by Sir Patrick Abercrombie and J. H. Forshaw and adopted in principle by the County council. A plan for the City was completed in 1944 but not approved by the minister of town and country planning. A subsequent plan was prepared by Sir William Holford and C. H. Holden. In 1945 Sir Patrick Abercrombie published on behalf of the standing conference the Greater London plan, which covered a much wider area than that normally regarded as Greater London. It dealt with a population (1938) of 6,250,000 and an area of 2,600 sq.mi. controlled by 143 planning authorities. The plan, which was complementary to the county plan, was accepted in 1946 with some modifications by the Advisory Committee for London Regional Planning representative of the planning authorities concerned. In 1947 a new Town and Country Planning act made the county and county borough councils the planning authorities and charged them with the duty of submitting to the minister a development plan for their area. The plan for London was approved in 195j.

An important feature of any attempt to plan London is the problem of overspill. When a congested area in London is redeveloped, it is not usually possible to rehouse on the site the same number of people as has been displaced. The Abercrombie plans estimated that between 1,000,000 and 1,250,000 people would have to be decentralized. of whom 618,000 would be from the administrative county. If the "London sprawl" and the long journey to work were not to be further extended, this would require planned settlement with industrial and other employment to accompany them. The first method of achieving this was to build new towns under government direction through the New Towns act (1946). Of the first new towns, eight were associated with the London region: Hemel Hempstead, Stevenage, Hatfield and Welwyn in Hertfordshire, Harlow and Basildon in Essex, Crawley in Sussex and Bracknell in Berkshire. In many of these cases development took the form of expansion of existing towns. The Town Development act (1952) provided an alternative way of expanding towns to accommodate overspill by agreement between local authorities of receiving and expanding areas.

By 1952–53 permanent municipal housing available for the county amounted to 205,242 dwellings. Of these 148,510 were provided by the L.C.C. (78,690 outside the county) and 56,732 by the City and metropolitan boroughs. Large postwar L.C.C. estates are St. Paul's Cray (Kent), 570 ac.; Oxhey (Herts.), 925 ac.; and Headstone Lane (Middlesex), 153 ac. Debden and Hainault estates in Essex and Sheerwater in Surrey we're still being developed in 1954.

Before 1919 about one-third of L.C.C. dwellings were cottages. In both the interwar and post–1945 periods the proportions were reversed, about one-third being in flats.

COMMUNICATIONS

This section deals with the main forms of transport in London.

Railways. — Despite national operation on a regional basis, London remains the principal focal point of the British railway system. Each region of British Railways has more than one terminal station in London--excepting the Scottish and North Eastern regions. The London Midland region operates from Euston and St. Pancras stations; the Southern from Waterloo, Victoria, Charing Cross and London Bridge stations, as well as several smaller terminals mainly concerned with suburban traffic. The Eastern region is responsible for King's Cross, Liverpool Street and Fenchurch Street, and the Western for Paddington and Marylebone.

Continental services are operated from Victoria, Liverpool Street and Waterloo, and services to Scotland from Euston, King's Cross and St. Pancras. Comparative figures of the number of passengers handled daily at the principal London terminals show Waterloo as having the largest turnover (200.000) followed by London Bridge (175,000), Victoria (140,000), Liverpool Street (125,000), Charing Cross (120,000) and Paddington (70,000). The last-named station deals principally with long-distance passengers and has little suburban traffic comparable with that at the other main London termini.

Airports. — London airport (Heath Row) was first licensed as a civil aerodrome in 1930, to a private company, and Gatwick in 1934. Northolt was largely used for civil aviation from 1946. From London airport services were operated to all parts of the world while Northolt handled about 2,000,000 passengers in 1953, out of 3,500,000 served by U.K. airports. London airport handled 1,200 000 passengers, 17,000 short tons of freight and 6.200 short tons of mail. It was proposed to develop Gatwick as the main alternate to London airport and Northolt was closed. On the plan's completion there would be three operational airports — London, Gatwick and Blackbushe.

Trams. — The first regular tramcar service in London began in Kennington road on May 1, 1870, and was follom-ed a week later by another from Whitechapel to Bow church. Electric traction appeared in 1905 but because of the fact that the streets in a large area of central London could not accommodate tram-lines along with other traffic over any great distance, there were never very many lines in the central area, though quite an extensive service existed in northern, western and eastern outskirts of the city and south of the Thames. Tram operation ceased on July 5, 1952, having at its greatest extent covered some 350 mi. of track.

Taxicabs. — At the end of 1950 there were 6,799 licensed cabs in London, but economic difficulties in the trade (*i.e.,* cost of new vehicles and of maintenance, coupled with increases in the duty on gasoline) had reduced the number to 5,209 by July 1954.

Traffic Congestion. — Attention was focused on the traffic problem as early as 1903, when a royal commission mas appointed to consider the question of transport in London. As a result of its recommendations a large and extensive program of arterial road works (mainly outside the county) was undertaken after

World War I. Nevertheless in 1951 the position in inner London had become so acute that the London and Home Counties Traffic Advisory committee issued a special report on traffic congestion. They reported that no major improvement to the roads in inner London had been made since 1905, when Kingsway and Aldwych were completed and recommended a boulevard scheme for Hyde park; the construction of slip roads on the northwest and southeast corners of St. Giles's circus to enable roundabout working to be instituted; the widening of the Strand between George Court and Charing Cross station; the widening of Euston road between Albany street and Gower street; and the construction of a roundabout at Hampstead road. It was also proposed that Tottenham Court road should be widened between Whitfield street and north of St. Giles's circus.

Some idea of the volume of traffic may be obtained from the police traffic census of July 1952 which showed that in the 12 hours from 8 A.M. to 8 P.M. the traffic volume of Hyde park corner was 77,013 vehicles, Trafalgar square 64,700, Marble arch 52,055, and Piccadilly circus 47,354.

The Traffic committee found that the largest contributory cause of congestion was the parked vehicle; a further serious cause was lack of road space at certain major intersections to allow free movement, particularly for turning vehicles. A working party on car parks set up by the minister of transport in 1951 recommended the provision of a number of garages under London squares, coupled with experiments in unilateral waiting and the use of parking meters at authorized street car parks.

PORT AND COMMERCE

The forces which led to the development of the Port of London arose primarily from its geographical and physical advantages. It is situated on a broad deep tidal river with a current sufficient to keep up a natural scour which maintains the channel, yet not so fast as to prevent the safe navigation of the largest vessels. But it is to the enormous expansion of British colonies and possessions that the port owes its prosperity.

The total value of the imports of all classes of merchandise from overseas in 1951 was £1,304,826,881, representing 33.4% of the total for Great Britain. The value of goods imported for transshipment under bond was £119,365,484. London also has the largest coastwise trade of any port in Britain, the principal commodity being coal.

The net registered tonnage of shipping (merchandise) entering and leaving the port in the year ending March 31, 1954, was:

	Foreign	*Coastwise*	*Transshipments*
Imports	18,449,780	20,494,826	1,757,324
Exports	5,936,815	3,009,486	

The total net registered tonnage of vessels that arrived and departed with cargoes and in ballast from and to British and foreign countries and coastwise, excluding naval vessels, in the same period, was 68,550,917.

The industrialization of outer London in the west and northwest increased rapidly between World Wars I and II and included many highly mechanized industries such as aircraft factories, motor-vehicle factories and electrical concerns; there were also many other ventures directed toward extensive overseas trade as well as to the home market. As a result of this industrial expansion and because of the size of London itself and its supremacy as a market for all kinds of consumer goods, the control of overseas trade gradually became concentrated in London to the exclusion of other ports in the country.

Port Administration. — Until the establishment in 1909 of the Port of London authority, the administration of the port had been largely in the hands of free competition between the dock companies and river wharfingers. The authority began its career by assuming the functions of the Thames Conservancy in the lower river and those of the old private companies in the docks and was charged with the duty of improving accommodation in the port.

The authority has a board of 28 members. Seventeen are elected by the ship owners, merchants, wharfingers and owners of river craft. One member is elected by the wharfingers in their own interests, and the remainder are appointed by the L.C.C. (4), the City corporation (2). Trinity House (1), the admiralty (1) and the ministry of transport and civil aviation (2). The authority's jurisdiction over the river extends from Teddington lock down to an imaginary line drawn from Warden point in Kent to Havengore creek in Essex. This line is 50 mi. below London bridge and 69 mi. from Teddington lock. On this part of the river, the authority is the conservator. It controls the licensing of all erections on the river banks. the regulation of the navigation of the river, the prevention of pollution and the licensing of lightermen and their craft. The control of the lighting and buoying of the river as well as of pilotage is in the hands of Trinity House. In the docks, the authority, as the successor to the dock companies, furnishes every class of accommodation, except storage for mineral oils and explosives. At the upper docks the authority undertakes the discharging of ships, whereas at the lower docks ship owners discharge their own ships, the only exception being bulk grain for which the authority provides floating elevators and carries out the work with its own staff. The actual loading of ships is not performed by the authority, its only service to export goods being the handling of such cargo as passes over the dock quays. The most important functions of the authority in the docks are connected with operations on goods stored in its warehouses and intended for sale in the wholesale markets of the City. In 1951 the tonnages of goods received by the authority for warehousing, immediate delivery or export were: imports 1,846,291 tons; exports 1,950,625 tons. The largest lock is Tilbury main entrance lock which has a length of 994 ft. and a width of 110 ft. The length of dock quays under the authority's jurisdiction is about 36 mi.

EDUCATION AND RECREATION

Education. — The British and Foreign School society (1808) and the National society (1811), together with the Ragged Schools union (1844), were the only special organizations providing for the education of the poor until 1870, but in that year, when the London School board was created. more than half the child population of London had no school to attend. Under the Education (London) act, 1903, which was passed in pursuance of the system, put into operation by the Education act. 1902, of bringing general education within the scope of municipal government, the board's activities were transferred (1904) to the County council, which at the same time was given the responsibility of maintaining the voluntary schools.

Organized higher technical education was slower in coming and did not get under way until the formation in 1893 of the Technical Education board under the county council which was, therefore, from the first the authority for such education. During its 11 years' existence it did much to improve matters, partly through grants to existing voluntary technical institutions and partly through conducting centres itself. There were also established the Central School of Arts and the London Day Training college (since 1932 the Institute of Education), besides many science lecture rooms, laboratories and workshops, while a scheme of scholarships to link elementary and secondary education was set up.

Provision for the foundation of polytechnics was made under the City of London Parochial Charities act, 1883, the model institution being that of Quintin Hogg, which had been opened in Regent street the previous year. In 1880 the City and Guilds of London institute had been formed for the advancement of technical education.

Under the Education act, 1944, elementary education ceased to be an operative term. The educational process was divided into primary, secondary and further education and the council was called upon to provide sufficient education throughout these stages. Free secondary education had to be available for all children of the appropriate age. The draft development plan was submitted to the minister of education in 1947. It estimated the number of pupils to be provided for as follows: nursery (2–5), 54,000 (one-half the age group); primary (5–12), 216,000; secondary (12–18), 160,000 (with compulsory attendance to 15; an additional 30,000 if compulsory age is raised to 16).

The development plan provided for 103 comprehensive high school units, each catering for all the children in its area of the appropriate age group. Of these, 67 would be county schools, the other 36 would be made up of voluntary schools and county complements. There would also be 21 Church of England, 42 Roman Catholic and 2 Jewish secondary schools. A further 2,500 places would be taken up in independent and direct grant schools. Nursery schools would require 1,350 units of 40 pupils, some of which would be in nursery classes in primary schools. Primary schools would average about 700 pupils. About one-fifth of the places would be in voluntary schools.

The council was required by the 1944 act to consider the provision of boarding education in appropriate cases. Two methods of doing so were adopted at first: to pay for places in existing boarding schools; and to provide new schools. By 1952 the council had become in whole or in part responsible for 572 children in boarding schools not maintained by it. One selective county boarding school was provided at Woolverstone hall in Suffolk. Entry was at the age of 11 or over.

Special Services.—The educational system also makes provision for handicapped children. In 1953 there were 8,278 London children receiving care of this kind. In addition to 14 schools for the blind, partially sighted and deaf, there were open air schools, 20 schools for the physically handicapped, 32 for the educationally subnormal, 5 schools for children presenting behaviour problems through psychological maladjustment and 6 hospital schools. For other children there were speech clinics, child guidance clinics and other specialist treatment.

Further Education.—In the year ended July 31, 1953, there were approximately 55,000 students, spending 10,000,000 student hours at evening institutes. These included vocational and general recreational classes for all ages.

More advanced technical education was provided in colleges and polytechnics. The student hours were provided about equally by the aided polytechnics and the council's technical and commercial colleges. There were 47 institutions of this kind of which 18 were aided and 29 maintained. The total number of students was about 144,000, some of whom attended full-time, some for a few days in the week and others in the evenings.

The University of London (see LONDON UNIVERSITY) which began in 1836 as purely an examining body is now a federation of a number of colleges and medical schools. It receives grants from local authorities as well as from central government funds. There are five national colleges of technology which receive direct grants from the central government.

Teachers.—The L.C.C. maintains six training colleges with places for 341 men and 1,067 women. These are not confined to London citizens many of whom go outside the county for their training. There are also 13 voluntary training colleges in the county.

In 1952–53 in London's primary and secondary schools there were 6,251 men and 9,657 women. Another 803 full-time teachers and 8,040 part-time were engaged in maintained institutions of further education.

Cost of the Education Service.—The gross expenditure of the L.C.C. education service in 1952–53 was £29,846,307. The cost per head in primary schools was £33 2s. 11*d.*, in secondary £56 0*s.* 11*d.* Of the gross expenditure 41.7% was absorbed by teachers' salaries and 4.3% by administration and inspection.

Public Schools.—In early times the priories and other religious houses generally had grammar schools attached to them. Those at St. Peter's, Westminster, and St. Paul's attained a fame which has survived, while other similar foundations lapsed, such as St. Anthony's (Threadneedle street, City), at which Sir Thomas More, Archbishop Whitgiit and many other men of eminence received education. Certain of the schools were re-endowed aiter the dissolution of the monasteries. St. Peter's college or Westminster school (see WESTMINSTER) is unique among English public schools of the highest rank in maintaining its original situation in London. Other early metropolitan foundations have been moved in accordance with modern tendencies either into the country or to sites aloof from the heart of London. Thus Charterhouse school, part oi the foundation of Sir Thomas Sutton (1611), was moved (1872) from Finsbury to Godalming, Surrey; St. Paul's school (1509) has occupied modern buildings at Hammersmith since 1884, and Christ's hospital (1553) has been at Horsham, Sussex, since 1902.

Of other schools, Merchant Taylors' was founded by the company of that name in 1561, and occupied the premises vacated by Charterhouse school from 1875 to 1933, when it moved to Sandy Lodge, near Rickmansworth. The Mercers' school, Holborn, originally attached to the hospital of St. Thomas of Acon, was refounded in 1447. It was taken over by the Mercers' company in 1542 and was transierred to Barnard's Inn in 1894. The City of London school (1442), refounded in Milk street, Cheapside, by the City corporation in 183j. occupies modern buildings on the Victoria embankment. Dulwich rollege originates in a licence granted in 1619 to Edward Alleyn to found a coilege in Dulwich. St. Olave's and St. Saviour's Grammar school received its charter in 1561 arid since 1896 has been in new buildings in Bermondsey.

Museums, Art Galleries, Libraries.—In the British Museum, London possesses one of the most celebrated collections in the world; originated in 1753 by the purchase of Sir Hans Sloane's collection and library by the government. The great building in Bloomsbury (1828–52) with its massive Ionic portico houses the collections of antiquities, coins, books, manuscripts and drawings and contains the reading rooms for the use of readers. The natural history branch was removed to a building at South Kensington (the Natural History museum) in 1881, where the zoological, botanical and mineralogical exhibits are kept.

Near the natural history branch is the Victoria and Albert museum for which an extension of buildings was begun in 1899. Here are collections of pictures and drawings, including the Raphael cartoons, objects of art of every description, including Japanese, Chinese and Persian collections, and an Indian section. The Science museum, nearby, has divisions of industrial and mechanical engineering, transport in all its branches and scientific instruments. In the vicinity also is the fine building of the Imperial institute, founded in 1887 as an exhibition to illustrate the resources oi all parts of the empire and as an institution for the furtherance of imperial intercourse. The London museum in Kensington palace illustrates the antiquities and history of London.

Other museums are Sir John Soane's collection in Lincoln's inn fields and the Museum of Practical Geology, South Kensington, while the scientific societies have libraries and in some cases collections of a specialized character. Among permanent art collections the first place is taken by the National gallery in Trafalgar square. This magnificent collection was originated in 1824, and the building dates from 1838 but has been more than once enlarged. The building of the National Portrait gallery, adjoining it, dates from 1896, but the nucleus of the collection was formed in 1858. The generosity of Sir Henry Tate provided the gallery, commonly named aiter him, by the Thames near Vauxhall bridge, which contains the national collection ot British art. The Wallace collection of paintings and objects of art, in Hertford house, Manchester square, was bequeathed to the nation by the widow of Sir Richard Wallace in 1897. Of the periodical art exhibitions that of the Royal academy is most noteworthy. It is held annually at Burlington house from the first Monday in May to the first Monday in August. There are many art galleries in and about Bond street and Piccadilly, Regent street and Pall Mall. A saiety, health and welfare museum was opened in Horseferry road by the home office in 1927. The Imperial War museum in Lambeth road was founded in 1917. The National Maritime museum is at Greenwich and the Royal Cnited Service museum in Whitehall.

The London County council administers the Horniman museum at Forest Hill, Lewisham, and the Geffrye museum in Shoreditch. The City corporation maintains the fine Guildhall library and museum. The principal library is at the British Museum with its newspaper annex at Colindale. The London library is a private lending library in St. James's square. The specialized libraries of the learned societies and of the university are oiten available for students. All the metropolitan boroughs adopted the public libraries act and provide services covering lending, reierence and juvenile sections.

Theatres and Places of Entertainment.—The principal London theatres and music halls lie between Piccadilly and Temple Bar, and High Holborn and Victoria street, the majority being in Shaftesbury avenue, the Haymarket, the neighbourhood of Charing Cross and the Strand. The Covent Garden and Sadler's Wells theatres are the principal homes of opera and ballet. The main concert hall is the Royal Festival hall (capacity 3,261) on the south bank, erected in 1951 as part of the Festival of Britain, but concerts are also given in the Royal Albert hall (capacity 7,000) along with boxing, wrestling and other large-scale functions. The Wigmore hall is devoted chiefly to recitals and chamber music. Among other popular places oi entertainment may be mentioned the Earl's Court exhibition, rebuilt 1936–37 and covering about 19 ac. It has iceskating and, with Olympia hall, Hammersmith road, is used for such purposes as military tournaments, motor-car shows, "ideal home" exhibitions and the like; the celebrated waxwork exhibition of Madame Tussaud in Marylebone road, burned in 1925, was restored and again damaged in World War II; and the Agricultural hall, Islington, where agricultural and other exhibitions are held. The gardens of the Zoological Society of London are in Regent's park and at Whipsnade (Redfords.). Theatres, music halls, concert halls, cinematograph theatres and so forth are licensed by the County council, except that the licence for stage plays is granted by the lord chamberlain under the Theatres act, 1843. The council provides for inspection of places of entertainment in respect of precautions against fire, structural safety, etc. The principal clubs are in and about Piccadilly and Pall Mall *(see* CLUBS).

Permitted times of opening for premises licensed to sell alcoholic refreshments are fixed by each petty sessional division. In total they amount in the county on weekdays to nine hours between 11 A.M. and 11 P.M., with a break of at least two hours after noon; on Sundays to five hours, not more than two between noon and 3 P.M. and not more than three between 6 P.M. and 10 P.M.

Parks. — St. James's park, Green park, Hyde park and Kensington gardens (which, with Regent's park, Richmond, Bushey and Greenwich parks and Kew gardens, are royal parks) stretch in an irregular belt for nearly 3 mi. between Whitehall and Kensington. St. James's park was transformed from marshy land into a deer park, bowling green and tennis court by Henry VIII, extended and laid out as a pleasure garden by Charles II and rearranged according to the designs of John Nash in 1827–29. Its lake, the broad Mall leading up to Buckingham palace, and the proximity of the government buildings in Whitehall, combine to beautify it. St. James's park is continued between the Mall and Piccadilly by the Green park. Hyde park, to the west, belonged originally to the manor of Hyde, which was attached to Westminster abbey, but was taken by Henry VIII on the dissolution of the monasteries. Two of its gateways are noteworthy, namely that at Hyde Park corner at the southeast and the Marble arch at the northeast. The first was built in 1828 from designs of Decimus Burton and comprises three arches with a frieze above the central arch copied from that of the Parthenon at Athens, now in the British Museum. The Marble arch was intended as a monument to Horatio Nelson; it was erected by John Nash in 1828 in front of Buckingham palace and was moved to its present site, in 1851. In 1908 this corner of the park was cut to give additional accommodation for the heavy traffic between Oxford street, Edgware road and Park lane, and the Marble arch was left isolated. Hyde park and Kensington gardens between them contain a lake 1,500 yd. in length, known in its park portion as the Serpentine and in the gardens portion as the Long Water; from the bridge which marks the division one of the finest prospects in London is seen, including the distant towers of Westminster and, on the north bank of the Serpentine, the bird sanctuary with Jacob Epstein's "Rima" memorial to W. H. Hudson. In the 17th and 18th centuries this park was a favourite duelling ground, and in the present day it is not infrequently the scene of political and other popular demonstrations (as is also Trafalgar square), while the neighbourhood of Marble arch is the resort of orators on social and religious topics. Kensington gardens were originally attached to Kensington palace, but were subsequently much extended; they are specially favoured by children, for the famous Round pond is located there, and in 1912 Sir George Frampton's statue of "Peter Pan" was placed there. They were magnificently timbered, containing plantations of rare shrubs and flowering trees. Regent's park, mainly in the borough of Marylebone, owes its preservation to George IV, who, when regent, intended to build a palace there and had the park laid out by John Nash in 1812. The other most notable open spaces wholly or partly within the county are: Hampstead heath in the northwest, a high-lying tract, preserved to a great extent in its natural state, which, with the adjoining Parliament hill, Ken wood and Golders Hill park, covers about 850 ac.; and in the southwest Wimbledon common and Putney heath (together 1,200 ac.) and the royal demesne of Richmond park (2,358 ac.), which from its higher parts commands a wonderful view up the rich valley of the Thames. The east, south and north are not lacking in open spaces, the chief of which are Victoria park (217 ac.), in the northeast; Greenwich park (188 ac.), Blackheath (267 ac.) and Woolwich commons in the southeast; and Battersea park (200 ac.) and Wandsworth (183 ac.) and Tooting Bec (217 ac.) commons in the south; but there is an extensive inner area where at most only small gardens and squares break the continuity of buildings and where, in some cases, old churchyards serve as public grounds. The proportion of open space in the administrative county is less than two acres per thousand of the population. Outside the county, the L.C.C. owns Hainault, and the City Epping forest in Essex.

Sports Grounds. — Among many sports grounds, the two best-known cricket grounds are Lord's, near Regent's park (M.C.C.—Marylebone Cricket club—and Middlesex county matches, Oxford *v.* Cambridge university matches, Eton *v.* Harrow school matches, etc.), and the Oval in Kennington (Surrey county matches, etc.). At these two grounds there also take place any "test" matches played in London by teams representing England against overseas sides. International Rugby football matches (among others) are played at Twickenham; and the final ties of the English association football cup at Wembley stadium. Athletic meetings take place at the White City (Hammersmith) and the lawn tennis championships at Wimbledon (Surrey). In Greater London are several horse racing courses, including Epsom, the home of the Derby. (J. E. ML.)

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LONDON, CONFERENCES OF. Many important international conferences have been held in London during the 19th and 20th centuries. The first, in June 1814, was the outcome of the visit of the Allied sovereigns to the prince regent after the downfall of Napoleon, the opportunity being used to effect some of the settlements agreed upon in the first treaty of Paris, notably the conditions attached to the erection of the kingdom of the United Netherlands. From 1815 onward, too, diplomatists of the Allies accredited to Great Britain formed a conference in London for the purpose of discussing measures for the suppression of the slave trade and of the Barbary pirates.

Greece. — In 1827 a conference met in London to attempt to settle the affairs of Greece. This conference (the first international gathering to be usually thus described) met on July 12, 1827, and sat till 1832. It was attended only by the representatives of the three powers which had signed the treaty of London (July 6, 1827); *i.e.,* France. Great Britain and Russia. The treaty of London of May 7, 1832, however, which established the kingdom of Greece, with Prince Otto of Bavaria as king, was signed also by Baron de Cetto on behalf of the king of Bavaria.

Belgium. — In 1830, while this conference was still in session, the insurrection of the Belgians against the king of the Netherlands led to the summoning of another conference in London, which first met on Nov. 4, 1830, there being in all 70 sessions. After the independence of Belgium had been recognized and Leopold of Coburg had been elected king (June 4, 1831) a Belgian plenipotentiary was also admitted. On Oct. 1, 1832, Austria, Prussia and Russia having refused to agree to the French proposal to coerce the Dutch king into accepting the 24 articles embodied in the treaty of Nov. 15, 1831, the conference virtually broke up, the further proceedings being conducted by the representatives of France and Great Britain. These ended on May 21, 1833, with the signature of a convention between the two powers and the Netherlands, providing for the nonrenewal of hostilities and freedom of navigation on the Scheldt and Meuse. Thus matters remained till 1839 when, the king of the Netherlands having at last consented to recognize the inevitable. the plenipotentiaries of all the five powers met in London to sign with those of the Netherlands, on April 7–19, a treaty to which the 24 articles of Nov. 15, 1831. were annexed (see BELGIUM).

Schleswig-Holstein and Luxembourg. — In 1848 the war between Prussia and Denmark over the Schleswig-Holstein question (*q.v.*) led to the assembling of an international conference in London. It met after the pressure of the powers had forced Prussia to conclude the truce of Malmö (Aug. 26) and resulted in the peace signed at Berlin on July 2. 1850, which left the main problems unsolved. By the protocol signed on May 8, 1852. the conference settled the succession to the Danish throne and the duchies of Schleswig and Holstein on Christian of Gliicksburg.

In 1864, during the war between the two great German powers and Denmark, Great Britain invited the signatories of the protocol of 1852 to a conference in London, with a view to a settlement. The conference met on April 25, immediately after the storming of the Diippel lines; but, as a result of Bismarck's diplomacy, it broke up on June 25 without having effected anything.

In 1867 an important international conference met in London, at the instance of the king of the Netherlands, to deal with the situation in regard to Luxembourg created by the war of 1866 and the consequent dissolution of the old German confederation. The conference consisted primarily of the representatives of the states signatory of the treaty of 1839, by which the status of the grand duchy of Luxembourg had been determined (*i.e.,* Austria, Belgium, France, Great Britain, Holland-Luxembourg, Prussia and Russia). but on the motion of Lord Stanley, who presided, the Italian ambassador was also invited to assist. The conference resulted in the treaty of London of May 11, 1867, by the terms of which the Prussian troops, which had garrisoned the city of Luxembourg since 1815, were to be withdrawn and the fortress demolished. On the motion of the Prussian plenipotentiary, Count Bernstorff, the signatories guaranteed Luxembourg's neutrality.

Russia. — In 1871, during the Franco-German War, the denunciation by Russia of the Black sea clauses of the treaty of Paris of 1856 led to the assembling of a conference in London, in order to regularize the situation thus created by a revision of the treaty of 1856, so far as regarded the neutralization of the Black sea, the straits of the Dardanelles and Bosporus, and the navigation of the Danube. The conference, which sat from January to March and was attended by the representatives of North Germany. Austria-Hungary, Great Britain, Italy, Russia and Turkey, while revising the treaty in accordance with Russia's wishes, asserted the principle of the inviolability of treaties (see TREATIES).

Treaty of Berlin. — In 1883 a conference sat in London (Feb. 8–March 10) to consider the execution of articles 54 and 55 of the treaty of Berlin of July 13, 1878, concerning the navigation of the Danube (*q.v.*). It was attended by representatives of all the powers which had signed the Berlin treaty and those of the other riverain states (*i.e.,* Serbia and Rumania) which had not signed the treaty were invited to attend but without a deliberative voice. Bulgaria, as a vassal state, was represented by the Turkish delegate. Rumania refused to accept these conditions, but the Serbian plenipotentiary attended the sessions.

Egypt. — In 1885 a conference between the great powers and Turkey was held in London to deal with the situation arising out of the financial crisis in Egypt. The result was the signature in March of what is known as the London convention, the terms of which were embodied in a khedivial decree and, with some modifications, remained for 20 years the organic law governing the administration of the finances of Egypt (see EGYPT: *History*).

Naval Conference. — In 1908, at the invitation of the British government an international naval conference met in London to attempt a settlement of those questions regarding contraband, blockade, etc., which had been raised at the second Hague conference. The conference met on Dec. 4, 1908 and continued in session until Feb. 26, 1909, the outcome of its labours being the Declaration of London. This declaration was never ratified.

The Balkans. — In 1912 and 1913 conferences were held in London to arrange terms of peace between Turkey and the allied Balkan states, Bulgaria, Greece, Montenegro and Serbia. The conference, which was attended by representatives of the belligerent states, was opened on Dec. 16, 1912, by the British foreign secretary but was suspended without result on Jan. 6. It met again on May 30, 1913, the outcome being the treaty of London signed on the same day. The conference was dissolved on June 9, and its work was rendered abortive by the outbreak, immediately afterward, of the Second Balkan War (see BALKAN WARS).

Conferences After World War I.—In 1921–22 four conferences of Allied statesmen were held in London, to adjust matters arising out of the peace treaties which ended World War I. The first met from Feb. 21 to March 14, 1921, and carried on alternately two sets of negotiations, one with the Athens, Constantinople and Angora governments on the near eastern question (see TURKEY), the other with Germany on the subject of reparations. The result in both cases was failure. The conference was hardly over before the Greeks launched a new offensive against the Turkish Nationalists, while the unacceptable German counterproposals led, early in March, to fresh sanctions being taken against Germany (occupation of Diisseldorf, etc.).

On April 29 the Allied leaders met again in London, having before them the Reparations commission's estimate of Germany's total liability. They made this the basis of a schedule of payments which was sent to Berlin on May 5, with an ultimatum, and on the 11th the German government accepted the Allies' terms.

In 1922 as a result of the failure of Germany to carry out this agreement, similar conferences of Allied leaders met in London, in August and in December. At each of these R. Poincaré put forward his claim for "productive guarantees" from Germany as a precondition of any moratorium. The British could not agree to such sweeping measures and the conference adjourned on Dec. 11 without agreement being reached (see REPARATIONS).

In Jan. 1930 the United States, France, Italy and Japan, accepting a British invitation, met in London to discuss naval disarmament. By the end of three months general agreement had been secured on the regulation of submarine warfare and a five years' holiday for capital ship construction. The United States, Great Britain and Japan signed, on April 22, a treaty limiting battleship tonnage in the ratios of 10:10:7. France and Italy, opposed respectively to the concept of ratios and the acceptance of any inequality, declined to sign (see DISARMAMENT).

On June 12, 1933, the World Economic conference met in London, with representatives of the U.S. and all the League of Nations states in attendance. Soon after it opened, the announcement by Pres. Franklin D. Roosevelt of his opposition to currency stabilization rendered its proceedings nugatory, and on July 27 it adjourned with nothing accomplished.

Conferences After World War II.—On Jan, 10, 1946, the first part of the first session of the United Nations assembly met in London at the Central hall, Westminster. It was principally notable for the election of Trygve Lie as secretary-general and the bringing into operation of the Security council and the Economic and Social council.

After the failure of the French assembly to accept the European Defense community plan a nine-power conference was hurriedly summoned to meet in London on Sept. 28, 1954. The foreign ministers of Great Britain, the United States, Italy, Belgium, the Netherlands and Canada and the prime ministers of France, the German Federal republic and Luxembourg were present. The agreements which they signed on Oct. 3 provided for the termination of the occupation regime in western Germany, the establishment of an agency to control continental armaments, and the admission of Germany and Italy to the Brussels Treaty organization and of Germany to the Korth Atlantic Treaty organization (*q.v.*). Britain undertook to maintain four divisions on the continent for 44 years and the German Federal Republic pledged itself not to seek German reunification by force.

In 1956 the nationalization ot the Suez canal by the Egyptian government created an urgent problem for all the canal users. At the invitation of Britain. France and the United States a conference of 22 countries met in London during Aug. 16–23. Eighteen countries agreed on a plan to guarantee free use of the canal. This was rejected by Egypt. and a second London conference (Sept. 19–21) proposed the establishment of a canal users association.

The association, imperfectly conceived and inadequately directed, failed to materialize and in October the Israeli attack on Egypt and the Anglo-French armed intervention in Suez gave events an entirely different turn. (W. A. P.; H. G. N.)

LONDONDERRY, EARLS AND MARQUESSES OF. The 1st earl of Londonderry was Thomas Ridgeway (c. 1565–1631), a Devon man, who was treasurer in Ireland from 1606 to 1616 and was engaged in the plantation of Ulster. Ridgeway was knighted in 1600, made a baronet in 1611, Baron Ridgeway in 1616 and earl of Londonderry in 1622. The Ridgeways held the earldom until March 1714, when Robert, the 4th earl. died without sons. In 1726 Robert's son-in-law, Thomas Pitt (c. 1688–1729), son of Thomas Pitt (1653–1726; often called "Diamond Pitt," governor of Fort St. George, Madras. India) and uncle of the great earl of Chatham, was created earl of Londonderry, the earldom again becoming extinct when his younger son Ridgeway, the 3rd earl of this line, died unmarried in Jan. 1765. In 1796 Robert Stewart (1739–1821), of Mount Stewart, County Down, was made earl of Londonderry in the Irish peerage. He had been created Baron Londonderry in 1789 and Viscount Castlereagh in 1795; in 1816 he was advanced to the rank of marquess of Londonderry. His son, the 2nd marquess, who succeeded in 1821, was styled Viscount Castlereagh from 1796 to 1821, and is better known by that title (*see* LONDONDERRY, ROBERT STEWART. 2ND MARQUESS).

He was succeeded by his half brother Charles William Stewart Vane (*q.v.*), who in 1819 married as his second wife the daughter and heiress of Sir Harry Vane-Tempest and consequently took the name of Vane instead of that of Stewart. He was succeeded by his son by his first wife, Frederick William Robert Stewart, the 4th marquess (1805–72), who was M.P. for County Down from 1826 to 1852; a lord of the admiralty, 1826–52; and vice-chamberlain of the royal household, 1834–35. He died without issue and was succeeded by his half brother, who in 1854 took the name of Tempest after that of Vane. The 6th marquess (1852–1915) in 1885 added the name Stewart, becoming Vane-Tempest-Stewart. He was M.P. for County Down, 1878–84, and lord lieutenant of Ireland from 1886 to 1889. Chairman of the London School board from 1895 to 1897, he became postmaster general in 1900 and was president of the board of education from 1902 to 1905. His son, Charles Stewart Henry Vane-Tempest-Stewart, the 7th marquess (1878–1949), was M.P. for Maidstone, Kent, from 1906 to 1915, and was undersecretary for air, 1920–21; minister of education for Northern Ireland, 1921–26; first commissioner of works, 1928–29 and again in 1931; secretary of state for air, 1931–35; and lord privy seal and leader of the house of lords in 1935.

LONDONDERRY, CHARLES WILLIAM STEWART (VANE), 3RD MARQUESS OF (1778–1854), British soldier and diplomatist, who served in the peninsular war and took part in the diplomatic affairs of the Napoleonic and post-Napoleonic period. He was the son of the 1st marquess by his second marriage, with the daughter of the 1st Earl Camden, and was born in Dublin on May 18, 1778. He was thus half brother to Lord Castlereagh, the 2nd marquess of Londonderry (*see* LONDONDERRY, ROBERT STEWART). He entered the army and served in the Netherlands (1794), on the Rhine and Danube (1795), in the Irish rebellion (1798) and in Holland (1799), rising to be colonel. He was elected M.P. for Derry and became undersecretary for war under his half brother Lord Castlereagh in 1807. In 1808 he was given a cavalry command in the peninsula, where, in 1809, and in the campaigns of 1810–11 as major general, he served under the duke of Wellington as his adjutant general.

He was at the capture of Ciudad Rodrigo, but at the beginning of 1812 he was invalided home and Wellington refused his request of a cavalry command. Castlereagh then sent him as ambassador and military representative to Prussia, now engaged in the struggle against Napoleon. He was no great diplomatist hut his energy and courage were sometimes most useful. In 1814 he nas made a peer as Baron Stewart, and later in the year was appointed ambassador at Vienna, and was a member of the important congresses which followed, where he sometimes shocked high society by his undiplomatic behaviour. In 1822 Castlereagh's death made him 3rd marquess of Londonderry, and after attending the conference of Verona he resigned. being created Earl Vane (1823). In 1835 he nas appointed by Sir Robert Peel at the suggestion of the duke of Wellington as ambassador to St. Petersburg but criticism in the house of commons forced him to resign at once. After the death of Wellington in 1852, he received the order of the Garter.

He was twice married, first in 1808 to the daughter of the earl of Darnley, and secondly in 1819 to the rich heiress of Sir Harry Vane-Tempest. when he assumed the name of Vane. He was devoted to his half brother. defended his reputation and published 12 volumes of his correspondence as well as books on his own military career and travels. He died in London on March 6, 1854. (C. K. W.)

LONDONDERRY, ROBERT STEWART, 2ND MARQUESS OF (1769–1822), British statesman, better known as VISCOUNT CASTLEREAGH, ranks high among British foreign ministers. He was the eldest son of Robert Stewart of Ballylawn Castle, in Donegal, and Mount Stewart in County Down, an Ulster landowner, of kin to the Galloway Stewarts, who became baron, viscount, earl and marquess in the peerage of Ireland. He was born on June 18, 1769. in the same year as Napoleon and Wellington. His mother, Lady Sarah Seymour, daughter of the marquess of Hertford, died shortly after his birth. He went from Armagh school to St. John's college, Cambridge, where he worked diligently, but illness interfered with his studies. With Lord Downshire, then holding sway over County Down, his father had a standing feud, and he put forward his son, in July 1790, for one of the seats in the Irish parliament. Young Stewart was returned, but at a vast cost to his family, when he was barely 21. He paid two visits to the continent and later was a member of the British house of commons for a short period and attracted the attention of William Pitt. He married Lady Emily Hobart, daughter of the earl of Buckinghamshire. They were devoted to one another throughout their married life. There were no children. From 1796, when his father became an earl, he took the courtesy title of Viscount Castlereagh. When his uncle, Lord Camden, became lord lieutenant, he became keeper of the privy seal in Ireland and acted as chief secretary during, the prolonged absence of Thomas Pelham, afterward earl of Chichester, from March 1798. He succeeded him in Nov. 1798. Castlereagh's conviction was that, in presence of threatened invasion and rebellion, Ireland could only be made safe by union with Great Britain. In Lord Camden, as afterward in Lord Cornwallis, Castlereagh found a congenial chief. In suppressing Lord Edward Fitzgerald's conspiracy, and the rebellion which followed in 1798, Castlereagh's vigilance and firmness were effective. He was then the principal actor in abolishing the separate parliament of his own country and thus incurred the undying hatred of Irish nationalists. Some bribery was used, but Castlereagh, like Pitt, intended Catholic emancipation to follow the union, though no express promise was made to the Catholics. (*See* IRELAND.)

When the Act of Union was carried through the Irish parliament, in the summer of 1800, Castlereagh's official connection with Ireland practically ended. Before the imperial parliament met he urged upon Pitt the measures which he and Cornwallis thought requisite to make the union effective. But the king flatly refused to sanction emancipation, and Pitt and his cabinet made way for Henry Addington's administration. Thereupon Castlereagh resigned, with Cornwallis. He took his seat at Westminster for Down, the constituency he had represented for ten years in Dublin. The leadership of an Irish party was offered to him, but he declined so to limit his political activity. His father accepted, at the duke of Portland's request, an Irish marquessate, on the understanding that in the future he or his heirs might claim the same rank in the imperial legislature; so that Castlereagh was able to sit in the house of commons as marquess in 1821–22.

In 1802, Castlereagh, at Pitt's suggestion, became president of the board of control in the Addington cabinet. He had, though not in office, taken charge of Irish measures under Addington, including the Suppression of Rebellion bill and the temporary Suspension of Habeas Corpus act in 1801, and he continued to advocate Catholic relief, tithe reform, state payment of Catholic and dissenting clergy and "the steady application of authority in support of the laws." To Lord Wellesley's Indian policy he gave a staunch support, warmly recognized by the governor general. On Pitt's return to office (May 1804), Castlereagh retained his post, and, next year, he took over the duties of secretary for war and the colonies. His house became a meeting place of the party, and his influence in parliament grew.

After Pitt's death (1806) his colleagues failed to form a cabinet able to face the combination known as the ministry of "all the talents," and Castlereagh acquiesced in the resignation. But to the foreign policy of the Fox-Grenville ministry and its conduct of the war he was always opposed.

In 1807 Castlereagh returned to the war office under Portland, but grave difficulties arose. The operations to avert the ruin of the coalition at the battle of Friedland (June 1807) came too late. The tsar Alexander believed that England would no longer concern itself with the continental struggle, and Friedland was followed by the treaty of Tilsit which left Great Britain isolated. The seizure of the Danish squadron at Copenhagen and the measures taken to rescue the fleets of Portugal and Sweden from Napoleon crushed a combination as menacing as that defeated at Trafalgar. The expedition to Portugal, though Castlereagh's influence was able only to secure Arthur Wellesley (afterward duke of Wellington) a secondary part at first, soon dwarfed other issues. In the debates on the conyention of Cintra (Aug. 1808), Castlereagh defended Wellesley against parliamentary attacks. Early in 1809, Castlereagh secured his friend's appointment as commander in chief of the second Portuguese expedition. (See also PENINSULAR WAR.)

Disagreement With Canning. — Meanwhile a breach arose between Castlereagh and George Canning, the foreign secretary. Canning was not openly opposed to the Walcheren expedition. Castlereagh's proposal of action in the Netherlands was for a coup de main, under strict conditions of celerity and secrecy, as Antwerp was unable to make any adequate defense. But the expedition, planned at the end of March, did not reach Walcheren till the end of July, 1809; and more time was lost, until sickness in the army necessitated its withdrawal in September. Meanwhile Canning had insisted on the removal of Castlereagh from his office and the prime minister had secretly consented. Public opinion threw the whole blame upon Castlereagh, who then found that some of his colleagues had determined, behind his back, on his removal. Castlereagh held himself justified in sending a challenge to the original author, as he held, of a disloyal intrigue against a colleague. In the subsequent duel Canning was wounded and the rivals simultaneously resigned. Though Wellington's retreat after Talavera had been included, with the disasters of the Corunna and Walcheren campaigns, in the censures on Castlereagh, and though ministers were often depressed and doubtful, Castlereagh never lost faith in Wellington's genius. Lord Wellesley's resignation in 1812, when the Whigs failed to come to terms with the regent, led to Castlereagh's return to office as foreign secretary (March 1812). The assassination of Spencer Perceval (May 1812) soon threw upon him the leadership of the house of commons, and this double burden he continued to bear during the rest of his life.

The Duel With Napoleon. — From March 1812 to July 1822 Castlereagh's biography is, in truth, the history of England. He set himself at once to meet Napoleon's designs in northern Europe, where Russia was preparing for its life-and-death struggle. After the Moscow debacle and Prussia's defection, subsidy treaties were made with Russia and Pruesia. One had previously been made with Sweden, which eventually led to Swedish armies under Bernadotte (Charles XIV John) taking part in the struggle against Napoleon, and one was made with Austria when it abandoned its neutrality after a vain effort at mediation. The result was the battle of Leipzig (Oct. 1813) and the advance of the allies to the Rhine. The allied powers were willing, even after Leipzig, to treat with France on the basis of restoring its "natural frontiers" — the Rhine, Alps and Pyrenees. This step, which would have left Belgium and Antwerp in French possession, was partly due to the lack of skill and personal rivalry of the three British ambassadors to Russia, Prussia and Austria. They had also failed to obtain the treaty of alliance between the four allied powers which Castlereagh had proposed in the autumn, thus taking the first step toward carrying out the policy laid down by Pitt in 1805. The cabinet, therefore, decided to send Castlereagh himself to the continent to maintain British interests in the approaching settlement. The coalition against Napoleon was already showing signs of weakness and division when he arrived at Basle on Jan. 18, 1814. Austria distrusted Russia, while the policy of the tsar was ambiguous and vacillating. Napoleon, on the other hand, was now displaying once more his military genius. Castlereagh succeeded, by frank conversations with Metternich and Alexander in cementing the coalition, and the treaty of Chaumont (March 1, 1814) bound the four powers together in an alliance against France which was to continue after victory had been won. He himself had gone previously to Châtillon where the negotiations nith the marquis de Caulaincourt, Napoleon's foreign minister, were taking place. He insisted on making the return of France to its ancient limits the basis of the peace. When Napoleon refused these terms it uas largely due to Castlereagh's advice and action that the German troops under the reluctant Bernadotte were transferred to the command of the energetic G. L. von Blucher. The latter gained two victories, the allies were able to enter Paris and the treaty of Fontainebleau (April 11, 1814) by which Napoleon was given Elba was made before Castlereagh arrived. Louis XVIII was now restored as Britain had always desired if the French people, as had now happened, showed themselves ready to receive him.

The Reconstruction of Europe.—In the negotiations which led to the first peace of Paris (May 30, 1814) Castiereagh, having secured the inclusion of Belgium in the restored Netherlands, treated France generously, giving back many colonies and seeking no indemnity. The rich Dutch East Indies were also restored to the Netherlands. But, despite efforts at agreement at Paris and during the subsequent visit of the allied sovereigns and statesmen to London, the settlement of the other European frontiers had to be postponed to a congress of all the European powers at Vienna, Talleyrand, Louis XVIII's foreign minister, agreeing in the peace treaties to accept the decisions of the allies. These had hoped to come to an agreement before the congress met. But they failed to do so (see VIENNA, COKGRESS OF) and Castlereagh had to play a principal role in the reconstruction of Europe. His object was the same as that of Pitt—to establish a balance of power so that no state could attack the others with success. He failed in his first plan, which was to combine Prussia and Austria together to resist the absorption of Poland by Russia, but when Prussia joined Russia in order to obtain the whole of Saxony, he was the principal author of the secret treaty with France and Austria (Jan. 3, 1815) and their united front forced a compromise. The result was to bring Prussia to the left bank of the Rhine, while Austria obtained control in Italy, the former thus supporting the restored Netherlands and the latter an enlarged Piedmont, as barriers against France. In the east Alexander retained nearly all of Poland that he claimed, but Castlereagh persuaded him to give back Thorn to Prussia, while Cracow was made a free state. In all these negotiations Castlereagh had the role of mediator and the result was largely due to his diplomatic skill and energy. He even proposed a general guarantee of the new frontiers, in which those of the Ottoman empire were to be included, though later he preferred the alliance to a guarantee of this kind. He also secured a declaration against the slave trade, the principal interest of the British people at this time, and in subsequent years spent much effort in trying to make it effective.

After Wellington had replaced Castlereagh at Vienna Napoleon returned from Elba, a new treaty of alliance had to be made (March 25, 1815) and Britain again took Europe into its pay. After Napoleon had been overthrown at Waterloo and Louis XVIII, largely by the efforts of Castlereagh and Wellington, restored to the throne a second time as a constitutional monarch, Castlereagh negotiated the second peace of Paris (Nov. 20, 1815). It was largely due to him, splendidly supported by the victorious Wellington, that France incurred only a small reduction of territory and a moderate indemnity. An allied army of occupation remained in France for three years, but Castlereagh put his main trust in the treaty of alliance (also signed on Nov. 20, 1815) between the four great powers against French aggression. In this renewal of the treaty of Chaumont, he introduced the device of periodical meetings between the sovereigns and statesmen to resolve differences and maintain peace. This simple idea was confused in the minds of the public with the Holy Alliance, a treaty between the sovereigns engaging them to act as Christians, which Alexander forced the others to adopt and which was subsequently signed by every monarch in Europe except the pope, the sultan and the prince regent of England.

Home Policies.—Castlereagh had to defend the reactionary and unpopular conduct of the British government in a policy of repression of the social unrest caused by the financial and economic problems of the return to peace which culminated in the Peterloo massacre (*q.v.*) and the repressive six acts which attempted to put down political gatherings and to prevent the spread of seditious literature. He thus incurred the savage hatred of the radicals and reformers. The king's attempt to obtain a divorce almost overthrew the Liverpool government in 1820 and it was only finally saved by Castlereagh's influence on the king and his reorganization of the cabinet in 1821 (see GEORGE IV).

The System of the Alliance.—Meanwhile the new system of diplomacy had worked admirably at the conference of Aix-la-Chapelle (*q.v.*; 1818), when the army of occupation was withdrawn and France, after arranging loans to pay its reparations and indemnity, was made a member of the great power conference. A number of other questions were also broadly discussed and some of them were settled. They included that of the relations of Spain to the Latin-American colonies now in revolt. Others concerned the interests of other small powers not represented, but in a protocol of Nov. 15, 1818, often referred to later in the century, the great powers promised that in the future a conference on questions in which other powers were specially interested should only take place at their initiative and with their participation. However when revolutions broke out in Spain and Italy in 1820 Metternich, who had hitherto worked closely with Castlereagh, joined the tsar in an attempt to use the alliance as a means to enable the autocratic states to combine together to repress them. Castlereagh allowed Lord Stewart, the British ambassador at Vienna, to attend the conferences at Troppau and Laibach in which this policy was agreed upon, but he protested, at first secretly and then, when their actions became apparent, in a public state paper of Jan. 21, 1821, against such intervention in the internal affairs of states which was no part of the treaty of alliance and which Britain had, therefore, no obligation to support. He had already in 1818 done so as regards the revolutions in the Spanish colonies whose independence he now prepared to recognize. The revolution in Greece in 1821 brought Castlereagh and Metternich together again and in the autumn of that year after an interview at Hanover they agreed to work together to restrain the tsar from attacking Turkey to help the Greeks. France, which had hitherto taken an intermediate position on the question of suppressing revolutions, now threatened to intervene in Spain. Castlereagh, therefore! prepared to go himself to the next conference, then to be held at Vienna though it was later transferred to Verona, in order to settle in accordance with British interests the three great problems of the eastern question, the Spanish colonies and Spain. He made skilful moves in the summer of 1822 to attain his purpose, making an especial effort to get into close touch with France and arranging to visit Paris on his way to the conference. But he could no longer endure the strain to which he had been subjected for over ten years and his mind gave way. Though his wife and doctor had been warned by Wellington that suicide was possible and took precautions, Castlereagh cut his throat with a small penknife and died immediately (Aug. 12, 1822). With him also died the European alliance though it left behind it the Concert of Europe which was used for the same purpose intermittently throughout the 19th century. Castlereagh died unpopular and misunderstood, but his great achievements have been recognized in recent years.

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LONDONDERRY, a county of Northern Ireland, bounded by the Atlantic ocean on the north, by the Foyle and the Republic of Ireland on the west, by Antrim and the river Bann on the east, and by Tyrone and the Sperrin mountains on the south. The area is 521,230 ac., or 814 sq.mi. Pop. (1951), exclusive of Londonderry county borough, 105,448. This roughly triangular county has wide areas of mountain and moorland, particularly in the south and centre; but on two sides, east to the Bann valley, and northwest to the Roe valley and the shores of the Foyle, the hills fall away into rich agricultural lowlands.

In the south and east, Old Red Sandstone and Lower Carboniferous Sandstone overlie older rocks, meeting the igneous rocks and intrusive granite of north Tyrone at Slieve Gallion. As in a great part of Antrim, Londonderry contains a wide area of limestone covered by basalt, which rises into scarped hills close to the north coast at Benevenagh. A raised shelf of postglacial clays forms the flat land west of Limavady. The outlet of the Foyle is narrowed by a long sandy spit of raised sea bed, ending in Magilligan point.

In the shiring of Ulster, carried out on the commission of Lord Deputy Perrott in 1585, this county was described as the county of Coleraine and was of smaller extent than at present. The area was O'Neill territory and was the country of the O'Cahans who were subordinate allies of the O'Neills. After the final defeat of Hugh O'Neill, earl of Tyrone, in 1603, and the confiscation of O'Neill territory in 1607, the county of Coleraine was committed to the companies of the City of London to be administered and colonized by them. A special body was set up in 1610 to represent the City of London in the matter, the body which later came to be known as the Honourable The Irish society. A charter in 1613 transformed the area into the new county of Londonderry, adding to it the town and district of Derry, and the barony of Loughinsholin which was formerly part of Tyrone.

The colonization scheme was only a limited success. Many of the planters did not carry out the conditions laid down for them. After a long quarrel the City of London was prosecuted in the court of star chamber and heavily fined for its failures in implementing its undertakings. Its Ulster property was confiscated in 1637. This did much to throw London more decisively on the parliamentarian side in the ensuing Civil War. Parliament later reversed the decision against the City, and the Irish society was restored and received a new charter from Charles II. It has continued to own property and carry out duties in the county up to the present day, though the Irish land acts and other changes have reduced its property to small extent.

Much disturbance of persons and property also occurred in Londonderry at the time of the rising of 1641 and during the war in 1689, when the siege of Londonderry took place.

Although the city of Londonderry is an industrial centre, specializing particularly in the manufacture of shirts, the county is mainly agricultural. Small industries are situated in a number of the towns. The spinning and weaving of linen and the manufacture of milk products and automatic numbering machines go on in Coleraine. Handkerchiefs are made in Kilrea, and corsets at Limavady, which is also the market and administrative centre for the prosperous farming area of the Roe valley. There are fisheries on the Bann and along the north coast, where, at Portstewart, Castlerock, Downhill and several smaller resorts, there is also an active tourist industry. Along the north coast the railway connects Londonderry city with Belfast; and by skilful engineering a main road from Belfast has been carried in a fairly direct line to Londonderry across the mid-Derry mountains by the Glenshane pass. Londonderry (including Londonderry county borough) returns five members to the parliament of Northern Ireland and one to the United Kingdom parliament. (Hu. S.)

LONDONDERRY, a city, county and parliamentary borough, the second city of Northern Ireland. situated on the Foyle, a broad estuary into which flow the rivers Finn, Mourne, Strule, Derg and Deele. The city is 75 mi. W.N.W. of Belfast by road. Pop. (1961) 53,744. Area 3.44 sq.mi.

Derry, the older name of Londonderry. comes from the Gaelic word for an oak nood. At that site Columba established a monastery in the middle of the 6th century. The fortunes of Derry as an ecclesiastical and monastic centre were varied. It was plundered by Scandinavians and is said to have been burned down at least seven times before the year 1200. As a strategic site, Derry was of interest to Anglo-Norman adventurers, being plundered by John de Courcy and finally granted by Richard II to Richard de Burgh, well-known as the Red Earl. It served as a strategic point in the Tudor wars against the native Irish, being destroyed in 1568 by the blowing up of a munition dump. Sir Henry Docwra established a fort at Derry in 1600 as part of a successful plan to enclose Hugh O'Neill, earl of Tyrone. The little town at Docwra's fort was burned down by Sir Cahir O'Doherty of Inishowen in his shortlived insurrection in 1608 Derry was granted in 1613 to the City of London as part of the area to be colonized by the City. (See LONDONDERRY, county.) Derry itself received the name of Londonderry and was given a municipal corporation. The representatives of the Londoners planned a new tonn and built the present city walls. The district suffered much in the rising of 1641 and subsequent fighting. the city being besieged in 1649. It again experienced siege in 1689 when it held out for 105 days against the forces of James II, being defended with great heroism and relieved just before resistance became impossible.

The city stands on a hill. It is surrounded by the city walls. about one mile in circumference. having seven gates and several bastions, but modern buildings extend far beyond the walls and across the Foyle nhich is spanned by Craigavon bridge. The Protestant cathedral, built in 1633, contains many relics of the siege. Other important buildings are St. Eugene's Roman Catholic cathedral (1870), the guildhall, Magee University college (1865), and Foyle college, a school for boys, founded in 1617.

The staple industry of Londonderry is the manufacture of shirts and collars. and there are a good many smaller industries including the manufacture of furniture, small ships, sound-reproducing machines, tire fabrics and various foods. The city returns one member to the parliament of Xorthern Ireland and is merged in the Londonderry county constituency for the purpose of returning one member to the United Kingdom parliament. (Hu. S.)

LONDON PRIDE: see SAXIFRAGE

LONDON UNIVERSITY. Plans for a university in London, Eng., were put forward as early as the 16th and 17th centuries, but it was not until after 1825 that a start was made. By then a rapidly growing urban middle class, in which dissent was strongly represented, was making demands for higher education that the older universities, uhich confined their degrees to members of the Church of England and paid little attention to physics, chemistry and other new branches of learning, could no longer meet in full. At the same time. the state of English medical teaching was arousing public concern.

In 1825 a group of influential dissenters, Whigs and Radicals led by Thomas Campbell, the poet, and Henry Brougham set to work to raise funds for founding a college in London on Scottish and German models to give a broad and wholly nonsectarian education in arts, science and medicine. This college was opened in 1828 as "the London university" in fine classical buildings in Gower street designed by William Wilkins. Church and Tory interests at once responded by founding in 1829 on Church of England principles a rival institution, King's college, which was opened in 1831 in a building adjacent to Somerset house. Strand, designed by Sir Robert Smirke. King's college did not seek university status; but the promoters of "the London university" petitioned the crown for powers to grant both general and medical degrees. This claim aroused widespread opposition, and a compromise was adopted. On Nov. 27, 1836, King William IV granted a charter which established the University of London in the form of a chancellor, and a senate of 36 fellows appointed for life by the crown, to hold examinations and grant degrees in arts, laws and medicine, but without teaching functions. On the same day the Gower street college accepted a charter of incorporation as "London University college." Candidates for examinations were to present certificates of attendance at University college or King's college, but other educational institutions, not necessarily situated in London, could be admitted by the government into connection with the university. But, with no organic link to unite them, the university and the London colleges soon drifted apart, the university developing its examination system primarily for national purposes through a free use of the power to admit provincial and even colonial colleges, while University college and King's college struggled to reach high academic standards unaided by the prestige of full university rank. In 1858 the senate acknowledged the realities of the position by throwing all examinations, except those for medical degrees, open to all candidates irrespective of their place of education. The university thus became, and remained until. the end of the century, a general examining body. As such, it was the first body in England to institute degrees in science (1859) and the first to open its degrees to women (1878). Toward the end of the century a strong agitation developed in favour of a teaching university and two royal commissions reported on the question in 1889 and 1894. The existing system had staunch supporters, who feared the results of placing it under the control of an academic body dominated by local college interests, and a long and at times bitter controversy was ended only in 1898, when the first University of London act became law.

The statutes made under this act, which came into force in 1900, reconstituted the university as a dual-purpose institution. Its governing body. the senate, was composed on its "internal" side of representatives elected by the teachers of certain established London colleges and other educational institutions, grouped in faculties of theology, music, arts, laws, medicine, science, engineering and economics; and on its "external" side of a like number of representatives of the convocation of graduates; a third group of representatives was appointed by the crown in council, the London county council and some other public bodies. The principal colleges received the academic status of "schools of the university" but only University college and King's college had statutory representation in the senate. They and the other schools admitted in 1900 carried on the bulk of the teaching work, and remained legally and financially independent of the senate, whose powers of intervention in their affairs were limited to instituting and appointing the holders of professorships and readerships, recognizing the more junior teachers, regulating the courses of instruction for degrees and periodical inspection. A peculiar feature of the constitution was the recognition of individual teachers, under whom students could follow courses of instruction leading to internal degrees, in a number of educational institutions in London not otherwise connected with the university. The former examining system of the university was placed under an external council controlled by the convocation members of the senate, and statutory precautions were adopted to ensure that the standard and prestige of the external degrees should not suffer.

Progress was at first delayed by mutual distrust between the internal and external parties, and by lack of additional resources for the new responsibilities which public opinion expected the university to undertake. With a view to strengthening it at its centre University college in 1905 and King's college in 1908 surrendered their legal independence and in 1907 and 1910 respectively became incorporated in the university, but this example was not followed by other schools. The emergence of the powerful Imperial College of Science and Technology made the excuse for

London University Institutes and Schools (With Dates of Admission)

Institutes and schools	Admission date
University institutes	
Courtauld Institute of Art†	1932
Institute of Advanced Legal Studies	1947
Institute of Archaeology	1934
Institute of Classical Studies	1953
Institute of Commonwealth Studies	1949
Institute of Education	1909‡
Institute of Germanic Languages and Literatures	1950
Institute of Historical Research	1920
School of Slavonic and East European studies	1932
Warburg Institutes	1944
Schools of the university	
Nonmedical	
*Bedford College‖	1900
Birkbeck College¶	1920
Imperial College of Science and Technology♀	1908
*King's College	1900
*London School of Economics and Political Science	1900
Queen Elizabeth College‖, a	1928
Queen Mary College□	1907
*Royal Holloway College‖	1900
Royal Veterinary College	1949
School of Oriental and African Studies	1928
School of Pharmacy	1925
*University College	1900
Westfield College‖	1902
*Wye College	1900°
Medical	
British Postgraduate Medical Federation▲	1947
*Charing Cross Hospital Medical School	1900
*Guy's Hospital Medical School	1900
King's College Hospital Medical School	1909+
Lister Institute of Preventive Medicine	1905
*London Hospital Medical College	1900
London School of Hygiene and Tropical Medicine	1905
*Middlesex Hospital Medical School	1900
Royal Dental Hospital of London School of Dental Surgery	1911
*Royal Free Hospital School of Medicine●	1900
*St. Bartholomew's Hospital Medical College	1900
*St. George's Hospital Medical School	1900
*St. Mary's Hospital Medical School	1900
*St. Thomas's Hospital Medical School	1900
University College Hospital Medical School	1907+
*Westminster Hospital Medical School	1900
Theological	
King's College Theological Department (Anglican)	1910+
London College of Divinity (Anglican)	1900
*New College†† (Congregational)	1900
*Richmond College‡‡ (Methodist)	1900

*Original colleges of the university as reconstituted in 1900. †*I.e.*, art history. ‡As London Day Training college; became university institute under present name 1932. §Formerly Bibliothek Warburg, Hamburg, Ger.; for study of classical tradition in art literature, science, etc. ‖For women. ¶Formerly London Mechanic's institution and Birkbeck institution; mainly for evening and part-time studies. ♀Federation of *Central Technical college (1900; now City and Guilds engineering college), *Royal College of Science (1900) and Royal School of Mines. ♂Formerly King's College of Household and Social Science. □Formerly East London college "Formerly South-Eastern Agricultural college. ▲Comprising Institutes of Basic Medical Sciences, Cancer Research, Cardiology, Child Health, Dental Surgery, Dermatology, Diseases of the Chest, Laryngology and Otology, Neurology, Obstetrics and Gynaecology, Ophthalmology, Orthopaedics, Psychiatry (1924, as Maudsley hospital medical school), Urology; and Postgraduate Medical School of London (1934). +On separation from parent college. *Formerly London School of Medicine for Women. **Or, formerly, St. John's hall. ††Formerly Hackney and New college. ‡‡Formerly Wesleyan college.

the appointment in 1909 of yet another royal commission to review the whole position of the reconstituted university. Its drastic recommendations for replacing the loose federation by a closely articulated unitary organization were suspended by the outbreak of World War I. When in 1924 a governmental committee at length reconsidered the royal commission's report, a much more limited plan of reform was adopted. The principal changes effected in the revised statutes which came into force in 1929 were first, the creation of a new body, the court, with supreme authority in matters of finance which extended over the independent schools in respect of all public grants or benefactions; and secondly, the closer association of the schools with the central body, mainly through statutory representation on the senate, which remained the supreme governing body of the university in all academic matters. The court, with 15 (later 16) members, was composed of those representatives of the crown and the local authorities who had hitherto sat in the senate, together with 8 members appointed by the senate. The representation of other public bodies ceased. The essential features of the reconstitution of 1900—the federal principle and the dual system of internal and external degrees—were preserved. During the first half of the 20th century a great expansion of the teaching university took place. In 1900 there were 18 schools of the university and in 1902–03 it had 2,004 internal students. In 1952–53 it comprised 34 schools (of which 18 were nonmedical and 16 medical) and 10 university institutes, with 646 professors and readers; there were also 1,086 other recognized teachers. The internal students numbered 22,482 of whom 4,215 were in "institutions having recognized teachers" not organically connected with the university. All schools of the university engaged in undergraduate teaching also promote advanced study and research. A significant feature of the modem growth of the university has been the development, in supplementation of the main teaching work carried on in the schools, of central institutes directly administered through committees or councils responsible to the senate.

The external work of the university continued to expand after 1900. While the university still registered many technical college and private students, it was increasingly concerned on its external side with fostering the growth of university colleges (*q.v.*) both in the home country and in the colonial territories of the British commonwealth, providing them with advisory services and an examination and degree system during the period of their growth toward full and independent university status. The number of students registered for external degree and diploma examinations of the university in 1952–53 was 23,803.

The colleges and other institutions of the university are dispersed over a wide area, two (Royal Holloway college, near Staines, and Wye college, near Canterbury) being indeed outside London altogether. From 1836 to 1936 the university headquarters were housed by the government, from 1871 to 1900 in Burlington gardens, and later in part of the Imperial institute building at South Kensington. After 1910 the provision of a new headquarters on a central site became a major issue of policy. It was not, however, until 1927 that the university mas able to acquire, with the aid of a munificent gift of £400,000 from the Rockefeller foundation, a site of $11\frac{1}{2}$ ac. in Bloomsbury close to University college, on which it erected between 1931 and 1937 a monumental senate house and library to the designs of Charles Holden, the cost being met by gifts of more than £1,3013,000 from local authorities, City companies, business firms, banks and private donors. The Institutes of Education and Historical Research and the School of Slavonic and East European studies are in the same building. Space was also found on the site for the School of Oriental Studies, Birkbeck college and the university students' union.

In 1949–51 the university acquired, with the aid of the treasury and the London county council, further property covering $13\frac{1}{2}$ ac. adjoining the original site. It was thus able to establish a "university precinct." (W. D. H.)

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LONG, CRAWFORD WILLIAMSON (1815–1878), U.S. physician, who first used ether as an anesthetic in surgery, was born in Danielsville, Ga., on Nov. 1, 1815. He received an A.M. degree from Franklin college, Athens, Ga., in 1835 and then read medicine under George R. Grant at Jefferson, Ga. He matriculated at the medical department of Transylvania university, Lexington, Ky., and later transferred to the University of Pennsylvania, Philadelphia. After his graduation in 1839, he went to New York city to walk the hospitals, then returned to Jefferson, where he soon acquired an extensive practice.

Long's imagination was stirred by the observation that injuries were sustained without pain during "ether frolics." On March 30, 1842, Long painlessly removed a tumour from the neck of James Venable, to whom he administered ether. At first, credit was denied to Long, who, as a rural physician, had no opportunities to test his discovery during major operations and cautiously accumulated data to justify publication in 1849 in the *Southern Medical and Surgical Journal.* In the famous ether controversy Charles T. Jackson. Horace Wells and William T. G. Morton (*q.v.*) each claimed the discovery for himself and applied for a national reward from congress. Long claimed no money; he wanted only recognition of the fact that he discovered and used the anesthetic effect of ether in surgery for the first time. Wells, a Hartford, Conn., dentist, conceived the idea, independently of Long, of anesthesia during "laughing gas parties"; he introduced anesthesia for tooth extractions, using nitrous oxide gas, in 1844. Morton, Wells's friend and onetime partner, in 1846 gave the first public demonstration of ether anesthesia in surgery; but he borrowed the idea from Jackson, a chemist and geologist, whose own claim to priority rests on accidental self-observations without uitnesses.

Long emerges from all the evidence as the discoverer of ether anesthesia in surgery and as a figure justly aloof from the ethically questionable implications of this chapter of medical history. He died at Athens on June 16, 1878.

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LONG, HUEY PIERCE (1893–1935), U.S. political leader, u-as born on hug. 30, 1893, at Winnfield, La.. the son of a farmer. After public-school education and incomplete legal training at the University of Oklahoma. Norman, and Tulane university of Louisiana, New Orleans! he became a lawyer in 1915. Politically ambitious, he gained election to the Louisiana Railroad commission at age 25 and continued in that or similar posts for ten years. Winning the governorship in 1928 with heavy support from backwoods districts. he soon became nationally famous for his erratic and picturesque conduct as "the Kingfish," but his real importance lay in: (1) his assertion of a broad, positive role for the previously static state government (*e.g.*, a vast highway program); and (2) his gradual concentration of political power into an executive dictatorship unique in C.S. history. In 1930 he was elected Cnited States senator and as such appealed to a depression-shocked public with his fallacious but tempting Share-the-Wealth program ("every man a king"). Simultaneously harassing the Franklin D. Roosevelt administration and consolidating his absolutism in Louisiana, he was at the height of his power when, in 1935, he was assassinated in the Louisiana capitol by Carl Weiss, the son of one of his political enemies.

His brother EARL K. LONG (1895–1960), who thereafter dominated Louisiana politics, was governor three times (1939–40; 1948–52; 1956–60). Huey Long's son RUSSELL B. LONG (1918–) was elected U.S. senator from Louisiana in 1948 and was reelected in 1950 and 1956. (D. PR.; X.)

LONG, WALTER HUME LONG, 1ST VISCOUNT (1854–1924). English politician, was born at Bath July 13, 1854. Educated at Harrow and Christ Church. Oxford. he entered parliament in 1880 as Conservative member for North Wilts and sat in the house of commons till he was created a peer in 1921, though he changed his constituency several times. In March 1905 Long became chief secretary for Ireland. He was returned to parliament for a Dublin seat in the general election of 1906. In the first coalition ministry. 1915. he was president of the Local Government board and in the second coalition, 1916, colonial secretary. He was first lord of the admiralty, 1919–21, and mas created Viscount Long of Wraxall in 1921. He died Sept. 26, 1924, at Rood Ashton, Wilts.

LONG. A buyer or holder of securities is said to be "long" of the market or "long" of stock if he has more of a particular security than he has contracts to deliver. The longs are usually those who have bought expecting a rise in prices and are commonly included among those known as "bulls" (see STOCK EXCHANGE). The opposite term, "short," is applied to one who has contracted to deliver more of a certain security than he holds. The shorts are principally those who have "sold short" in anticipation of a drop in prices, in which event they will buy at the lower price for delivery. They are often included among those known as "bears."

LONG BEACH, a city of Los Angeles county. Calif., U.S., 20 mi. S. of Los Angeles, on San Pedro bay, is a tourist resort and an important industrial and commercial centre. Catalina Island is 23 mi. off the coast and the Palos Verdes hills lie to the west. The elevation ranges from 14.5 below sea level to 170 ft. above sea level. Long Beach completely surrounds the cities of Signal Hill and Lakewood, and the three cities, along with Catalina, form a unified school district. The site was once a portion of a Spanish land grant given to Manuel Nieto in 1784 which was divided among his five children as ranchos. Two of the latter, Los Xlamitos and Los Cerritos, which included most of modern Long Beach, passed into the hands of Abel Stearns and John Temple in the early 1840s. By 1882 both ranchos had been purchased by the Bixby family. William E. Willmore made the first attempt to found a town in 1882; after securing an option from Jotham Bixby on 4.000 ac.. he organized the American colony, but the plan collapsed in 1884. The Long Beach Land and Water company continued with the project and gave the seven miles of wide strand the name Long Beach. It was first incorporated in 1897.

Until 1921 Long Beach was a seaside resort with a largely transient population. Harbour development was made possible by the acts of 1911 and 1925 by which the state granted to the city the bordering tidelands and submerged lands. Bond issues and revenue from oil and gas provided funds to develop an excellent man-made harbour. The discovery of oil in 1921 at Signal Hill resulted in increased industrial activity and a spectacular leap in population. After 1937 the city was plagued with litigation and legislation over the revenue accruing from the tideland reserves u-here the removal of oil and gas also produced the serious problem of subsidence.

In March 1933, Long Beach suffered a destructive earthquake: after which a widespread building program was inaugurated. During World War II a naval base (now a shipyard) was established there. Douglas Aircraft corporation built and progressively expanded a plant, which at peak production employed 30.000 workers. In nearby Seal Beach and Los Alamitos, a naval ammunition and net depot and air base were opened and continue to operate. A naval hospital was also erected. which became a veterans administration hospital. A modified council-manager form of government. with some aspects of the commission type. was adopted in 1921. Gas and water utilities are municipally owned.

The port of Long Beach has modern facilities, used by about 1,700 ships annually. and can berth 30 vessels at one time. After World War II most of the commerce was with Japan, and the principal export was petroleum. Long Beach and Los Angeles harbours are connected by Cerritos channel: Fisheries are important, and thousands of tons of fish are processed in local canneries. Freeways serve the port and the city. Diversified industries include automobile assembling and the manufacture of oil-drilling equipment. aircraft. soap an. toiletries. chemicals. paints, furniture, clothing, furnaces and heaters. ceramics and glass, paper, plastics, and building and insulation products.

The great inundation of population after World War II produced grave educational problems, and it became necessary to double the capacity of the public schools. Long Beach City college '(established 1927) is one of the largest two-year colleges in the nation; Long Beach State college (1949) has an enrollment of about 10.000. The city supports an art centre, an extensive library system, a symphony orchestra. a municipal band, a light opera association and community playhouses. It also maintains parks, municipal golf courses, a stadium. a marine stadium and the modern marina (1,250 ac.) for private ocean-going craft. The annual "Miss International Beauty" pageant gained international publicity for the city. Pop. (1960) 343,168. (H. P. Jo.)

LONG BEACH, a resort and residential city in Nassau county on Long Island. N.Y., U.S. Henry Hudson's log from the "Half Moon" reported in 1609 a "long glistening bar of exceptionally white sand" off the westerly. southern shore of the island. More than 200 years later the name Long Beach was given to this 7-mi. sand bar approximately 6 mi. from the New Tork city line. The white sandy beach, one of the few on the east coast which faces directly south off the Atlantic ocean, was ideally situated for New York vacationists. In 1880 the Long Beach hotel was constructed. In the early 20th century it was developed into a thriving resort where many prominent citizens maintained summer residences. However, after the 1930s Long Beach attracted an increasing number of permanent residents, so that its character as a community became more suburban. For comparative population figures see table in NEW YORK: Population. (WI. M D.)

LONGBENTON, an urban district (1935) in the Wallsend parliamentary division of Northumberland, Eng., adjoining the northeastern boundary of Newcastle upon Tyne for which it is a residential area. Pop. (1951) 25.066. Area 10.6 sq mi. The church of St. Bartholomew, originally built in the 12th century, stands between Longbenton and Killingworth. Thomas Addison, the physician, was born at Longbenton in 1793 and George Stephenson (*q.v.*) the inventor of the locomotive, was at one time the engineer at Killingworth colliery and his house is still preserved. In the 17th century the Newcastle races were run on Killingworth moor, later known as the district of Forest Hall and West Moor. The knights hospitallers also held land in Killingworth which was granted to them after 1308. Other than agriculture. the principal industry, for about 200 years, has been coal mining.

LONG BRANCH, a city of Monmouth county, N.J., U.S.. is located on the Atlantic coast, 45 mi. S. of New York. For years it uas knonn as one of the oldest summer resorts, but with the growth of the garment and electrical industries in the 20th century, it gradually became an all-year residential community. Fishing and truck farming are also significant. Its name stems from the fact that it borders on the eastern or long branch of the South Shrewsbury river.

The first village was established at West Long Branch, one mile from the shore. The section nearer the beach developed later, when there was a regular line of stages from Philadelphia and a steamboat service from New York. In 1860 the first railroad arrived. In the late 19th and early 20th centuries people visited the resort, including the presidents U. S. Grant, Rutherford B. Hayes. Benjamin Harrison and Woodrow Wilson. Pres James A. Garfield, after he was shot in Washington, D.C., was brought to his Long Branch summer cottage, where he died in 1881. The city was chartered in 1904 and includes the communities of Elberon, North Long Branch and West End. For comparative population figures see table in NEW JERSEY: *Population.* (H. F. WI.)

LONGCHAMP, WILLIAM (d. 1197), chancellor of England and bishop of Ely, entered public life at the close of Henry II's reign as official to the king's son Geoffrey, for the archdeaconry of Rouen. Henry II. nho disliked him, called him the "son of two traitors." He soon deserted Geotirey for Richard, who made him chancellor of the duchy of Aquitaine. As Richard's envoy, in Paris, he defeated Henry II's attempt to make peace with Philip Augustus (1189). On Richard's accession William became chancellor of the kingdom and bishop of Ely. When Richard left England (Dec 1189), he put the tower of London in his hands and chose him to share with Hugh de Puiset, the great bishop of Durham, the office of chief justiciar. William immediately quarrelled with Hugh and by April 1190 had ousted him from office. In June 1190 he received a commission as legate from Pope Celestine.

John returned to England in 1191; he and his adherents were immediately involved in disputes with William. At last (June 1191) Geoffrey, archbishop of York and William's earliest benefactor, was violently arrested by William's subordinates on landing at Dover. They exceeded their orders, which were to prevent the archbishop from entering England until he had sworn fealty to Richard. This outrage was made a pretext lor a general rising against William, whose legatine commission had now expired, and whose power was balanced bv the presence of the archbishop of Rouen. Walter Coutances, uith a commission from the king William shut himself up in the Tower, but he was forced to surrender his castles and expelled from the kingdom. In 1193 he joined Richard in Germany. Richard employed Longchamp in confidential and diplomatic missions in Germany, in France and at Rome. He died in Jan. 1197.

LONG EATON, an urban district in the South East Derbyshire parliamentary division of Derbyshire, Eng., 10 mi. E.S.E. of Derby and 8 mi. S.W. of Nottingham by road, on the Erewash canal between the Erewash and the Trent. Pop. (1951) 28,641. Area 5.6 sq.mi. The church of St. Laurence, with a Norman south aisle, stands in the market place. Trent college, a boys' boarding school, was founded in 1866. Long Eaton is a modern industrial town with straight, wide roads. Formerly a centre of the lace-making trade. among its varied industries now are upholstery and furniture. pianos, elastic goods, food and chemicals.

LONGEVITY, or length of days, is the prolongation of life to or beyond the standard duration. Generally speaking there is a rough correspondence between the bodily bulk and the span of life; thus the imagines of ephemerids or dayflies after an hour or two of "aerial life devoted to love" die, whereas the tortoise may survive for one or even two centuries; but this relation is not absolute, parrots, ravens, and geese live longer than many larger birds and than most mammals (Mitchell); some fish, such as salmon (100 years), carp (150) and pike (200), have a longevity contrasting with the 30 years of horses. Trees are constructed on an entirely different plan from that underlying the complex higher animals, and are thus endowed with a kind of potential immortality. The section of the trunk of a mammoth tree (Sequoia gigantea) in the Natural History Museum, South Kensington, showing 1,335 rings, might have been as many years old.

Death, the termination of life, is avoided in the protozoa by the division of the individual into two, which thus start afresh, so that, as Weismann long ago argued, the organism is immortal. But in the higher grades of the animal kingdom such rejuvenation is impossible, and the processes of senescence and death must be regarded as the penalty to be paid for their higher differentiation; they are dependent for their term of life on an inherited physico-chemical constitution, and are thus. like a clock, set for a definite period. After the time of Aristotle, the vital cycle has been thought to be a multiple of the period of growth; Francis Bacon considered that as a rule animals should live eight times, Flourens five times, as long as they take to reach maturity; in the case of man both Buffon and Flourens, though on rather different grounds, estimated that 100 years is the physiological duration of life, and this has been widely accepted, in spite of the psalmist's "three score years and ten," with perhaps a sorrowful extension to four score.

In more modern times the number of reputed centenarians has been shown by critical enquiry to be much in excess of the real figure, and that the ages popularly ascribed to Henry Jenkins (169), Thomas Parr (152), Katherine, Countess of Desmond (140), and many of the 1,712 centenarians in James Easton's list covering the years A.D. 66 to 1799 cannot be accepted as authentic. Fallacies easily creep in and memories and records fail; thus in the census of 1911 the excess of persons alive over 91 and the deficit of those between 85 and 90 could only be explained by exaggeration of their age by old people.

It is desirable to distinguish clearly between the concept of the life span and that of the average length of life. The former term is best reserved to denote the extreme limit of life characteristic of the species, say a little more than 100 years in the case of man. On the other hand, the term average length of life is applied to a figure computed from a life table; it measures the average number of years lived by the individuals of a large cohort of persons passing from birth to death in accordance with the mortality exhibited in the life table. The average length of life, so defined, is also often spoken of as the expectation of life at birth. Similarly, the average number of years lived beyond a given age, such as age 30 for example, is called the expectation of life at that age. While the life span has probably changed little, if at all, in all historic time, the average length of life has been greatly extended, especially in modern times. So, *e.g.*, the average length of life, as given by the registrar-general for England and Wales in 1838–54, was 39.91 years for males and 41.85 years for females; by 1937, the latest year for which a life table is available (1947), the corresponding figures were 60.18 and 64.40 years. The expectation of life at later ages, that is to say the average after-lifetime; also shows improvement; thus in 1854, males at the age of 60 had an expectation of 13.53 years, females an expectation of 14.34 years. The corresponding figures for 1937 were 14.32 and 16.48 years. In the United States, the expectation of life at birth for both sexes combined in the white population in 1901 was 48.23 for males and 51.08 for females; by 1944, these figures had risen to 63.55 and 68.95 years respectively. The gain has been chiefly in the childhood ages. It is due in large part to the success gained in the treatment, and even more in the prevention, of infectious diseases. The diseases characteristic of middle life and advanced age—the so-called degenerative diseases, especially those associated with hardening of the arteries—have so far yielded little to efforts of control.

Presumably if all were placed under similar environmental circumstances, there would be certain racial differences in longevity. This statement is hardly capable of definite test, since the more outstanding racial differences in different parts of the world cannot be separated from accompanying environmental differences. As to sex differences, in all civilized countries females have a lower mortality than males at most ages of life. Figures for the last census year, 1940, in the United States show that if deaths from causes connected with childbirth are excluded, the difference in favour. of female mortality extends to all ages of life. An interesting observation by Graham Bell, in his analysis of the Hyde genealogy, dealing with 8.972 persons and dating from the 17th century, shows that, in this group at least, the proportion of those living long increased with size of family up to families containing nine and ten children, and then fell in the case of still larger families. It also appeared that the first born lived as long as subsequent children, and that children born between four and eight years after their parents' marriage were on the average longer lived than those born earlier or later.

Heredity.—The two great factors influencing the length of life are heredity and environment in its broadest sense; for obvious reasons it is impossible to disentangle them and ascertain what share each of these two factors contributes. That longevity well beyond the average tends to run in families seems to be well established. To this topic an important contribution has been made by the late Raymond Pearl in a book under joint authorship with his daughter, Ruth DeWitt Pearl, entitled *The Ancestry of the Long-Lived.* A most striking example of apparently hereditary longevity quoted by these authors is that of a group of seven persons, grandparents, parents and son, whose aggregate age at death was no less than 699 years; at that, two of them died by accident. Another significant investigation of inheritance of longevity, conducted on the basis of records of insurance companies by Louis I. Dublin and Herbert Marks, showed very clearly how longevity of parents favourably influences the longevity of offspring.

Inborn vitality may counteract the evil influences of unhealthy environment and bad habits, such as overcrowding in towns and alcoholism, and so explain the occasional longevity of those who have lived in most unfavourable circumstances; *e.g.*, the contrast between two aged brothers, one a confirmed toper, the other a total abstainer. Of the hereditary factors innate vitality of the nervous and the circulatory systems are the most important; the nervous system decides the mental disposition and the reactions of the body as a whole. Cazalis' aphorism "Man is as old as his arteries" expresses the advantage of possessing a circulatory system which does not degenerate readily, harden into the condition of arteriosclerosis, or show an excessive blood pressure; for it is well known that the members of some families tend to die about the age of 60 from apoplexy, heart or kidney disease, the latter being often the result of arterial disease in the kidneys.

Environment.—One way in which environmental conditions affect longevity is through diseases contracted in the course of life. It has been stated that only those who have escaped illness up to the age of 60 years are likely to reach extreme old age, but nearly half of the 824 persons between the ages 80 and 100, analysed by Sir George Humphry, had passed through a severe illness, in many of them an acute infection. An acute illness may be the apparent starting point of old age and senescence, especially if sufficient time for convalescence is not allowed. It has been suggested that the deteriorating influence of malaria on individuals may, by its mass effect, account, in some degree at any rate, for the decadence of Magna, Graecia (W. H. S. Jones). Functional activity, mental and bodily, plays an important part in postponing the advent of morbid old age, and there is more danger of rusting out than of wearing out, provided the body is healthy and the mind free from worry. The advanced ages of many dignitaries of the Church and the bench and of prime ministers, though many of these may be supermen, point to the beneficial influence of long-continued activity. Among painters Giovanni Bellini, Michelangelo, and Sidney Cooper worked up to nearly their death, and Titian was painting with "incomparable steadiness of hand" when cut off by the plague at the age of 99. The same retention of productivity was seen in Voltaire, Littré, Anatole France, Goethe, von Ranke, and Frederick Harrison. The members of the Académie Française are long-lived, and thus doubly justify their title of "the immortals." Retirement, often looked forward to in early life, is a source of danger, as it may bring with it cessation from activity.

The majority of centenarians have been small eaters, and several aphorisms point to the evil, if slow, effect of being a good trencherman, such as Montaigne's "Man does not die, he kills himself" and the forcible proverb "You dig your grave with your teeth." Overfeeding by overworking the resources of the body leads to metabolic disease, such as diabetes mellitus. and to arterial, heart and kidney affections, which are preceded often by long periods of latency during which the individual flatters himself on his vigour, but in which his arterial blood pressure is unduly high. During World War I it was observed that in certain countries the death rate from diabetes was reduced. and this has been attributed to dietary curtailment. Poverty, within limits, is an advantage inasmuch as it removes the dangers of excessive eating, particularly of meat, after the body has reached maturity. The beneficial effects of a meagre dietary were set forth by the noble Venetian Luigi Cornaro (1467–1566), by Metchnikoff, Henry Thompson the surgeon, Hermann Weber, and many others who practised their own precepts. With regard to the influence of alcohol there can be no doubt, as the actuarial reports of life assurance companies amply prove, that excess is harmful.

It is true that Raymond Pearl's statistical enquiry into over 5,000 lives at Baltimore showed that "a moderate use of alcohol does not tend to shorten life." But what constitutes moderation is open to question.

Prolongation of life towards its limits may be healthy or attended by morbid manifestations. Healthy or normal old age is attended by diminution in functional activity which corresponds with the characteristic changes of atrophy and involution in the structure of organs and tissues and of a diminished area of the capillary blood vessels. With the waning of sexual power the mind becomes calmer and more philosophic, so that the limitations of activity are more cheerfully accepted; but fatigue is more readily produced, memory, especially for names, becomes less agile, and will power, like the gait, becomes less certain. The mental outlook is largely determined by that of the individual in the past, happy and kindly, or pessimistic and uncharitable. Often there is a tendency to ego-centricity and to nervous apprehension, as the preacher (Koheleth) in Ecclesiastes said "Fears shall be in the way." It may be pointed out that the glands of internal secretion become old with the rest of the body, not that their atrophy causes old age. For it has been thought that senescence results from failure of the thyroid, and especially of the interstitial cells of the testes, and experiments and operations by Steinach and Voronoff to supplement this want have been followed by dramatic, if temporary, rejuvenation, which in animals at least cannot be explained by suggestion; but that life is thus prolonged as well as being made to burn more brightly remains to be proved in the case of man.

It is hard to draw a sharp line of demarcation between normal old age (senescence), with its limitations due to atrophic changes in the body, on the one hand, and on the other hand the manifestations in the elderly resulting from past infections and diseases (senility). Physiological old age, that is freedom from any pathological change, is agreed to be rare, and it has been said by Terence, Cicero, Sanctorius, and often since that old age is itself a disease.

Eli Metchnikoff attributed the senile accompaniments of advanced years to pathological and preventable causes, especially poisons produced by bacteria in the large intestine, these toxins causing degeneration of the bodily cells which are eaten up by more resistant cells called macrophages; this hypothesis has been much discussed.

That disease may produce the picture of morbid old age prematurely is well established, and in the remarkable but rare condition of progeria this occurs in childhood. The various parts of the body do not all grow old at the same time. but when these changes are much more advanced in a vital organ, especially the brain, than elsewhere, the proper harmony of the system is so disturbed that the condition becomes pathological, and then instead of a happy, healthy and pleasant old age there is the picture of incapacity, pain and misery so that existence becomes a burden to the individual and to his family.

Some diseases are especially prone to attack the aged, though they are not entirely confined to the evening of life. The chief diseases mainly concentrated in later life are diabetes, cancer and the cardiovascular-renal group. This last is closely related to arteriosclerosis which may affect various parts of the body, such as the kidneys, the brain and the heart.

The acute fevers, such as measles, typhoid, scarlet fever and diphtheria, rarely attack the old, probably because immunity has gradually been acquired, but pneumonia and erysipelas are exceptions to this rule, and pneumonia, with but few symptoms, often proves to be the last straw in breaking the feeble thread of existence.

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LONGFELLOW, HENRY **WADSWORTH** (1807–1882), the most popular of U.S. poets in the 19th century, was born in Portland, Me., on Feb. 27. On both sides of the family he came from Yorkshire stock. His mother. Zilpah Wadsworth, was the daughter of a general in the American Revolution, who traced his ancestry back to the Plymouth Pilgrims. His paternal ancestor, a blacksmith, settled in Byfield, Mass., in 1680. His early education was in private schools and in the Portland academy. He entered Bowdoin college as a sophomore and graduated in the class of 1825 with Nathaniel Hawthorne. At college he studied unremittingly to fit himself for a literary career. He was attracted especially to Sir Walter Scott's romances and Washington Irving's *The Sketch Book*. While an undergraduate he published verses in national magazines. His father wanted him to enter his law office, but the future poet wrote, "I most eagerly aspire after future eminence in literature." During his junior year he had so deeply impressed a college trustee by the fluency with which he translated an ode of Horace that on graduation he was offered a professorship in modern languages provided that he would first study in Europe.

On the continent he learned French, Spanish and Italian, but refused to settle down to a regimen of scholarship at any university. In 1829 he returned to the U.S. to be a professor and librarian at Bowdoin. There he proved himself an excellent teacher. He wrote and edited textbooks, translated poetry and prose, and wrote essays on French, Spanish and Italian literature.

He felt himself somewhat too isolated at Bowdoin, so when he was offered a professorship at Harvard, with the hint of another opportunity to go abroad, he gladly accepted and set forth for Germany in 183j. Before settling down he visited England, Sweden and the Low Countries. Saddened by the death of his wife in 1835 he ceased his wandering and settled at Heidelberg where he fell under the influence of German Romanticism. The transcendental quality of such poetry as in Novalis' "Hymns to the Night" induced in him an introspective mood.

In Oct. 1836 he sailed for home and returned to Harvard. Meanwhile he had published a book of travel sketches, *Outre-Mer*, vignettes of life in France, Spain and Italy, written under the influence of Irving's *Sketch Book*. He lacked Irving's sense of humour and capacity for creating character and the book did not succeed. In 1839 he published *Voices of the Night*, a volume containing "The Psalm of Life" and "The Light of the Stars"—poems that became immediately popular. Early in the same year he brought out *Hyperion*, a romantic novel idealizing his European travels.

For 18 years he presided successfully over Harvard's modern language program, but his "poetic dreams were shaded by French irregular verbs," and he longed for freedom. The poet in him was kept alive by his work as a translator. In 1841 his *Ballads and Other Poems*, containing "The Wreck of the Hesperus," came out and swept the nation. In 1854 he left teaching and entered upon his long-cherished dream of building "some tower of song with lofty parapet." While this major ambition was maturing he wrote a few *Poems on Slavery* (1842), finished productions which lacked, however, the power of John Greenleaf Whittier's Hebraic denunciations. He was more at home in *Evangeline*, an idyll of Acadia skillfully written in dactylic hexameters, which reached almost every literate home in the U.S.

The Song of Hiawatha, published in 1855, proved another popular success. With Henry Rowe Schoolcraft's two books on the Indian tribes of North America as the base, and the trochaic metrics of the Finnish epic *Kalevala* as his medium, he fashioned one of his most artistic productions. Its appeal was immediate. In 1858 he wrote *The Courtship of Miles Standish* in the "Evangeline" measure. The material is less idyllic than that of the earlier story, but the metrics are enriched by a more varied accent.

The death in 1861 of his second wife, who died of burns after she had accidentally set her dress on fire while sealing packages, deepened his melancholy (cf. "Cross of Snow," 1879). Her death drove him for spiritual relief into translating that "Medieval miracle of song," the *Divine Comedy of Dante Alighieri*, one of the most notable translations of the Florentine to that time. While engaged in this work he wrote six sonnets on Dante which are among his finest productions.

The *Tales of a Wayside Inn*, modeled roughly on the plan of Geoffrey Chaucer's *Canterbury Tales* and published in 1863, reveals his marked narrative gift. The first poem, "Paul Revere's Ride," became a national favorite. He published in 1872 what was intended to be his masterpiece, the *Christus: A Mystery*, a trilogy dealing with the subject of Christianity from its beginning, and followed this trilogy with two fragmentary dramatic poems: "Judas Maccabaeus" and "Michael Angelo." But his genius was not dramatic, as he had demonstrated earlier in *The Spanish Student* (1843), although it should be noted that these neglected later works contain some of his most effective writing.

In the 19th century Longfellow was loved and honoured at home and abroad. Oxford conferred upon him a D.C.L. and Cambridge an LL.D. in 1868. After his death March 24, 1882, a memorial to him was unveiled in Westminster abbey. Some years after his death a violent reaction against his poetry set in. Critics who had put the Romantic movement behind them and who deplored his sometimes heavy-handed didacticism appeared to take pleasure in reducing him to the status of a hearthside rhymer. This harsh dismissal was somewhat unfair. His poetry is still loved by the unpretentious, and such poems as "My Lost Youth" transcend the metrical scaffolding on which they are erected. His poetry rarely touches greatness; he does not produce the "martial music" of John Milton or Homer, but good singing poetry can be found throughout his work.

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LONGFORD, a county of Ireland, bounded northwest by Leitrim, northeast by Cavan, southeast and south by Westmeath and west by Loughrea and Roscommon. The land area is 257,936 ac., or 403 sq.mi. Pop. (1956) 32,969.

The Silurian axis of Newry reaches the north of the county, where Lough Gowna lies upon it. Anticlinals bring up Old Red Sandstone at Longford town and Ardagh, above the Carboniferous limestone plain, in which Lough Ree forms a characteristic lake, with signs of extension by solution along its shores. Marble of fine quality has been quarried. In the north indications of iron are abundant, and there are also traces of lead, The principal rivers are the Camlin, which rises near Granard and flows past Longford to the Shannon, and the Inny, which enters the county from Westmeath, crosses its southern corner and falls into Lough Ree. Lough Ree is partly included in Longford. The other principal lakes are Derrylough and Loughs Gowna, Drum and Bannow.

The early name of Longford was Annaly or Analé, a principality of the O'Farrells. Then included in Meath, it was granted by Henry II to Hugh de Lacy, who started an English colony. On the division of Meath into two counties in 1543, Annaly was included in Westmeath, but in 1569 it was made shire ground under the name of Longford.

The chief rath is called the Moat of Granard. There are monastic remains at Ardagh, a former bishopric, Longford, Moydow and on several of the islands of Lough Ree. The principal castles are those of Rathcline near Lanesborough, and Ballymahon on the Inny. Oliver Goldsmith spent his early childhood at Pallas, a village near Ballymahon, in this county; and at Edgeworthstown (now called Mostrim) lived the family of Maria Edgeworth.

The climate is moist and cold, and there is much marsh and bog. The soil in the southern districts resting on the limestone is a deep loam well-adapted for pasture, but in the north it is often poor. Oats and potatoes are the principal crops. The railway from Mullingar to Sligo crosses the county by way of the county town of Longford; and the Cavan branch touches the extreme east.

The Royal canal enters the county in the south at Abbeyshrule, and joins the Shannon near Cloondara. The constituency of Longford-Westmeath returns five members to *dail eireann.*

LONGFORD, the county town of County Longford, Ireland, on the Camlin river, 76 mi. W.N.W. of Dublin. Pop. (1956) 3,716. The principal building is St. Mel's Roman Catholic cathedral for the diocese of Ardagh and Clonmacnoise, which includes nearly all Longford, most of Leitrim and parts of Offaly, Nestmeath, Roscommon, Sligo and Cavan. Trade is in grain, butter and bacon. There are corn mills, a spool factory and tanneries. The ancient name of the town was Athfada, and there a monastery is said to have been founded by St. Idus, a disciple of Patrick.

LONGHI, ALESSANDRO (1733–1813), Italian painter, etcher and biographer of Venetian artists. the most important Venetian portrait painter of his day, son of Pietro Longhi (*q.v.*), was born and died at Venice. His father gave him his first training but quite soon put him to study under the Rembrandtesque painter of portraits and fancy subjects, Giuseppe Nogari. In 1759 he was elected a member of the Venetian academy, for which he painted one of his rare subject pictures, the allegorical "Painting and Merit." In 1762 Longhi issued his book *Compendio delle Vite de' Pittori Veneziani Istorici piu rinomati del presente secolo con sui ritratti dal naturale delineati ed indisi,* one of the most important source books for the history of Venetian 18th-century painting. Both portraits and text were printed from plates he etched. In addition, he etched some of his own and some of his father's works. His work is best seen at Venice. (F. J. B. W.)

LONGHI, PIETRO (PIETRO FALCA) (1702–1785), Italian painter of small scenes of Venetian social and domestic life, was the son of a silversmith in whose workshop he received his first training. Later he worked under the Veronese history painter Antonio Balestra, but his one important work of this sort, the monumental ceiling of the "Fall of the Giants," executed in 1734 for the Palazzo Sagredo, was a complete failure. It is likely that it was because of this that he left Venice for a time and studied at Bologna under Giuseppe Maria Crespi. After his return to Venice he devoted himself to painting somewhat in the manner of Nicolas Lancret but more satirical. He also painted occasional portraits. Longhi was also undoubtedly influenced by Dutch *genre* painting, of which there was at least one important collection in Venice at that date. His paintings, like those of Antoine Watteau, were based on carefully observed figure drawings, a large number of which survive. Many of his paintings were engraved. He was elected to the Venetian academy at its foundation in 1756 and died in Venice on May 8, 1785. His works are best seen at Venice, though there are a few in London. (F. J. B. W.; X.)

LONGINUS, CASSIUS (*c.* A.D. 213–273), Greek rhetorician and philosophical critic, surnamed PHILOLOGUS. The origin of his gentile name Cassius is unknown; it can only be conjectured that he adopted it from a Roman patron. He was perhaps a native of Emesa (Homs) in Syria, the birthplace of his uncle Fronto the rhetorician. He studied at Alexandria under Origen the heathen, and taught for 30 years at Athens. Longinus upheld, in opposition to Plotinus, the doctrine that the Platonic ideas existed outside the divine *nous* (*see* NEOPLATONISM). Plotinus, after reading his treatise *On First Principles,* remarked that Longinus might be a scholar, but that he was no philosopher. The reputation which Longinus acquired by his learning was immense; he is described by Porphyry as "the first of critics," and by Eunapius as "a living library and a walking museum" or encyclopaedia.

During a visit to the east he became teacher in Greek, and subsequently chief counsellor in state affairs, to Zenobia, queen of Palmyra. It was by his advice that she endeavoured to regain her independence; Aurelian, however, crushed the attempt, and while Zenobia was led captive to Rome to grace Aurelian's triumph, Longinus paid the forfeit of his life.

Longinus was the author of a large number of works, nearly all of which have perished. Among those mentioned by Suïdas are *Quaestiones Homericae, An Homerus fuerit philosophus, Problemata Homeri et solutiones, Atticorum vocabulorum editiones duae;* the most important of his philological works, *Philological Discourses,* consisting of at least 21 books, is omitted. A considerable fragment of the *De finibus, On the Chief End,* is preserved in the *Life of Plotinus* by Porphyry. Under his name there are also extant Prolegomena to the *Encheiridion* of Hephaestion on metre and the fragment of a treatise on rhetoric inserted in the middle of a similar treatise by Apsines. It gives brief practical hints on invention, arrangement, style, memory and other things useful to the student.

It is as the reputed author of the well-known and remarkable work generally, but inadequately, rendered *On the Sublime* that Longinus is best known. Modern scholars, however, with few exceptions, are agreed that it can not with any certainty be ascribed to him, and that the question of authorship can not be determined.

The alternative author, Dionysius, of the manuscript has been variously identified with the rhetorician and historian Dionysius of Halicarnassus, the Atticist Aelius Dionysius of Halicarnassus, Dionysius Atticus of Pergamum, Dionysius of Miletus. W. R.

Roberts concluded on an unidentified Greek man of letters who probably lived at Rome not more than 30 or 40 years after the birth of Christ. Wilamowitz-Möllendorff also gives his date as about A.D. 40. The rendering On *the* Sublime implies more than is intended by the original Greek ("impressiveness in style," R. C. Jebb). Nothing abnormal, such as is associated with the word "sublime," is the subject of discussion; it is rather a treatise on style. According to the author's own definitions, "sublimity is a certain distinction and excellence in expression," "sublimity consists in elevation," "sublimity is the echo (or expression) of a great soul." The treatise is especially valuable for the numerous quotations from classical authors.

"Its main object is to point out the .essential elements of an impressive style which, avoiding all tumidity, puerility, affectation and bad taste, finds its inspiration in grandeur of thought and intensity of feeling, and its expression in nobility of diction and in skilfully ordered composition" (J. E. Sandys).

A full bibliography of this subject will be found in the edition by W. Rhys Roberts (2nd ed. 1909), with introduction, analysis, translation and appendices. *See* also W. R. Roberts' introduction to *Demetrius on Style* in *Aristotle: the Poetics* (ed. with Eng. trans. by W. Hamilton Fyfe, 1927); F. Marx, *Wiener Studien* (xx, 1898) and F. Kaikel, *Hermes* (xxxiv, 1899), who respectively advocate and reject the claims of Longinus, and J. E. Sandys, *History of Classical Scholarship* (2nd ed. 1906). The number of translations in all the languages of Europe is large, including the famous one by Boileau. A text and translation was published by A. O. Prickard (1907–08).

LONG ISLAND, a fragment of the North American continent extending 118 mi. E.N.E. from the mouth of the Hudson river on the northeastern shore of the United States. It roughly parallels the south shore of Connecticut from which it is separated by Long Island sound (go mi. long) and lies southeast of the mainland of New York state, of which it is a part.

The island is from 12 to 23 mi. wide and has an area of 1,723 sq.mi. The east end is divided into two narrow peninsulas by three bays, Great Peconic, Little Peconic (in which lies Shelter Island) and Gardiners (in which lies Gardiners Island). The northern peninsula, about 25 mi. long, culminates in Orient point; the southern peninsula, about 40 mi. long, ends in Montauk point, the eastern extremity of the island. The north shore of the island is broken in its western half by Flushing bay, Little Neck bay, Manhasset bay, Cold Spring harbor, Huntington bay, Smithtown bay and Port Jefferson. The south shore has Jamaica bay, with many low islands and nearly cut off from the ocean by the narrow spit of Rockaway beach; and the ill-defined Great South bay, which is separated from the Atlantic by the narrow Long beach, Jones beach and Oak Island beach and by the long peninsula called Fire Island or Great South beach. Still farther east is Shinnecock bay, about 10 mi. long and cut off from the ocean by a narrow beach.

Physiography, climate and location have combined to make Long Island one of the richest and most important garden spots in the United States. The hills of glacial moraine and much of the outwash plains of the southern half of the island, covered for centuries with forest mold, offer a rich soil to the husbandman. A mild maritime climate brings the spring earlier and holds the autumn later than in the continental interior at the same latitude.

History.—When the Europeans first settled on Long Island, they found the area occupied by Indians who were generally of Delaware stock and who, according to early accounts, were divided into a number of small groups, loosely called tribes. There were supposedly at least 13 of these major groups and there may have been more. As part of the Atlantic coast line claimed by England, the island was part of the territory originally included under the jurisdiction of the Plymouth company in the early 1600s and later in 1635 its title was presumably conveyed to the earl of Stirling (Sir William Alexander) by Charles I. The earl's agent, James Farret, was sent to the area and conveyed land titles to groups of individuals between 1635 and 1640.

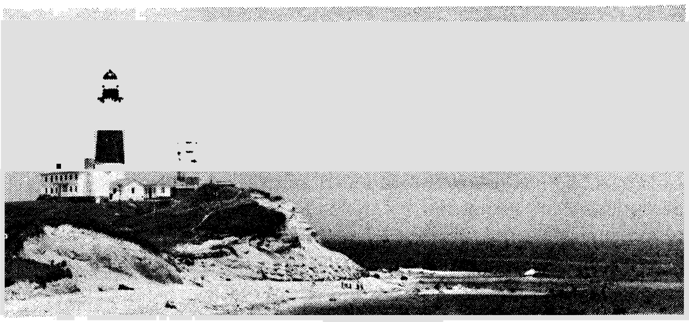
Dutch interest in this part of the new world had been aroused by the voyage of Henry Hudson in 1609 and resulted in the Dutch West India company setting up a trading post on Manhattan Island in 1624. Long Island was part of the territory claimed by the company even though it conflicted with English claims to the same area. There is some evidence of settlement in the extreme western part as early as 1625; certainly Dutch settlers crossed the East river in the mid-1630s and located in what is now Kings county. Breuckelen (Brooklyn), Amersfort (Flatlands), Midwout (Flatbush), and Nieuw Utrecht (New Utrecht) were Dutch communities established under the authority of the company from 1636 to 1660.

In 1640 Englishmen from Lynn, Mass.. under a Stirling patent, attempted to settle near Manhasset bay but were warned anay by Gov. William Kieft of New Netherland, who would not admit the validity of the English claim. Later that year these people settled at Southampton, toward the eastern end of the island; at about the same time a group from New Haven located at Southold, a little to the north. These two settlements together with the Gardiner family on Gardiners Island (1639) were the first English groups on the Long Island scene. Another band of English settlers obtained a patent from Governor Kieft in 1644 to found Hempstead under the Charter of Freedoms and Exemptions. Other English towns, Gravesend (1645), Flushing (1645), Newtown (1655), and Jamaica (1656), were set up in similar fashion with the inhabitants swearing allegiance to the Dutch authorities. By the treaty of Hartford of 1650 between New Netherland and the United Colonies of New England, a demarcation line was drawn from Oyster bay to the ocean, recognizing the island as Dutch to the west and English to the east.

In March 1664 Long Island was part of the area given to the duke of York by Charles II and in August the conquest of New Amsterdam and the Dutch territory was effected. By this time the English settlements in the eastern part of the island had associated themselves generally with either New Haven or Connecticut, the latter making some claim to the Long Island area by its charter of 1662. Besides Southampton and Southold, the eastern towns included East Hampton (1648), Shelter Island (1652), Huntington (1653), Oyster Bay (1653), Brookhaven (1655) and Smithtown (1663).

Long Island, together with Westchester and Staten Island, became known as Yorkshire and was governed by the Duke's Laws promulgated at Hempstead in March 1665. In 1683, Yorkshire was abolished and the county system introduced in the province with Long Island receiving three of the original counties—Suffolk, Queens and Kings. A major political change occurred in 1899, when the three eastern towns of Queens county—Hempstead, North Hempstead and Oyster Bay—formed the new Nassau county and the other towns in Queens became part of New York city. The p[illegible] of the American Revolution saw Long Island a hotbed of [illegible] vity on the [illegible] t of both Loyalist and Patriot, and its coastal area was the scene of raids by privateers and organized military units For the entire period [illegible] f the British [illegible] upati[illegible] of New York city, Long Island was the major source of supplies of wood a[illegible]d food, [illegible] d its western area was continuously occupied [illegible]y detachments of British troops.

Industries.—During the 19th century Long Island was chiefly known for it[illegible] agriculture and its fishing industry. Manufacturing was present in the metropolitan area of King[illegible] cou[illegible]ty and to a certain extent in some th[illegible] regions. Lonr Island agriculture of the 17th and 18th centuries was characterized by the self-sufficient farm. Toward t[illegible] end [illegible] f the 18th century some farmers began selling their surplus crops in New York. Connection with this



BY COURTESY OF NEW YORK STATE DEPARTMENT OF COMMERCE

MONTAUK POINT LIGHTHOUSE AT THE EASTERNMOST TIP OF LONG ISLAND market was made by wagons from the farms at the western end of the island and by small coasting boats from the homesteads of the north shore. Two events in the first half of the 19th century established Long Island agriculture on its modern basis. In 1825, the completion of the Erie canal gave New York city a connection with the continental interior and allowed a swift development which made it the metropolis of North America. In 1844 the Long Island railroad was completed to Greenport. The growth of New Uork and the completion of the railroad caused the general farms to be turned into market gardens, cultivated intensively.

Whaling was the most important maritime industry. So far as Long Island was concerned, the fishery had its origin in the 17th century at East Hampton and Southampton. Early in the 19th century Sag Harbor became the chief Long Island whaling port. The village, dependent almost solely upon whaling, prospered in the golden age of the industry and suffered heavily when whaling swiftly declined after the middle of the century. Throughout most of the 19th century the menhaden fishery flourished along the southern shore and in Peconic bay. Before the end of the 18th century, the blue point oyster bed in Great South bay had been discovered and was being worked, and in 185j New York permitted the leasing of sea bottom. which was not part of a natural bed, for the purpose of establishing oyster farms. Oystering under the new conditions became one of the most important industries, not only of Great South bay, but of Peconic bay and some of the north shore harbors. Throughout the history of the island, deep-sea fishing—for cod, mackerel, bluefish, sea bass, weakfish, etc.—has been the major support of many Long Island families. Fishing for recreation has always been of importance and Long Islanders for many decades have serviced these interests.

In the colonial period, milling of various kinds was carried on in the scattered settlements and some types of primitive manufacturing was engaged in to a limited degree. The chief manufacturing enterprises of the first half of the 19th century were those supplying the needs of the maritime industries. Cooperages and ropewalks characterized Sag Harbor in the whaling days. The building of ships and boats became an important industry at Port Jefferson and other north shore towns located near good timber The development of oystering on a large scale made a new demand for boats and for repair work. More important was the growth of summer colonies on the shores. The making, repairing and storing of pleasure craft during the winter became an important industry. Here and there, as at Patchogue and Sag Harbor, other manufacturing industries sprang up, and, as the years passed, Brooklyn and Queens became two of the most important industrial centres in the United States.

Recreation.—In the first decade of the 19th century Far Rockaway became a watering place for New York's elite. After the Civil War. nith the increase of railroad facilities, Long Island took on an added attraction for the wealthy. Southampton became a second Newport and great estates were built along the north shore For some distance along the south shore eastward from the city of New York, summer hotels were constructed which by the turn of the century were attracting thousands of summer vacationists. Coney Island, pioneer of U.S. amusement parks, has always flourished. while the major recreational achievement in recent years has been the continued development of Jones Beach by the Long Island State Park commission; it attracts millions of visitors each summer.

Population.—An outstanding phenomenon in the latter part of the 20th century was the tremendous upward surge of Long Island's population.

The four counties of the island expanded from 5,237,918 in 1950 to 6,403,852 in 1960. Between 1950 and 1960 Nassau county grew from 672,765 to 1,300,171 while Suffolk showed an increase from 276,129 to 666,784. One reason for this expansion in population was the construction of low-priced, one-family housing units in both Nassau and western Suffolk; a prime example is Levittown, developed after World War II as a private investment.

Transportation.—Long Island is served on both shores and through the central part of the island by the Long Island railroad, which is reputed to carry more commuters than any other railroad in the country. A highly developed and efficient system of parkways is in operation, while Manhattan is connected with Brooklyn and Queens by the Interborough Rapid Transit and Independent subway lines. Bridges connect the western part of the island with Manhattan and the Bronx; there is direct ferry service from north shore points to Connecticut and from the south shore to Staten Island.

With the advent of the airplane in the early decades of the 20th century, Long Island attracted attention because its flat plains presented ideal conditions for the manipulation of aircraft. By the 1920s Roosevelt field (closed in 1951) and Mitchell air force base (deactivated in 1961) had become internationally known. Both LaGuardia field and Idlewild (New York International) airport are on the island and the airplane industry there is regarded as the single most important manufacturing enterprise outside the New York metropolitan limits.

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Battle of Long Island, 1776.—The interest of this battle lies in the fact that it was the first engagement in the campaign of 1776 (see AMERICAN REVOLUTION) and was expected in England to be decisive of the contest in the colonies. After the evacuation of Boston (March 1776), Lord Home moved against New York city, which he thought would afford a better base of operations for the future. The Americans undertook its defense although recognizing the difficulties in the case, as the bay and rivers adjoining would enable the British fleet to co-operate effectively with the army. To protect his left flank George Washington was forced to throw a portion of his troops over to the Long Island side of the East river; they fortified themselves there on the site of the present borough of Brooklyn. Lord Howe, who had encamped on Staten Island at the entrance to the harbour, determined to attack this isolated left wing, and on Aug. 22 landed at Gravesend bay, Long Island, with about 20,000 men. The Americans maintained strong outposts in the wooded hills in advance of their fortified lines. On the morning of Aug. 27 Howe, after four days' reconnaissance, attacked these posts with three columns, the left and centre delivering the holding attack, and the right and strongest column turning the enemy's left by a detour. Howe himself, accompanied by Generals (Sir H.) Clinton and Lord Cornmallis, led the turning movement, which came upon the rear of the enemy at the moment when they were engaged with the two other columns. By noon the Americans had been driven back into the Brooklyn lines in considerable confusion, and with the loss of about half their number. This constituted the battle. The completeness of the British victory resulted from the neglect of the Americans in guarding the left of their outposts. Howe has been criticized for not immediately assaulting the American works, which he might have carried on the evening of the battle. In view of the fact that he had only defeated a small portion of the American forces. and that the works were of considerable strength, he decided to make a formal siege, and Washington took advantage of the delay in operations to retreat across the river to New Uork on the night of the 29th. This successful movement repaired to some extent the bad moral effect of the defeat of the 27th in the American camp. In the engagement of Long Island Washington lost 1,200 prisoners, 30 guns, and 400 killed and wounded; of the latter the British lost nearly the same number.

See T. W. Field, "The Battle of Long Island," *Long Island Hist. Soc. Memoirs,* vol. ii (1869); and C. F. Adams, "The Battle of Long Island," *Amer. Hist. Rev., 1*:650–670 (1896). (C. F. A.)

LONG ISLAND SOUND, a semienclosed arm of the Atlantic ocean. lies between Connecticut and the island whose name it bears. Its easterly limits are defined by Long Island's Orient Point, and by Plum Island, Great Gull Island, and Fishers Island. The narrow western gateway is at Throgs Neck, where the waters of the sound meet the swift cross currents of the East river. The sound has a length of 90 mi. (78 nautical mi.), a width of 20 mi. (15 nautical mi.) and an area of 1,180 sq.mi. In Pleistocene time, the sound was deepened by two advances of the great Labrador ice sheet which scoured its crystalline bedrock and left two terminal moraines as a dominant feature of Long Island's topography. There is a maximum depth of 330 ft. near the sound's eastern limits, but elsewhere the water is little more than 100 ft. in depth. The mean tidal range is from less than 3 ft. in the east to more than 6 ft. in the west. The drainage basin of the sound is approximately 13 times its area and the annual volume of fresh water is about 35% of its total. Most of this runoff, chiefly from the Housatonic, Connecticut and Thames rivers, enters the sound's relatively open eastern end and is flushed out rapidly to Block Island sound; its effect on the salinity of the sound as a whole is minima!. As this freshened surface layer moves eastmard it is replaced by a more saline inflow along the bottom. The relatively :hallow waters of the sound are rich in plankton and bottom organisms, which make them favourable for young fish but deter most commercially valuable fish. Except for menhaden, processed for fish meal, the sound does not support an important commercial fishery. The major sports fishing is for weakfish and bluefish. Lobsters, crabs, and clams are caught along the Connecticut shores, and oyster farms are found from Bridgeport eastmard. Long Island sound is an important coastal shipping route. Its shores have many residential communities and yachting centres. (W. Wr.)

LONGITUDE, the angle which the terrestrial meridian from the pole through a point on the earth's surface makes with some standard meridian, commonly that of Greenaich. It is equal to the difference between local time on the standard meridian, and at the place defined, one hour of time corresponding to 15° difference of longitude. Formerly each nation took its own capital or principal observatory as the standard meridian from which longitudes were measured. Another system had a meridian passing through or near the island of Ferro, defined as 20° W. of Paris, as the standard. While the system of counting from the capital of the country is still used for some purposes, the meridian of Greenwich has been used for nautical and international calculations since the Washington Meridian conference of 1884. In astronomy, the longitude of a celestial body is the distance of its projection upon the ecliptic from the vernal equinox, counted in the direction west to east from 0° to 360°.

LONGMANS, a firm of English publishers. The founder. Thomas Longman (1) (1699–17jj), was the son of Ezekiel Longman, a gentleman of Bristol. Thomas was apprenticed in 1716 to John Osborn. a London bookseller. He married Osborn's daughter, and in 1724 purchased the goods of William Taylor, the first publisher of *Robinson Crusoe,* for 52,282 9s. 6d. Taylor's two shops in Paternoster Row were known respectively as the Black Swan and the Ship. Osborn, who afterwards entered into partnership with his son-in-law, held one-sixth of the shares in Ephraim Chambers's *Cyclopaedia of the Arts and Sciences,* and Thomas Longman was one of the six booksellers who undertook the responsibility of Samuel Johnson's *Dictionary.* In 1754 Thomas Longman took his nephew into partnership, the title of the firm becoming T. and T. Longman.

Upon the death of his uncle in 1755, Thomas Longman (2) became sole proprietor. He had three sons. Of these, Thomas Norton Longman (3) succeeded to the business. In 1794 Owen Rees became a partner. and Thomas Brown, who was for many years after 1811 a partner, entered the house as an apprentice. He published the works of Wordsworth, Coleridge, Southey and Scott. In 1324 the title of the firm was changed to Longman, Hurst, Rees, Orme. Brown & Green. In 1814 arrangements were made with Thomas Moore for the publication of *Lalla Rookh,* for which he received £3.000; and when Archibald Constable failed in 1826, Longmans became the proprietors of the *Edinburgh Review.*

Thomas Norton Longman (3) died on Aug. 29, 1842, leaving his two sons. Thomas (4) and William Longman in control. They first published Macaulay's *Lays of Ancient Rome,* which was followed in 1849 by the issue of the first two volumes of his *History of England.* Thomas Langman edited a beautifully illustrated edition of the New Testament, and William Longman wrote a *History of the Three Cathedrals dedicated to St. Paul* (1869) and a work on the *History of the Life and Times of Edward III* (1873). In 1890 they incorporated all the publications of the firm of Rivington, established in 1711.

LONGOMONTANUS (Christian Severin) (1562–1637), Danish astronomer and astrologer, who is best known for his association with Tycho Brahe and for his published expositions of the Tychonic system of the world, was born at Longberg, in Jutland, Den.. on Oct. 4, 1562. He is usually known as Christian Longomontanus, from the latinized form of his birthplace. Educated at. Longberg and at Viborg, he was employed for eight years (1589–97) by Tycho Brahe at Copenhagen, as an assistant. He was appointed rector of the gymnasium at Viborg in 1603, elected professor in the University of Copenhagen in 1605 and promoted to the chair of mathematics in 1607. Longomontanus began the construction of the Copenhagen observatory in 1632, but he died on Oct. 8, 164;. before its completion. (O. J. E.)

LONGSTREET, JAMES (1821–1904), American soldier, lieutenant general in the Confederate army, was born on Jan. 8, 1821, in Edgefield district, S.C., and graduated from West Point in 1842. He was severely wounded in the Mexican war, and received two brevets for gallantry. In 1861, having attained the rank of major, he resigned when his state seceded, and became a brigadier general in the Confederate army. In this rank he fought at the first battle of Bull Run, and at the head of a division in the Peninsular campaign and the Seven Days. This division later became the nucleus of the 1st corps, army of northern Virginia, which was commanded throughout the war by Longstreet, and took part in the second battle of Bull Run, Antietam and Fredericksburg. Most of the corps was absent in North Carolina when the battle of Chancellorsville took place, but Longstreet, now a lieutenant general, returned to Lee in time to take part in the campaign of Gettysburg. In Sept. 1863 he took part in the great battle of Chickamauga. In November he commanded the unsuccessful expedition against Knoxville. In 1864 he rejoined Lee's army in Virginia, and on May 6 arrived upon the field of the Wilderness as the Confederate right had been turned and routed. His attack was a model of impetuosity and skill, and drove the enemy back until their entire force upon that flank was in confusion. At this critical moment, as Longstreet in person. at the head of fresh troops, was pushing the attack in the forest he uas fired upon by mistake by his own men and desperately wounded. This mischance stayed the Confederate assault for two hours, and enabled the enemy to provide effective means to meet it. In Oct. 1864 he resumed command of his corps. which he retained until the surrender, although paralyzed in his right arm.

During the period of Reconstruction, Longstreet's attitude toward the political problem, and the discussion of certain military incidents, notably the responsibility for the Gettysburg failure, brought the general into extreme unpopularity. His admiration for General Grant, and his loyalty to the Republican party accentuated the ill feeling of the southern people. But in time his services in former days were recalled, and he became once more "General Lee's war horse" to his old soldiers and the people of the south.

He held several civil offices, among them that of minister to Turkey under Grant. and that of commissioner of Pacific railways under Presidents McKinley and Roosevelt. In 1896 he published *From Manassas to Appomattox,* and in his later years he prepared an account of Gettysburg, which was published soon after his death, with notes and reminiscences of his whole military career.

Longstreet died at Gainesville. Ga., on Jan. 2, 1904.

See Helen D. Longstreet, *Lee and Longstreet at High Tide* (1904), also Sir F. Maurice, *Statesmen and War* and *Robert E. Lee.*

LONGUEVILLE, ANNE GENEVIEVE, Duchesse de (1619–1679), was the only daughter of Henri de Bourbon, Prince de Condé, and the sister of Louis. the great Condé (*q.v.*). She was the guiding spirit of the first Fronde (*q.v.*) when she brought over Armand, Prince de Conti, her second brother, and her husband to the malcontents, but she failed to attract Condé himself, whose loyalty to the court overthrew the first Fronde.

The second Fronde was largely her work, and in it she played the most prominent part in attracting to the rebels, first Condé and later Turenne. After the war she became more and more Jansenist in opinion.

In her house Antoine Arnauld, Pierre Nicole (*qq.v.*) and De Lane were protected. Her letters to the pope are part of the history of PORT ROYAL (*q.v.*), and as long as she lived the nuns of Port Royal des Champs were left in safety.

As her health failed she hardly ever left the convent of the Carmelites in which she had been educated. On her death in 1679 she was buried with great splendour by her brother Condé, and her heart, as she had directed, was sent to the nuns of Port Royal des Champs.

The chief authority for Madame de Longueville's life is a little book in two volumes by Villefore the Jansenist, published in 1738. Victor Cousin has devoted four volumes to her, which, though immensely diffuse, give a vivid picture of her time. *See* also Sainte-Beuve, *Portraits of Women* (tr. 1891). Her connection with Port Royal should be studied in Arnauld's *Memoirs,* and in the different histories of that institution. *See* also Hugh Noel Williams, *A Princess of Intrigue, Anne Geneviève de Bourbon, Duchesse de Longueville, and her Times* (1908).

LONGUS, Greek romancer, author of *Daphnis and Chloe.* All that can be said about him is that he probably lived at the end of the 2nd or the beginning of the 3rd century A.D. Even the name attributed to the author may be a misreading of the title of the work.

Longus's style is rhetorical, his shepherds and shepherdesses are wholly conventional, but he has imparted human interest to a purely fanciful picture. As an analysis of feeling *Daphnis and Chloe* makes a nearer approach to the modern novel than its chief rival among Greek erotic romances, the *Aethiopica* of Heliodorus, which is remarkable mainly for the ingenious succession of incidents. Daphnis and Chloe, two children found by shepherds, grow up together, nourishing a mutual love which neither suspects. The development of this simple passion forms the chief interest, and the only notable incident is the abduction of Chloe by a pirate. The two lovers eventually discover their parents and marry.

See J. Dunlop, *History of Prose Fiction* (1888), and especially E. Rohde, *Der griechische Roman* (1900). Longus found an incomparable translator in Jacques Amyot, bishop of Auxerre, whose French version, as revised by Paul Louis Courier, is better known than the original. It appeared in 1559, 39 years before the publication of the Greek text at Florence by Columbani. The chief subsequent editions are those by G. Jungermann (1605), J. B. de Villoison (1778, the first standard text with commentary), A. Coraes (Coray) (1802), P. L. Courier (1810, with a newly discovered passage), E. Seiler (1835), R. Hercher (1858), N. Piccolos (1866) and Kiefer (1904), W. D. Lowe (1908). A. J. Pons's edition (1878) of Courier's version contains an exhaustive bibliography. There are English translations by G. Thorneley (1733, reprinted 1893), C. V. Le Grice (1803) ; R. Smith (in Bohn's *Classical Library),* and the rare Elizabethan version by Angel Day from Amyot's translation (ed. J. Jacobs in *Tudor Library,* 1890).

LONGVIEW, a city of eastern Texas, U.S., is the centre of a rapidly growing urban area, 126 mi. E. of Dallas, and the seat of Gregg county. It has a large municipal airport and is the principal city of the east Texas oil field, a region with 20,000 producing wells. There are also numerous gas wells and iron-ore deposits in the vicinity, with a fully integrated steel plant located 30 mi. to the north.

Longview has petroleum refineries, and plants manufacturing oil-field machinery and equipment, chemicals, paper, plastics, agricultural implements, feedstuff, building materials and photographic supplies. The city's industrial growth has reduced the number of farms in the area, but agriculture is still significant, with many small landowners working part time in the industrial plants. It adopted a commission-manager form of municipal government in 15123. For comparative population figures *see* table in TEXAS: *Population.* (N. McG.)

LONGVIEW, a seaport city at the confluence of the Cowlitz and Columbia rivers, in Cowlitz county, Wash., U.S.is about 50 mi. N. of Portland, Ore. Founded in 1922 by R. A. Long, of the Long-Bell Lumber company, on the site of old Monticello, it is one of the world's greatest lumber centres end was the first city of the Pacific northwest to be completely planned with streets, parks and zoned areas. Longview was dedicated in 1923. A large timber company maintains its largest lumber, paper and pulp mills there, drawing raw material from a 500,000-ac. tree farm.

In addition to Longview's lumber and pulp industries, aluminum. paint. concrete pipes, canned goods, dairy products and fisheries are significant. Nearly 600 ships a year call at the city's public port docks. The Longview bridge, which spans the Columbia and connects Washington and Oregon, is one of the longest cantilever bridges (1,200 ft.) in the U.S. Adjoining Longview to the northeast is the older city of Kelso.

On Nov. 25, 1852, a group of residents of northern Oregon territory held a convention at Monticello to petition congress for division of the territory. This led to the creation of Washington territory in 1853.

For comparative population figures *see* table in WASHINGTON: *Population.* (J. M. McC.)

LONICERA: *see* HONEYSUCKLE.

LÖNNROT, ELIAS (1802–1884), Finnish philologist and discoverer of the *Kalevala,* was born at Nyland, Finland, on April 9, 1802. He entered the university of Åbo in 1822, and qualified as a physician.

As early as 1827, he had begun to publish contributions to the study of the ancient Finnish language, and to collect the national ballads and folklore. In 1833 he settled as a doctor in the country district of Kajana, and began to travel throughout Finland and the adjoining Russian provinces, collecting songs and legends. In this way he was able to put together the great epic of Finland, the *Kalevala,* the first edition of which he published in 1835; he continued to add to it, and in 1849 issued a larger and completer text.

Lonnrot also published an important collection (1840) of the *Kanteletar,* or folk songs of ancient Finland, which he had taken down from oral tradition; and the *Proverbs of Finland* (1842). In 1853 Lonnrot succeeded Castrén as lecturer on the Finnish language and literature at the Helsingfors high school; he retired in 1862.

Lonnrot died on March 19, 1884.

LONSDALE, EARLS QF. This English earldom is held by the ancient family of Lowther, which traces its descent to Sir Hugh Lowther, who flourished in the reign of Edward I. Sir Hugh's descendant Sir Richard Lowther (1529–1607) received Mary queen of Scots on her flight into England in 1568, and in the two follo ing years was concerned with his brother Gerard in attempts to release her from captivity. He was sheriff of Cumberland and lord warden of the west marches. Sir Richard's eldest son. Sir Christopher Lonther (d. 1617), was the ancestor of the later Lowthers, and another son, Sir Gerard Lowther (d. 1624), was judge of the common pleas in Ireland.

One of Sir Christopher's descendants was Sir John Lowther, Bart. (d. 1706), the founder of the trade of Whitehaven, and another was John Lowther (1655–1700), who was created Viscount Lonsdale in 1696.

Before this creation John had succeeded his grandfather, another Sir John Lowther (d. 1675), as a baronet. In 1690 he was first lord of the treasury, and he was lord privy seal from March 1699 until his death in July 1700.

James Lowther, 1st earl of Lonsdale (1736–1802), was descended from Sir Christopher Lowther; through his mother, James was a great-grandson of the 1st Viscount Lonsdale. From 1757 to 1784 he was a member of parliament, exercising enormous influence on elections in the north of England on account of his great wealth, and controlling nine seats in the house of commons, where his nominees were known as "Sir James's ninepins." In 1784 Lowther was created earl of Lonsdale and in 1797 Viscount Lowther with an extended remainder.

The earldom became extinct in 1802, but was revived in 1807, and William Lowther (1757–1844), a cousin of James Lowther, was created the 1st earl of Lonsdale after the earldom was revived. He was succeeded by his eldest son. William Lowther II (1787–1872), upon whose death a nephew, Henry Lowther (1818–76), became the 3rd earl. St. George Henry Lowther (1855–82), son of Henry Lowther, and 4th earl, was succeeded by his brother, Hugh Cecil Lowther, 5th earl of Lonsdale. He died on April 13, 1944.

LONSDALE, DAME KATHLEEN (née YARDLEY) (1903–), English crystallographer, who in 1945 was one of the first two women to be elected to the fellowship of the Royal society, was born on Jan. 28, 1903. She was educated at the University of London, where she graduated in physics. From 1922 to 1927 and from 1937 to 1942 she was research assistant to Sir William Henry Bragg (*q.v.*) at University college and the Royal institution, London. Between these two periods, she was Amy Lady Tate scholar in the University of Leeds and then Leverhulme research fellow, and afterward, during 1944–46, Dewar fellow at the Royal institution. In 1947 she was special research fellow, United States federal health service. In 1949 she became professor of chemistry at University college, London. In 1956 she was created Dame of the British Empire and in 1957 was awarded the Royal society's Davy medal in recognition of her distinguished studies in the structure and growth of crystals.

Dame Kathleen Lonsdale's publications include *Structure Factor Tables* (1936), *Crystals and X-Rays* (1949), *International Tables for X-Ray Crystallography* vol. i (1952), and many papers in scientific journals. Her other interests are reflected in *Quakers Visit Russia* (1952), *Removing the Causes of War* (1953) and *Is Peace Possible?* (1957). (D. McK.)

LONSDALE, WILLIAM (1794–1871), English geologist and palaeontologist, born at Bath on Sept. 9, 1794, was educated for the army, and in 1810 was gazetted as ensign in the 4th (King's Own) regiment. He served in the Peninsular War at the battles of Salamanca and Waterloo, for both of which he received medals; and he retired as lieutenant. At his home at Batheaston he collected a series of rocks and fossils which he presented to the Literary and Scientific Institution of Bath. He became the first honorary curator of the natural history department of the museum.

He was assistant secretary and curator of the Geological society of London at Somerset House from 1829 to 1842. In 1829 Lonsdale read before the society an important paper "On the Oolitic District of Bath" (*Trans. Geol. Soc.* ser. 2, vol. iii), the results of a survey begun in 1827; later he was engaged in a survey of the Oolitic strata of Gloucestershire (1832), and he laid down on the one-inch ordnance maps the boundaries of the various geological formations.

He became the highest authority in England on corals, and he described fossil forms from the Tertiary and Cretaceous strata of North America and from the older strata of Britain and Russia.

In 1837 he suggested from a study of the fossils of the South Devon limestones that they would prove to be of an age intermediate between the Carboniferous and Silurian systems. This suggestion was adopted by Sedgwick and Murchison in 1839, and may be regarded as the basis on which they founded the Devonian system.

Lonsdale's paper, "Notes on the Age of the Limestones of South Devonshire" (read 1840), was published in the same volume of the *Transactions of the Geological Society* (ser. 2, vol. v) with Sedgwick and Murchison's famous paper "On the Physical Structure of Devonshire." Lonsdale died at Bristol on Nov. 11, 1871,

LONS-LE-SAUNIER, a town of eastern France, capital of the *dkpartement* of Jura, 76 mi. N.N.E. of Lyons on the P.L.M. railway, on which it is a junction for Chalon-sur-Saône, Dôle, Besançon and Champagnole. Pop. (1954) 13,806. The town is on both sides of the river Vallibre and is surrounded by the vine-clad hills of the western Jura.

Lons-le-Saunier, known as Ledo in the time of the Gauls, was fortified by the Romans, who added the surname Salinarius to the Gallic name. An object of contention owing to the value of its salt, it belonged for a long time during the medieval period to the house of Chalon. It was burned in 1364 by the English, and again in 1637, when it was seized by the duke of Longueville for Louis XIII. It became definitely French in 1674. There the meeting between Ney and Napoleon took place, on the latter's return from Elba in 1815.

The town owes its name to the salt mines of Montmorot, its western suburb, which have been used from early times. The church of St. Désiré (12th and 15th centuries), has a huge Romanesque crypt.

The town is the seat of a prefect and of a court of assizes, and there are tribunals of first instance and of commerce and a chamber of commerce. There are sodio-chlorinated mineral waters. The principal industry of the place is the manufacture of sparkling wines.

LOO, formerly called "Lanterloo" (Fr. *lanturlu,* the refrain of a popular 17th century song), a game of cards, invariably played for a stake. The players may number from five to about nine, each for himself. The pack of 52 cards is used.

In the simplest form of the game, three cards are dealt to each player, and the next is turned for trump. Eldest hand leads, and one-third of the pool goes to the winner of each trick. The pool is formed by antes before each deal, and may be increased by payments for *loo* (failure to win a trick) and fines for irregularities.

Among the features added to this base are found:

1. Turn of a card for trump is deferred until the first time any hand fails to follow suit. The trump then fixed affects the winning of the current and any subsequent tricks.

2. The first pool is a *single,* three counters put in by dealer alone. The players who are looed pay three counters each to the next pool, making it a *double.*

An extra hand called the *miss* is dealt at the right of the next dealer. Each player in turn, eldest hand first, must *pass, stand* or take the miss if it is still available. The player who takes the miss discards his original hand. After the miss is taken, the remaining players must pass or stand. All who pass throw in their cards; all who stand must play. Dealer must take the miss if no other does, playing for himself or "for the pool" (in which case his winnings if any remain in the next pool). The pool is divided, one-third for each trick. Players looed contribute to the next pool. Whenever the pool is cleared, the next deal is a *single,* otherwise the *doubles* continue.

3. The first dealer (eldest hand of those who stand) must lead the ace of trumps if he has it, or the king if the ace was previously turned for trump. The leader is also bound to lead a trump if he has two. Each player must *head* a trick if able, by playing higher in the suit led, by trumping if void of the suit led, or by playing a higher trump than any previously played to the trick.

4. A player dealt a *flush* wins the pool without play. A flush is three trumps.

5. The penalty for loo is to double the current pool. This variant, unlimited loo, has caused some considerable fortunes to change hands.

6. The hand may be five cards instead of three.

7. The turned trump may be taken up by the dealer in place of a discard.

8. *Pam,* the knave of clubs, is always the highest trump. It may be used as a "wild card" to complete a *flush* or a *blaze.* A flush is five trumps; a blaze is five court cards. The holder of either wins the pool without play.

9. Pam may be withheld on a trump lead, and must be withheld if the leader of the trump ace says, "Pam be civil!"

See J. Warren, *Rules for Three Card Loo* (1820); *The Laws of Loo of the Blenheim Club* (London, 1866).

LOOE, a seaport, market town and urban district in the Bodmin parliamentary division of Cornwall, Eng., 18 mi. W. of Plymouth by road. Pop. (1951) 3,833. Area 2.6 sq.mi. It is divided into East and West Looe by the Looe river, which forms the harbour and is crossed by a seven-arched stone bridge. Above the bridge the river also divides into the East and West Looe rivers. The town is so sheltered by the surrounding hills that myrtles, geraniums, fuchsias and other Mediterranean plants flourish at all seasons. Its streets are narrow, steep and winding, with many ancient thick-walled houses. The East Looe beach is sandy while the Hannafore beach, on the other side of the river, is largely rocky. The parish church of St. Mary adjoins the sea front at East Looe. Remains of a Benedictine priory and of a Celtic chapel have been found. The harbourage was probably the original cause of settlement at Looe. At the time of the Domesday survey East Looe was assessed under Pendrym, which was of the king's demesne, and West Looe under Hamelin's manor of Trelowia. In the 14th century the former manor was held by the family of Bodrugan, the latter by that of Dauney. In 1237 Henry Bodrugan received the grant of a market on Fridays and a fair at Michaelmas. A charter of incorporation was granted in 1587 and in 1685 James II provided that there should be a mayor and 11 aldermen, 36 free burgesses, four fairs and a court of piepowder. East Looe was governed under this charter until 1885. West Looe (known also as Porpighan or Porbuan), was constituted a free borough by a charter ratified in 1325. Upon the attainder of the earl of Devon in 1539 the borough fell to the crown and in 1574 a charter of incorporation was granted providing for a mayor and 11 burgesses, also for a market on Wednesdays and two fairs. West Looe continued to be administered under this charter until 1869. Of the markets and fairs only the U'ednesday and Saturday markets and a fair on May 6 remain. Looe was second only to Fowey as a port in the 15th century. It furnished 20 ships for the siege of Calais. A considerable export trade in copper, tin and granite was formerly carried on; the harbour is now used by sailing dinghies and other small craft, and by fishing boats. There are thriving fisheries, the Looe fishermen being particularly expert with the seine on a rocky bottom. Up the West Looe river is a pilchard canning establishment. Looe Island, lying $\frac{1}{2}$ mi. from the beach, is 1 mi. in circumference. It has many legends and is presumed to have been connected with the abbey of Glastonbury.

LOOFAH: *see* LUFFA.

LOOM: *see* WEAVING.

LOON *(DIVER)*, name properly restricted to birds of the family Gaviidae, containing four species of the genus *Gavia* and constituting the order Gaviiformes. Measuring about two to three feet in length, they have thick plumage, which in summer is mainly black or gray above and white below, with spots, streaks or bars of white on the upper parts. With the exception of the red-throated loon, G. *stellata,* distinguished by its rich chestnut throat and foreneck (summer plumage), they lose the bold dorsal pattern in winter. They all have a strong, tapering bill; rather small, pointed wings; and legs placed so far back on the body that walking is virtually impossible. The tarsal bones of the ankles are laterally compressed and the first three toes webbed.

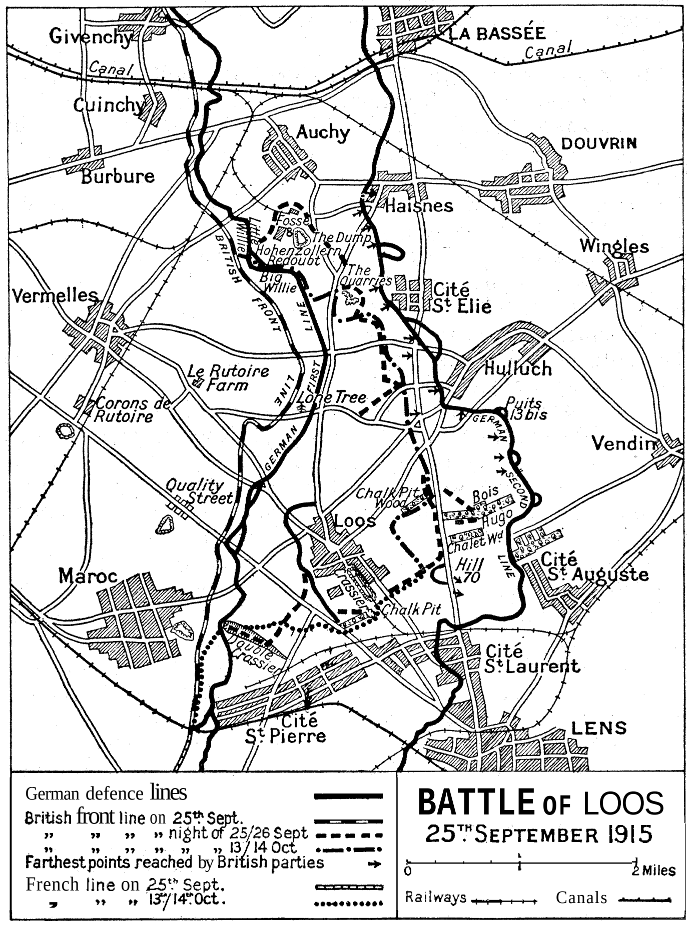
Almost wholly aquatic, divers or loons are capable of swimming long distances beneath water and have been known to dive to depths approaching 200 ft. Usually they are found singly or in pairs but may winter in small flocks. The voice is distinctive, consisting of various guttural notes and very loud quavering calls. They feed mainly on fish, crustaceans and insects. The nest usually is a heap of vegetable matter at the edge of water. The eggs, one to three in number, are olive-brown spotted with darker brown.

H. M. HALLIDAY FROM THE NATIONAL AUDUBON SOCIETY

COMMON LOON OR GREAT NORTHERN DIVER (GAVIA IMMER) IN SUMMER PLUMAGE

The loons are wide ranging: the common loon or great northern diver, G. *immer*, of the northern hemisphere, is the most abundant loon in North America; the arctic loon or black-throated diver, G. *arctica,* is circumpolar in distribution, being commonest in the old world; the yellow-billed loon, G. *adamsii,* is found on arctic coasts from Siberia to northwestern Canada. (E. R. BE.)

LOOS, THE BATTLE OF (Sept. 25–Oct. 19, 1915), is the name given to the actions fought by the British in the Allied offensive in France in the autumn of 1915.



The French Plan.—The plan elaborated by Gen. Joseph Joffre was to attack on both sides the great salient formed by the German front in France: on the right in Champagne with the French 2nd and 4th armies, the main effort; and on the left in Artois with the 10th army. He hoped by these two operations to cut off the German troops in the salient knd get astride their communications. He asked that the British should co-operate by attacking in Artois on the left of the 10th army. Sir John French, therefore, was given definite orders to co-operate with the French. The 1st army under Gen. Sir D. Haig, was selected to carry out the attack. Both Sir John French and Gen. Haig were opposed to attacking in the area between Lens and the La Bassée canal, as Gen. Foch required; for it involved advancing over unfavourable ground, open, but dotted with coal mines and mining villages, while Lens and its suburbs formed one vast industrial town. They suggested an objective further north. This proposal was overruled.

The Employment of Gas.—While the British leaders were doing their best, against their better judgment, to prepare the offensive at a spot not of their own selection and with totally inadequate artillery, the first consignment of chlorine gas arrived, for trial. Its use seemed to promise a chance of surprise and provide a solution of the problem of attack with inadequate means. A sufficient supply of gas was manufactured and preparations were made to employ it. After four days' bombardment, during the later part of which the weather was unsuitable for flying and observation, on Sept. 25 the offensive was begun simultaneously in Champagne (30 French divisions) and Artois (17 French and nine—later 12—British divisions), whilst diversions were made at other parts of the line: by the British near Givenchy, Neuve Chapelle and Hooge; by the Belgians near Nieuport; and by the navy on the coast. On the British front gas and smoke were discharged for 40min. preceding the assault, which took place at 6:30 A.M. The French X. Army did not leave its trenches until 12:45 P.M. and even then the Allied contingents in Artois were not shoulder to shoulder, for between them opposite Lens was left a passive front of 3m. held by a French Territorial division.

The Assault on Sept. 25.—The British assault was made by the 47th (2nd London Territorial), 15th (Scottish, of the New Army) and 1st Divisions of the IV. Corps (Rawlinson), and the 7th, 9th (Scottish, of the New Army) and 2nd Divisions of the I. Corps (Gough). Although the wind was very feeble, and on the front of the 2nd Division unfavourable so that the gas and smoke blew back, considerable success was obtained by the British. The German defences comprised two separate positions (see sketch) disposed on the great rolling plain in which the spurs of the Artois plateau sink down. In spite of insufficient bombardment, the German front line position was overrun from the British right nearly as far as Auchy. The 47th Division reached all its objectives and formed a defensive flank towards Lens; the 15th Division captured Loos, but then lost direction and moved south-east on Hill 70 instead of continuing eastwards; the 1st Division got beyond the Lens-La Bassée road, but, in trying to keep touch with the 15th, became divided, thus creating a gap in its front; the 7th Division advanced beyond the German first line, captured the Quarries, and in places arrived at the German second line, a few men actually entering Hulluch; the 9th Division was even more successful: it overran the Hohenzollern redoubt, a strong independent work in the general line, and its wings, Big and Little Willie, captured Fosse 8 and the Dump, a valuable observatory, and got up to, and in places into, the second line between Cité St. Elie and Haisnes. Only the 2nd Division, in whose area the gas had blown back, made no progress

With this effort the IV. and I. Corps had shot their bolt and fresh troops were required to carry on the attack and break through the second line. Unfortunately Sir John French had kept back near Béthune his general reserve, the XI. Corps (Haking), consisting of the Guards Division, recently formed, and the 21st and 24th Divisions, two New Army divisions, just out from England. No orders for the 21st and 24th Divisions to move from their rendezvous 5 to 8 miles from the battlefield were sent until 9:30 A.M. on the 25th, and it was not until 1:20 P.M. that these divisions were put under Sir D. Haig.

The Attack on Sept. 26.—Already fatigued by a series of night marches to reach Béthune unseen by enemy aeroplanes, and by delays due to the congestion of traffic on the roads behind the battlefield, it was the morning of Sept. 26 before the 21st and 24th Divisions were on the field and ready to move to the attack of the German second line between Bois Hugo and Hulluch. And meantime it had become necessary to use the two leading brigades to patch up the British line. Hill 70 and Hulluch, on the flanks of the attack, were still in enemy hands, renewed attacks having failed to capture them, and soon after 9 A.M. the Germans had recaptured Bois Hugo. In the hours which had elapsed since the original attack, they had recovered from their surprise, brought up reinforcements and strengthened their second line. During the night of the 25th–26th and early morning of the 26th they made counter-attacks on both flanks of the line gained by the British in the first advance and recovered part of the lost ground.

The attack of the four remaining brigades of the two divisions at 11 A.M. against the intact second line was a failure, though some units actually reached the wire entanglement in front of it. Eventually the men, new to war, having done all that was possible, began to stream back. The Guards Division was brought up to fill the gap in the line that their retirement caused, and the 3rd Cavalry Division to stiffen the defence near Loos village. The French X. Army, having no gas, had less success than the British; but its persistent attacks, against the crest of Vimy Ridge by Gen. Foch's orders, caused the Germans to divert the Guard Corps from the British to the French front.

After Sept. 26 the fighting became desultory and degenerated into trench warfare, and on the 30th the French offensives, both in Champagne (where also no success had been achieved) and Artois, were formally stopped in order to prepare for another combined effort. Delays brought about by bad weather, enemy interference with the preparations and enemy counter-attacks, led to postponement after postponement.

The Last Phase.—Finally a renewed French attack in Champagne was made on Nov. 6, a French attack in Artois on Nov. 11, and a British (fresh divisions, the 12th, 28th and 46th having arrived) on the 13th, with no result but heavy casualties. Trench fighting, particularly round the Hohenzollern Redoubt, went on for several days longer, and then both sides settled down to winter conditions. The fighting of the year had but proved that, with the guns and munitions then available, the defence was still stronger than the attack. The British losses in the battle of Loos included three divisional commanders killed (Maj.-Gen. Sir T. Capper, G. H. Thesiger and F. D. V. Wing) and 2,407 officers and 57,985 other ranks killed, wounded and missing, and were probably three times as heavy as those of the enemy.

See *History of the Great War Based on Official Documents*, "Military Operations France and Belgium, 1915," vol. ii. (1928, where there is a bibl.); *Les Armées Françaises dans la Grande Guerre*, tome iii. (1922); M. Schwarte, *Ed., Der grosse Krieg, 1914–1918*, vol. ii. (1921–25). (J. E. E.)

LOOSESTRIFE, the common name of any plant of the genus *Lysimachia* of the family Primulaceae. The Eurasian L. *vulgaris*, an erect plant, 2 to 4 ft. high, is common on river banks in England; the branched stem bears tapering leaves in pairs or whorls, and terminal panicles of rather large deep yellow flowers. L *nemorum*, yellow pimpernel or wood loosestrife, a low-growing plant with slender spreading stem and yellow flowers standing singly in the leaf-axils, is frequent in England. L. *nummularia* is the well known creeping jenny or moneywort, a larger plant with widely creeping stem. pairs of shining leaves and large solitary yellow flowers; it is found on banks of rivers and damp woods, and is a common rockery plant. Purple loosestrife, *Lythrum salicaria*, belongs to a different family, Lythraceae. It is a handsome plant growing 2 to 6 ft high on river banks and ditches with a branched stem bearing whorls of narrow pointed stalkless leaves and ending in tall tapering spikes of beautiful rose-purple flowers. The flowers are trimorphic, that is to say, exist in three forms which differ in the relative length of the styles and stamens and are known as long-styled, mid-styled and short-styled forms; the size and colour of the pollen also differ. These differences are important in the pollination of the flower, making self-fertilization next to impossible. (See POLLINATION.)

LOPE DE VEGA: see VEGA CARPIO, LOPE FELIX DE.

LOPES, FERNÃO (1380?–1460?) (**FERNAM LOPEZ**), the patriarch of Portuguese historians, was appointed keeper of the royal archives, then housed in the castle of St. George in Lisbon, by King John I. in Nov. 1418. He acted as private secretary to the Infantes D. Duarte and D. Fernando, and when the former ascended the throne he charged Lopes, by a letter of March 19, 1434, with the work of "putting into chronicles the stories of the kings of old time as well as the great and lofty actions of the most virtuous king my lord and father" (John I.). King Alphonso V. confirmed him in his post by a letter of June 3, 1449, and in 1454, after 36 years' service in the archives and 20 as chronicler he resigned in favour of Gomes Eannes de Zurara. The modern historian Herculano says, "there is not only history in the chronicles of Fernão Lopes, there is poetry and drama as well; there is the middle age with its faith, its enthusiasm, its love of glory." Lopes has been called the Portuguese Froissart, and that rare gift, the power of making their subjects live, is common to the two writers; indeed, had the former written in a better-known language, there can be little doubt that the general opinion of critics would have confirmed that of Robert Southey, who called Lopes "beyond all comparison the best chronicler of any age or nation." Lopes composed a general chronicle of the kingdom, which almost certainly served as a foundation for the chronicles of Ruy de Pina. Lopes prepared himself for his work by a study of the archives belonging to municipalities, monasteries and churches in Portugal and Spain.

See extant works of Lopes: *Chronica de D. João I* (1644; part 1, ed. B. Freire, 1915); *Chronica de D. Pedro I,* in vol. iv of the *Collecção de Livros Ineditos da Historia Portugueza* (1816); *Chronica de D. Fernando,* in the same volume. (E. P.; A. B.)

LÓPEZ, CARLOS ANTONIO (1792–1862), second dictator of Paraguay, ended his country's isolation, sought to modernize its economy and society, and became deeply involved in international disputes. Born in Asunción on Nov. 4, 1792, López attended the San Carlos seminary, taught there until it was closed by the dictator José Gaspar Rodríguez Francia (*q.v.*), and then became a lawyer. Exiled to his *estancia* in 1837, López returned to his suburban home when Francia died in 1840. The next year he became the principal of two consuls and in 1844 was elected president with dictatorial powers, an office he held until his death on Sept. 10, 1862.

López amassed a large personal fortune and bestowed favours liberally on his family. Imported foreign technicians built a railway, highways, foundries and modern fortifications. López founded Paraguay's first newspaper, encouraged education and relaxed some of Francia's stern laws. Commerce, agriculture and foreign trade, largely monopolized by the state, improved moderately. At first conciliatory, Pres. Juan Manuel de Rosas of Argentina refused to recognize Paraguay's independence and a brief war occurred (1845–46); relations improved when Rosas was overthrown in 1852. Recognition by several countries followed in 1853, but Paraguay's foreign relations were never smooth. Difficulties with the United States almost resulted in war and neighbouring countries remained unfriendly during most of the López regime. (H. G. Wn.)

LÓPEZ, FRANCISCO SOLANO (1827?–1870), dictator of Paraguay and eldest son of Carlos Antonio López (*q.v.*) seized power upon his father's death in 1862. Born near Asunción on July 24, 1826 or 1827, he received an indifferent education but fancied himself without a peer in military science. A brigadier general at 18, he commanded Paraguay's army in the abortive war with Argentina (1845–46). A few years later he headed a diplomatic mission to Europe during which he purchased munitions, engaged foreign artisans, and acquired an Irish mistress, Eliza Lynch. When he became dictator López continued the construction of public buildings and roads and installed the first telegraph system in South America. He devoted most of his time and resources to military preparations until Paraguay had a standing army of more than 60,000, a force López was ready to use to settle boundary and navigation disputes with Brazil and to prevent disruption of the delicate political balance in the La Plata basin. He believed that maintenance of Paraguay's independence and territorial integrity required that he champion nonintervention in Uruguay. On Nov. 12, 1864, less than a month after Brazil intervened in the Uruguayan civil war, López seized a Brazilian merchant vessel and started what became the War of the Triple Alliance. Instead of marching to the aid of his favoured Uruguayan faction, López in December sent an army northward which overran the disputed region of Mato Grosso north of the Río Apa and captured Corumbá. Reinforced with supplies taken in this campaign, López prepared to attack southern Brazil. When Pres. Bartolomé Mitre refused permission to cross Argentine territory, López seized Argentine ships and attacked Corrientes in April 1865. This move brought Brazil, Argentina and Uruguay together in alliance on May 1. López launched a combined river and land attack in July which resulted in disaster. While the allies prepared to invade Paraguay, López concentrated his forces around the famed fortress of Humaitá which finally fell in July 1867. Thereafter López fought a war of movement, gradually falling back to the north of Paraguay where he was killed on March 1, 1870, at the Aquidabán river. López in 1868 executed several hundred prominent Paraguayans whom he accused of conspiring against him. The war, which exterminated more than 300,000 Paraguayans, caused significant changes in demographic and cultural characteristics. Long considered a cruel tyrant, López later was elevated to the pantheon of Paraguayan heroes. (H. G. Wn.)

LÓPEZ DE AYALA, PEDRO (1332–1407), Spanish historian, poet and chancellor of Castile from 1398 until his death (in Calahorra), was born at Vitoria. His most impressive works are the chronicles of the four kings under whom he served. After transferring his allegiance in youth from Peter the Cruel to Henry of Trastámara, he held high office under the latter and his successors John I and Henry III, seeing action against the Black Prince at Nájera (1367) and the Portuguese at the disaster of Aljubarrota (1385), where he was taken prisoner. Ayala has been called the first Castilian humanist because of his translations from Boccaccio and Guido da Colonna. As a poet, he is the last representative of the medieval "clerkly craft," and his *Rimado de Palacio,* written largely in the old *cuaderna vía,* is notable for its blistering satire on contemporary society, sparing the mighty of neither church nor state. The chronicles (of which the standard edition is that of 1779–80) display the same powers of implacable observation and vivid expression as the *Rimado,* but substitute for the *saeva indignatio* of the poem an icily impassive surface objectivity even more effective, thanks to Ayala's shrewd choice of significant detail and incident, in conveying his moral judgments.

Ayala's *Poesías* were edited by A. F. Kuersteiner (1920) for the Hispanic Society of America. (F. S. R.)

LÓPEZ DE MENDOZA, ÍÑIGO, MARQUÉS DE SANTILLANA; *see* SANTILLANA, ÍÑIGO LÓPEZ DE MENDOZA, MARQUÉS DE.

LOP NOR (LOB NOR, Chinese LO-PU-NO-ERH), a lake in Sinkiang Uigur Autonomous Region of China. It lies in the eastern Tarim basin, between the Astin Tagh on the south and the Kuruk Tagh on the north. Ancient Chinese and Greek accounts and maps placed the lake south and east of the great Silk Road station of Lou-lan, at a point about 42° 30′ N. lat. About A.D. 330 the lower Tarim river broke out of its old course, turning southeastward, to establish a new terminal water body rather close to the base of the Astin Tagh, causing the abandonment of Lou-lan as a Silk Road station. No medieval European travelers mentioned this change, and European cartographers continued to place Lop Nor in the classical location. In 1876 the Russian explorer N. Prjevalsky discovered two closely connected lake basins 1° S. of the classical site of Lop Nor, which he regarded as being identical with the classical lake.

Several decades of exploratory search for the lake followed. Explorers and geographers engaged in heated debate over the physical history of the Tarim river and Lop Nor. In 1928 Sven Hedin, who had repeatedly sought to solve the puzzle, found both the lower Tarim river and Lop Nor back in their classical positions, the river having returned to its ancient channel in 1921. Hedin's studies made clear that the precise location of the terminal lake had steadily shifted over the centuries, and that the lake varied both in area (about 946 sq.mi.) and in depth.

See Sven Hedin, *The Wandering Lake* (1940). (J. E. Sr.)

LOQUAT, a subtropical tree (*Eriobotrya japonica*) of the family Rosaceae, related to the apple and other well-known fruit trees of the temperate zone. It is occasionally called, erroneously, Japanese plum and Japanese medlar, but these names are gradually disappearing.

Though its native home is probably central-eastern China, the loquat tree was introduced very early into Japan, where it was much developed horticulturally. Some superior Japanese varieties eventually reached Europe, the Mediterranean basin and a few other regions. The loquat is grown commercially (usually on a rather small scale) in many subtropical regions. It is not adapted to the tropics, except at elevations where the climate is cool.

Ornamental in appearance and rarely more than 30 ft. in height, the evergreen loquat is frequently planted in parks and gardens. The leaves, which are clustered toward the ends of the branches, are thick and stiff, elliptic to lanceolate in form, eight to ten inches long, with coarsely serrate margins. The small fragrant white flowers are arranged in dense terminal panicles. The fruits are borne in large loose clusters; individually they are round. obovoid or pear shaped, one to three inches in length, with juicy, whitish to orange-coloured flesh surrounding three or four large seeds. The flavour is agreeably tart, suggesting that of several other fruits of the same family.

While the loquat is commonly grown from seeds, commercial plantings are usually based on grafted trees of superior varieties, such as Tanaka of Japanese origin. Gold Nugget, Champagne and Early Red of California. Propagation is by shield budding and cleft grafting; loquat seedlings or quince rootstocks grown from cuttings can be used, the latter if a dwarf tree is desired.

When planted in orchard form, the trees are spaced 20 to 25 ft. apart. They grow well on various soils. from sandy loams to clays) and come into bearing at an early age, three or four years.

(W. Po.)

LORAIN, a city of Ohio, U.S., in Lorain county, is a port on the Great Lakes. Its harbour. the lower 3 mi. of the Black river, is on the south shore of Lake Erie! 25 mi. W. of Cleveland and 70 mi. E. of Toledo. The city occupies the level terrain on both sides of the river to and beyond the head of navigation.

In the early 19th century the area was occupied by Indians. Title to the Connecticut Western Reserve district passed to the Connecticut Land company with the signing of the treaty of Fort Industry in 1805. The territory was then surveyed and opened for settlement under the name of Mouth of Black River. The village was first incorporated as Charleston in 1536. It declined in importance and lost its charter after Cleveland was selected as the terminus of the Ohio and Erie canal and when the westward extension of the railroad was routed through Elyria. leaving Charleston's port without rail connections with the interior. When the Poe lock at Sault Sainte Marie, Mich. was opened in 1896 and the Cleveland. Lorain and Wheeling railroad (now the Baltimore and Ohio railroad) to the coal fields of southeastern Ohio was completed in 1872, the coal and iron ore trade was established. The town was rechartered in 1874 as Lorain because the U.S. post office had approved another Ohio town as Charleston.

In 1890 the Johnstown Steel company was located on 3.000 ac. of land at the head of navigation on the Black river. This company mas chiefly responsible for the city's growth. Other manufacturing industries include shipbuilding. power shovels, cranes, bearings, steel stampings, car and truck assembly, railroad shops, gypsum lath and wallboard, and clothing. Coal averages 98% of all water-borne shipments, and iron ore and limestone constitute 95% of total receipts of the port of Lorain. About 50% of the iron ore and limestone are used locally.

Lorain is a cosmopolitan city with large population segments of Puerto Ricans, Hungarians, Poles, Germans, Italians. Czechoslovakians and Slovenians. Five public parks comprising 171 ac. provide recreational facilities. Population (1960) 68.932.

(R. B. Fr.)

LORAN: *see* Navigation.

LORANTHACEAE, the mistletoe family, containing 36 genera and 600 species. All the members of this dicotyledonous family are parasitic plants with green leaves. In the United States the family is represented by about six species of *Phoradendron* (American mistletoe) and some eight species of *Arceuthobium* (pine mistletoe). The only British species is *Viscum album*, the mistletoe (*q.v.*). For a treatment of the genera *see* A. Engler and K. Krause, "Loranthaceae." *Die Natürlichen Pflanzenfamilien,* ed. 2, 16b: 98–203, fig. 48–102 (1935).

LORCA, FEDERICO GARCÍA (1899–1936), Spanish poet. notable for his poems of death, was born on April 15, 1899, in Fuente Vaqueros: Granada, where he spent his early years on his father's farm. His delicate health encouraged in him a contemplative attitude toward life and the characteristic Granadine love of diminutive objects in nature. During his youth in Granada in the intervals of reading the Spanish classical and romantic poets he studied music and came under the influence of Manuel de Falla. He studied law at Granada and Madrid, but that his main interests were literary is evident from the small book *Impresiones y paisajes* which describes a Spanish town. It was at this time that Lorca began to affirm himself as poet and dramatist. His first work was a collection of poems called *Libro de poemas* (1921), which contains images that recall the *greguerías* (humorous metaphors) of Ramon Gómez de la Serna. From the outset Lorca's cult of children's songs was striking. Through them he penetrated into the life of the people and their folklore. In later years he devoted his energies to La Barraca — the vagabond theatre with which he roamed through the towns and villages of Spain.

In 1922 Lorca collaborated with Falla and Ignacio Zuloaga, the painter, in the *Fiesta de cante jondo,* which marked an important epoch in Andalusian folk art and music. In the following year he produced a children's fiesta with an interlude of Cervantes, an Andalusian tale in dialogue and a 13th-century auto sacramental entitled the "Mystery of the Three Wise Men." The music was arranged by Falla. The result of the struggle in him between poetry and music was his masterpiece *Primer romancero gitano* (1928) which won great fame in Spain and South America. In 1931 he published *Poema del cante jondo — a* subtle evocation of the celebrated Andalusian gypsy singers. In these two volumes we find continually in the background the theme of death when discussing the blood feuds of the gypsies, who in Lorca's poems are always heroic dreamers vanquished by reality. Tragedy was implicit in Lorca's genius from the beginning, and the poems of death culminate in the "Lament" on the death of his friend, the bullfighter Sanchez Mejías, in the bull ring. The finest elegy in modern Spanish literature, this is an expressionistic monodrama with phantom voices repeating again and again the fatal phrase A *las cinco de la tarde* ("At five o'clock in the afternoon").

In 1929 Lorca visited New Tork. This marked an important stage in his career for it revived his poetic demon, and the result was *Poeta en Nueva York* and the odes to the king of Harlem and to Walt Whitman in which surrealistic influences appear, and the poet adopts the tone of a seer. On his return to Spain his experiences with his vagabond theatre inspired him to write his two striking gypsy plays *Bodas de sangre* (1933) and the more romantic *Yerma* (1934). When the Spanish civil war broke out in 1936 he was finishing his play *La casa de Bernarda Alba* (1936). Although invited to visit Mexico he decided to remain in Granada. On the outbreak of the civil war some friends invited him to their house to protect him against irresponsible fanatics. According to trustworthy accounts an armed group broke in while his friends were absent, carried him off and murdered him in the outskirts of Granada on Aug. 19, 1936.

Garcia Lorca's complete works were published in Buenos Aires (1938–49); *Poems of F. Garcia Lorca,* with English translation by Stephen Spender and J. L. Gili, R. M. Nadal (ed.), were published in 1939.

Bibliography. — Roy Campbell, *Lorca: An Appreciation of His Poetry* (1952); Dámaso Alonso, *Ensayos sobre poesía española* (1946); Walter Starkie, In *Sara's Tents* (1953). (W. F. Se.)

LORCA, a town of eastern Spain, in Murcia province, on the Sangonera river. Pop. (1950) 71,269 (mun.). Lorca is the Roman Eliocroca (perhaps also the Ilorci of Pliny, *N.H.* iii, 3) and the Moorish Lurka. It was the key of Murcia during the Moorish wars. In 1810 Lorca suffered from the French invasion. There is trade in agricultural products, livestock, and manufactures of woolen stuffs, leather, chemicals and porcelain.

LORD, in its primary sense, the head of a household, the master of those dependent on him for their daily bread; the word frequently occurs in this sense in the Bible, *cf.* Matt. xxiv, 45. As a term implying the ownership of property, "lord" survives in "lord of the manor" and "landlord." The chief applications are due to its use as the equivalent of Lat. *dominus,* Gr. *kyrios* and Fr. *seigneur;* thus in the Old Testament it represents *Yahweh,* Jehovah, and, in the New Testament *kyrios* as a title of Jesus Christ. It is not only a general word for a prince or sovereign, but also the common word for a feudal superior, and particularly for a feudal tenant holding directly of the king, a baron (*q.v.*), hence a peer of the realm, a member of the House of Lords, constituted of the lords temporal and the lords spiritual; this is the chief modern usage. The prefix "lord" is ordinarily used as a less formal alternative to the full title: whether held by right or by courtesy, of marquess, earl or viscount, and is always so used in the case of a baron (which in English usage is generally confined to the holder of a foreign title). Where the name is territorial the "of" is dropped, thus the marquess of A., but Lord A. The younger sons of dukes and marquesses have, by courtesy, the title of Lord prefixed to the Christian and surname, *e.g.,* Lord John Russell. In the case of bishops, the full and formal title of address is the Lord Bishop of A., whether he be a spiritual peer or not. Many high officials of the British Government have the word "lord" prefixed to their titles. (*See* CABINET, THE.) In certain cases the members of a board which has taken the place of an office of State are known as lords commissioners or, shortly, lords of the office in question, *e.g.,* lords of the treasury, civil or naval lords of the admiralty.

For lord lieutenant and lord mayor *see* LIEUTENANT and MAYOR. As the proper form of address, "my lord" is used not only to those members of the nobility to whom the title "Lord" is applicable, and to bishops, but also to all judges of the High Court in England, and of the Scottish and Irish Superior Courts, and to lord mayors and lord provosts (*see* also FORMS OF ADDRESS.)

LORD ADVOCATE, or king's advocate, the principal law-officer of the Crown in Scotland. His business is to act as a public prosecutor, and to plead in all causes that concern the Crown. He is the head of the administration of criminal justice, and thus his functions are of a far more extensive character than those of the English law-officers. He is aided by a solicitor-general and advocates-depute. The office seems to have been established about the beginning of the 16th century. Originally he could only prosecute with the concurrence of a private party; but in the year 1597 he was empowered to do so at his own instance. He has the privilege of pleading in court with his hat on.

LORD CHAMBERLAIN, in England, an important officer of the king's household, to be distinguished from the lord great chamberlain (*q.v.*). He is the second dignitary of the court, and is always a member of the government of the day (before 1782 the office carried cabinet rank), a peer and a privy councillor. He carries a white staff, and wears a golden or jewelled key, typical of the key of the palace, which is supposed to be in his charge, as the ensigns of his office. He is responsible for the necessary arrangements connected with State ceremonies, such as coronations and royal marriages, christenings and funerals; he examines the claims of those who desire to be presented at court; all invitations are sent out in his name by command of the sovereign, and at drawing-rooms and levees he stands next to the sovereign and announces the persons who are approaching the throne. It is also part of his duty to conduct the sovereign to and from his carriage. At one time he discharged some important political functions. The bedchamber, privy chamber and presence chamber, the wardrobe, the housekeeper's room, the guardroom and the chapels royal are in the lord chamberlain's department. He is regarded as chief officer of the royal household, and he has charge of a large number of appointments, such as those of the royal physicians, tradesmen and private attendants of the sovereign.

All theatres in the cities of London and Westminster (except patent theatres), in certain of the London boroughs and in the towns of Windsor and Brighton, are licensed by him and he is also licenser of plays.

The vice-chamberlain of the household is the lord chamberlain's assistant and deputy. He also is one of the ministry, a white-staff officer and the bearer of a key; and he is generally a peer or the son of a peer as well as a privy councillor. Next to the vice-chamberlain comes the groom of the stole, an office only in use during the reign of a king. He has the charge of the vestment called the stole worn by the sovereign on State occasions, In the lord chamberlain's department also are the master, assistant master, marshal of the ceremonies and deputy-marshal of the ceremonies, officers whose special function it is to enforce the observance of the *etiquette* of the court. The reception of foreign potentates and ambassadors is under their particular care, and they assist in the ordering of all entertainments and festivities at the palace. The gentleman usher of the black rod—the black rod which he carries being the ensign of his office—is the principal usher of the court and kingdom. He is one of the original functionaries of the order of the Garter, and is in constant attendance on the House of Lords, from whom, either personally or by his deputy, the yeoman usher of the black rod, it is part of his duty to carry messages and summonses to the House of Commons. There are six lords and six grooms "in waiting" who attend on the sovereign throughout the year and whose terms of attendance are of a fortnight's or three weeks' duration at a time. Usually "extra" lords and grooms in waiting are nominated by the sovereign, who, however, are unpaid and have no regular duties. Among the serjeants-at-arms there are two to whom special duties are assigned: the one attending the speaker in the House of Commons, and the other attending the lord chancellor in the House of Lords, carrying their maces and executing their orders. The comptroller and examiner of accounts, the paymaster of the household, the licenser of plays, the dean and subdean of the chapels royal, the clerk and deputy clerks of the closet, the groom of the robes, the pages of the backstairs, of the chamber and of the presence, the poet laureate, the royal physicians and surgeons, chaplains, painters and sculptors, librarians and musicians, etc., are all under the superintendence of the lord chamberlain of the household.

The queen consort's household is also in the department of the lord chamberlain of the household. It comprises a lord chamberlain, a vice-chamberlain and treasurer, equerry and the various ladies of the royal household, a groom and a clerk of the robes. The ladies of the household are the mistress of the robes, the ladies of the bedchamber, the bedchamber women and the maids of honour. The mistress of the robes in some measure occupies the position of the groom of the stole. She is the only lady of the court who comes into office and goes out with the administration. She is always a duchess, and attends the queen consort at all State ceremonies and entertainments, but is never in permanent residence at the palace. Since the great "bedchamber question" of 1839 the settled practice has been for all the ladies of the court except the mistress of the robes to receive and continue in their appointments independently of the political connections of their husbands, fathers and brothers. The ladies of the bedchamber share the personal attendance on the queen consort throughout the year. Of these there are eight, always peeresses, and each is in waiting for a fortnight or three weeks at a time. But the women of the bedchamber, of whom there are also eight, appear only at court ceremonies and entertainments according to a roster annually issued under the authority of the lord chamberlain of the queen consort. They are usually the daughters of peers or the wives of the sons of peers. The eight maids of honour have the same terms of waiting as the ladies of the bedchamber. They are commonly if not always the daughters or granddaughters of Peers.

LORD CHIEF JUSTICE OF ENGLAND is the head of the king's bench division of the high court of justice and next in rank to the lord chancellor. He is *ex officio* a member of the court of appeal, and is appointed by the Crown on nomination of the prime minister. This title was conferred upon him by the Judicature Act, 1873, by which the court of queen's bench became one of the divisions of the queen's bench division. It may be traced to that of the first minister of the Crown under the Norman and Angevin kings—capitalis *Angliae justiciarius.* He is now the only judicial officer entitled to wear the collar of SS, formerly worn by the chief justices of the three common law courts. His salary is £8,000 a year.

LORD GREAT CHAMBERLAIN, in England, a functionary who must be carefully distinguished from the lord chamberlain; he is one of the great officers of State, whose office dates from Norman times; and the only one who still holds it under a creation of that period. As his name implies, he was specially connected by his duties with the king's chamber (***camera curie);*** but this phrase was also used to denote the king's privy purse, and the chamberlain may be considered as originally the financial officer of the household. But as he was always a great baron, deputies performed his financial work, and his functions became, as they are now, mainly ceremonial, though the emblem of his office is still a key. The office had been held by Robert Malet, son of a leading companion of the Conqueror, but he was forfeited by Henry I., who, in 1133, gave the great chamberlainship to Aubrey de Vere and his heirs, earls of Oxford, who, with some intermissions, held the office till 1779 when it passed to the coheiresses of Lord Willoughby d'Eresby. The office is now vested jointly in Lords Ancaster, Cholmondeley and Carrington.

The lord great chamberlain has charge of the palace of Westminster, especially of the House of Lords, in which he has an office; and when the sovereign opens parliament in person he is responsible for the arrangements. At the opening or closing of the session of parliament by the sovereign in person he disposes of the sword of State to be carried by any peer he may select, and walks himself in the procession on the right of the sword of State, a little before it and next to the sovereign. At coronations he emerges into special importance; he still asserts before the court of claims his archaic right to bring the king his "shirt, stockings and drawers" and to dress him on coronation day and to receive his ancient fees, which include the king's bed and "night robe." He also claims in error to serve the king with water before and after the banquet, which was the function of the "ewry," a distinct office held by the earls of Oxford. At the actual coronation ceremony he takes an active part in investing the king with the royal insignia.

(J. H. R.)

LORD HIGH CHANCELLOR, a British officer of state with three main functions: he presides over the house of lords; he is the head of the judiciary; he is also a minister, a member of the government and of the cabinet, having under his control all the judicial appointments in the country except those reserved to the prime minister, and a great deal of ecclesiastical patronage.

This miscellany of duties and powers are united in one person for reasons that lie deep in history. In England the office of chancellor dates back to St. Edward, the Confessor, who, in making this appointment, followed the model of the Carolingian court. Until the 14th century the chancellor was invariably a priest; he was at once a royal chaplain, the king's secretary in secular matters and keeper of the royal seal. This combination of duties, characteristic of the primitive administrative systems of the early middle ages, has left its imprint on the chancellorship to the present day: as chaplain the chancellor was keeper of the king's conscience, as secretary he was the king's closest confidant in secular matters and as keeper of the seal he played a necessary part in all formal expressions of the king's will. By him and his staff of chaplains the whole secretarial work of the royal household was conducted, the accounts were kept under the justiciar and treasurer, writs were drawn up and sealed and the royal correspondence was carried on. The chancellor was, in fact, as the historian Bishop Stubbs put it, a sort of secretary of state for all departments.

From the 12th century until the early Tudor period the chancellor wielded immense power, especially during an interregnum or the king's absence abroad. Among notable chancellors were Roger (d. 1139), bishop of Salisbury, who organized the exchequer in the reign of Henry I, and Thomas Becket (d. 1170), who held the office before Henry II made him archbishop of Canterbury. In the reign of Richard I, Archbishop Hubert Walter (d. 1205) achieved particular prominence because of the king's prolonged absences. Robert Burnell (d. 1292) was Edward I's most trusted and influential minister, while tenure of the office contributed greatly to the power and self-importance of the cardinals Henry Beaufort (d. 1447) and Thomas Wolsey (d. 1530).

The chancellorship in England developed on different lines from the chancellorship in the Holy Roman empire and, later, the Austrian and the German empires; there the chancellors, as exemplified by Metternich and Bismarck, remained up to modern times the effective heads of government, as is the chancellor in the Federal Republic of Germany (*see* CHANCELLOR). The reason for the difference lies in the development, in England, of the judicial duties of the chancellor. These grew out of the fact that all petitions addressed to the king passed through the chancellor's hands. Already in the reign of Henry II the chancellor was largely employed in judicial work. The office acquired a more definitely judicial character when, in the reign of Edward III, the chancellor's court ceased to follow the king; and the time when, in the middle of this reign, all petitions that were matters of grace were definitely committed to the king may be taken as the start of the equitable jurisdiction of the chancellor (*see* EQUITY). The chancellor's court was the direct precursor of the court of chancery, which, by the Judicature act, 1873, was fused into the high court of justice, the chancery division of which is primarily responsible for that court's equitable jurisdiction. The lord chancellor is the president of the chancery division; he is a member of the court of appeal and, if present, presides over it.

The judicial work of contemporary chancellors is, however, almost exclusively confined to the house of lords and the judicial committee of the privy council (*q.v.*); when the chancellor is present, he presides over both tribunals, though, because of the weight of administrative business, modern chancellors seem to have less time for their judicial duties than had their predecessors before 1939.

The position of the chancellor as speaker or prolocutor of the house of lords dates from the time of the English Norman kings, when the ministers of the royal *curia* (the king's court) formed ex officio a part of the *commune concilium* (the great council) and parliament. The chancellor originally attended with the other officials, and he continued to attend ex officio after they had ceased to do so. The chancellor attends the house of lords by virtue of his office, but he has generally, and since the reign of Queen Anne invariably, been a peer. There have been times when the great seal has been put into commission and other times when its custody has been transferred from the chancellor to a minister with the title of lord keeper of the great seal (*q.v.*). By the Act of Union (1707) of England and Scotland one great seal was appointed to be kept for all public acts; the chancellor's authority thus extends to the whole of the United Kingdom, and the commissions of the peace for Scotland. as well as for England, issue from him. By the Roman Catholic Relief act, 1829, it was enacted that no Roman Catholic was to be appointed lord chancellor or keeper or commissioner of the great seal.

As speaker of the house of lords, the chancellor's powers and duties differ considerably from those of the speaker of the house of commons. He puts the question but has no power to rule upon points of order. Like the speaker of the house of commons, he may take part in debates, and, unlike modern speakers, chancellors frequently do so.

See also MINISTRY. GOVERNMENT. (W. T. Ws.)

LORD HIGH CONSTABLE: *see* CONSTABLE.

LORD HIGH STEWARD. The lord high steward of England, who must not be confused with the lord steward (*q.v.*), ranks as the first of the great officers of State. Appointments to this office are now made only for special occasions, such as the coronation of a sovereign or the trial of a peer by his peers. The history of the officeis noteworthy. The household of the Norman and Angevin kings of England included certain domestics and officials styled dapifers, seneschals or stewards (the prototypes of the lord steward). At coronations, however, and great festivals it became the custom in England and else here to appoint magnates of the first rank to discharge for the occasion these domestic functions. In accordance with this custom Henry II. appointed both Robert II., earl of Leicester, and Hugh Bigod, earl of Norfolk, to be his honorary hereditary stewards; and at the Christmas festival of 1186 the successors in title of these two earls are described as serving the king at the royal banqueting table. Subsequently the earls of Leicester bought out the rights of the earls of Norfolk for ten knights' fees.

The last of these earls of Leicester to inherit the hereditary stewardship was Simon V. de Montfort, upon nhose death his forfeited estates were conferred on his son Edmund of Lancaster, who also obtained a grant of the stewardship, but only for life. Edmund was succeeded by Thomas, earl of Lancaster, who, upon his execution for treason, was succeeded in the earldom by his brother Henry. The subsequent earls and dukes of Lancaster were all recognized as stewards of England, the office apparently being treated as annexed to the earldom, or honour, of Leicester. Strictly speaking, none of the Lancasters after Thomas had any clear title either by grant or otherwise; such title as they had merged in the Crown when Henry IV. usurped the throne. Meanwhile the stewardship had increased in importance. On the accession of Edward III., Henry, earl of Lancaster, as president of the council, had superintended the coronation of the infant king; John of Gaunt did the same for the infant Richard II., and, as part of the duties involved, sat in the White Hall of Westminster to hear and determine the claims to perform coronation services. The claims were made by petition, and included, amongst others, the claim of Thomas of Woodstock to act as constable, the rival claims of John Dymock and Baldwin de Frevile to act as champion, and the claim of the barons of the cinque ports to carry a canopy over the king. Minutes of these proceedings, in which the duke is stated to have sat "as steward of England," were enrolled by his order. This is the origin of what is now called the court of claims. The precedent of Richard II. has been followed on all subsequent occasions, except that in modern times it has been the practice to appoint commissioners instead of a steward to superintend this court. In 1397 John of Gaunt created a notable precedent in support of the steward's claim to be supreme judge in parliament by presiding at the trial of the earl of Arundel and others.

When Henry IV. came to the throne he appointed his young son Thomas, afterwards duke of Clarence, to the office of steward. Clarence held the office until his death. He himself never acted as judge in parliament; but in 1415 he was appointed to preside at the judgment of peers delivered in Southampton against Richard, earl of Cambridge, and Lord Scrope of Masham, who had been previously tried by commissioners of oyer and terminer. No permanent steward was ever again created; but a steward was always appointed for coronations to perform the various ceremonial services associated with the office, and, until the court of claims was entrusted to commissioners, to preside over that court. Also, in the 15th century, it gradually became the custom to appoint a steward pro *hac vice* to preside at the trial, or at the proceedings upon the attainder, of a peer in parliament; and later, to preside over a court, called the court of the lord high steward, for the trial of peers when parliament was not sitting. To assist in establishing the latter court a precedent of 1400 appears to have been deliberately forged. This precedent is reported in the printed *Year-Book* of 1400, first published in 1553; it describes the trial of "the earl of H" for participation in the rebellion of that year, and gives details of procedure. John Holand, earl of Huntingdon, is undoubtedly the earl indicated, but the evidence is conclusive that he was murdered in Essex without any trial. The court of the lord high steward seems to have been first definitely instituted in 1499 for the trial of Edward Plantagenet, earl of Warwick; only two years earlier Lord Audley had been condemned by the court of chivalry, a very different and unpopular tribunal. The Warwick trial was most carefully schemed: the procedure, fundamentally dis-similar to that adopted in 1415, follows exactly the forged precedent; but the constitution of the court was plainly derived from the Southampton case. The record of the trial was consigned to a new repository (commonly but wrongly called the *Baga de Secretis),* which thenceforth became the regular place of custody for important state trials. Latterly, and possibly from its inception, this repository consisted of a closet with three locks, of which the keys were entrusted, one to the chief justice of England, another to the attorney-general and the third to the master of the Crown office, or coroner. Xotwithstanding the irregular origin of the steward's court, for which Henry VII. must be held responsible, the validity of its jurisdiction cannot be questioned. The Warwick proceedings were confirmed by act of parliament, and ever since this court has been fully recognized as part of the English constitution.

For about a century and a half prior to the reign of James I. the criminal jurisdiction of parliament remained in abeyance, and bills of attainder were the vogue. The practice of appointing a steward on these occasions to execute judgment upon a peer was kept up till 1477—when George, duke of Clarence, was attainted—and then dropped. Under the Stuarts the criminal jurisdiction of parliament was again resorted to, and, when the proceedings against a peer were founded on indictment, the appointment of a steward followed as a matter of settled practice. The proper procedure in cases of impeachment had, on the contrary, never been defined. On the impeachment of Strafford the lords themselves appointed Arundel to be high steward. In Danby's case a commission under the great seal was issued in the common form adopted for the court of the .steward; this was recalled, and the rule agreed to by a joint committee of both houses was that a steward for trials of peers upon impeachments was unnecessary. But, as such an office was obviously convenient, the lords petitioned for a steward; and a fresh commission was accordingly issued in an amended form, which recited the petition, and omitted words implying that the appointment was necessary. This precedent has been treated as settling the practice of parliament with regard to impeachments.

Of the proceedings against peers founded upon indictment very few trials antecedent to the revolution took place in parliament. The preference given to the steward's court was largely due to the practice, founded upon the Southampton case, of summoning only a few peers selected by the steward, a practice which made it easy for the king to secure a conviction. This arrangement has been partially abrogated by the Treason Act of William III., which in cases of treason and misprision of treason requires that all peers of parliament shall be summoned 20 days at least before every such trial. The steward's court also differed in certain other particulars from the high court of parliament. For example, it was ruled by Lord Chancellor Jeffreys, as steward at the trial of Lord Delamere, that, in trials of peers which take place during the recess of parliament in the steward's court, the steward is the judge of the court, the court is held before him, his warrant convenes the prisoner to the bar, his summons convenes the peers for the trial, and he is to determine by his sole authority all questions of law that arise in the course of the trial, but that he is to give no vote upon the issue of guilty or not guilty; during a session of parliament, on the contrary, all the peers are both triers and judges, and the steward is only the chairman of the court and gives his vote together with the other lords. Lord Delamere was tried in 1685 in the steward's court; since then all trials of peers have taken place before the lords in parliament. The most recent trial was that of Earl Russell in 1901, when Lord Chancellor Halsbury was made lord high steward. The steward is addressed as "his grace," he has a rod of office, and the commission appointing him is dissolved according to custom by breaking this rod.

A court of claims sat and a steward was appointed for the coronation of Edward VII.; and during the procession in Westminster Abbey the duke of Marlborough, as steward, carried "St. Edward's crown" in front of the bearer of the Bible (the bishop of London), who immediately preceded the king; this function of the steward is of modern origin. The steward's ancient and particular services at coronations are practically obsolete; the full ceremonies, processions from Westminster Hall and banquet in which he figured prominently were abandoned on the accession of William IV.

Bibliography.—For the early history of the steward *see* L. W. Vernon-Harcourt, *His Grace the Steward and Trial of Peers* (1907); for the later history of the office *see* Sir E. Coke, *Institutes* (1797); Cobbett and Howell, *State Trials* (1809, *seq.)* ; Sir *M.* Foster, *Crown* Law (1809); J. Hatsell, *Precedents of Proceedings in the House of Commons*, vol. iv. (1818); and S. M. Phillips, *State Trials* (1826). *See* also the various works on *Coronations* for the steward's services on these occasions. (L. W. V.-H.)

LORD HIGH TREASURER, in England, once the third great officer of state. The office was of Norman origin and dated from 1216. The duty of the treasurer originally was to act as keeper of the royal treasure at Winchester, while as officer of the exchequer he sat at Westminster to receive the accounts of the sheriffs, and appoint officers to collect the revenue. From the middle of the reign of Henry III. he became one of the chief officers of the Crown. He took an important part in the equitable jurisdiction of the exchequer, and was now styled lord high treasurer and treasurer of the exchequer. The first office was conferred by delivery of a white staff, the second by patent. On the death of

Lord Salisbury in 1612 the office was put in commission; it was filled from time to time until 1714, when the duke of Shrewsbury resigned it; since that time it has always been in commission. (See GOVERNMENT DEPARTMENTS.) The Scottish treasury was merged with the English by the Act of Union, but the office of lord high treasurer for Ireland was continued until 1816.

LORD HOWE, an island in the southern Pacific ocean, situated in long. 159° 5′ E. and in lat. 31° 36′ S., 436 mi. N.E. of Sydney, Austr. Pop. (1954) 278. The island measures about 5 mi. by 1 mi., is well wooded and rises to 2,830 ft. at the southern end. It is of volcanic origin, and its coral reefs on the western shore are the most southerly known. The island was discovered in 1788 and was settled in 1843 as a dependency of New South Wales, and is now governed by a board of control in Sydney. Although mainly a tourist resort, the island has a rock-melon seed trade. which replaced an earlier palm-seed trade. Lord Howe is also the name of an atoll in the Solomon Islands.

LORD JUSTICE CLERK, in Scotland, the judge next in rank to the lord justice-general. He presides in civil cases in the second division of the court of session, and in the absence of the lord justice-general, presides in criminal cases in the court of justiciary. The justice clerk was originally not a judge at all, but simply clerk and legal assessor of the justice court. In course of time he was raised from the clerk's table to the bench, and by custom presided over the court in the absence of the justice-general. Up to 1672 his position was somewhat anomalous, as it was doubtful whether he was a clerk or a judge, but an act of that year, which suppressed the office of justice-depute, confirmed his position as a judge, forming him, with the justice-general and lords commissioners of justiciary, into the court of justiciary. The lord justice clerk is also one of the officers of State for Scotland, and one of the commissioners for keeping the Scottish regalia.

LORD JUSTICE-GENERAL, the highest judge in Scotland, head of the court of justiciary, called also the lord president, and as such head of the court of session and representative of the sovereign. The office of justice-general was for a considerable time a sinecure post held by one of the Scottish nobility, but by the Court of Session Act, 1830, it was enacted that, at the termination of the existing interest, the office should be united with that of lord president of the court of sessions, who then became presiding judge of the court of justiciary.

LORD KEEPER OF THE GREAT SEAL, in England, formerly a great officer of State. The great seal of England, which is affixed on all solemn occasions to documents expressing the pleasure of the sovereign, was first adopted by Edward the Confessor (see SEALS), and entrusted to a chancellor for keeping. The office of chancellor from the time of Becket onwards varied much in importance; the holder being an ecclesiastic, he was not only engaged in the business of his diocese, but sometimes was away from England. Consequently, it became not unusual to place the personal custody of the great seal in the hands of a keeper; this, too, was the practice followed during a temporary vacancy in the chancellorship. This office gradually developed into *a* permanent appointment, and the lord keeper acquired the right of discharging all the duties connected with the great seal. He was usually, though not necessarily, a peer, and held office during the king's pleasure; he was appointed merely by delivery of the seal, and not. like the chancellor, by patent. His status was definitely fixed (in the case of lord keeper Sir Nicholas Bacon) by an act of Elizabeth, which declared him entitled to the same powers and jurisdiction as the lord chancellor. Subsequently he was generally raised to the chancellorship, and retained the custody of the seal. The last lord keeper was Sir Robert Henley (afterwards Lord Northington), made chancellor on the accession of George III.

LORD PRESIDENT OF THE COUNCIL, in England, one of the great officers of State, and a member of the ministry. It was only in 1679 that the office of lord president became permanent. Previously either the lord chancellor, the lord keeper of the seal, or some particular court official took formal direction of the Privy Council. In the reign of Charles I, a special lord president of the council was appointed, but in the following reign the office was left unfilled. The office was of considerable importance when the powers of the Privy Council, exercised through various committees, were of greater extent than at the present time. (See GOVERNMENT DEPARTMENTS.) The duties of the office are to preside on the infrequent meetings of the Privy Council, and to draw up the minutes of council upon subjects which do not belong to any other department of State. The office is very frequently held in conjunction with other ministerial offices. The lord president is appointed by a declaration made in council by the sovereign. He is invariably a member of the House of Lords, and is included in the cabinet.

LORD PRIVY SEAL, the officer in the British government who has custody of the Privy Seal. See SEALS.

LORDS JUSTICES OF APPEAL: see JUDICIARY AND COURT OFFICERS.

LORDS OF APPEAL IN ORDINARY: see JUDICIARY AND COURT OFFICERS.

LORD STEWARD, in England, an important official of the king's household. He is always a member of the Government, a peer and a privy councillor. Up to 1782 the office was one of considerable political importance and carried cabinet rank. The lord steward receives his appointment from the sovereign in person, and bears a white staff. He is the first dignitary of the court. In the Statutes of *Eltham* he is called "the lord great master," but in the Household Book of Queen Elizabeth "the lord steward," as before and since. He presides at the Board of Green Cloth, a committee of the king's household, charged with the audit of its accounts. The board had also power to punish all offenders within the verge or jurisdiction of the palace. The name is derived from the green-covered table at which the transactions of the board were originally conducted. Under the lord steward are the treasurer and comptroller of the household, usually peers or the sons of peers and privy councillors, who sit at the Board of Green Cloth, carry white staves, and belong to the Ministry. But the duties which in theory belong to the lord steward, treasurer and comptroller of the household are in practice performed by the master of the household, who is a permanent officer and resides in the palace. He is a white-staff officer and a member of the Board of Green Cloth but not of the Ministry, and among other things he presides at the daily dinners of the suite in waiting on the sovereign. In his case history repeats itself. He is not named in the Black Book of Edward IV. or in the Statutes of Henry VIII., and is entered as "master of the household and clerk of the green cloth" in the Household Book of Queen Elizabeth. But he has superseded the lord steward of the household, as the lord steward of the household at one time superseded the lord high steward of England.

In the lord steward's department are the officials of the Board of Green Cloth, the coroner ("coroner of the verge"), and paymaster of the household, and the officers of the almonry. (See ALMONER.) The lord steward had formerly three courts besides the Board of Green Cloth under him. First, the lord steward's court, superseded (1541) by—second—the Marshalsea court, a court of record having jurisdiction, both civil and criminal, within the verge (the area within a radius of 12m. from where the sovereign is resident), and originally held for the purpose of administering justice between the domestic servants of the sovereign, "that they might not be drawn into other courts and their service lost." Its criminal jurisdiction had long fallen into disuse and its civil jurisdiction was abolished in 1849. Third, the palace court, created by letters patent in 1612 and renewed in 1665 with jurisdiction over all personal matters arising between parties within 12m. of Whitehall (the jurisdiction of the Marshalsea court, the City of London and Westminster Hall being excepted). It had no jurisdiction over the sovereign's household, nor were its suitors necessarily of the household. The privilege of practising before the palace court was limited to four counsel. It was abolished in 1849. The lord steward or his deputies formerly administered the oaths to the members of the House of Commons. In certain cases (messages from the sovereign under the sign-manual) "the lords with white staves" are the proper persons to bear communications between the sovereign and the houses of parliament.

Bibliography.—*See* the *Statutes of Eltham;* the *Household Book* of Queen Elizabeth; Sir E. Coke, *Institutes* (1797); J. Reeves, *History of English Law* (1869); Sir H. J. Stephen, *Commentaries on the Laws of England* (18th ed., 1925); J. H. Hatsell, *Precedents of Proceedings in the House of Commons* (1818); T. E. May, *A Practical Treatise on the Law . . . and Usage of Parliament* (13th ed., 1921).

LOREBURN, ROBERT THRESHIE REID, 1st Earl (1846–1923), British lawyer and politician, who as lord chancellor was largely responsible for the passage of the Court of Criminal Appeal act (1907), was born at Corfu on April 3, 1846. He was educated at Cheltenham and Balliol college, Oxford, where he won the Ireland scholarship in 1868. He was called to the bar in 1871, and in 1880 entered politics as Liberal M.P. for Hereford. In 1882 he became queen's counsel and represented Dumfries Burghs from 1886 to 1905. In 1894 he became solicitor-general and during 1894–95 was attorney general. On the formation of Campbell-Bannerman's government in 1905, Sir Robert Reid, who had been knighted in 1894, became lord chancellor, and was created Baron Loreburn. In 1912 he resigned on grounds of health. Lord Loreburn, who was created an earl in July 1911, published *Capture at Sea* (1913) and *How the War Came* (1919). He died at Dover on Nov. 30, 1923.

LOREE, LEONOR FRESNEL (1858–1940), American railway president, son of William Mulford Loree, a millwright, was born in Fulton City, Ill., on April 23, 1858. After graduating at Rutgers college in 1877, he entered the service of the Pennsylvania railroad as a rodman. In 1879 he served in the U.S. army engineering corps and in 1881 as civil engineer for the Mexican National railway. Re-entering the employ of the Pennsylvania railroad in 1883, he served in engineering positions of increasing importance until 1889 when he was made a division superintendent, and in 1896 he rose to the position of general manager. In 1901 he was elected to a vice-presidency but resigned in the same year to become president of the Baltimore and Ohio railroad company, an office held until 1904 when he was chosen president of the Rock Island company. In 1907 he was elected president of the Delaware and Hudson company, a position in which he served for more than 30 years. He served also as a director of several other railways and in 1926 was made chairman of the board of the Missouri-Kansas-Texas railroad company. He invented the upper quadrant system of semaphore signaling, now standard on American railways; built the first high-pressure locomotive; and made other improvements. In the effort to consolidate American railways into a limited number of systems in accordance with the policy formulated by Congress in 1920 he took an active and influential part. He also established the first organized railway police force. He wrote *Railroad Freight Transportation* (1922).

LORELEI, the name of a rock with a remarkable echo in the Rhine river near St. Goar. The word is derived from Old High German, *Lur,* connected with modern German *lauern,* "to lurk," "be on the watch for," and equivalent to *Elf* ("goblin") and *Lai* ("a rock"). In the commonest form of the story associated with it the Lorelei is a maiden who threw herself into the Rhine in despair over a faithless lover, and became a siren who lured fishermen to destruction. Clemens Brentano created the legend in its main essentials in his novel *Godwi* (1800–02). In the 19th century it formed the subject of a number of songs and dramatic sketches (listed in H. Seeliger, *Loreleysage in Dichtung und Musik;* 1898). The poem most often set to music was Heinrich Heine's "Ich weiss nicht was soll es bedeuten," of which the settings by Friedrich Silcher (from a folk song) and by Franz Liszt are the most famous.

See R. Elwenzeller-Favre, *Lorelei. Entstchung und Wandlung einer Sage* (1946).

LORENTZ, HENDRIK ANTOON (1853–1928), Dutch physicist, who shared the 1902 Nobel prize for physics with Pieter Zeeman for work on the influence of magnetism on radiation and helped lay the basis for Albert Einstein's special theory of relativity. He was born at Arnheim on July 18, 1853. He studied at Leyden, where he was appointed professor of mathematical physics in 1878. In 1923 he became director of research at the Teyler institute, Haarlem. He remained honorary professor at Leyden, where he gave a weekly lecture on modern physics, which was usually reported for publication by one of the audience.

Lorentz's work in physics was very wide in its scope, but its central aim, it appears, was to arrive at some consistent theory for electricity, magnetism and light. He tried to explain these phenomena by assuming an ether which was at rest and had electrons either at rest or moving in it. A number of phenomena were successfully explained on this electron theory, but it failed to give an explanation of the negative result of the Michelson-Morley experiment (*q.v.*). To overcome this difficulty Lorentz introduced the idea of "local time" in 1895. The connection between this and the Fitzgerald contraction was pointed out by Sir Joseph Larmor, and in 1903 Lorentz extended his work and arrived at the "Lorentz transformation," which helped form the basis (1905) of Einstein's restricted theory of relativity.

Lorentz's earlier investigations were originally published in Dutch in the *Archives Néerlandaises* and consequently were not known to English physicists; Lord Rayleigh and Sir Oliver Lodge were largely responsible for the spread of his ideas in England. His first paper, published in 1875, dealt with the reflection and refraction of light by dielectrics and metals. In 1880 he published a memoir on the relation between the refractive index and the density of a medium. This was the first application of James C. Maxwell's theory to a medium consisting of discrete molecules. Lorentz dealt with optical dispersion and tried to give an explanation on the assumption that it was due to resonant vibrations. This work was continued in his two well known memoirs, *La Théorie électromagnétique de Maxwell et son application aux corps mouvants* (1892) and *Versuch einer Theorie der electrischen und optischen Erscheinungen in bewegten Körpern* (1895). In the latter memoir he deals with the electrodynamic field of a system moving with uniform velocity. Lorentz gave an explanation of the Zeeman effect very soon after it was observed, and predicted polarization effects which were verified later by experiment. He was also the author of a number of papers on gravitation theory, thermodynamics, radiation and kinetic theory. He was chairman of the committee of intellectual co-operation set up by the League of Nations. He died at Haarlem on Feb. 4, 1928.

Bibliography.—Lorentz's works include *Collected Papers* (1934–39); *Lectures on Theoretical Physics* (1927–31); *Problems of Modern Physics* (1927); *The Theory of Electrons* (2nd ed. 1953). *See* G. L. de Haas-Lorentz, *H. A. Lorentz* (1957). (E. Tr.; X.)

LORENZETTI, the name of two brothers, both Italian painters of the Sienese school, active in the first half of the 14th century. Their style combined the harmonious colour and expressive design of Duccio with the monumental realism of Giotto and, in the case of the elder, the dramatic naturalism of Giovanni Pisano. Their art was much imitated in Siena during the third quarter of the 14th century, and many works by close followers are still commonly attributed to one or the other.

Ambrogio Lorenzetti (*c.* 1290–1348), the younger brother, ranks in importance with the greatest Sienese painters, Duccio and Simone Martini. Since neither he nor his brother is mentioned in documents after 1348, it is assumed that both died of the plague that devastated Siena in that year. Only six documented works of Ambrogio, apparently covering a period of merely 13 years, have survived. They include four scenes from the legend of St. Nicholas of Bari in the Uffizi gallery, Florence, which are parts of an altarpiece painted about 1332 in Florence; the wall decorations of 1337–39 in the Sala della Pace in the Palazzo Pubblico, Siena, representing "Good Government," "Effects of Good Government," "Bad Government" and "Effects of Bad Government"; and the signed and dated panels of the "Presentation of Christ in the Temple" (1342) in the Uffizi, and of the "Annunciation" (1344) in the Pinacoteca, Siena. Ambrogio's most important undocumented works are panel paintings of the "Madonna and Child."

It is not known who Ambrogio's teacher was, but his early works indicate that the young painter received his main inspiration from the art of Duccio, his brother Pietro and Giotto. Already at this early period his representations reveal a realistic individualism and an intense occupation with significant composition and form. These characteristics are most evident in the "Allegories" in the Palazzo Pubblico, the most important Sienese fresco decoration. In it we see Ambrogio as an acute observer of the world around him, an empirical explorer of linear and aerial perspective, a student of classical works of art, and a political and moral philosopher. His desire to depict spatial depth convincingly led Ambrogio to an increasingly accurate rendering of space in his paintings and almost to one-point perspective in his last work, the "Annunciation." With his profound interest in perspective and in classical antiquity Ambrogio anticipated the Renaissance.

PIETRO LORENZETTI (*c.* 1280/90–1348), incorrectly called Pietro Laurati by Vasari, apparently was the elder brother of Ambrogio. His earliest certain work, the Madonna polyptych of 1320, an altarpiece in the Pieve at Arezzo, indicates that he studied under Duccio or a close pupil of this master, and that he was influenced by Giotto's solemn and Giovanni Pisano's dramatic representations. These influences are evident also in the somewhat later frescoes of the "Madonna and Child with Saints," and the "Crucifixion, Deposition, Entombment, Descent into Limbo, and Resurrection of Christ" in the left transept of the lower church of S. Francesco, Assisi. In the Madonna painting at Arezzo and in that at Assisi the Virgin and Child are depicted intently gazing at each other, a motif directly derived from Giovanni Pisano's sculpture. In the important altarpiece of 1329 for the Carmine church, Siena, now in the Pinacoteca of that city, the artist chose a less intimate composition for the Virgin and Child, but he compensated for the formal main representation by adding very animated predella scenes, in which spatial depth is skillfully asserted.

During the 1330's Pietro became somewhat influenced by the art of his brother, with whom he produced in 1335 four scenes from the life of the Virgin (destroyed in the 18th century) on the facade of Sta. Maria della Scala, Siena. In Pietro's triptych of the "Nativity of the Virgin" in the Museo dell'Opera del Duomo, Siena (1335–42), the figures have a breadth and composure and the space representation has an originality suggestive of Ambrogio.

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LORENZO, FIORENZO DI (*c.* 1445–*c.* 1525), Umbrian painter, a precursor of Pinturicchio, became a member of the guild of painters in Perugia between 1463 and 1469. In 1472 he was elected prior of the guild and his birth is for this reason generally assumed to have taken place about 1445. A signed altarpiece in the Galleria Nazionale dell'Umbria representing SS. Peter and Paul beside a niche with a lunette of the Virgin and Child was painted in 1487. Works conjecturally datable before this time are a triptych from the Confraternità della Giustizia at Perugia and an Adoration of the Shepherds from Monteluce, both in the Perugia gallery, and a triptych in the National gallery, London. The London triptych is related to paintings by Niccolò Alunno at Deruta and by Benozzo Gozzoli at Vienna, and both these artists seem to have exercised a significant, though not necessarily direct, influence on Fiorenzo's early style. The relationship of Fiorenzo di Lorenzo's early works to paintings by Verrocchio is also noteworthy and lends some force to the view that before 1470 he worked in Florence. Documents of 1490, 1491 and 1513 relate to the production of lost works, but the artist's mature development can be traced through frescoes in S. Francesco at Deruta (1478), Monteluce (1491), Monte l'Abate (1491–92) and in the Perugia gallery (from S. Giorgio, 1498). The last reference to Fiorenzo di Lorenzo's activity dates from Feb. 1522 and he was dead by Feb. 14, 1525. After about 1480 the Verrocchiesque elements in Fiorenzo's work become less pronounced and thereafter he develops a typically Umbrian style. An attractive but relatively weak artist, Fiorenzo di Lorenzo was a precursor of Pinturicchio, who was probably a member of his studio during the 1470s. His later work is a pallid reflection of that of Pinturicchio and Perugino.

See W. Bombe, *Geschichte der Peruginer Malerei* (1912); R. van Marle, *The Development of the Italian Schools of Painting*, vol. xiv (1933). (J. W. P.-H.)

LORENZO MONACO (DON LORENZO) (*c.* 1370–*c.* 1425), Italian painter whose work combined the rhythmic, graceful flow of line and decorative feeling of the Sienese school with the Florentine traditions of the followers of Giotto. Lorenzo was born at Siena. He took the vows of the Camaldolese order in 1391 and lived mostly at the monastery of Santa Maria degli Angeli, in Florence. His name as a layman was Piero di Giovanni del Popolo di San Michele de Bisdomini and a painter of that name was entered in the books of the guild of St. Luke at Florence in 1396. Lorenzo was in some respects an innovator in Florence; in his later work he appears to be influenced by the realistic tendency of the early Renaissance. The Uffizi in Florence contains a signed work by the master, "Coronation of the Virgin" with many figures, painted in 1413 for his convent. The National gallery in London has another smaller version of the same subject; one of his most graceful altarpieces is the "Annunciation" in the Bartolini chapel in the church of Sta. Trinita at Florence. His "Madonna and Child with Angels" was acquired by the Metropolitan Museum of Art, New York city. Another late work of the master is the "Adoration of the Magi" in the Uffizi. The master's feeling for decorative composition, his expressive line and his originality come out well in his small predella pieces, as in the three small fragments at the Florence academy, representing the "Nativity," the "Life of a Hermit" and a stormy seascape, and in the two remarkable illuminations in Berlin museums of the "Journey of the Three Kings" and the "Visitation."

LORETO, episcopal see and a noted pilgrimage resort of The Marches, Italy, in Ancona province, 15 mi. S.S.E. of Ancona by rail. It lies on the right bank of the Musone. Pop. (1957 est.) 8,663 (commune).

The town, surrounded by 16th-century walls and bastions, is virtually a long narrow street, lined with shops for the sale of religious objects. The principal buildings in the Piazza della Madonna are the Palazzo Apostolico (containing works of Lorenzo Lotto and Lodovico Carracci and a replica of the tapestries designed by Raphael for the Sistine chapel) and the Basilica of the Holy House or the Santuario della Santa Casa (a late Gothic structure begun in 1468 and continued by Giuliano da Maiano, Giuliano da Sangallo, Bramante and other architects, who altered the original plan, which was again revived in 1886 by Giuseppe Sacconi). The façade of the basilica was completed under Pope Sixtus V; his colossal statue stands in the middle of the entrance steps. Over the main door is a life-size bronze statue of the Virgin and Child by Girolamo Lombardo; the three superb late-16th-century bronze doors are also by Lombardo, his sons and his pupils. The doors of the Santa Casa (*see* below) and the magnificent chandelier over the presbytery are by the same artists. The richly decorated campanile by L. Vanvitelli is 250 ft. high, and the principal bell, presented by Leo X in 1516, weighs eight tons. The interior of the church has mosaics of Domenichino, Guido Reni, Barrocci and C. Maratta. In the old sacristies are frescoes by Melozzo da Forlì and Luca Signorelli. The Treasure room, where precious gifts and a collection of 16th-century majolica are on view, is close by.

The Santa Casa itself is of plain stone, 28 by 12½ ft., and 13½ ft. in height, with a niche containing a small black image of the Virgin and Child, in Lebanon cedar, and richly adorned with jewels. It is enclosed by a lofty marble screen, designed by Bramante, which has four sides representing the Annunciation, the Nativity, the arrival of the Santa Casa at Loreto and the Virgin's Nativity. According to tradition, the Holy House of the Virgin, threatened with destruction by the Turks, was carried from Nazareth by the ministry of angels and deposited (1291), in the first instance, on a hill at Tersatto in Dalmatia, where an alleged appearance of the Virgin and miraculous cures attested its sanctity. Three years later it was similarly transported across the Adriatic to a laurel grove (*lauretum*, whence Loreto) near Recanati and from there removed (1295) to the present hill. Papal Bulls in favour of the shrine were issued. Pope Innocent XII appointed a *missa* cum *officio proprio* for the feast of the Translation of the Holy House (Dec. 10). Benedict XV declared the Madonna di Loreto to be the patron of aviators (1920). The chief festival is held on Sept. 8, the Nativity of Our Lady.

The Fountain of the Madonna, by C. Maderno, in the piazza, and the Fountain of the Galli (cocks) are worthy of note. The Polish War cemetery is nearby. (PO. G.)

LORETO, the largest and most easterly department of Peru, bounded north and northeast by Colombia, northwest by Ecuador, east by Brazil, west by the departments of Amazonas, San Martin, Huánuco and Junin. and south by Cuzco. Area, 184.686 sq mi. Pop. (1958 est.) 433.560. The montafia territory at the time of independence in the early 19th century was a province of the intendencia of Trujillo, under the name of Maynas. Later it became a province of La Libertad, then of Amazonas in 1853, an independent "littoral province," and finally a department. In 1906 the western portion was attached to the new department of San Martin (*q.v.*).

The chief river in the east of the department, the Ucayali, joins the Marañón or upper Amazon at Nauta. Other significant affluents of the Marañón are the Tigre, Pastaza, Morona, Huallaga and Samiria. From Iquitos westwardly ocean steamers ascend to the confluence of the Ucayali with the Marañón. The Marañón is navigable at all seasons for steamers of four to eight feet draft as far as Puerto Limon, a distance of 484 mi. The Huallaga is navigable at all seasons for steamers of the same draft to beyond Turimaguas, about 150 miles. The lower Ucayali is navigable to the confluence of the Pachitea for vessels of six-feet draft.

Iquitos (pop. [1958 est.] 54,286) is the capital of the department and entrepôt for the upper Amazon. It is served by ocean steamers and can be reached from Lima in five days via the Pucallpa highway and the Ucayali river, two days by bus and three days by river steamer.

The department, largely made up of the Amazonian plains, is almost completely forested. The climate is hot and humid with heavy rainfall (103 in.. annually at Iquitos). The average elevation is about 500 ft. above sea level and the greater part of the region is inundated part of the year. Important exports of the department are rubber (the leading export before the East Indian plantations came into production), Brazil nuts, skins and hides, products of oil, medicinal and wax-bearing plants, and hardwoods. Rice, sugar cane, bananas, manioc, tobacco and other tropical products are cultivated there. The population is chiefly Indian and mestizo. (J. L. TR.)

LORIENT, a maritime town of western France, capital of an *arrondissement* in the *département* of Morbihan, on the right bank of the Scorff, at its confluence with the Blavet, 34 mi. W. by N. of Vannes by rail. Pop. (1954) 37,981.

Lorient took the place of Port Louis as the port of the Blavet. The latter stands on the site of an ancient hamlet fortified during the wars of the League and handed over by Philip Emmanuel, duke of Morcoeur, to the Spaniards. After the Treaty of Vervins it was restored to France, and received its name of Port Louis under Richelieu. Some Breton merchants trading with the Indies established themselves first at Port Louis, but in 1628 built their warehouses on the other bank. The Compagnie des Indes Orientales, created in 1664, took possession of these, giving them the name of l'Orient. The importance of the Compagnie des Indes waned after the English conquest of India, and in 1770 its property was ceded to the State. In 1782 the town was purchased by Louis XVI from its owners, the Rohan-Guéméné family. The trade in fresh fish, sardines, oysters and tinned vegetables is important, and the manufacture of basketwork, rope, nets, etc., tin boxes and ice, and the preparation of preserved sardines and vegetables are carried on. The roadstead is the estuary of the Blavet. In the middle of the channel is the granite rock of St. Michel.

LORIMER, GEORGE HORACE (1867–1937), U.S. editor, was born at Louisville, Ky., Oct. 6, 1867. He attended Colby college and Yale university and, after a short time in business in Chicago, became a newspaper reporter and correspondent. In 1897 he was literary editor of the *Saturday Evening Post* and in 1899 became its editor in chief. The remarkable success of this periodical was largely caused by Lorimer's keen appreciation of the public taste, coupled with his ability to meet it. His *Letters From a Self-Made Merchant to His Son* (1902), which attained great popularity, and *Old Gorgon Graham* (1904) are effective expositions of the philosophy of getting on. He continued his editorship of the *Post* until Jan. 1, 1937, and died at Wyncote, Pa., Oct. 22, 1937.

See John Tebbel, *George Horace Lorimer and The Saturday Evening Post* (1948).

LORIMER, JAMES (1818–1890), Scottish jurist and authority on international law, was born at Aberdalgie, Perthshire, on Nov. 4, 1818. and was educated at Edinburgh university. After study abroad he was admitted to the Scottish bar and in 1862 became professor of public law in Edinburgh university, where he taught until his death on Feb. 13, 1890. Against the positivism of contemporary English jurisprudence Lorimer taught a doctrine of natural law founded on divine authority and revealed in conscience and in history; in particular he held that the science of international law should be concerned with the application of this natural law to the relations of nations with one another. Lorimer's system did not prove of permanent value but his writings are memorable for their vigour and for flashes of prophetic insight, notably his draft scheme (1870) for a "permanent congress of nations" and an international court of justice.

His major writings are: *The Institutes of Law* (1872); *The Institutes of the Law of Nations,* 2 vol. (1883–84); *Studies National and International* (1890). (AR. H. C.)

LORIS, the common name for Indo-Malay lemurs (*see* PRIMATES). Their soft fur, huge staring eyes, rudimentary tails and imperfectly developed index-fingers render lorises easy of recognition. The smallest is the slender loris (*Loris tardigradus)* of the forests of Madras and Ceylon, a creature smaller than a squirre!. The slow loris (*Nycticebus coucang)* is a heavier built and larger animal, known for its deliberate and unhurried pace. It ranges from eastern Bengal to Indochina, the Malay peninsula, Java, Borneo and Mindanao.

W SUSCHITZKY

SLOW LORIS (NYCTICEBUS COUCANG), FOUND IN SOUTHEASTERN ASIA

LORIS-MELIKOV, MICHAEL TARIELOVICH, COUNT (1826–1888), Russian statesman, son of an Armenian merchant, was born at Tiflis on Jan. 1, 1826, and educated in St. Petersburg, first in the Lazarev School of Oriental Languages, and afterward in the Guard's Cadet Institute. He joined a hussar regiment, and in 1847 he was sent to the Caucasus, where he spent 20 years. He was governor of the Terek district from 1855 to 1876, and sought to educate the people so as to make possible the transition from military to civil government. In the Russo-Turkish War of 1877–78 he commanded a separate *corps d'armée* on the Turkish frontier in Asia Minor. After taking the fortress of Ardahan, he was repulsed by Mukhtar Pasha at Zevin, but subsequently defeated his opponent at Aladja Dagh, took Kars by storm and laid siege to Erzerum. For these services he received the title of count.

In 1879 he was appointed temporary governor-general of the region of the lower Volga, to combat an outbreak of the plague. He was then transferred to the provinces of central Russia to combat the nihilists and anarchists, who had adopted a policy of terrorism, and had assassinated the governor of Kharkov. He advocated removing the causes of popular discontent, and for this purpose he recommended to the emperor a large scheme of administrative and economic reforms. Alexander II thereupon appointed Loris-Melikov minister of the interior with exceptional powers. The proposed scheme of reforms was never carried out. On the very day in March 1881 that the emperor signed an *ukáz* creating the necessary commissions, he was assassinated; and his successor, Alexander III, adopted a reactionary policy. Loris-Melikov resigned, and lived in retirement until his death (Dec. 22, 1888) at Nice.

LORME, MARION DE (1613–1650). the celebrated French courtesan whom Victor Hugo made the heroine of a drama and who figures also in Alfred de Vigny's novel *Cinq-Mars,* was born in Paris on Oct. 3. 1613. the daughter of Jean de Lon, sieur de Lorme, and Marie Chastelain, and was brought up at the chbteau of Baye, near Champaubert. She was introduced to the life of pleasure by Jacques Vallée, sieur des Barreaux, a *libertin* or free-thinker, who expressed his sincere love for her in passionate verse. She soon left him, however, for the marquis de Cinq-Mars (*q.v.*), Louis XIII's elegant young favourite, whom at one moment she was on the point of marrying. She then set herself up in the fashionable Place Royale (now the Place des Vosges) in Paris, where her salon attracted the most brilliant company of the town. After the execution of Cinq-Mars (1642), she had many lovers: Saint-Evremond; the marquis de Rouville (Hercule Louis); the soldier and poet Isaac Arnauld de Corbeville; the comte de Miossens (César Phébus, later marshal d'Albret); the comte de Coligny (Gaspard de Chatillon). who was converted to Catholicism to please her; the duc d'Enghien (Louis de Bourbon Condé); the duc de Brissac (Louis de Cossé); the comte de Gramont (Philibert); the superintendant of the finances Michel Particelli d'Emery; and even the cardinal de Richelieu himself. Paul Scarron and other poets were among her friends and wrote in praise of her. The marshal de La Meilleraye (Charles de La Porte), Emery's successor as superintendant during the Fronde, began a persecution of her, and she had to leave the Place Royale and go to her mother's house in the rue de Thorigny. Though most of her friends and lovers supported the opposition to Cardinal Mazarin, there is no proof of the story that she was about to be arrested when she died. in poverty, on July 2, 1650. Her body, in a white dress, was laid out as if in state, and the cure of the parish of St. Paul had to intervene to stop this scandal. The 18th-century story that she died a centenarian is without foundation.

See J. Péladan, *Histoire et légende de Marion de Lorme,* 2nd ed. (1927); G. Mongredien, *Marion de Lorme et ses amours (1940).*

(G. Mo.)

LÖRRACH, a town in the *Land* of Baden-Württemberg, Germany, in the Wiese valley, 6 mi. N.E. of Basle. Pop. (1959 est.) 30,146. Lorrach received market rights in 1403, but did not obtain municipal privileges until 1682. Manufactures include calico, cloth, silk, chocolate, cotton, ribbons, hardware and cigars; there is trade in wine, fruit and timber. It is a centre for the transmission of electric power generated from the Rhine near by. There is a fine view from the nearby Schdtzenhaus, 1.378 ft. high. In the neighbourhood also is the castle of Rotteln, formerly the residence of the counts of Hachberg and of the margraves of Baden.

LORRAINE, a former province and a geographical region of France. The name has been applied to the territory covered by the independent duchy of Lorraine and Bar (*see* BAR, COUNTS AND DUKES OF) and the three episcopal lordships of Metz, Toul and Verdun; or, at the end of the 18th century, by the two *généralités* of Nancy and Metz, which were divided at the Revolution into the departments of Meurthe, Meuse, Moselle and Vosges. Bounded north by the Ardennes and the *Massif schisteux rhénan,* east by the Vosges, south by the plateau of Langres and west by the Argonne, and watered by the upper courses of the Meuse and Moselle, Lorraine corresponds to the western slopes of the Vosges and to the easternmost, highest and oldest parts of the *Bassin Parisien;* the alternation of limestone and clay in the sedimentary rocks gives an undulating landscape, where wet plains, lofty *cuestas* and dry plateaus succeed each other from east to west.

The **Origins** of Lorraine.— The name Lotharingia (Lorraine) appears first in the 9th century. Its origins are to be found in the treaty of Verdun (Aug. 843). The northern part of the Francia Media, allotted by this treaty to the emperor Lothair I, corresponds to the kingdom of Lorraine, created by Lothair when he retired in 855 in favour of his second son, Lothair, (825–869), from whom the names of the country are derived. This kingdom lay between Francia Orientalis and Francia Occidentalis and was bounded to the north by the sea between the mouths of the Scheldt and the Ems; on the east by the Rliine from Wesel (with a westward recession, in the neighbourhood of Bingen, that left Worms and Speyer to Germany) as far as its confluence with the Aar, which formed the southern boundary; and on the west, across the Jura. by the Saône (from a point a little south of its confluence with the Doubs), the Ornain, the Meuse and the Scheldt. Thus, that kingdom comprised the countries of the Moselle and the Meuse, with the dioceses of Cologne, Trier, Metz, Toul, Verdun, Liège, Cambrai, Basle, Strasbourg and Besanqon, including territories now divided between the Netherlands, Belgium, France, Germany and Switzerland. Apparently of an absolutely artificial character, it yet corresponded to Austrasia, the old country of the Franks, cradle of the Carolingian house (which sprang from Metz) and main centre of the Carolingian Renaissance. When King Lothair died heirless in 869, his two uncles, Charles the Bald, king of France, and Louis the German, at once tried to seize Lorraine. It was dismembered by the treaty of Mersen (Aug. 8, 870). by which Charles received Toul, Verdun, Mézières and Libge, while Louis had Besanqon, Saint-Die, Metz, Trier, Aachen and Frisia. But in 880 the unity of Lotharingia was restored, when Charles the Bald's grandsons, Louis III of France and Carloman, gave up their share to Louis the Young, king of Germany (son of Louis the German), who ruled Lorraine till 882. Then, from 882 to 887, the emperor Charles the Fat united it with the reconstituted Carolingian empire. After Charles's deposition in 887 Rudolph I, king of Burgundy, tried to conquer Lorraine but succeeded only in detaching (definitively) the province of Besanqon. The main part of Lorraine fell to the German king Arnulf, who in 895 constituted it a distinct kingdom for his bastard Zwentibold. Zwentibold, however, soon became embroiled with the nobles and the bishops and was killed in battle on Aug. 13, 900, the last independent king of Lorraine. The Lotharingian lords then recognized Arnulf's son, the German king Louis the Child, as king; and he retained Lorraine till his death (911). Since he was the last German Carolingian king, Lotharingians refused to recognize his successor, Conrad I, and elected Charles the Simple of France. But Charles was dethroned in 922 by his vassals; and, after an attempt on Lorraine by the new king of France, Rudolph (Raoul), Lorraine fell in 925 to the German king Henry I. There were further attempts on Lorraine by the last French Carolingians; but the year 925 saw the end of the separate kingdom, after which Lorraine was for centuries a German duchy.

Henry I had been supported by Giselbert, son of Reginar (Regnier), count of Hainaut, and rewarded him with the hand of his daughter Gerberga and the title of duke of Lorraine (928). But the German kings of the Saxon house met with serious difficulties from the Lotharingian lords. In 939 Giselbert revolted against Otto I the Great, Henry's son, and appealed to Louis IV d'Outremer, who came to his help but had soon to return to France to oppose a revolt; Giselbert was defeated and killed near Andernach. Otto got himself recognized in the whole of Lorraine, securing it by a treaty with Louis d'Outremer, who married Gerberga. Otto entrusted the duchy to Count Otto (d. 944), son of Ricuin, then to his son-in-law Conrad of Franconia (who revolted and was deposed in 953) and finally, in 954, to his brother Bruno (*q.v.*), archbishop of Cologne. Bruno had to contend against the efforts of King Lothair of France, as well as against the independent spirit of the Lotharingian nobles. To obviate these difficulties he divided Lotharingia into Lower Lorraine and Upper Lorraine (959).

In 959 Upper Lorraine, corresponding to the ecclesiastical province of Trier, had been given to Frederick, count of Bar (d. 978), a member of the house of Ardenne and a relative of the Carolingians, whose cause, however, he deserted, being also the nephew of Otto and brother-in-law of Hugh Capet; but his grandson, Frederick II, died without male heir in 1033. Lotharingia was then restored in favour of Gothelon (Gozelo), count of Verdun and duke of Lower Lorraine (son of Duke Godfrey, d. 1023). At Gothelon's death in 1043, however, his son Godfrey the Bearded received from the emperor Lower Lorraine only, the other son, Gothelon II, obtaining Upper Lorraine. Godfrey attempted to seize Upper Lorraine, but was defeated in 1045; trying again on Gothelon II's death in 1046, he failed likewise and, deprived of his own duchy by the emperor Henry III, had to flee to Italy, recovering Lower Lorraine only in 1065. The latter duchy passed to his son Godfrey the Hunchback (d. 1076), then to the Hunchback's nephew Godfrey of Bouillon (d. 1100), then to Henry, count of Limburg, and then in 1106, to Godfrey, count of Louvain, who was the first hereditary duke of Brabant (*q.v.*), as the dukes of Lower Lorraine came to be called.

Upper Lorraine in the Middle Ages.—From the 11th century the name of Lorraine was restricted to the duchy of Upper Lorraine, which, from 1043, was definitively separated from Lower Lorraine. On Gothelon II's death the emperor Henry III gave it to Adalbert of Alsace, of the family of the counts of Metz. Adalbert was succeeded in 1048 by his nephew Gerard of Châtenois (d. 1069), whose descendants in direct line possessed the duchy until 1431. The growth of feudal lordships had already seriously weakened the power of the dukes, who had, particularly, to face the three powerful episcopal lordships of Metz, Toul and Verdun, the counts of Bar and the counts of Luxembourg; their own demesne was restricted to the country east of the Moselle. The history of Lorraine in the middle ages can be divided into two parts, separated by the great interregnum of the empire (1250–73): before 1250 it was part and parcel of the Holy Roman empire, the dukes generally supporting the emperors while their rivals, the counts of Bar, supported the Guelph party; but after the death of Frederick II, who had come to Lorraine in 1215 and 1227, the German sovereigns ceased to intervene in the country, and the links with an anarchic Germany slackened. The situation of the 10th century was now reversed: the influence of the powerful western neighbour, already strong in the fields of culture and the arts, began to be felt in the political fields also. With the union of Champagne to the French crown (1285), the duke of Lorraine and the count of Bar became vassals of the king of France for a number of fiefs, mostly on the left bank of the Meuse (*e.g.,* the *Barrois mouoant,* 1301); and the king took under his protection several ecclesiastical lordships, including Toul (1289) and Verdun (treaty of *sauvegarde* with Louis *X*, 1315). The dukes fought for France on the battlefields of the Hundred Years' War; and Charles II was made constable of France (1418) and married his daughter and heiress, Isabella, to René of Anjou, duke of Bar (1420). But on Charles's death (1431) his nephew Antony of Vaudemont disputed the succession with René, who was taken prisoner at Bulgnéville (July 2, 1431) and released in 1436 only against a heavy ransom. Henceforth, however, a French house reigned at Nancy, and the duchy of Bar was united to Lorraine (1480). In 1444, called by René, Charles VII came to Lorraine with an army, besieged Metz and restored the rights of the French crown.

But French influence was temporarily checked by the new menace of the Burgundian state, whose growth was hampered by its division into two parts, the Low Countries and Burgundy, with communications necessarily passing through Lorraine. Charles the Bold, who was dreaming of a restored Lotharingia, invaded Lorraine in 1475 but was defeated and killed before Nancy on Jan. 5, 1477. The duchy had preserved its independence, but its situation had become very dangerous, since most of the Burgundian inheritance passed to the Habsburgs, who, in Luxembourg and Franche-Comté, became the neighbours of Lorraine. The country was thus in danger of becoming a battlefield in the struggle between France and the house of Austria.

Lorraine in Modern Times.—René II (d. 1508) and Antony (d. 1544) tried hard and generally succeeded in maintaining a neutral position in the struggle between their two powerful neighbours. By the treaty of Nuremberg (Aug. 26, 1542) Antony prevailed upon the emperor Charles V, who wanted his friendship, to recognize Lorraine as a free and autonomous state, whose duke was sovereign: the last feudal links with the empire were cut. But Francis I of France had already obliged Antony to cede Stenay and allow the free passage of French troops (1541). In 1544 the imperial army invaded France through Lorraine and penetrated to Meaux; and the weakness of the Meuse frontier was evident. The internal and religious struggles within the empire gave the French the opportunity to consolidate that frontier and to strengthen their grasp on Lorraine. By the treaties of Lochau and Chambord (1551–52) the Protestant princes of Germany authorized Henry II to occupy, in the quality of imperial vicar, the cities of Metz, Toul, Verdun and Cambrai. The occupation took place early in 1552. Later in 1552 Charles V laid siege to Metz but was forced to retreat with heavy loss before the energetic resistance of Francis of Guise (who belonged to a branch of the ducal house). France had secured the key strategical position in the heart of Lorraine.

From 1552 to 1624 the truce in the struggle between France and the Habsburgs, as well as the civil wars in France, gave the duchy a long period of peace, troubled only by the devastating passage of German bands on their way to help the French Protestants. The long reign (1545–1608) of Charles III marks the apogee of the duchy of Lorraine. Charles devoted himself to improving the administration of the duchy: he increased the ducal domain, modernized the judiciary and financial institutions and fostered economic development, setting up a salt monopoly and creating new mines and glassworks. To fight Calvinism he established the Jesuits at Pont-à-Mousson and gave over to them the university that he had founded there in 1572. The country was prosperous, and its artistic development was brilliant (J. Callot, Georges de la Tour).

The Thirty Years' War brought this happy period to a brutal end. On the one hand, French policy again became aggressive under Cardinal Richelieu (1624 #.), who wanted a frontier on the Rhine. The French grasp on Metz, Toul and Verdun was strengthened, and from a regime of "protection" they passed to one of annexation (in 1633 a *parlement* was created at Metz, and in 1648 the treaty of Munster recognized officially the possession by France of the three bishoprics, which constituted the *généralité* of Metz). On the other hand, Duke Charles IV (1604–75) abandoned the neutrality of his predecessors and sided against France, intriguing incessantly against Richelieu, until in 1633 Louis XIII invaded Lorraine. Charles spent the rest of his life in exile fighting and intriguing against France but recovered his duchy for two short periods only (1641 and 1663–70). His nephew Charles V (1643–90) never obtained effective possession of the duchy. From' 1633 to 1697 it was almost continuously occupied by the French, who established a *généralité* at Nancy. The annexation of Alsace to France had completed the encirclement of the duchy, which was itself pronounced annexed, in 1683, by the *chambre de réunion* of Metz. But defeats at the end of the 17th century forced the French to make concessions: by the treaty of Ryswick (1697) the duchy was restored to Leopold, Charles V's son (d. 1729), who had however to dismantle all his fortresses and to disband his army. Despite a new French occupation (1702–14), Leopold's reign was a period of economic reconstruction: he attracted thousands of immigrants and fostered commercial and industrial development, particularly the manufacture of cloth, lace, glass and paper. He ordered moreover the compilation of the Code Léopold. But Leopold's son and heir, Francis III, had been betrothed to Maria Theresa of Austria, daughter and heiress of the emperor Charles VI, whom he married in 1736; and France could hardly admit the union of Lorraine with the empire. The War of the Polish Succession offered an opportunity of settling the problem: negotiations opened in 1735 led to the treaty of Vienna (Nov. 18, 1738), whereby Francis, in exchange for Tuscany, ceded his rights on Lorraine and Barrois to Stanislaus Leszczynski, the dethroned king of Poland, after whose death they were to pass to his daughter, Louis XV's queen, and so to France. Stanislaus reigned but did not rule; by the secret treaty of Meudon (1736) he gave up the whole administration to a chancellor, who was in fact a French *intendant,* Chaumont de La Galaizière. Chaumont introduced the French system of taxation and reorganized the administration on a stricter basis. Stanislaus received a yearly subsidy, held a brilliant little court at Lunéville and did a lot of building. At his death (1766) the chancellor became *intendant* and the duchies of Lorraine and Bar were definitively incorporated into the kingdom of France. They formed the *généralité* of Nancy, where a *parlement* was created in 1776.

The Revolution was at first welcomed wholeheartedly by a country in which loyalty toward the monarchy had had no time to grow, and the revolutionary period was rather uneventful except for the Prussian invasion of 1792. Later Lorraine developed a particular blend of liberalism and moderate republicanism with strongly pro-French tendencies. The loss in 1814 and 1815 of the revolutionary conquests on the left bank of the Rhine and of some of Lorraine's land in the Saar was resented, and the German problem came to loom larger and larger in the people's minds. Under the treaty of Frankfurt (*1871*) the whole of Moselle and a part of Meurthe were annexed by Germany. Prince Otto von Bismarck had at first meant to take only the German-speaking districts, but the general staff, for strategic reasons, demanded the annexation of the fortress of Metz and its district (entirely French-speaking). This dismemberment of the country, which lasted from 1871 to 1918 and was repeated from 1940 to 1944 (*see* ALSACE-LORRAINE), together with the heavy physical damage brought upon it, as a borderland, by three great wars, constituted a dominant factor in Lorraine's later history.

On the other hand, industrial development has made Lorraine one of the great industrial centres not only of France but of all Europe. The soil contains the largest iron-ore deposits in Europe (about 40,000,000 tons have been extracted in certain years). The iron and steel industry began to develop under the Second Empire and made great strides on both sides of the new border after 1880, when the Thomas Gilchrist process made possible the extensive use of phosphoric ores. Unfortunately, coking coal has to be imported from the Ruhr, where much ore is sent; so that Lorraine and the Ruhr are competing but complementary. Lorraine has also important cotton, chemical, glass and pottery industries.

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LORTZING, GUSTAV ALBERT (1801–1851), German composer, was born at Berlin on Oct. 23, 1801. Both his parents were actors, and when he was 19 he began to play at the theatres of Dusseldorf and Aachen, sometimes also singing in small tenor or baritone parts. His first opera, *Ali Pasclza von Jannina,* appeared in 1824, but his fame as a musician rests chiefly upon the two operas *Der Wildschütz* (1842) and *Czar und Zimmermann* (1837). The latter, although now regarded as one of the masterpieces of German comic opera, was received with little enthusiasm by the public of Leipzig. Subsequent performance in Berlin, however, provoked such a tempest of applause that the opera was soon placed on all the stages of Germany. It was translated into English, French, Swedish: Danish, Dutch, Bohemian, Hungarian and Russian.

Der Wildschütz was based on a comedy of Kotzebue, and was a satire on the unintelligent and exaggerated admiration for the highest beauty in art expressed by the *bourgeois gentilhomme.* Of his other operas it is only necessary to note *Der Pole und sein Kind,* produced shortly after the Polish insurrection of 1831, and *Undine* (1845). Lortzing died at Berlin on Jan. 21, 1851.

LORY, any of some 60 species of small (mostly 4.5 to' 12 in.), brilliantly-coloured (many with bright red) parrots (*q.v.*), with beak less toothed and tongue brush-tipped, constituting the subfamily Loriinae. Some are called lorikeets. Lories are mostly from New Guinea and adjacent islands, though ranging to southeastern Australia, New Caledonia, the Philippines and Marquesas Islands.

They fly swiftly in flocks, have shrill voices and feed mostly on soft fruits and the nectar of flowers, gathered with the bushy tongue. The four or five white eggs are laid in holes in trees. There are about 15 genera. the best known being *Domicella, Trichoglossus, Chalcopsitta, Phigys, Vini* and *Eos.* (G. F. Ss.)

LOS ALAMOS (Spanish meaning "the cottonwoods"), a town of New Mexico, U.S., and seat of Los Alamos county lies 24 air mi. N.W. of Santa Fe, at an elevation of 7.300 ft., on the summit of one of the innumerable mesas comprising the Pajarito plateau, a forested shelf on the eastern slope of the Jemez mountains.

Until 1942 the site was occupied solely by a group of log cabins and stone buildings comprising the Los Alamos Ranch School for Boys. The mesa was selected because of its comparative isolation and natural facilities as the site for the atomic research laboratory then known as the Manhattan project or Project Y which developed the first nuclear-fission or A-bomb. (*See* ATOMIC ENERGY: *The Atomic Bomb.*) After World R'ar II. the Los Alamos Scientific laboratory, operated by the University of California for the Atomic Energy commission, developed the first thermonuclear-fusion or H-bomb. The town's sole reason for existence is the Scientific laboratory. which is one of the greatest atomic research institutions in the world. The laboratory has been expanded to neighbouring South Mesa where it utilizes about 300 buildings and 77 sq.mi. Research includes basic scientific development directed toward industrial uses of atomic energy, health, radiology, organic chemistry and industrial hygiene.

By the 1960s the small complex of makeshift residential quarters for scientists had grown into the modern town of Los Alamos. (For comparative population figures *see* table in NEW MEXICO: *Population.*) In 1949 it was named the seat of Los Alamos county. the state's newest and smallest county (area 108 sq.mi.), created from part of Sandoval county. In Feb. 1957 it was made an "open city" which anyone could visit, although only persons who are employed there can take up permanent residence. The commission-manager form of municipal government was adopted in 1955.

The Bandelier National park is 5 mi. S.. and the Puye pre-Columbian ruins are a few miles north of the town. (FR. W.)

LOS ANGELES. A vast, sprawling metropolis, seat of Los Angeles county, located in southern California, U.S., was, until 1961, the largest city in area (458 sq.mi. in 1960) and the second largest metropolitan centre of the nation. It has an average altitude of about 275 ft., ranging from sea level to 1,692 ft. atop Mt. Hollywood. The geographical setting between the mountains and the sea is attractive; the central commercial district lies several miles from the Pacific ocean on a coastal shelf extending inland to the foothills of the San Gabriel mountain range.

The original Spanish town or pueblo, located close to a series of man-made water ditches or *zanjas* that drained water from these mountains, was built around a square, which is the historic plaza area of the modern city. Urban growth was to the south, east and west from this original nucleus, especially after the coming of the railroads in the 1870s. Separate municipalities, by the 1880s, sprang up nearby, of which Pasadena (*q.v.*) is the largest; others whose interests are closely bound with Los Angeles include Alhambra, Burbank, Compton. Culver City, Glendale, Huntington Park, Inglewood, Long Beach, Santa Ana, Santa Monica, South Gate and Torrance (*qq.v.*). A sizable spur of foothills toward the west, which for a time blocked expansion in that direction, was eventually pierced by tunnels and boulevards. The problem of access to the sea was solved by annexation of a strip of land, about 20 mi. long, and $\frac{1}{4}$ mi. wide, known as the "shoestring strip." This corridor connects the metropolis with Los Angeles harbour. The city touches the ocean at the annexed to ns of San Pedro, Wilmington and Venice, and entirely surrounds such separate municipalities as Beverly Hills (*q.v.*), Vernon and San Fernando. There are about 45 relatively large municipalities within Los Angeles county (area 4.155 sq.mi.). Among them is Hollywood (*q.v.*), 8 mi. N.W. of the business district which by annexation is municipally a part of Los Angeles, but retains its name and business entity. A city ordinance, repealed in 1957, that limited the height of buildings to 150 ft.. encouraged the decentralization of Los Angeles.

Climate. — Little variability is the chief characteristic of the climate at Los Angeles and in southern California generally. Winter is a season of moderate rainfall, 15.23 in. yearly being the average. There is relatively little rain from May to October. Winter days are sunny and warm and the nights are often cold, with occasional frost in December and January. A 50-year average of the records of the U.S. weather bureau shows the mean temperature to be 62.4". There is a 72% possibility of daily sunshine, an average of 179 clear' days each year, and only 37 days with more than .01 in. of rain. However, serious floods have occurred, notably in 1914 and in 1938; the greatest disaster was in 1928 when the St. Francis dam unit of the Los Angeles aqueduct collapsed resulting in violent floods of the Santa Clara river through Los Angeles and Ventura counties. Los Angeles experienced a moderate earth tremor about once every five years during the first half of the 20th century. The earliest recorded earthquake occurred in 1769 when the expedition led by Gaspar de Portola (see *History,* below) reached the banks of the Santa Ana river, which was appropriately named El *Rio del dulce nombre de Jesús de los temblores* ("the river of the sweet name of Jesus of the earthquakes").

The average wind velocity of only 6.1 mi. per hour, one of the lowest of any major U.S. city, has directly contributed to Los Angeles' modern problem, a seriously detracting climatic factor locally called smog. Pollution of the atmosphere by choking, noxious fumes causes uncomfortable eye irritation and has led to the establishment of an air pollution control district, operated by the Los Angeles county board of supervisors. This agency has conducted studies which traced smog to three main sources: automobile exhausts. industry and home incinerators. In 1956–57 local regulations forbade the burning of trash, and home incineration was replaced by the city's first thorough municipal rubbish collection system. Surveillance of industrial air pollution failed to reduce the climatic discomfort of Los Angeles. Two warning systems (one anticipatory, the other remedial) had to be instituted for the protection of health by averting hazardous concentrations of contamination. Eye irritation is especially severe in the summer months.

Population Characteristics. — In the past, the relationship of good climate to spectacular growth marked the development of Los Angeles. Sunny skies and the attractions of outdoor life caused population within the city limits to soar from 576,673 in 1920 to 1,238.048 in 1930. Further increase in the 1930s occurred partially because of the immigration of job hunters from depressed areas, retired persons and Hollywood aspirants. According to the census bureau. the city's population grew from 1,504.277 in 1940 to 1,970,358 in 1950. By 1960 it ranked as the third largest city in the U.S. The population booms of the 1880s and 1920s were eclipsed during and after World War II when expansion was accelerated by a huge influx of workers for defense industries such as airplane, missile and ship construction. The 1960 census of city and county population was 2,479,015 and 6,038,771 respectively. The Los Angeles-Long Beach standard metropolitan statistical area, comprising Los Angeles and Orange counties, had reached a population of 6,742.696 in 1960 and so surpassed greater Chicago as the nation's second largest population mass. Demographers forecast a population of 10,500.000 persons for the Los Angeles metropolitan area by 1975, when the city should (if annual population growth of about 240.000 should continue) become the largest in the U.S. The population. aside from groups that characterize other large American cities, includes considerable numbers of Mexicans. Chinese, Japanese and Filipinos.

History.—On hug. 1, 1769 a Spanish exploring expedition under Gaspar de Portolá (*q.v.*) and Father Juan Crespi, traveling northward from the peninsula of Lower California through San Diego, reached an Indian village called Yang-na near a stream, at the present site of Los Angeles. They named the place Our Lady Queen of the Angels (*Nuestra Señora* la *Reina* de Los Ángeles), The Indian settlement remained relatively undisturbed for 12 more years. Then, on Aug. 18, 1781, as part of Spain's design to colonize California more thoroughly, the future city's first permanent residents arrived after a 100-day march northward from Mexico through the blistering heat of the deserts. These humble, mostly illiterate folk consisted of 12 families (46 persons in all), of mestizo (Spanish-Indian), Negro and Spanish blood. On Sept. 4, 1781, California's Spanish governor, Felipe de Neve, gave the community of Los Angeles official status as the territory's second (after San Jose, founded in 1777) pueblo.

The nearby Franciscan mission of San Gabriel—still in existence as an intact landmark—had been established ten years earlier a few miles from the centre of the new pueblo. Development of a better overland route from Sonora and Sinaloa to California (opened as early as 1775 by Juan Bautista de Anza) markedly increased the number of travelers that had come over the Lower California route. The new arrivals cleared the wild mustard and sagebrush and settled upon land grants given them by Spain's authority. They thereby began the great southern California ranchos of the future, some of which were to be larger than whole European countries.

After Mexico's independence from Spain (1822) frequent political disturbances and revolts hampered the social and economic stability of the little town. The few Americans who visited it during this period included the fur trapper Jedediah Strong Smith, the first white man to come overland, in 1826. via San Gabriel mission: from the Missouri river frontier settlements. In search of beaver and land otter. Smith preceded the first organized overland pioneers (the William Workman-John Rowland party of 1841) into Los Angeles by 15 years. During the 1830s, however, other American fur trappers such as James Ohio Pattie and Ewing Young reached Los Angeles, pioneering the future western routes of the covered-wagon migrants.

In 1835 the Mexican congress declared Los Xngeles the capital of California, an edict that was hardly enforced by governors who favoured the north. For a time, just prior to the C.S. conquest of 1846, Gov. Pio Pico, California's last Mexican governor, removed the capital to Los Angeles. The city was rent by north-south and local factional quarrels when war broke out between Mexico and the United States. With the appearance of C.S. troops under Commodore Robert Field Stockton and Capt. John Charles Frémont (*qq.v.*), the Mexican defenders of Los Xngeles fled and the U.S. flag was raised over the city on Aug. 13, 1846. An insufficient garrison of 50 men, left in control, was compelled in October to withdraw because of a revolt of the inhabitants, and Los Angeles was not retaken until Gen. Stephen Watts Kearny and Commodore Stockton entered the city from San Diego in Jan. 1847.

After a short period as a military garrison Los Angeles reverted to civilian rule under U.S. control. On April 4, 1850, the city was incorporated and became the county seat. and in that year the first English-language school was opened and the first Protestant church established. Los Angeles thrived upon a big cattle trade with California's northern mines. At first a lawless frontier town, the files of the Los Angeles Star, southern California's first substantial newspaper, are filled with stories of almost routine daily violence during the 1850s and 1860s.

Until the building of the railroads, large-scale immigration remained limited by California's remoteness and isolation. Distance alone. not to speak of such natural barriers as deserts and almost impassable mountains, restricted communication with the rest of the world. Such travelers as ventured to the west in the two decades after the gold rush of 1848–49 tended to move toward San Francisco, then a larger, more cosmopolitan, better-known city. In 1869, however, the transcontinental railroad era damned. Before that time (1866), Pres. Andrew Johnson confirmed the city's Spanish and Mexican pueblo land titles (consisting of 17.000 ac.). This action was particularly important as the claims of numerous residents under grants issued by the original pueblo rested on these titles.

Los Xngeles finally attained a railroad connection with San Francisco in 1876, and with the eastern U.S., via the Santa Fe system, in 1885. An immense tide of immigration soon thereafter enveloped southern California, partly because of a vigorous rate war between the Southern Pacific and Santa Fe railroad companies. In the year 1887 railroad fares from Los Angeles to Chicago (and other Mississippi valley terminals) dropped to $1. The dawn of the railroad age held commercial implications for Los Angeles as well as increasing its population. As early as 1877 local growers sent a carload of oranges eastward by rail. Then began a new era of horticultural enterprise. The railroad rate war and a simultaneous land boom soon created thousands of new customers for southern California's farmers and merchants. A significant proportion of the travelers to Los Xngeles in the 1880s became permanent settlers. It is from the real estate boom of 1887 that the tourist era also dates.

But Los Angeles, located 20 mi. from the ocean, could not expect to become a great metropolis without a harbour. San Pedro. an open roadstead, with scanty protection from the sea. had served as its only port facility. Before a harbour was finally built, a long political battle ensued with Collis P. Huntington and Southern Pacific railway interests. These wanted a $4,000,000 facility built: with government subsidy, at Santa Monica, rather than in the San Pedro-Wilmington area. The struggle over the site of the city's future harbour, with San Pedro favoured by a civic group known as the Free Harbour league, did not come to an end until 1896. That year the U.S. congress voted an appropriation of $2,900,000 to build an artificial harbour for Los Angeles at San Pedro, thereby defeating the Huntington interests. Three years later the city celebrated the Free Harbour jubilee and 20.000 persons gathered at San Pedro to watch the dumping of the first barge of stone for a breakwater. Construction of the harbour was finally completed in 1914 and. aided by traffic through the new Panama canal, Los Xngeles began almost immediately to benefit by this new world trade route. Thereafter the history of Los Angeles was marked by continued commercial and industrial expansion, and civic improvements.

Administration and Finance.—The city of Los Angeles is governed under a charter in operation from July 1, 1925. It provides for the initiative, the referendum, the recall and an executive budget. Elected at large are the mayor (the chief executive, with wide powers of appointment), the city attorney, the controller and seven members of the board of education. The 15 members of the city council (the legislative body) are elected by districts for a term of two years. They handle budget and tax problems, public improvements and local civil service matters. The principal functions of government are entrusted to 16 commissions of 5 members each, appointed by the mayor. which appoint and fix the salary of general managers for their departments. There is also a municipal housing commission consisting of 12 members together with 4 judges and the president of the chamber of commerce. All the above groups work in co-operation with a powerful board of county supervisors, who govern both urban and rural areas and control the many special districts and agencies in Los Angeles county.

In Southern California banking developed later and on a smaller scale than in the northern part of the state. Banks existed in San Francisco 15 years before they were established in Los Angeles. The first city bank mas opened by Isaias W. Hellman in 1865. In 1868 Hellman bought out the rival bank of William Workman and his son-in-law Francisco P. F. Temple and in 1871 joined forces with California's Gov. John G. Downey to form the Farmers and Merchants bank, which became Los Angeles' first large bank. The development of the city as southern California's banking and financial centre was the natural outcome of population growth. Los Angeles has long been the home of numerous building and loan associations which have supplied much capital for real estate development. This capital is invested directly in land, buildings, oil and manufactures and there is also a large local investment in securities. The area is ranked as the third largest financial centre in the U.S.

Commercial and Industrial Development. — The economy of greater Los Angeles is exceedingly varied as well as dynamic. The reasons for its continuing prosperity were many and diverse.

Agriculture.—The city's first commerce was highly agricultural. Following the gold rush of 1848–49 the growth of population furnished an urgent market for cattle, grain and other foodstuffs. Prior to 1860 fully 60% of California's population was engaged in mining; the southern counties, of which Los Angeles was the centre, became the agricultural suppliers of this moneyed population. In 1850 cattle sold for as high as $500 per head and the great ranchos of the south flourished. Until drought conditions and falling prices in the 1860s damaged the sheep and cattle industries, Los Angeles was known as "queen of the cow counties." Grain, wheat and fruit production also made Los Angeles important agriculturally. Wine was made from the mission variety of grape from the early Spanish period. As early as 1831 there were about 100 ac. of vineyards at Los Angeles, containing about half of the state's 200,000 vines. The Camulos rancho at nearby Ventura was renowned for its fruit long before the gold rush occurred. William Wolfskill and Don Luis Vignes experimented on a small scale with the growing of grapes and oranges throughout the 1860s on the site of the modern downtown area.

It was the orange industry that first brought Los Angeles widespread agricultural acclaim. At nearby Riverside (*q.v.*) in 1873 Luther Calvin and Eliza Tibbets planted the first Washington navels, a new variety of seedless orange from Bahia, Braz. The climate and soil proved so well suited to this species of orange that it attained an agricultural perfection unmatched by any other fruit. The new industry added immeasurably to the commercial stability of Los Angeles. With the development of large-scale wine production at nearby Cucamonga, egg production in the San Fernando valley and a big dairy industry at Norwalk, Los Angeles achieved agricultural maturity well before the turn of the 20th century.

At mid-20th century Los Angeles county had led the nation in the value of its agricultural production each year since 1910. The city was a marketing centre for a wide diversity of crops, including oranges, lemons, apricots, peaches, almonds, walnuts, truck vegetables, figs, avocados, poultry, grain, alfalfa, livestock and dairying. The first outstanding success in co-operative farm marketing was made by the orange industry's local California Fruit Growers' exchange. This organization, as well as the California Walnut Grower's association, and the avocado and lemon exchanges, established headquarters in Los Angeles. However, agriculture steadily yielded large areas of fertile land formerly devoted to the raising of crops and livestock to real estate subdivisions, defense plants, new industrial establishments and space-consuming freeways. Los Angeles county's status as a leading county in agricultural production slipped markedly as the area became increasingly industrialized.

Manufactures.—Early manufacturing was chiefly for local needs and included such products as soap, confectioneries (utilizing locally grown sugar beets), beverages and brewing, as well as household goods. By 1925 Los Angeles, nevertheless, ranked first among California cities with a manufacturing output valued at more than $500,000,000, a payroll of 58,000 and an annual wage expenditure of $86,000,000. A significant feature of this development was the shifting of manufacturing leadership from San Francisco to Los Angeles. In 1900 San Francisco ranked first among California's manufacturing cities but by 1910 had shown little increase in output while Los Angeles had advanced 100% in the same period. The shortages created by World War I further encouraged industrial enterprise at Los Angeles. World War II, with its Pacific fronts craving supplies, further stimulated, indeed forced, rapid industrial progress. By mid-20th century Los Angeles was a leading manufacturer of military and commercial aircraft.

After the war, the city had about 10.000 factories in the metropolitan area and by the early 1960s the number had increased to more than 16,000. Production of transportation equipment, motion pictures, fabricated metal products, machinery, petroleum products and printing formed a large part of this activity. Los Angeles also ranks as a fashion centre for sportswear and women's apparel; glass, chemicals, cement, paints, food processing and fish canning are also leading products. Until Japan entered the world market, southern California for decades had what amounted to a monopoly on the packing of tuna and Los Angeles became the largest fish-packing (including sardines) and fish-distributing centre in the U.S. Production of fish meal and fish oil are important by-products of this industry. Branch plants of eastern U.S. concerns are engaged in automobile assembling and the manufacture of tires, furniture, glass, textiles, tin cans, paper, steel and metal articles. Before the Fontana steel mill was built in 1942, Los Angeles foundries relied upon scrap and pig iron from England, Belgium and Utah and upon coke from Colorado.

Motion Pictures. — Reliable constancy of sunshine and varied scenery brought the motion-picture industry to Los Angeles. As late as 1909 only 4,000 people were living in Hollywood. At the turn of the century, with ample land for studios, it became with Universal City, Burbank and Culver City an international centre for this industry. By the 1960s, however. television had changed the nature of the industry as even the largest studios gave way to the production of films for TV. At the height of its success Hollywood employed more than 100,000 persons in the making of films. (See HOLLYWOOD; MOTION PICTURES.)

Natural *Resources.*—Petroleum and water power were the first resources developed on a large scale. Electricity was generated in the mountains and Los Angeles pioneered long-distance electric power transmission and the linking of large electric networks. Within a radius of 300 mi are valuable deposits of metals and minerals: copper, petroleum, soda, salt, potash, silica, infusorial earth, talc, graphite, limestone, building stone, marble and onyx. Except for utilization of borax and iron (from nearby Eagle mountain) these resources have not been widely exploited.

Associated with Los Angeles as much as oranges or motion pictures, however, has been large-scale oil production. A natural bituminous pitch, oozing out of the earth and called brea, was used by the Indians and early Spaniards to coat the roofs of their dwellings. After crude experiments to distill this product, in the 1850s and 1860s, there followed the colourful era of Edward L. Doheny who began the first widespread development of the gas and oil fields surrounding the city in the 1890s. Several oil companies mere founded within the first decades of the 20th century and vast quantities of oil were taken from newly discovered Signal Hill (1921), Santa Fe Springs (1921) and Huntington Beach (1920). The production of these three nearby fields was so great that they frequently upset the national oil price, storage and distribution structure throughout the 1920s and 1930s. Hundreds of millions of barrels were produced by these and other Los Angeles wells. Not only did the petroleum industry enrich many individuals; it also became a great source of revenue for the state and provided widespread employment. The oil industry also helped make Los Angeles a transportation hub for ships, the railroad and, later, the trucking industry.

Transportation —The development of transportation for Los Angeles has a long and colourful history. After U.S. occupation (1847) regular sea trade was established between San Pedro harbour and San Francisco, and mail was carried fortnightly by land between the latter city and Los Angeles. The first freight wagon overland from the east arrived in 1851, the first overland stage in 1858. In 1860. a ten-day pony express linked Los Angeles with the Missouri river. A local railway from Los Angeles to San Pedro harbour was opened in 15'69. The Southern Pacific railway from San Francisco to Los Angeles was completed in 1876. Until the Santa Fe connected the city with the east in 1835 the Southern Pacific company, under Collis P. Huntington, enjoyed a virtual monopoly of railroad transportation throughout California and into Los Angeles. By the 20th century this monopoly had been broken and the city had three direct railways to the east.

A municipal transport system of buses links the city with its harbour, beaches and various airports. At one time the Pacific Electric railway, a subsidiary of the Southern Pacific, had 1,161 mi. of track radiating from downtown Los Angeles to points as far outside the city as Redlands and Balboa beach. These inter-urban rail lines gave way to bus routes. Los Angeles is a terminal for various national highways and, because of the heaviest per capita density of automobiles in the world (more than 3,000,000 registered autos), is a natural centre for California's widespread freeway system (part of a master plan of highways to solve the traffic problem) which carries a heavy truck and bus traffic.

Los Angeles is also a travel centre for the southwest and several thousand visitors arrive daily by train, bus, car, ship and airplane. Hotels, apartment houses, motels and trailer courts cater to the tourist traffic.

Air service is available for transportation northward and eastward and Los Angeles has also become a terminus for the polar air route to Europe. Its International airport ranks high in the nation in volume of commercial passengers and freight. Other nearby airports are located in Van Nuys and at the Lockheed air terminal in Burbank.

The Port of Los *Angeles.*—By sea the city also maintains shipping connections to all parts of the globe, as well as a coastal traffic to both Pacific and Atlantic ports of North and South America. In Spanish times San Pedro bay afforded an uncertain roadstead, chosen because of accessibility by level land route to the city. Despite a stage route (1852) to the harbour and later a railroad, San Francisco enjoyed most of the sea trade in the 19th century. The lengthy squabble over the future site of Los Angeles harbour ended with the annexation in 1906 of the "shoestring strip" to the ocean, giving Los Angeles municipal jurisdiction over its future harbour, the annexation of San Pedro and Wilmington (1909), the building of a breakwater by the U.S. government (1910) and of an inner harbour by the city itself (1912–14). Cargo shipments increased eight times in both tonnage and value, in the decade 1920–30. With more than 40 mi. of water front, and superior accommodations for large ocean-going vessels, facilities were enlarged in 1941 in co-operation with the separate harbour at Long Beach. After World War II Los Angeles became second only to New York in tonnage of U.S. export harbour commerce. Chief imports of both are bananas, newsprint: copra, rubber, coffee, sodium nitrate, jute, iron and steel scrap, vegetable oil and fibres. Chief exports include oil, cotton, borax. citrus fruits, asphalt, steel plates, industrial chemicals, pipes, tubes and fittings: canned fish, machinery, chemicals and automobile tires. Los Angeles harbour is an operating centre for the U.S. navy.

Water **Supply.**—Los Angeles required an unrelenting supply of mater for industrial and domestic purposes. Located in a semi-desert region, water was crucial to its growth. In 1904 William Mulholland, chief engineer of the city's water department, suggested an aqueduct to the Sierra Nevada range through the Mojave desert. By 1908 city bonds were voted, and work begun upon a most controversial project which virtually depleted Owens lake and turned part of the southern Sierra into a desert wasteland. Los Angeles aqueduct, finished in 1913, was 233 mi. in length and the longest work of its kind in the world. The cost of construction was nearly $25,000,000, including 142 tunnels, 97 mi. of covered conduit, 12 mi. of siphons, 39 mi. of lined canal, and 24 mi. of unlined canal. Despite a daily capacity of 288,000,000 gal., and additional water supplies from the Los Angeles river, by the 1930s the city began to fall seriously behind in its water requirements Construction in 1936 of the giant Colorado river (*q.v.*) aqueduct, part of a $220,000.000 project piercing six mountain ranges with 38 tunnels totaling 108 mi., afforded an additional allotment of 677,000,000 gal. daily and provided a new water supply to 13 cities in the metropolitan district. The major electrical energy comes over a transmission line of 266 mi. from Hoover (formerly Boulder) dam. By the 1950s the city was keenly aware that new sources of water supply would have to be developed. However, California's water problems became ensnarled in a bitter north-south sectional controversy over retention of water rights by northern "counties of origin" which were reluctant to release further water resources to a seemingly insatiable Los Angeles. The north needed flood control projects almost as much as the south needed mater, but political factionalism stymied co-operation in launching such remedial programs as the controversial Feather river project. which finally was begun officially in 1960.

Cultural and Educational Activities. — In addition to its numerous well-known "motion-picture palaces," Los Angeles supports considerable legitimate theatre. Hollywood is the centre of energetic little theatre activity. The Player's Ring, Huntington-Hartford theatre and Pasadena's Community playhouse are familiar sites. Extensive television and radio facilities have been built in Los Angeles, from which many national and regional network programs emanate.

Grand opera is usually presented in Shrine auditorium, seating 7,000 persons. Orchestra programs and other recitals are given in the Philharmonic auditorium. As the climate makes outdoor entertainment attractive. the city has a number of gathering places such as the Los Angeles coliseum seating 105,000 persons, a sports arena for athletic events and conventions (35,000), Hollywood Bowl (25,000), the adjoining Pilgrimage Play amphitheatre and outlying auditoriums, such as the Pasadena Rose Bowl (89,000). The Symphony Under The *Stars* is presented in Hollywood Bowl and ballet and outdoor drama are presented each summer at the municipal Greek theatre in Griffith park.

The Los Angeles County Museum of History, Science, and Art in Exposition park exhibits skeletons of prehistoric mammals from nearby La Brea pits. It also maintains an important art museum located near the state museum of science and industry. The Southwest museum at Highland Park specializes in the civilizations of the southwestern United States, Mexico and Central America and is particularly strong in materials concerning the American Indian. Its Casa de Adobe is a replica of an early Spanish colonial home, complete with furnishings. At Barnsdall park in Hollyhock house, a structure of Mayan inspiration, built in 1913 by Frank Lloyd Wright, is located the Municipal Art gallery. the site also of cultural activities and small musicales. City zoos are located at Elysian and Griffith parks. At Griffith observatory are 12- and 6-in. refracting telescopes, a 3-in solar telescope; a museum of the physical sciences; and a planetarium. The function of these latter facilities is to interpret the universe to the visitors nho patronize the observatory's educational program.

Numerous professional writers, artists and architects have been attracted by southern California and have made Los Angeles and Hollywood their home.

The Los Angeles public library with more than 60 branch*s has about 2,250,000 volumes. The Los Angeles county public library, also with more than 60 branches, has over 1,000,000 volumes. The city has special libraries belonging to colleges, professional associations and business concerns, devoted to law, medicine, architecture, mining, petroleum, minerals and industrial subjects. One of these is the William Andrews Clark library of the University of California (devoted to the collection of books on Anglo-American civilization) and the Henry E. Huntington library and art gallery (at nearby San Marino) which is rich in rare books and manuscripts, mostly English and American, with collections of incunabula. There is also an outstanding collection of portraits and landscapes of the English painters of the "golden age"— Thomas Gainsborough, Sir Joshua Reynolds, Sir Thomas Lawrence and George Romney. The J. Paul Getty museum, near Santa Monica, includes collections in two major fields: French 18th-

H. ARMSTRONG ROBERTS

VIEW OF DOWNTOWN LOS ANGELES SHOWING THE CITY HALL ON THE LEFT

century art and Greek and Roman sculpture.

Enrollment in the Los Angeles public schools during the early 1960s totaled more than 600,000. In a 15-year period after World War II, enrollment in the city's high schools increased by 60% while elementary school growth during the same period was 75%.

Among the major institutions for higher education, in order of their founding, are: (1) the private coeducational University of Southern California (1880), in the central part of the city; (2) Occidental college (1887), located on an attractive campus in the Eagle Rock section, at the northern border of Los Angeles, a private coeducational college devoted to the liberal arts and sciences; (3) California Institute of Technology (1891), at Pasadena, a private institution whose work is largely confined to scientific and engineering subjects; it is notable for pure science and research. At the Institute's Jet Propulsion laboratory the United States' first earth satellites were constructed in 1957; (4) Loyola University of Los Angeles (1911), Roman Catholic, with courses in engineering, commerce, premedical studies and law; (5) the public University of California at Los Angeles (1919), on a huge, sprawling campus at the western border of the city; it is increasingly graduate in character, but gives complete university training. Its facilities include schools of law, medicine and engineering. Other nearby public institutions are Los Angeles state college (1947) and San Fernando Valley state college (1956). Located in greater Los Angeles are Whittier college (1901) ; the Associated colleges, five institutions at Claremont, and Redlands university (1907). All except the state institutions were founded by religious denominations but, by agreement with their respective churches, many gave up all organic denominational connection early in the 20th century.

Parks and Recreation. — Los Angeles city and county maintain several hundred parks, playgrounds, swimming pools and youth centres. Among these are: Griffith park, 4.253 ac.; Exposition park, 114 ac., with Los Angeles museum; Elysian park, 599 ac., in a natural state; Sycamore grove, 15 ac., Lincoln park, 46 ac., and Pershing square, the only park in the business section besides the old Spanish plaza. At the latter is the old Plaza church, one of the plaza's many historic buildings dating from the period 1800–12 onward. Nearby are the Lugo house, the city's first multistory building, dating from 1840 when it was built by Don Vicente Lugo; it was later used for a time by St. Vincent's college (later Loyola university) as its first campus. Olvera street, called El Paseo by the Spaniards, is a brick walkway named for Don Agustin Olvera, and visited traditionally by tourists. Avila adobe, a private museum on this street, was built in 1818 by Don Francisco Avila; surrounding it are several dozen shops that sell Mexican handicrafts, including several candlemaking establishments. Also near the Plaza and Olvera street there stands the Pico house, a hotel on Main street built in 1869 by Gov. Pio Pico.

Another tourist attraction is La Brea pits. Located further west on Wilshire Blvd., these "pitch springs," as they were known when utilized by the Indians, were discovered by the Portolá exploring expedition of 1769. These fossil-bearing tar pits, containing prehistoric remains of extinct animals once caught in sticky seepage, came into the possession of G. Allan Hancock, who gave them to the city in 1915 for park development purposes. Hancock park now contains life-size restorations of such prehistoric animals as the sabre-toothed tiger, mastodon, giant ground sloth and prehistoric camels and bison.

Many tourists visit Mt. Wilson, site of the 100-in. Carnegie telescope located northeast of the city, Lake Arrowhead and Big Bear lake in the San Bernardino mountains and Santa Catalina island. 23 mi. S.W. from San Pedro. Other attractions include Disneyland. Knott's berry farm, Pacific Ocean park and the Marineland of the Pacific, an oceanarium near Palos Verdes.

Since 1957 Los Angeles has been the home of the former Brooklyn Dodgers, a professional major (National) league baseball club. In 1961 the Los Angeles Angels, an American league club, began play. The Los Angeles (formerly Cleveland) Rams of the professional National Football league are also located there.

City Planning and problems of Growth. — Once a sleepy pueblo of red-tiled, whitewashed adobe buildings and muddy streets, the town presented a distinctive impression upon travelers in former times. Its population at the turn of the 20th century was 102,489 inhabitants. Baedeker's Guide said in 1899 that within the preceding decade "its adobe houses have given place almost entirely to stone and brick business blocks and tasteful wooden houses." The typical "California house" of the early 20th century was frequently an adaptation of Spanish design and the bungalow from India. In fact, southern California's architecture is still highly eclectic. The Monterey-style house, with its balconies and terraces became especially popular. Stucco or wood frame construction were alternately featured by builders who pioneered real estate tracts that mushroomed interminably in a horizontal construction boom that eventually obliterated the Los Angeles countryside.

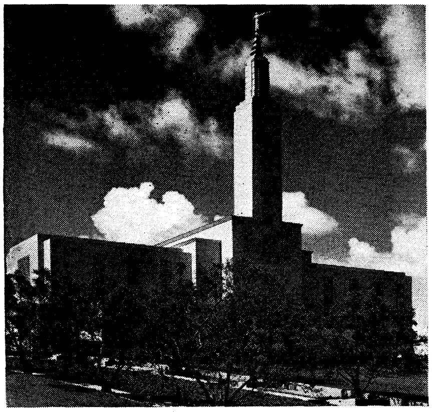
Only after 1925 did the city develop a real civic centre, with its nearby Spanish-style union passenger railroad terminal and accompanying government buildings. By the 1960s these developments were giving way to massive redesigning of the city's entire civic centre. A central mall became the site of a series of city, county, state and federal buildings. Slum clearance and relocation developments were simultaneously transforming the Bunker Hill region into a new commercial and residential area. After the removal in 1957 of a 150-ft. height maximum on public buildings came the construction of many 20- to 40-story buildings that line 15 mi. of the city's central sector and its westward extension into the Wilshire boulevard district with an increasingly vertical skyline of apartment houses and office buildings.

Construction of freeways. parks, airfields, schools, fire stations, libraries, sewers and other facilities on the city's expanding periphery barely kept up with the population avalanche that came to Los Angeles after World War II. Statistics for the 1950s indicated that on the average one new person enters southern California every 55 seconds. A new school was needed for additional pupils every Monday morning into the 1960s. Each year Los Angeles added a city larger than Syracuse, N.Y. The costs of such expansion were great as municipal plans became obsolete even before they emerged from blueprints.

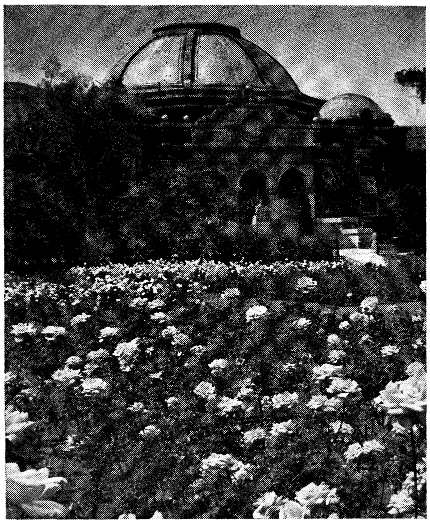
All this frenzied growth was not without concern to those residents who knew the city when it was a pleasanter place in which to live. The smog, increased traffic congestion, industrialization and other municipal problems decreased the charm of rural and suburban living. The traditionally colourful orange groves and vineyards made way for aircraft factories, steel mills, housing developments and large apartment construction. Nevertheless there was no evidence that migration to southern California in general, and Los Angeles in particular, would taper off. The pattern indicated the city would move outward to swallow up even more of its countryside. Population experts predicted a vast urban complex stretching almost solidly from Santa Barbara to San Diego, its centre — and controlling focus — Los Angeles.

LOS ANGELES

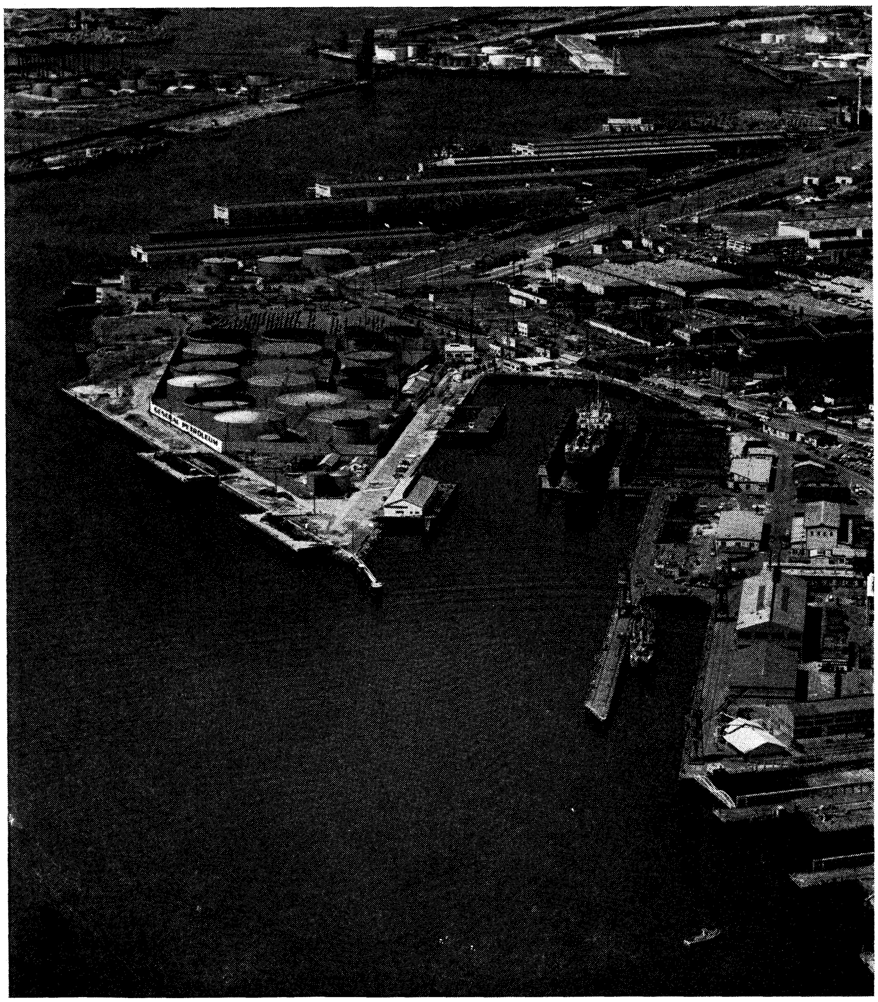
General view of the centre of the city. Two large buildings in the foreground house government offices: Los Angeles city hall is at left (with tower); next to it is the Federal building and post office



Church of Jesus Christ of Latter-day Saints, dedicated in 1956, largest Mormon temple in the world



Rose garden, Exposition park. In background is the Los Angeles County museum, which has both art and science collections and exhibits

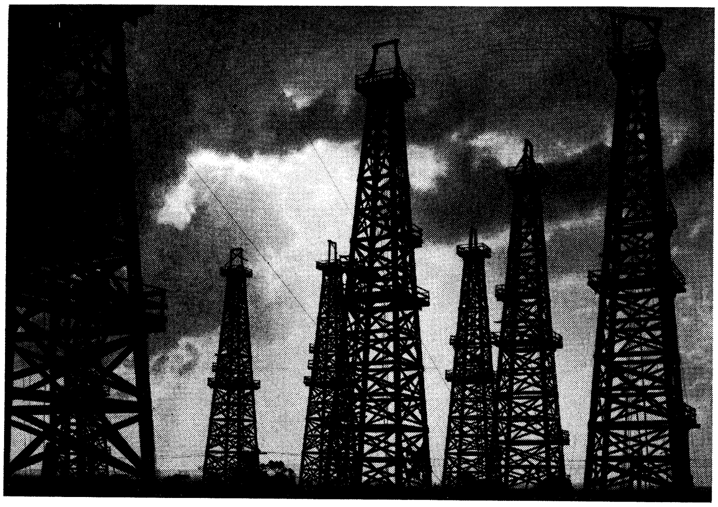


Some of the docks and shipping facilities of San Pedro harbour, the port of Los Angeles. An artificial harbour, created by dredging the flats of San Pedro bay, it is connected to the rest of metropolitan Los Angeles (on the north) by a narrow Piece of land called the "shoestring strip"

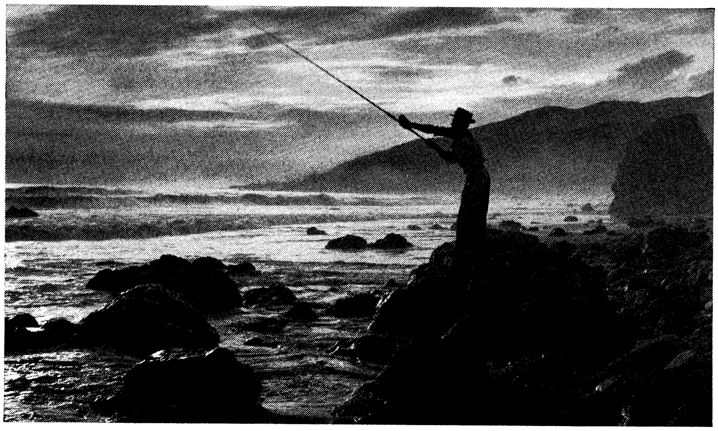
METROPOLITAN LOS ANGELES

BY COURTESY OF (TOP) LOS ANGELES CHAMBER OF COMMERCE, (BOTTOM RIGHT) UNION PACIFIC RAILROAD COMPANY; PHOTOGRAPHS, (CENTRE LEFT) JOSEF MUENCH, (BOTTOM LEFT) DAVID MUENCH

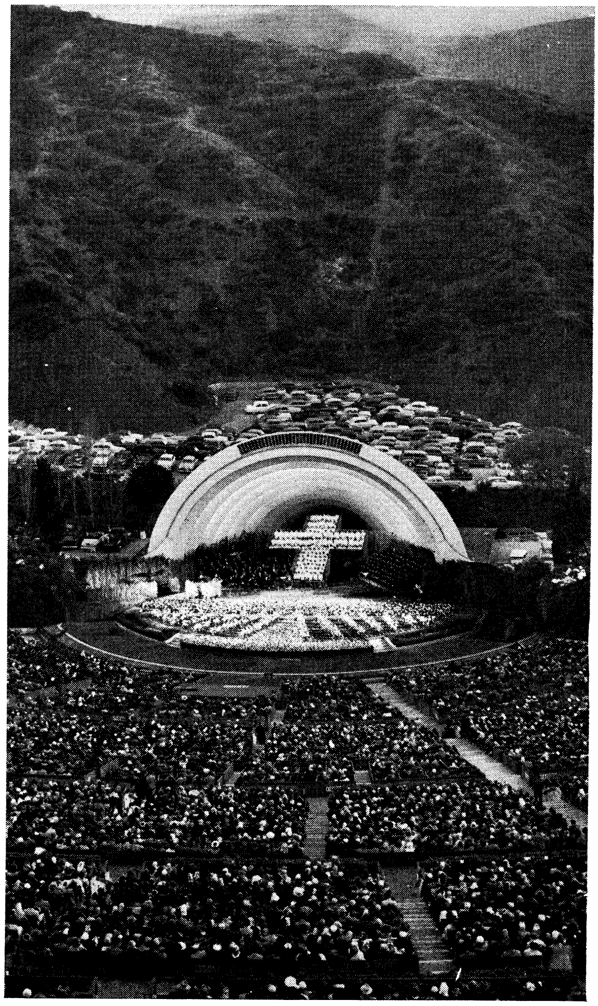
LOS ANGELES



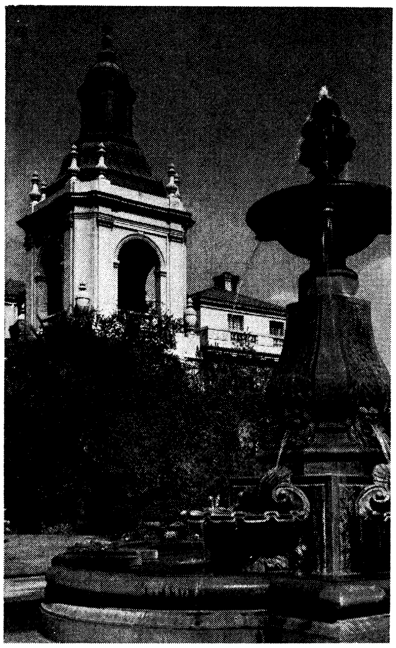
Oil-well derricks silhouetted against the sky at Signal Hill, one of the three highly productive petroleum fields discovered in the Los Angeles area in 1920–21



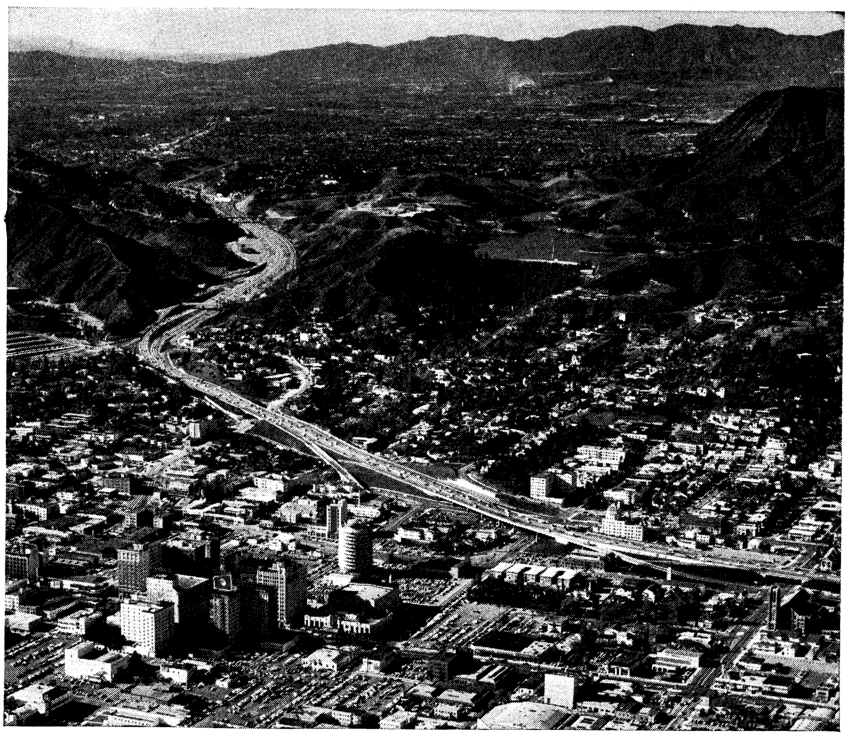
Fisherman surf casting along the shore at Malibu Beach, an unincorporated corn-rnunity near Santa Monica



An Easter sunrise service at Hollywood Bowl, a 50-ac. natural amphi-theatre in Beachwood canyon, Hollywood



Fountain in the courtyard of the city hall of Pasadena, largest of the separate communi-ties associated with Los Angeles



General view of Hollywood (foreground) and the Hollywood freeway, major motor traffic artery between Los Angeles and the northwest

SCENES IN LOS ANGELES COUNTY

BY COURTESY OF (TOP RIGHT, BOTTOM RIGHT) UNION PACIFIC RAILROAD COMPANY: PHOTOGRAPHS (TOP LEFT, CENTRE LEFT, BOTTOM LEFT) DAVID MUENCH

See Index references under "Los Angeles" in the Index volume.

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LOS ISLANDS (ISLAS DE LOS ÍDOLOS), a group of islands off the coast of Guinea, West Africa, south of Sangarea bay. and about 80 mi. N.N.W. of Freetown. Sierra Leone. There are five principal islands: Tamara. Factory. Crawford. White (or Ruma) and Coral. The two largest islands are Tamara and Factory. These two islands lie parallel to each other. Tamara to the west; they form a' sort of basin, in the centre of which is the islet of Crawford. The two other islands are to the south. The archipelago is of volcanic formation. Tamara and Factory islands forming part of a ruined crater. with Crawford Island as the cone. All the islands are richly clothed with palm trees and flowering underwood. The inhabitants are immigrants of the Baga tribe of Senegambian Negroes, whose home is the coast land between the Pongo and Nunez rivers. In 1818 Sir Charles McCarthy, governor of Sierra Leone, obtained the cession of the islands to Great Britain from the chiefs of the Baga country, and in 1882 France recognized them to be a British possession. By the Anglo-French convention of April 8, 1904. the islands were ceded to France. In Oct. 1958, French Guinea became the Republic of Guinea, and Los Islands became part of it.

LOS RÍOS, province in the coastal lowland of Ecuador, bounded west by Guayas, north by Pichincha and Cotopaxi, east by Bolivar and south by Guayas. Area, 2,292 sq.mi. Pop. (1960 est.) 219.800. Its capital is Babahoyo. pop. (1959 est.) 13.100. The province is mostly in the lowlands west of the mountains, along the middle courses of the Rio Vinces and of the Río Babahoyo. tributaries of the Rio Guayas. The chief land use is for beef cattle, bananas, cacao. sugar cane and rice. From the forests come balsa wood, timber, tagua nuts and rubber. As the name suggests, transportation is almost entirely by river boat to Guayaquil. Steamers reached Babahoyo even during the dry season and in flood season can ascend to Zapotal. (P. E. J.)

LOS SANTOS, a small province in southern Panamá occupying much of the hilly, Azuero peninsula and facing the Gulf of Panamá. Area, 1.494 sq.mi. Pop. (1960) 70.372, of which 70% was rural. The largest town and capital is Las Tablas, pop. (1960) 3.326; it is 8 mi. N.W. of the port of Mensabé. Los Santos is important agriculturally, ranking high in the production of corn, rice, sugar, swine, cattle and poultry. The province is a major supplier of eggs and chickens to the urban centres in and near the Canal Zone, to which it ships products by boat and truck. (C. F. I.)

LOSSIEMOUTH, a seaport and small burgh of Moray, Scot., at the mouth of the Lossie on the Moray firth, $5\frac{1}{2}$ mi N. of Elgin. Pop. of burgh (1961) 5,855; area 0.7 sq.mi. Lossiemouth, or the old town, dates from 1700, Seatonn is somewhat later, Branderburgh, farther north, grea nith the harbour and began about 1830 and Stotfield is now purely modern, although on the site of the oldest settlement. In the 15th century Lossiemouth succeeded Spynie as Elgin's port. when that tonn was silted up by sand and shingle, but it declined nith the migration of the herring until its popularity as a seaside town brought back its prosperity. There are long sandy beaches and a fine golf course. Fishing is still the main industry (whitefish only) and the town has a fleet of 80 seine-net boats. J. Ramsay MacDonald (1866–1937) was born in Lossiemouth. The cliffs at Covesea, 2 mi. \Ir.. contain caves, in one of which prehistoric weapons were found and the roof of another is carved with early Celtic ornamentation. On the coast is Covesea lighthouse.

Nearly midway between Lossiemouth and Elgin stand the massive ruins of the palace of Spynie, formerly the castle of the bishops of Moray. The large toner, with walls nine feet thick, was built about 1470.

LOSSKI, NIKOLAI ONUFRIEVICH (1870–), Russian philosopher, was born at Kreslavka near Vitebsk on Dec. 6, 1870. He was educated at Kreslavka and at the University of St. Petersburg (Leningrad), where he was professor, 1916–21. In 1922 he was compelled to leave the U.S.S.R. and went to live in Prague. He nas a professor in Bratislava, 1942–45. After World War II he emigrated to the U S. and became a professor in the Russian Orthodox seminary, New York (professor emeritus, 1950). According to Losski's viens, knowledge is immediate contemplation (intuition). His intuitionalism differs from Bergson's in so far as he considers the ideal-rational forms to be elements of realities, intuitively cognizable. Losski assumes not only concrete real being, but concrete ideal being as well; *i.e.*, supratemporal and supraspatial substantial agents nith creative force, which are the basis of spatiotemporal being. This doctrine leads Losski to his teaching of the freedom of the will. Among Losski's most important books are *Die Grundlehre der Psychologie vom Standpunkte des Voluntarismus,* published in Russian (1903), in German (1905); *The Intuitive Bases of Knowledge* (1904; Eng. trans., 1919); *Handbuch der Logik* (1922); *Tlze World as an Organic Whole* (Eng. trans.. 1928); *Freedom of Will* (Eng. trans. 1932); *Value and Existence* (Eng. trans . 1935); *Des conditions de la ntorale absolue* (French trans.. from Russian manuscript, 1948) ; and *History of Russian Philosophy* (1951).

LOSTWITHIEL, a market tonn and municipal borough in the Bodmin parliamentary division of Cornwall. Eng., on the Fowey river, 6 mi S.S.E. of Bodmin. Pop. (1961) 1,954. Area 4.9 sq.mi. St. Bartholomem's church has a fine Early English tower and a Decorated spire. A bridge of the 14th or early 1jth century crosses the river. The Shire hall or Duchy palace includes remains of a building, called the Stannary prison, dating from the 13th century. The Western Region railway route has workshops there. The boundaries of the borough were further extended in 1934.

Lostwithiel probably owed its existence to the neighbouring circular castle of Restormel, restored in 1930. The first charter dates back to about 1190. The Pipe Rolls (1194–1203) show that Robert de Cardinan, lord of Restormel, paid ten marks yearly for having a market at Lostwithiel. He surrendered to the burgesses all the liberties given them by his predecessors (*antecessores)* mhen they founded the town. Isolda, granddaughter of Robert de Cardinan, gave the town to Richard. king of the Romans, who granted to the burgesses a guild merchant and many privileges, as well as a yearly fair and a weekly market. His son Edmund decreed that the coinage of tin should be at Lostwithiel only. In 1609 a charter of incorporation provided for courts of record and piepowder. From 130j to 1832 two members represented Lostwithiel in parliament, but under the Reform act (1832) the borough became merged in the county.

For the victory gained by Charles I over the earl of Essex in 1644. *see* CIVIL WAR. ENGLISH.

LOT, in the Bible, the legendary ancestor of the two Palestinian peoples, Moab and Ammon (Gen. xix. 30–38; *cf.* Ps. lxxxiii, *8);* he appears to have been represented as a Horite or Edomite. As the son of Haran and grandson of Terah. he was Abraham's nephen and he accompanied his uncle in his migration from Haran to Canaan. Near Bethel Lot separated from Abraham. because of disputes betneen their shepherds and, being offered the first choice, chose the fertile and nell-irrigated Jordan valley. It was in this district that the cities of Sodom and Gomorrah (*q.v.*) were situated. He was saved from their fate by two divine messengers nho spent the night in his house, and next morning led Lot. his wife and his two unmarried daughters out of the city. His wife looked back and was changed to a pillar of salt, but Lot with his two daughters escaped first to Zoar and then to the mountains east of the Dead sea. where the daughters planned and executed an incest by which they became the mothers of Moab and Ben-Ammi (i e, Ammon). The account of Chedorlaomer's invasion and of Lot's rescue by Abraham. recounted in Gen xiv. belongs to an independent source, the age and historical value of which has been much disputed. *See* ABRAHAM; AMMONITES; MOAB.

LOT, a department of south-western France, formed in 1790 from the district of Quercy, part of the old province of Guyenne. It is bounded N. by Corrèze, W. by Dordogne and Lot-et-Garonne, S. by Tarn-et-Garonne, and E. by Aveyron and Cantal. Area 2,018 sq.mi. Pop. (1936) 162,572. The department is that part of the south-western slope of the Massif Central which is drained by the river Lot, navigable with the help of locks, while its northern portion is crossed by the parallel Dordogne, both streams flowing west to the Garonne-Gironde. On its eastern side, towards the heights of Cantal, there are hills 2,560 ft. in height. The centre of the department is occupied by a calcareous Jurassic plateau called the Causses, 700–1,300 ft. (Causse de Martel north of the Dordogne, Causse de Gramat or de Rocdmadour between Dordogne and Lot, and Causse de Cahors south of Lot). On the west, stream dissection has formed a series of hills fringing the plain of Aquitaine. Water soaks through the porous surface of the causses and vanishes down its many fissures (igues) and springs emerge lower down to form large streams in the narrow and beautiful valleys. Temperature varies greatly between the warm valleys and the highlands of impermeable rock in the east; rainfall is somewhat above the average for France. Wheat, oats, maize, buckwheat and rye are the chief cereals. Wines are well known. The north-east cantons produce large quantities of chestnuts, walnuts, truffles, plums, and potatoes are also grown. Sheep abound, but cattle, pigs, horses, mules and goats are also reared, as well as poultry and bees. Some iron and coal are mined, and a little zinc. Limestone is quarried. The three arrondissements are those of Cahors, the capital, Figeac and Gourdon; there are 29 cantons and 331 communes.

Lot belongs to the 17th military district (Toulouse), and to the *académie* of Toulouse, its court of appeal is at Agen, and it is in the province of the archbishop of Albi, bishopric of Cahors. It is served by the Orléans railway. Cahors, Figeac and Rocamadour are the principal places. The fine feudal fortress at Castelnau has an audience hall of the 12th century, the Romanesque abbey-church at Souillac has a finely sculptured entrance. The plateau of Puy d'Issolu, near Vayrac, is believed by most authorities to be the site of the ancient Uxcellodunum, the scene of the last stand of the Gauls against Julius Caesar in 51 B.C. Lot has many dolmens.

LOT, a river of southern France, about 300 m. long, rising in the Hercynian gneisses of the Cévennes on Mt. du Goulet, at a height of 4,918 feet. Its direction is westward through a deep gorge between the Causse of Mende and Aubrac mountains, and the tableland (causses) of Sauveterre, Sévérac and Comtal. It passes off the gneisses near Capdenac; hence its sinuous course crosses the plateau of Quercy, of Jurassic limestones, to enter a wider fertile plain, covered with Tertiary deposits and alluvium. Its largest tributary, the Truyère (right), joins it at Entraygues. Lower down it receives the Dourdou (left) and the Célé (right) above Cahors, below which is the town of Villeneuve-sur-Lot. The Lot is canalized and navigable between the Garonne and Bouquiès (160 miles).

LOT-ET-GARONNE, a department of south-western France, formed in 1790 of Agenais and Bazadais, two districts of the old province of Guienne, and of Condomois, Lomagne, Brullois and pays d'Albret, formerly portions of Gascony. It is bounded W. by Gironde, N. by Dordogne, E. by Lot and Tarn-et-Garonne, S. by Gers and S.W. by Landes. Area, 2,079 sq.mi. Pop. (1936) 252,761. The department is that part of the Garonne basin above and below the point at which the Lot joins it. The north-east and the south are hilly, and in the west are the borders of the Landes (*q.v.*). The Garonne, the Lot and the Drot, a right bank tributary of the Garonne, are navigable. The mean temperature of Agen is 56·6° F, or 5° above that of Paris; the annual rainfall, from 20 to 24 in., is nearly the least in France. Of cereals wheat is the chief, with oats and maize. Potatoes, vines and tobacco are important sources of wealth. The best wines are those of Clairac. Vegetables and fruit, especially plums, prunes d'ente and apricots, are grown. The chief trees are the pine and the oak; there is a good deal of forest and the cork-oak flourishes in the Landes. Horned cattle are the chief live stock. Poultry and pigs are also reared profitably. There are deposits of iron in the department. The forges, blast furnaces and foundries of Fumel are important; and agricultural implements and other machines are manufactured. The making of lime and cement, of tiles, bricks and pottery, of confectionery and dried plums (*pruneaux d'Agen*) and other delicacies are important. At Tonneins (pop. [1936] 4,506) there is a national tobacco manufactory. Cork cutting, of which the centre is Mézin, candle-making, tanning and paper making are other industries. The arrondissements are three, named from the towns of Agen, Marmande and Villeneuve-sur-Lot, and there are 35 cantons and 326 communes.

Agen, the capital, is the seat of a bishopric under Bordeaux and of the court of appeal. The department belongs to the region of the XVII. army corps (Toulouse), the *académie* of Bordeaux. Lot-et-Garonne is served by the lines of the Southern and the Orléans railways. The department possesses Roman remains at Mas d'Agenais and at Aiguillon. The churches of Layrac, Monsempron, Mas d'Agenais, Moirax, Mézin and Vianne are of interest, as also are the 13th century fortifications of Vianne, and the châteaux of Xaintrailles, Bonaguil, Gavaudun and of the industrial town of Casteljaloux.

LOTHAIR I. (795–855), Roman emperor, was the eldest son of the emperor Louis I., and his wife Irmengarde. Little is known of his early life, which was probably passed at the court of his grandfather Charlemagne, until 815, when he became ruler of Bavaria. When Louis in 817 divided the empire between his sons, Lothair was crowned joint emperor at Aix-la-Chapelle and given a certain superiority over his brothers. In 821 he married Irmengarde (d. 851), daughter of Hugo, count of Tours; in 822 undertook the government of Italy; and, on April j, 823, was crowned emperor by Pope Paschal I. at Rome. In Nov. 824 he promulgated a statute which reserved the supreme power to the secular potentate, and he afterwards issued ordinances for the good government of Italy. On his return to his father's court his step-mother Judith persuaded him to secure a kingdom for her son Charles, a scheme which was carried out in 829. Lothair, however, soon changed his attitude, and spent the succeeding decade in constant strife over the division of the empire with his father. He was alternately master of the empire, and banished and confined to Italy; at one time taking up arms in alliance with his brothers and at another fighting against them; whilst the bounds of his appointed kingdom were in turn extended and reduced.

When Louis was dying in 840, he sent the imperial *insignia* to Lothair, who, disregarding the various partitions, claimed the whole of the empire. Negotiations with his brother Louis and his half-brother Charles, both of whom armed to resist this claim, were followed by an alliance of the youngtr brothers against Lothair. A decisive battle was fought at Fontenoy on June 25, 841, when, in spite of his personal gallantry, Lothair was defeated and fled to Aix. With fresh troops he entered upon a war of plunder, but he was compelled to surrender Aix to his brothers. In June 842 the brothers met on an island in the Sâone, and agreed to an arrangement which eventually developed into the treaty of Verdun (843).

By this Lothair received Italy and the imperial title, together with a stretch of land between the North and Mediterranean seas lying along the valleys of the Rhine and the Rhône. He abandoned Italy to his eldest son, Louis, and remained in his new kingdom, engaged in alternate quarrels and reconciliations with his brothers, and in efforts to defend his lands from the attacks of the Normans and the Saracens. In 855 he fell ill, and divided his lands between his three sons. On Sept. 23 he entered the monastery of Prüm, where he died six days later.

LOTHAIR II. or **III.** (*c.* 1070–1137), surnamed the "Saxon," Roman emperor, son of Gebhard, count of Supplinburg, succeeded to extensive lands around Helmstadt in Saxony, on his father's death in 1075. Gebhard had been a leading opponent of the emperor Henry IV. in Saxony, and his son, taking the same attitude, assisted Egbert II., margrave of Meissen, in the rising of 1088. His position in Saxony was increased by his marriage (1100) with Richenza, daughter of Henry, count of Nordheim. Having assisted the German king, Henry V., against his father in 1104, Lothair was appointed duke of Saxony by Henry, when Duke Magnus, the last of the Billungs, died in 1106. His independent attitude brought him into collision with Henry V., to whom, however, he was forced to submit after an unsuccessful rising in 1112. In 1112 Lothair supported the claim of Siegfried, count of Ballenstadt to inherit the domains of Ulrich II., count of Weimar and Orlamunde, against the emperor, Henry V. The rebels were defeated, and Siegfried was killed at Warnstadt in 1113, but his son secured possession of the disputed counties. After the defeat by Lothair of Henry's forces at Welfesholz on Feb. 11, 1115, events called Henry to Italy; and Lothair appears to have been undisturbed in Saxony until 1123, when the death of Henry II., margrave of Meissen and Lusatia raised a dispute as to the right of appointment to the vacant margraviates. A struggle ensued, in which victory remained with the duke.

When Henry V. died in 1125, Lothair was chosen German king at Mainz on Aug. 30, 1125. His election was largely owing to the efforts of the papal party. The new king was crowned at Aix-la-Chapelle on Sept. 13, 1125. Lothair requested Frederick of Hohenstaufen to restore to the crown the estates bequeathed to him by the emperor Henry V. Frederick refused, and was placed under the ban. Lothair, unable to capture Nuremberg, gained the support of Henry the Proud, the new duke of Bavaria, by giving him his daughter, Gertrude, in marriage, and that of Conrad, count of Zahringen, by granting him the administration of the kingdom of Burgundy, or Arles. But Conrad of Hohenstaufen, the brother of Frederick, was chosen German king in December 1127, and was quickly recognized in northern Italy. But by the end of 1129 the Hohenstaufen strongholds, Nuremberg and Spires, were in Lothair's possession. This struggle was accompanied by disturbances in Lorraine, Saxony and Thuringia, but order was soon restored after the resistance of the Hohenstaufen had been beaten down. In 1131 the king led an expedition into Denmark; resistance was offered, and the Danish king, Niels, promised to pay tribute to Lothair.

The king's attention at the time was called to Italy where two popes, Innocent II. and Anacletus II., were clamouring for his support. At first Lothair remained heedless and neutral; but in March 1131 he was visited at Liége by Innocent, to whom he promised his assistance. Crossing the Alps with a small army in September 1132, he reached Rome in March 1133, accompanied by Innocent. As St. Peter's was held by Anacletus, Lothair's coronation as emperor took place June 4, 1133 in the church of the Lateran. He then received as papal fiefs the vast estates of Matilda, marchioness of Tuscany, thus securing for his daughter and her Welf husband lands which might otherwise have passed to the Hohenstaufen. He returned to Germany, where he restored order in Bavaria, and on the lower Rhine. Resuming the struggle against the Hohenstaufen, Lothair soon obtained the submission of the brothers, who retained their lands, and a general peace was sworn at Bamberg. The emperor's authority was now generally recognized, and the annalists speak highly of the peace and order of his later years. In 1135, Eric II., king of Denmark, acknowledged himself a vassal of Lothair; Boleslaus III., prince of the Poles, promised tribute and received Pomerania and Riigen as German fiefs; while the eastern emperor, John Comnenus, implored Lothair's aid against Roger II. of Sicily.

The emperor seconded the efforts of his vassals, Albert the Bear, margrave of the Saxon north mark, and Conrad I., margrave of Meissen and Lusatia, to extend the authority of the Germans in the districts east of the Elbe, and assisted Norbert, archbishop of Magdeburg, and Albert I., archbishop of Bremen, to spread Christianity. In Aug. 1136, attended by a large army, Lothair set out upon his second Italian journey. The Lombard cities were either terrified into submission or taken by storm; Roger II. was driven from Apulia; and the imperial power enforced over the whole of southern Italy. A mutiny among the German soldiers and a breach with Innocent concerning the overlordship of Apulia compelled the emperor to retrace his steps. An arrangement was made with regard to Apulia, after which Lothair, returning to Germany, died at Breitenwang, a village in the Tirol, on Dec. 3 or 4, 1137. Lothair has been described as the "imitator and heir of the first Otto." His reign was regarded, especially by Saxons and churchmen, as a golden age for Germany.

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LOTHAIR (941–986), king of France, son of Louis IV., succeeded his father in 954, and was at first under the guardianship of Hugh the Great, duke of the Franks, and then under that of his maternal uncle Bruno, archbishop of Cologne. The beginning of his reign was occupied with wars against the vassals, particularly against the duke of Normandy. Lothair attempted to recover Lorraine by a sudden attack, and in the spring of 978 nearly captured the emperor Otto II. at Aix-la-Chapelle. In the autumn Otto invaded France, penetrating as far as Paris, but was forced to retreat with heavy loss. Peace was concluded in 980 at Margut-sur-Chiers, and in 983 Lothair was even chosen guardian to the young Otto III. Towards 980, however, Lothair quarrelled with Hugh the Great's son, Hugh Capet, who, at the instigation of Adalberon, archbishop of Reims, became reconciled with Otto III. Lothair died on March 2, 986. By his wife Emma, daughter of Lothair, king of Italy, he left a son who succeeded him as Louis V.

See F. Lot, *Les Derniers Carolingiens* (Paris, 1891); and the *Recueil des actes de Lothaire et de Louis V.,* edited by L. Halphen and F. Lot (1908).

LOTHAIR (825–869), king of the district called after him Lotharingia, or Lorraine, was the second son of the emperor Lothair I. On his father's death in 855, he received for his kingdom a district lying west of the Rhine, between the North Sea and the Jura mountains, which was called Regnum Lotharii and early in the 10th century became known as Lotharingia or Lorraine. On the death of his brother Charles in 863 he added some lands south of the Jura to this inheritance. The reign was chiefly occupied by efforts on the part of Lothair to obtain a divorce from his wife Teutberga, a sister of Hucbert, abbot of St. Maurice (d. 864); and his relations with his uncles, Charles the Bald and Louis the German, were influenced by his desire to obtain their support to this plan. Louis favoured the divorce, and Charles opposed it, while neither lost sight of the fact that Lothair was without male issue. Lothair put away Teutberga; but Hucbert took up arms on her behalf, and after she had submitted successfully to the ordeal of water, Lothair was compelled to restore her in 858. He then won the support of his brother, the emperor Louis II., by a cession of lands, and obtained the consent of the local clergy to the divorce and to his marriage with Waldrada, which was celebrated in 862. A synod of Frankish bishops confirmed this decision at Metz (863), but Teutberga fled to the court of Charles the Bald, and Pope Nicholas I. declared against the decision of the synod. An attack on Rome by the emperor failed, and in 865 Lothair again took back his wife. Teutberga, however, now expressed her desire for a divorce, and Lothair went to Italy to obtain the assent of the new pope Adrian II. On the return journey he died at Piacenza on Aug. 8, 869. He left, by Waldrada, a son Hugo who was declared illegitimate, and his kingdom was divided between Charles the Bald and Louis the German.

See Hincmar, "Opusculum de divortio Lotharii regis et Tetbergae reginae," in *Cursus completus patrologiae,* tome cxxv., edited by J. P. Migne (Paris, 1857–79); M. Sdralek, *Hinkmars von Rheims Kanonistisches Gutachten über die Ehescheidung des Königs Lothar II.* (Freiburg, 1881); E. Diimmler, *Geschichte des ostfränkischen Reiches* (Leipzig, 1887–88); and E. Mühlbacher, *Die Regenten des Kaiserreichs unter den Karolingern* (Innsbruck, 1881).

LOTHIAN, MARK KERR, FIRST EARL OF (d. 1609), the eldest son of Mark Kerr (d. 1584), abbot, and then commendator, of Newbattle, was a member of the famous border family of Ker of Cessford. Mark Kerr was an extraordinary lord of session under the Scottish king James VI; he became Lord Newbattle in 1587, and earl of Lothian in 1606. He died on April 8, 1609, having had, as report says, 31 children by his wife, Margaret (d. 1617), daughter of John Maxwell, 4th Lord Herries.

LOTHIAN, PHILIP HENRY KERR, 11TH MARQUESS OF (1882–1940), British ambassador to the United States, was born April 18, 1882. He was educated at the Oratory school, Birmingham, and at New college, Oxford university. In 1905 he was appointed assistant secretary of the Inter-Colonial Council of Transvaal and Orange River Colony and of the Railway Committee of Central South African Railways, and in those capacities he went to South Africa, where he remained until 1910. In South Africa he edited a magazine, *The State,* which favoured union of the South African colonies. After his return to England, he became editor of *The Round Table, a* journal of government and politics. Lloyd George made Kerr his secretary in 1916, in which capacity he assisted in preparing the Versailles treaty. He resigned in 1921 to direct the United Newspapers, Ltd.; served in the British cabinet as parliamentary under-secretary of the India office (1931–32); was chairman of the Indian Franchise committee (1932); and was secretary of the Rhodes trust, which administers the Rhodes scholarships (1925–39). In 1939 he was appointed British ambassador to the United States, a position he held until his death, Dec. 12, 1940, in Washington, D.C.

In the early 1930s, Kerr was an advocate of appeasing Germany but he abandoned that position after Hitler's seizure of Czechoslovakia. His chief effort as ambassador was to obtain war materials for Britain from the United States.

LOTHIAN. This name was formerly applied to a considerably larger extent of country than the three counties of Linlithgow, Edinburgh and Haddington Roxburghshire and Berwickshire at all events were included in it, probably also the upper part of Tweeddale (at least Selkirk). It would thus embrace the eastern part of the Lowlands from the Forth to the Cheviots, *i.e.,* all the English part of Scotland in the 11th century. This region formed from the 7th century onward part of the kingdoms of Bernicia and Northumbria. It cannot have come into English hands before the last decades of the previous century; for in the *Historia Brittonum* the Bemician king Theodoric, whose traditional date is 572–579, is said to have been engaged in war with four Welsh kings. One of these was Rhydderch Hên who, as we know from Adamnan, reigned at Dumbarton, while another named Urien is said to have besieged Theodoric in Lindisfarne. If this statement is to be believed it is hardly likely that the English had by this time obtained a firm footing beyond the Tweed. Most probably the greater part of Lothian was conquered by the Northumbrian king Aethelfrith, who, according to Bede, ravaged the territory of the Britons more often than any other English king, in some places reducing the natives to dependence, in others exterminating them.

In the time of Oswio the English element became predominant in northern Britain. His supremacy was acknowledged both by the Welsh in the western Lowlands and by the Scots in Argyllshire. On the death of the Pictish king Talorgan, the son of his brother Eanfrith, he seems to have obtained the sovereignty over a considerable part of that nation also. Early in Egfrith's reign an attempt at revolt on the part of the Picts proved unsuccessful. We hear at this time also of the establishment of an English bishopric at Abercorn, which, however, only lasted for a few years. By the disastrous overthrow of Egfrith in 685 the Picts, Scots and some of the Britons also recovered their independence. Yet we find a succession of English bishops at Whithorn from 730 to the 9th century, from which it may be inferred that the southwest coast had already by this time become English. The Northumbrian dominions were again enlarged by Eadberht, who in 750 is said to have annexed Kyle, the central part of Ayrshire, with other districts. In conjunction with Oengus mac Fergus, king of the Picts, he also reduced the whole of the Britons to submission in 756. But this subjugation was not lasting, and the British kingdom, though now reduced to the basin of the Clyde, whence its inhabitants are known as Strathclyde Britons, continued to exist for nearly three centuries. After Eadberht's time we hear little of events in the northern part of Northumbria, and there is some reason for suspecting that English influence in the southwest began to decline before long, as our list of bishops of Whithorn ceases early in the 9th century; the evidence on this point, however, is not so decisive as is commonly stated. About 844 an important revolution took place among the Picts. The throne was acquired by Kenneth mac Alpin, a prince of Scottish family, who soon became formidable to the Northumbrians. He is said to have invaded "Saxonia" six times, and to have burned Dunbar and Melrose. After the disastrous battle at York in 867 the Northumbrians were weakened by the loss of the southern part of their territories, and between 883 and 889 the whole country as far as Lindisfarne was ravaged by the Scots. During the next 50 years the influence of the Scottish kingdom seems to have increased in the south, and in 945 the English king Edmund gave Cumberland, *i.e.,* apparently the British kingdom of Strathclyde, to Malcolm I, king of the Scots, in consideration of his alliance with him. Malcolm's successor Indulph (954–962) succeeded in capturing Edinburgh, which thenceforth remained in possession of the Scots. His successors made repeated attempts to extend their territory southwards, and certain late chroniclers state that Kenneth II in 971–975 obtained a grant of the whole of Lothian from Edgar. Whatever truth this story may contain, the cession of the province was finally effected by Malcolm II by force of arms. At his first attempt in 1006 he seems to have suffered a great defeat from Uhtred, the son of earl Waltheof. Later, however, he succeeded in conjunction with Eugenius, king of Strathclyde, in annihilating the Northumbrian army at Carham on the Tweed *(c.* 1016 or 1018?), and Eadulf Cudel, the brother and successor of Uhtred, ceded all his territory to the north of that river as the price of peace. Henceforth in spite of an invasion by Aldred, the son of Uhtred, during the reign of Duncan, Lothian remained permanently in possession of the Scottish kings. *(See* SCOTLAND.)

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(F. G. M. B.)

LOTI, PIERRE (the pen name of Louis Marie Julien Viaud) (1850–1923), French author, was born at Rochefort on Jan. 14, 1850. His education began in Rochefort, but at the age of 17, following the tradition of his family, he entered the navy and began to attend the naval school at Brest. He gradually rose in his profession, attaining the rank of captain in 1906, and in 1910 was placed on the reserve list. His pseudonym is said to have been due to his extreme shyness and reserve in early life, which made his comrades call him after *le Loti,* an Indian flower which grows in unfrequented spots. He was never given to books or study, and it was not until 1876 that he was persuaded to write down and publish some curious experiences at Constantinople, in *Aziyadé,* a book which, like so many of Loti's, seems half a romance, half an autobiography. Thereafter he continued to write novels, which were mainly reminiscent of his travels. While taking part as a naval officer in the Tonking war, Loti exposed a series of scandals which followed on the capture of Hué (1883), and was suspended from the service for over a year. He continued silent for some time, but in 1886 published his most famous book, *Pêcheur d'Islande,* a novel of life among the Breton fisher-folk. In May 1891 he was elected a member of the French academy. He died at Hendaye (Basses Pyrénées), June 10, 1923.

Loti's greatest successes were gained in the species of confession, half-way between fact and fiction, of his earlier books. His later books of pure description were rather empty, for in spite of the beauty and melody and fragrance of his works, his mannerisms are likely to pall. With all his limitations, however, he was, in mechanism of style and cadence, one of the most original and talented French writers of the second half of the 19th century.

Among his most important works are: *Rarahu* (1880), republished as *Le Mariage de Loti; Le Roman d'un Spahi* (1881); *Mon frère Yves* (1883); *Propos d'exil* (1887); *Madame Chrysanthbme* (1887); *Au Maroc* (1890); *Le Livre de la pitié et de la mort* (1891); *Fantôme d'orient* (1892); *Ramuntcho* (1897); *L'Inde (sans les Anglais)* (1903); *La troisième jeunesse de Mme. Prune* (1905); *Les Désenchantées* (1906; Eng. trans. by C. Bell); *La Mort de Philae* (1908); *Judith Renaudin* (Théâtre Antoine, 1904).

LOTICHIUS or LOTICH, **PETRUS SECUNDUS** (1528–1560), German humanist, was born at Schluchtern, Hesse-Cassel. In 1547 he was a member of the army of the Protestant league of Schamlkalden which was defeated by the forces of Charles V at Miihlberg. Lotichius was made professor of medicine at Heidelberg in 1557 and he died in that city three years later. Lotichius is noted for his poems, particularly his elegies. of which he left several volumes. Stylistically they resemble the works of some of the classic Latin poets.

LÖTSCHEN PASS or LÖTSCHBERG, an easy glacier pass (8,825 ft) leading from Kandersteg (Bernese Oberland) to the Lotschen valley (Valais), Switzerland. It is first mentioned in 1352, but was probably crossed earlier by the Valaisans, who colonized various parts of the Bernese Oberland.

In 1384 and in 1419 battles were fought on it between the Bernese and the Valaisans, uhile in 1698 a mule path (of which traces still exist) was constructed on the Bernese slope, though not continued beyond. The railway between Berne and Brig passes beneath the pass in the Lotschberg tunnel (9 mi. long and built in 1906–12). The tunnel starts above Kandersteg and enters the Lotschen valley at Goppenstein. This pass is to be distinguished from the Lotschenlucke (10,512 ft.), another glacier pass which leads from the head of the Lotschen valley to the Great Aletsch glacier

LOTTERY, a scheme for the distribution of prizes to be determined by chance, was reputedly an invention of the Romans. In its usual form, tickets are sold bearing different numbers Duplicates are placed in a drum or wheel from which winning numbers are drawn on a specified date

Although the Roman emperors Nero and Augustus used lotteries to distribute slaves, houses or ships as prizes. the chances were free. Lotteries in the modern sense originated in Italy during the middle ages spreading to France. Germany and Austria where rulers used them to raise revenue.

France first used lotteries as state revenue measures in 1539 although they had been permitted there under the name of *blanques* in 1520 by edict of Francis I.

The first English lottery drawing was held in 1569. In 1612 the Virginia company's colonial expedition was partly financed through a lottery. English lotteries encouraged mass gambling. Fraudulent drawings and the counterfeiting of tickets were commonplace. In the Lottery Act of 1823 Parliament provided for their discontinuance.

A century later, following agitation for legalized lotteries, a Royal commission in 1932 reported unanimously against permissive legislation, pointing out that existing prohibitory acts stemmed from evils prevailing when they were legal.

American colonial lotteries, patterned after those in England, were used to raise money for public improvements and to assist in the financing of colleges including Columbia Harvard, Dartmouth and Williams. In 1762 the Pennsylvania Provincial assembly denounced lotteries, declaring they were responsible for vice and idleness and were injurious to trade. Following the Revolutionary War lotteries flourished throughout the nation. Abuses including fraud were commonplace. Various state legislative committees recommended their abolishment. In 1833 legislation enacted in Massachusetts, New York and Pennsylvania outlawed lotteries, and early in 1834 similar action was taken by Ohio, Vermont, Maine, New Jersey, New Hampshire and Illinois. Provisions prohibiting legislatures from authorizing lotteries in the future were inserted in many state constitutions.

Following the Civil War the Louisiana Lottery company 'obtained from the state legislature a 2j-year charter effective Jan. 1, 1869. Its ostensible purpose was to raise money for the New Orleans Charity hospital. The lottery company became tremendously wealthy, politically powerful and corrupt. Pres. Benjamin Harrison, in a special message on July 30, 1890, to the U.S. senate and house of representatives declared: "The people of all the states are debauched and defrauded . . . by the Louisiana Lottery." He recommended that "severe and effectual legislation . . . be promptly enacted to enable the Post Office Department to purge the mail of all letters, newspapers, and circulars relating to the business." Congress responded by enacting legislation making it a federal crime to deposit lottery matter in the United States mails. In the Louisiana election of 1892, the lottery was the sole issue in the governor's contest. The antilottery candidate won and the lottery was outlawed.

Since that time lotteries have been illegal in the United States except in a few states where bingo (*q.v.*), a form of lottery, is permitted when conducted by specified religious or fraternal organizations for charity.

Policy, a form of lottery, flourishes among Negroes in urban areas. Pellets numbered 1 to 78 are deposited in a drum shaped wheel. Players wager that certain numbers will appear among twelve that are selected at the drawing. A bet that three particular numbers will be selected is known as a gig, four numbers a horse and five numbers a jack. Odds against the players are enormous.

Bolita.—A lottery similar to policy is bolita, played in Puerto Rico, and in the United States among Cuban and Puerto Rican groups. In this lottery, numbered balls from one to 100 are placed in a canvas sack. A small tear is made in the sack and the drawer inserts his hand and grasps one of the numbered balls. The sack is then split open and the remaining balls allowed to fall out. Although the odds are actually 99 to 1, the winning number usually pays only 70 for 1.

Numbers Game differs from policy largely in the method of selecting the winning numbers. Numbers game winners are determined from specified digits in such publicized figures as bank clearances, U.S. Treasury balances or pari-mutuel payoffs in designated races.

Legalized lotteries have a long and continuous history in Central and South American countries and exist in several European countries. Following World War II Russia used a lottery scheme to sell bonds for economic development financing. Non-winners received no interest on their bonds while winners received prizes. Among the best known lotteries are the Irish Sweepstakes, and Tattersalls in Australia.

See also GAMBLING AND BETTING.

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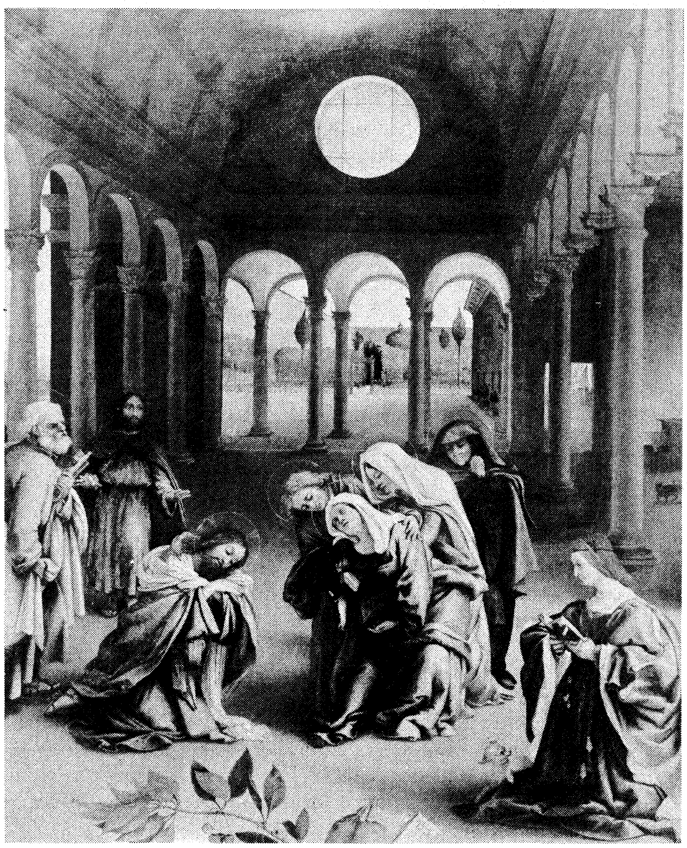
LOTTO, LORENZO (c. 1480–1556), Italian painter, was born in Venice, but in the earlier years of his life lived at Treviso and always remained somewhat apart from the main Venetian tradition.

His earliest dated pictures. the "Madonna and St. Peter Martyr" (1503) and the "Portrait of Bishop de' Rossi" (1505), both in Naples together with its allegorical cover, now in Washington, D.C., have unmistakable quattrocento traits in the treatment of the drapery and landscape and the cool tonality. To his early period belong the "Assumption of the Virgin," at Asolo, and "St. Jerome in the Wilderness" (1506) at the Louvre; the altarpiece at Sta. Cristina near Treviso (1507); the Recanati polyptych and "Madonna and Saints" (1508), at the Villa Borghese; and "Marriage of Catherine," at Munich

Lotto was in Rome between 1508 and 1512, when Raphael was painting the Stanza della Segnatura. A document in the Corsini library mentions that Lotto received 100 ducats as an advance payment for fresco work in the upper floor of the Vatican, but there is no evidence that this work was ever executed. In the next dated norks, the "Entombment" (1512) at Jesi and the "Transfiguration." "St James" and "St. Vincent" at Recanati, Lotto has abandoned the dryness and cool colour of his earlier style, and adopted a fluid method and a blonde. joyful colouring.

In 1513 Lotto mas living in Bergamo, where he had entered into



PHOTOGRAPHISCHE GESELLSCHAFT

"CHRIST TAKING LEAVE OF HIS MOTHER" BY LORENZO LOTTO. AT THE KAISER FRIEDRICH MUSEUM, BERLIN

a contract for 500 gold ducats to paint an altarpiece for S. Stefano, completed in 1516 and now at S. Bartolommeo.

From the next years. spent mostly at Bergamo, date the London portrait of the della Torre brothers (1515); the "Susanna and the Elders" (1517) in the Contini collection, Florence; the Dresden "Madonna" (1518); the London portrait of the' Prothonotary Giuliani (c. 1520) and the "Madonna and Two Saints" (1521); the Madrid "Bride and Bridegroom" (1523); the Berlin "Christ Taking Leave of His Mother" (1521) and the "Youth Against a Red Curtain" (c. 1525); the "Young Man in His Study" (c. 1524) at the Venice academy; numerous altarpieces in and near Bergamo, together with the fine series of frescoes in the Oratorio Suardi at Trescore, near Bergamo (1524), and the remarkable designs for the inlaid choir stalls in Sta. Maria Maggiore.

In 1526 or 1527 Lotto returned to Venice, where Titian ruled supreme in the world of art; and it was only natural that the example of the great master should have fired him to emulation. However, it was only a passing phase; even in the Carmine altarpiece of "St. Nicholas of Bari" (1529), which is his nearest approach to Titian, he retained his individualized, as opposed to Titian's generalized, expression of emotion. From the Venetian years 1526 to 1529 date the portraits "Andrea Odoni" at Hampton Court and "Bishop Tommaso Negri" at Split (both 1527); the so-called "Lucretia" at London, the "Man on a Terrace" at Cleveland and the "Man Holding a Claw" at Vienna (all c. 1527); the Recanati "Annunciation" and the Brescia "Adoration of the Shepherds" (c. 1528); and the strangely misnamed "Triumph of Chastity" at the Rospigliosi palace in Rome.

Among pictures executed between 1529 and 1540, chiefly in the Marches, are the Louvre "Christ and the Adulteress" (c. 1530); the "Youth Against a Green Curtain" (*c.* 1530) and the "St. Sebastian" and "St. Christopher" (1531) at Berlin; the "Crucifixion" (1531) at Monte San Giusto; the "Visitation" (*c.* 1530) and the "St. Lucy Altarpiece" (1532) at Jesi; the Bergamo "Holy Family and Catherine" (1533); male portraits at Villa Borghese (*c.* 1530) and Palazzo Doria (c. 153j) in Rome; the Uffizi "Madonna and Saints" (1534); and the monumental Cingoli "Madonna of the Rosary" (1539).

Between 1540 and 1548 Lotto was in Venice and Treviso and was once more influenced by Titian. Works of these years include the "St. Antonino Giving Alms" (1542), in SS. Giovanni e Paulo, and the "Madonna and Saints" (1546) in San Giacomo dell'Orio at Venice; the portraits of "Messer Febo da Brescia" and of "Madonna Laura da Pola" (1544) as well as the "Pietà" and the "Portrait of an Old Man" all in the Brera at Milan; the "Madonna and Saints" (c. 1546) in Sta. Maria della Piazza at Ancona; the "Family Group" (1547) in London; and the "Madonna in Glory" (1548) at Mogliano.

In 1549 Lotto went once again to the Marches where he painted the "Assumption" now in the Ancona museum. In 1550 he lost his voice and partly his eyesight. In 1554 he made over all his belongings to the Holy House at Loreto and began one of his most sensitive masterpieces, the "Presentation in the Temple," which remained unfinished at his death in the autumn of 1556.

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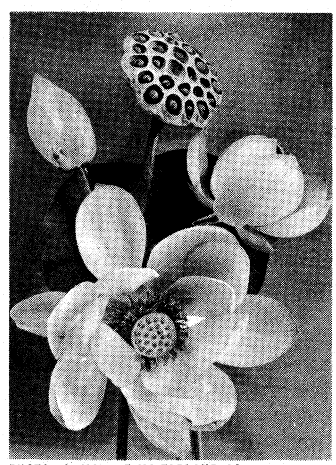
LOTTO: see BINGO.

LOTUKO: see LOATUKO.

LOTUS, a popular name applied to several plants. The lotus fruits of the Greeks belonged to *Zizyphus* lotus, a bush native in south Europe. It has large fruits containing a mealy substance, which can be used for making bread and fermented drink. In ancient times the fruits were an article of food among the poor. A wine made from the fruit was thought to produce content and forgetfulness (hence the "Lotophagi" or lotus-eaters). *Zizyphus* is a member of the family Rhamnaceae.

The Egyptian lotus was a water lily, Nymphaea lotus: also the sacred lotus of the Hindus, Nelumbium nelumbo, and the American lotus, N. *pentapetolum*. The lotus tree, known to the Romans as the Libyan lotus, was probably *Celtis* australis, the nettle tree (*q.v.*), a southern European tree, a native of the elm family, with fruits like small cherries, first red and then black. Lotus of botanists is a genus of the pea family (Leguminosae). containing a large number of species of herbs and undershrubs widely distributed in the temperate regions of the old world. It is represented in Britain by L. corniculatus, bird's-foot trefoil, a low-growing herb. common in pastures and waste places, with clusters of small bright yellow pealike flowers, which are often streaked with crimson; the popular name is derived from the pods which when ripe spread like the toes of a bird's foot. (X.)



PHOTO, J. HORACE MC FARLAND CO.

BLOSSOM AND SEED POD OF THE HINDU LOTUS (NELUMBIUM NELUMBO)

In decoration, the lotus, through gradual conventionalization, became one of the most prolific ornamental forms. Its universal use in Egypt resulted from its symbolic association with the Nile, the giver of life. The flower itself is represented as a common votive offering and is frequently painted as though tied on to shrines or house pillars.

The conventionalized form is not only the origin of the lotus bud capital, and the late lotus flower capital, but also serves in various wavs as a basis for borders and allover patterns. Two conventionalized varieties, the trilobe or three-leaved lotus, and the lotus palmette (in which the flower is combined with a semicircle or semiellipse of radiating petals above it), were largely used by the Assyrians and all the peoples along the eastern shore of the Mediterranean. Thus the lotus is at the basis of such varying forms as the Assyrian sacred tree and those Phoenician stele capitals which were the parents of the Ionic order.

Lotus flower bud and palmette forms are also the origin of a great number of Greek, painted ceramic patterns and from them evolved into the eggs and dart and into the anthemion (*q.v.*). The Romans not only borrowed and modified these Greek lotus derivatives but also received further lotus forms from Etruscan art. Lotus derivatives, like many other Roman decorative motives, appear in modified form throughout Byzantine and Romanesque art.

Lotus forms or derivatives are common even in the 20th century; thus their influence can be traced continuously back from modern times. through the Renaissance, medieval. Roman. Greek and western Asiatic work to its source in Egypt at least 5,000 years ago.

For a complete, though not entirely sound discussion, *see* W. H. Goodyear, *Grammar of the Lotus* (1891). (T. F. H.)

LOTUS-EATERS (LOTOPHAGI), a people encountered by Odysseus in the journey recounted in the *Odyssey*. They lived on a plant called *lotos,* which they offered to Odysseus' men. Those who ate of it forgot home and friends and wanted only to remain there and eat of that food.

It should be plain enough that the lotus-eaters and their country are situated in fairyland, but in addition to interpreting the story allegorically, many ancient scholars amused themselves by trying to identify them with some people of northern Africa, since that continent produces one or two edible plants called *lotos* by the Greeks. This foolishness has been imitated by some moderns.

The phrase "to eat lotus" is used metaphorically by numerous ancient writers to mean "to forget." "to be unmindful."

See HOMERIC POEMS; ODYSSEUS.

LOTZE, RUDOLF HERMANN (1817–1881), German philosopher who bridged the gap between classical German philosophy and 20th-century idealism, was born at Bautzen, on May 21, 1817, the son of a physician. After studies in the *Gymnasium* of Zittau he entered the University of Leipzig in 1834. Four years later he gained doctorates of philosophy and of medicine.

Lotze's studies were governed by two distinct interests. The first was scientific, based upon mathematical and physical studies under the guidance of E. H. Weber, W. Volckmann and G. T. Fechner. The second was his aesthetical and artistic interest, which was developed under C. H. Weisse. His vocation then seemed to be the reconciliation of science with art, literature and religion; and hence the central point of his philosophy has been described as an analysis of the concept of the mechanism of nature with the object of proving that this concept necessarily leads to the assumption of an ideal principle of existence. While a lecturer at Leipzig he published two short works, his *Metaphysik* (1841) and his *Logik* (1843), which laid the foundation of his system. In 1844 he was appointed professor of philosophy at Gottingen, where he remained until 1881. During this period he produced his most important works.

The first of Lotze's works to attract attention were articles contributed to Rudolf Wagner's *Handwörterbuch der Physiologie* in which Lotze combated the then current vitalistic theories. He first became generally known through his *Allgemeine Pathologie und Therapie als mechanische Naturwissenschaften* (1842; 2nd ed., 1848). To the same period belong his more systematic *Allgemeine Physiologie des korperlichen Lebens* (1851) and his *Medicinische Psychologie oder Physiologie der Seele* (1852). Notwithstanding the idealistic position adopted in his earlier works, his polemic against vitalistic theories led him to be regarded as a materialist, and to correct this misinterpretation he published his *Streitschriften* (1857).

In 1856 Lotze had published the first volume of his chief work, the *Mikrokosmus*, the second volume of which appeared in 1858 and the third in 1864. This contained a comprehensive account of his philosophical views. In 1868 he published his *Geschichte der Aesthetik in Deutschland.* He then planned to set out in three further volumes a more systematic account of his philosophy as a whole. The first of these, *Logik,* appeared in 1874 (2nd ed., 1880), the second. *Metaphysik*, in 1879. The third, dealing with practical philosophy, art and religion, was uncompleted at Lotze's death, which took place on July 1, 1881, a few months after he had moved from Gottingen to the chair of philosophy at Berlin.

Lotze belongs to the earliest phase of the transition from a conception of philosophy which claims or assumes that by deductive reasoning or reflection discoveries can be made about the nature of the universe to the view that philosophy is concerned only with the analysis and clarification of concepts. Though influenced in his early studies by Fichte, Schelling and Hegel, Lotze came to reject the methodology of these philosophers and more especially the dialectical method of Hegel. But neither in the method nor in the content of his philosophy did he differ so widely from his predecessors as he himself believed. Though rejecting dialectical methods, he relied upon reflection to defend hypotheses concerning the nature of reality which cannot be presented as self-evident or as evidenced by scientific observation. His conclusions were in accord with the idealist tradition. He believed that all that appears to us must be conceived as a reality, the nature of which must be construed as akin to our own nature and our own mental life. He held that this ultimate reality is an infinite divine being, within which finite individuals act and live.

More distinctive were Lotze's views concerning mechanism and teleology. He opposed the prevailing doctrine that mechanical laws apply only to inorganic matter and that processes in living things are determined by final causes and vital forces. His contention was that the laws that govern particles of matter in the inorganic world governed these particles also when they were combined in a living body. But he also rejected the view still widely assumed that explanations in terms of efficient causes and explanations in terms of final causes are alternative and incompatible. He held that mechanism is the instrument of purpose—that we explain why a living thing does what it does in terms of ends and how it does what it does in mechanistic terms. (This conception of the relation of mechanism and teleology later derived support from biological studies of directed behaviour and from the work of cyberneticians, who constructed mechanisms which behave like goal-directed living things; *see* CYBERNETICS.) Lotze argued that God in creating and maintaining the world and in attaining his ends does so entirely through the laws disclosed by the natural sciences.

As professor of philosophy at Gottingen, where he followed Herbart and was followed by G. E. Miiller, Lotze takes his place in a distinguished succession of philosophers who influenced the development of psychology as an independent science. His *Medicinische Psychologie* was the prototype of the many physiological psychologies which were to follow. His doctrine of "local signs" still receives attention from students of the theory of space perception. Retaining the doctrine of the soul, he attempted a more detailed analysis than had hitherto been attempted of the phases through which physical stimulation generates sensation and other experiences.

His interest in art and in morals and the biological approach necessary to the study of medicine combined to lead him to place special emphasis upon feeling and emotion. His contributions to the philosophy of mind and to psychology distinguish him both from the rationalist philosophers and from the intellectualist, sensationist and associationist psychologists. His influence was to be reinforced by other developments in biology, notably the Darwinian theory of evolution.

Lotze's influence upon the development of experimental psychology was mainly through his pupils and disciples such as C. Stumpf and G. E. Miiller. His psychological doctrines were interpreted by James Ward in Great Britain and by George T. Ladd in the United States. Each occupied in his own country a position similar to that of Lotze in Germany, and both played a significant part in the transition of psychology from being a philosophy of mind to being the study of its natural history.

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LOUBET, ÉMILE FRANÇOIS (1838–1929), 7th president of the French republic, was born on Dec. 30, 1838, the son of a farmer at Marsanne (Drôme). He practised at the Paris bar and in the crisis of 1870 backed L. Gambetta's policy. He entered the chamber of deputies in 1876 and worked for the republican cause, especially for education, attacking the clerical system established by the Loi Falloux, and working for the establishment of free, obligatory and secular primary instruction. In 1880 he became president of the departmental council in Drome. Loubet entered the senate in 188 j and became minister of public works in the Tirard ministry (December 1887—March 1888).

Forming his own ministry in 1892, Loubet held the office of minister of the interior as well as the premiership, and so had to deal with the Xnarchist outrages and strikes of that year. His ministry fell in November over the Panama scandal, but for a time Loubet continued to serve as minister of the interior under Alexandre Ribot (*q.v.*). In 1896 he became president of the senate, in Feb. 1899 president of the republic.

Loubet's presidency was marked by three major crises. In June 1899 he summoned P. M. Waldeck-Rousseau to form a ministry to settle the Dreyfus case and appealed to republicans of all shades to rally behind it. Acting on the advice of Gen. Gaston Galliffet, minister of war. Loubet eventually remitted the sentence passed on Dreyfus at Rennes. Secondly. friction between France and the Vatican intensified after Pius X became pope (Aug. 1903). It reached its height in March 1904 when Pius protested against Loubet's official visit to the king of Italy in Rome. Under E. Combes. anticlericalist policies triumphed, and in 1905 church and state mere separated amid violent controversy.

International tensions also reached their height, but frictions with Great Britain were satisfactorily ended by the Anglo-French entente of 1904. Loubet's tough peasant qualities. combined with a genial simplicity and an unaffected dignity, enabled him to fulfill with success one of the most exacting presidencies of the third republic.

After his term of office ended (Jan. 1906) he retired into private life and died at Montélimar, of which he had been mayor and deputy, on Dec. 20, 1929.

See A. Combarieu, *Sept ans à l'Elysée avec le Président Loubet* (Paris, 1932). (D. TN.)

LOUDON, ERNST GIDEON, FREIHERR VON (1717–1790), Austrian soldier, was born on Feb. 2, 1717, at Tootzen, Livonia, where his family, of Scottish origin, had been settled since before 1400. His father had been in the Swedish service; the boy entered the Russian army as a cadet in 1732, saw service in 1734, 1735, and 1738–39, then resigned (1741), and after vainly applying for employment with Frederick the Great, became a captain in Trenck's corps in Vienna. Soon after the outbreak of the Seven Years' War he became colonel, in 1757 major-general of cavalry, and in 1758 forced Frederick to raise the siege of Olmiitz. In 1760 he won a further victory at Kunersdorf, was promoted feldzeugmeister and made commander-in-chief in Bohemia, Moravia and Silesia.

He was successful at Landshut and Glatz, but was defeated by Frederick at Liegnitz (Aug. 15, 1760), which action led to bitter controversy with Daun and Lacy, the commanders of the main army, who, Loudon claimed, had left his corps unsupported. In 1761 he operated again in Silesia, but was hampered by the inactivity of his Russian allies. (*See* SEVEN YEARS' WAR.) His tireless activity continued to the end of the war, in conspicuous contrast with the temporizing strategy of Daun and Lacy, and led in the last three years of the war to ever-increasing friction between the "Fabius" and the "Marcellus," as they were called, of the Austrian army.

After the peace dissensions continued between Loudon and Lacy, and Loudon only remained in the army at the special request of Maria Theresa, acting as commander-in-chief in Bohemia and Moravia 1769–72. In 1776 he settled at Hadersdorf near Vienna, and was made a field-marshal in Feb. 1778.

In the same year he was reconciled with Joseph II. and Lacy and commanded one of the two armies in the field in the war of the Bavarian Succession, but this time with only moderate success. He then retired again to Hadersdorf; but recalled after the reverses of the other generals in the Turkish War, he was made commander-in-chief, and won a last brilliant success by capturing Belgrade in three weeks, 1789. He died on July 14 at Neu-Titschein in Moravia, still on duty. His last appointment was that of commander-in-chief of the armed forces of Austria, which had been created for him by the new emperor Leopold. Loudon was buried in the grounds of Hadersdorf.

See memoir *by* v. Arneth in *Allgemeine deutsche Biographie, s.v.* "Loudon," and life by G. B. Malleson.

LOUD-SPEAKER (SPEAKER), a device for converting electrical into acoustical signal energy that is radiated into a room or open air. The term "signal energy" indicates that the electrical energy has a specific form such as that corresponding to a speech or music signal. The speaker should preserve the essential character of this signal energy in converting the energy from electrical to acoustical form. This definition of a loud-speaker excludes such devices as buzzers, gongs, sirens and the like in which the acoustical signal does not correspond in form to the electrical signal. The part of the speaker that converts electrical into mechanical energy is frequently called the motor. The motor vibrates an element called the diaphragm that in turn vibrates the air in immediate contact with it. The vibration results in slight pressure changes in the air above and below atmospheric pressure. These pressure changes are transmitted into the room or open air as a sound wave (see SOUND).

Kinds.—Speakers are conveniently classified by the kind of motor employed to convert the electrical into mechanical energy. Common types are the moving coil or "dynamic," and the magnetic armature or "magnetic." Less common are the piezoelectric or crystal and electrostatic or condenser types. The moving-coil and magnetic-armature types are both technically defined as magnetic types because the mechanical forces result from the interaction of a steady magnetic field and a magnetic field produced by the electrical current. In the moving-coil motor the signal current passes through a coiled conductor and produces a varying magnetic field that interacts with a steady field. This interaction results in a force that moves the coil, which in turn moves the attached diaphragm. The strength or magnitude of the force is proportional to the strength of the current. In the magnetic-armature type the signal current passes through a fixed coil that induces a magnetic field in a movable element of magnetic material called the armature. Speakers using the latter motor are popularly called "magnetic." Those using moving-coil motors, particularly when they are of the large direct-acting diaphragm type, are popularly called "dynamic." The fixed magnetic field required by magnetic speakers may be supplied by a permanent magnet or by an electromagnet. The term "electrodynamic" is said to have been applied originally to early commercial versions of moving-coil speakers. The prefix "electro" had no bearing on the source of the fixed or steady magnetic field supplied by either electromagnets or permanent magnets.

In piezoelectric or crystal speakers the force produced by a crystal having piezoelectric properties moves the diaphragm. In electrostatic or condenser speakers a very light conducting diaphragm is used as one electrode of a condenser or capacitor and suspended so it vibrates freely. The fixed electrode (or electrodes) is closely spaced from the moving one. Both of these types have had limited application because of their relatively low conversion efficiency and power output limitations at low frequencies.

Alternatively speakers are classified as horn and hornless or direct-radiator types. A horn speaker has a horn attached to a relatively small diaphragm. The large or mouth end of the horn behaves as a large lightweight diaphragm that radiates sound more efficiently than the small diaphragm. The horn proportions, including the rate of area expansion or flare, are selected to give the desired compromise betneen efficiency, frequency response, directional properties and size. To reproduce low frequencies the rate of expansion or flare must be small, necessitating a long horn, and the mouth must be large. Low-frequency horns are therefore large. High-frequency horns are small and are frequently used as the high-frequency speakers in multispeaker systems. Horn speakers may be made quite efficient. They are therefore primarily used where efficiency and high acoustic power output are important and size less important.

In the direct-radiator or hornless speakers the diaphragm is made large enough to radiate directly into unconfined air. To prevent the low-frequency front and back waves from interfering or neutralizing each other, a rigid surface or baffle must be interposed as an extension of the diaphragm support. This extension may take the form of an open-back box or cabinet, a totally enclosed box, a box closed except for a vent or port or a conduit or duct which may be folded. The open cabinet is commonly employed in radio and television receivers. The closed box is lined with sound-absorbing material and is used when the radiation from an open back is objectionable. The closed box tends to give more uniform low-frequency response and is less influenced by proximity to a room wall but sacrifices some efficiency. The vented enclosure augments a portion of the low-frequency range. The "boomy" or excessively resonant low-frequency response present in some types arises primarily from the use of too small an enclosure and a speaker nith excessive diaphragm support stiffness.

Development.— Historically the horn type speaker first attained commercial success. The electrical signals generated by early radio receivers were very feeble, and a telephone receiver had to be held to the ear to obtain an audible signal. Because of their relatively nidespread introduction in World War I, vacuum tubes or valves were rapidly incorporated in the radio set design of the postwar era. This practice made available the much greater electrical signal energy required to operate a speaker. Many early speakers consisted of a telephone receiver, sometimes slightly modified to accept the greater signal energy, to which a horn was attached. The horn improved the efficiency of the electrical-to-acoustical energy conversion process although at the expense of naturalness of reproduction. The need for greater electrical energy for speakers led to the development of more powerful tubes and these in turn permitted the use of less efficient but more natural sounding speakers. Magnetic armature speakers employing large-area conical paper or cloth diaphragms were followed by the moving-coil or "dynamic" types employing moderate-size conical paper diaphragms. The latter are used almost universally in radio and television receivers because of their low cost, simple construction, frequency range and small size even when designed to reproduce relatively low frequencies. Their major disadvantage is low efficiency but this became of relatively little importance in view of the ease with which adequate signal energy could be obtained in receivers or amplifiers operated from external power sources.

Design Problems.— The major speaker-design problems arise from the frequency range to be produced and the need for attaining adequate efficiency. Other factors such as uniformity of response with frequency, uniform directivity or spatial distribution of the emitted sound, linearity or proportionality of the acoustic output and electrical input over the necessary signal-intensity range must also be considered. An ideal speaker would be capable of faithfully reproducing at least any sound the human ear can hear. This range involves sound intensities differing by a factor of more than 10,000,000,000,000, frequencies from about 20 to 20,000 cycles per second and sounds varying rapidly in character. In practice these difficult requirements are modified by the limitations of the associated sound-reproducing system, by the infrequent occurrence and relative unimportance of certain sounds and by the tolerance or charitability of the ear. Background noise at the microphone and at the listener's location and electrical disturbances in the signal-transmission system limit the minimum speaker signal intensity that can be heard. The intensity of the louder common speech and music sounds is substantially below the maximum intensity the ear will tolerate without pain. These factors reduce the ratio of maximum to minimum intensity required of a complete sound-reproducing system. including speaker, to approximately 1,000,000 to 1— an attainable but not commonly realized value. These numerical values are large but psychological tests have shown that over much of the useful intensity range the intensity has to be increased by a factor of from five to ten for the listener to judge that the loudness has doubled. The ideal frequency range required of the speaker is also reduced by the noise that obscures or masks the very high and very low frequencies, which are difficult to hear. The infrequent occurrence of these extreme frequencies also reduces their importance. Consequently even a range from 40 to 15,000 cycles is useful primarily in experimental and controlled studio reproduction. A range from 80 to 8,000 cycles in an otherwise distortion-free system is capable of giving very realistic and emotionally satisfying reproduction.

The speaker should treat all frequencies alike. This requirement means uniform electrical-signal-to-sound conversion efficiency at all frequencies— a goal difficult to attain in a single speaker. In a high-quality speaker the change in efficiency with frequency will occur gradually and compensation may be provided for this in the electrical system. The speaker should also treat all frequencies alike for all listener locations. This requirement involves the factors of distance to the listener and angle between the principal axis of the speaker and the listener location. Outdoors and in large auditoriums the speakers are directed toward the more remote listeners to attempt to maintain the intensity in their region. It is hard to radiate all frequencies equally well toward each listener location. Radiation, interference, focusing and similar space effects in the sound field depend on the relation between the diaphragm size and shape and the length of the sound nave. The length of 8,000- and 80-cycle sound waves is 1.7 and 170 in. respectively (these vary inversely with frequency).a variance which accounts in large measure for the difficulty of obtaining uniform space distribution and radiation efficiency over the broad frequency range. When the sound wave is long compared to the maximum dimension of the horn mouth or exposed diaphragm the speaker is nondirectional. When the wave is very short there tends to be marked concentration of the sound in a narrow beam. This effect is reduced by subdividing a horn into a number of small horns or cells (which accounts for their designation as "cellular horns"). by the use of acoustical lenses and by special mouth shapes involving a narrow dimension that produces less concentration. In the case of large exposed or direct-radiating diaphragms the effect is reduced by providing concentric circular diaphragm segments that help confine the diaphragm vibration to the region near the apex at high frequencies, thereby reducing the effective diaphragm size and broadening the radiated beam. More uniform space distribution and conversion efficiency are also obtained by using two or more speakers, each covering a portion of the frequency range.

The acoustical environment of the speaker influences its performance. Both direct and reflected sound reach the listener. In small rooms the reflected sound may markedly influence the speaker performance and what the listener hears. Much poor low-frequency performance attributed to speakers actually arises because a small room has few low resonant frequencies and these are widely separated in frequency. Consequently the speaker can transmit sound energy efficiently through the room to the listener only in narrow low-frequency bands.

See also HIGH-FIDELITY SOUND SYSTEMS.

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EOUDUN, a town of western France, capital of an *arrondissement*, in the *département* of Vienne, 45 mi. by rail S.W. of Tours. Pop. (1954) 4,677. Loudun (*Laudunum*) was a town of importance during the religious wars and gave its name in 1616 to a treaty favourable to the Protestants. Of the old walls a single gateway and two towers remain. A 12th-century rectangular donjon of the castle of the counts of Anjou is preserved; at its base traces of Roman constructions have been found, with fragments of porphyry pavement, mosaics and mural paintings.

There is a Carmelite convent; the old Romanesque church of Sainte Croix is now used as a market. The Gothic church of St. Pierre-du-Marché has a Renaissance portal and a high stone spire.

There are several old houses in the town.

The manufacture of farm implements is carried on, and there is a considerable trade in agricultural products. wine, etc.

LOUGHBOROUGH, ALEXANDER WEDDERBURN, 1ST BARON: see ROSSLYN, ALEXANDER WEDDERBURN, 1ST EARL OF.

LOUGHBOROUGH, a municipal borough (1888) in the Loughborough parliamentary division of Leicestershire, Eng.. near the Soar and on the Loughborough canal, 11 mi. N.N.W. of Leicester by road. Pop. (1951) 34,731. Area 14.4 sq.mi. There was a settlement there before the Roman invasion: but evidence of the Roman occupation is scanty. In Saxon times Loughborough was becoming a place of some size, and later reference is made to the township in Domesday Book. Grants for markets and fairs were made in the 13th century, when the wool trade was an important feature of the district. Lacemaking later became the chief industry, but when John Heathcoat's machines were destroyed by the Luddites the industry lost much of its importance.

The town is a marketing centre in a large and fertile agricultural district, lying to the east of Charnwood forest. The town hall and corn exchange (1855) stand prominently in the market place. Loughborough's principal industries are electrical engineering, bell founding and the manufacture of hosiery, lifting machinery and pharmaceutical goods.

Loughborough is an educational centre?Loughborough College of Technology being of very wide repute, while the Training college is the largest college in the country for men schoolteachers; there are also a college of further education and a college of art. The grammar school was founded by Thomas Burton: a wool merchant, in 1495. He and the Taylors, who established the bell-founding industry, are commemorated in the parish church. The memorial for World Wars I and II is a tower and carillon of 47 bells, which was built by public subscription and opened in 1923.

LOUGHREA, a market town of County Galway, Ire., on the northern shore of Lough Rea, 116 mi. W. of Dublin by road. Pop. (1956) 2,834. There are slight remains of an Early English Carmelite friary, dating from about 1300. Loughrea is the seat of the Roman Catholic bishop of Clonfert, and has a cathedral built in 1900–05. A part of the castle of Richard de Burgh, founder of the friary. still survives. and there are traces of the town fortifications. In the neighbourhood are a cromlech, "souterrains" (underground passages and chambers) and two ruined towers. Crannogs (*q.v.*), or prehistoric stockaded islands, have been found in the lough.

LOUHANS, a town of east-central France in the department of Saône-et-Loire, 34 mi. N.N.E. of Mâcon by road. Pop. (1954) 3.726. Its church has a fine 15th-century tower with a carved balustrade. The main street is arcaded. The town is the central market of the agricultural plain of Bresse, with much trade in chickens and horses. It has a subprefecture and a tribunal of commerce.

LOUIS I (778–840), surnamed the "Pious," Roman emperor, third son of the emperor Charlemagne and his wife, Hildegarde, was born at Chasseneuil in central France, and crowned king of Aquitaine in 781. He received a good education; but since his tastes were ecclesiastical rather than military, the government of his kingdom was mainly conducted by his counsellors. Louis, however, gained sound experience in warfare in the defense of Aquitaine, shared in campaigns against the Saxons and the Avars and led an army to Italy in 792. In 794 or 795 he married Irmengarde, daughter of Ingram, count of Haspen. After the deaths of his two elder brothers, Louis, at his father's command, crowned himself coemperor at Aix-la-Chapelle on Sept. 11. 813, and was formally associated in the government of the empire, of which he became sole ruler, in the following January. He earned the surname of "Pious" by banishing his sisters and others of immoral life from court; by attempting to reform and purify monastic life; and by showing great liberality to the church. In Oct. 816 he was crowned emperor at Reims by Pope Stephen IV; and at Aix in July **817** he arranged for a division of his empire among his sons.

This was followed by a revolt of his nephew Bernard, king of Italy; but the rising was easily suppressed, and Bernard was mutilated and killed.

The emperor soon began to repent of this cruelty, and when his remorse had been accentuated by the death of his wife in 818, he pardoned the followers of Bernard and restored their estates, and in 822 did public penance at Attigny. In 819 he married Judith, daughter of Welf I, count of Bavaria, who, in 823 bore him a son Charles, afterward called "the Bald." Judith made unceasing efforts to secure a kingdom for her child; and with the support of her eldest stepson, Lothair, a district was carved for Charles in 829. Discontent at this arrangement increased to the point of rebellion, which broke out the following year, provoked by Judith's intrigues with Bernard, count of Barcelona, whom she had installed as her favourite at court. Lothair and his brother Pippin joined the rebels; and after Judith had been sent into a convent and Bernard had fled to Spain, an assembly was held at Compiègne, when Louis was practically deposed and Lothair became the real ruler of the empire. Sympathy was, however, soon aroused for the emperor, who was treated as a prisoner, and a second assembly was held at Nimwegen in Oct. 830, when, with the concurrence of his sons Pippin and Louis, he was restored to power and Judith returned to court.

Further trouble between Pippin and his father led to the nominal transfer of Aquitaine from Pippin to his brother Charles in 831. The emperor's plans for a division of his dominions then led to a revolt of his three sons. Louis met them in June 833 near Kolmar, but possibly because of the influence of Pope Gregory IV, who took part in the negotiations, he found himself deserted by his supporters, and the treachery and falsehood which marked the proceedings gave to the place the name of *Lügenfeld*, or the "field of lies." Judith, charged with infidelity, was again banished; Louis was sent into the monastery of St. Medard at Soissons; and the government of the empire was assumed by his sons. The emperor was forced to confess his sins, and declare himself unworthy of the throne, but Lothair did not succeed in his efforts to make his father a monk. Sympathy was again felt for Louis, and when the younger Louis had failed to induce Lothair to treat the emperor in a more becoming fashion, he and Pippin took up arms on behalf of their father. The result was that in March 834 Louis was restored to power at St. Denis; Judith once more returned to his side; and the kingdoms of Louis and Pippin were increased. The struggle with Lothair continued until the autumn, when he submitted to the emperor and was confined to Italy. To make the restoration more complete, a great assembly at Diedenhofen declared the deposition of Louis to have been contrary to law, and a few days later he was publicly restored in the cathedral of Metz. In Dec. 838 Pippin died, and a new arrangement was made by which the empire, except Bavaria, the kingdom of Louis, was divided between Lothair, now reconciled to his father, and Charles. The emperor was returning from suppressing a revolt on the part of his son Louis, provoked by this disposition, when he died on June 20, 840, on an island in the Rhine near Ingelheim. He was buried in the church of St. Arnulf at Metz.

Louis was a man of strong frame, who loved the chase, and did not shrink from the hardships of war. He was, however, easily influenced and was unequal to the government of the empire bequeathed to him by his father. No sustained effort was made to ward off the inroads of the Danes and others, who were constantly attacking the borders of the empire.

Louis, who is also called *Le Débonnaire,* counts as Louis I, king of France.

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LOUIS II. (825–875): Roman emperor, eldest son of the emperor Lothair I., was designated king of Italy in 839, and was crowned king at Rome by Pope Sergius II. on June 15, 844. In 850 he was crowned joint emperor at Rome by Pope Leo IV., and soon afterwards married his cousin, Engelberga, a daughter of King Louis the German, and undertook the independent government of Italy. On the death of his father in Sept. 855 he became sole emperor. In 857 he allied himself with Louis the German against his brother Lothair, king of Lorraine, and King Charles the Bald, but after he had secured the election of Nicholas I. as pope in 858, he became reconciled with his brother. In 863, on the death of his brother Charles, Louis received the kingdom of Provence. In 864 he quarrelled with Pope Nicholas I. over his brother's divorce, which the pope had declared invalid, and in February reached Rome with an army, but made peace with the pope and left the city.

In 866 he routed the Saracens, but could not follow up his successes owing to the want of a fleet. In 869, with the assistance of his ally, the eastern emperor, Basil I., he captured Bari, the headquarters of the Saracens He had withdrawn into Benevento to prepare for a further campaign, when he was treacherously robbed and imprisoned by Adelchis, prince of Benevento, in Aug. 871, but was released a month later. Returning to Rome, he was crowned a second time as emperor by Pope Adrian II. on May 18, 872. After further successes against the Saracens, who were driven from Capua, he returned to northern Italy. He died, somewhere in the province of Brescia, on Aug. 12, 875, and was buried in the church of St. Ambrose at Milan, having named as his successor in Italy his cousin Carloman, son of Louis the German.

See *Annales Bertiniani, Chronica S. Benedicti Casinensis, both* in the *Monumenta Germaniae historica. Scriptores,* Bande i. and iii. (Hanover and Berlin, 1826 fol.); E. Miihlbacher, *Die Regesten des Kaiserreichs unter den Karolingern* (Innsbruck, 1881); Th. Sickel, *Acta regum et imperatorum Karolinorum, digesta et enarrata* (Vienna, 1867–68); and E. Dummler, *Geschichte des ostfrankischen Reiches* (Leipzig, 1887–88).

LOUIS III. (c. 880–928), surnamed the "Blind," Roman emperor, was a son of Boso, king of Provence or Lower Burgundy and Irmengarde, daughter of the emperor Louis II. The emperor Charles the Fat took Louis under his protection on the death of Boso in 887; but Louis was not recognized as king of Provence until 890, when Irmengarde had secured the support of the Bavarian king Arnulf and of Pope Stephen V. In 900, after the death of the emperor Arnulf, he went to Italy to obtain the imperial crown. He was chosen king of the Lombards at Pavia, and crowned emperor at Rome in Feb. 901 by Pope Benedict IV. He gained a temporary authority in northern Italy, but was soon compelled by his rival Berengar, margrave of Friuli, to leave the country. In 904, however, he went again to Italy, where he secured the submission of Lombardy; but on July 21, 905, he was surprised at Verona by Berengar, who blinded him and sent him back to Provence, where he remained until his death, at Arles, in Sept. 928. He married Adelaide, possibly a daughter of Rudolph I., king of Upper Burgundy. His eldest son, Charles Constantine, succeeded only to the county of Vienne.

See *Forschungen zur deutschen Geschichte,* Bande ix. and x, (Göttingen, 1862–86); E. Dummler, *Geschichte des ostfrankischen Reichs* (Leipzig, 1887–88); and *Gesta Berengarii imperatoris* (Halle, 1871); and F. de Gingins-la-Sarra, *Mémoires pour servir à Phistoire de Provence et de Bourgogne Jurane* (Zürich, 1851).

LOUIS IV., or **V.** (c. 1287–1347), surnamed the Bavarian, Roman emperor and duke of Upper Bavaria, was the second son of Louis II., duke of Upper Bavaria and count palatine of the Rhine, and Matilda, daughter of the German king Rudolph I. At his father's death in 1294 he inherited, jointly with his elder brother Rudolph, Upper Bavaria and the Palatinate, but passed his time mainly at the court of the Habsburgs in Vienna. In the quarrel with his brother over their joint possessions, Louis was supported by his uncle Albert I., the German king. Rudolph promised in 1301 to admit his brother to a share in the government of Bavaria and the Palatinate. When Albert was murdered in May 1308, Louis became a candidate for the German throne; but his claim was not strongly supported. The new king, Henry VII., was very friendly with Rudolph, and as the promise of 1301 had not been carried out, Louis demanded a partition of their lands, and received the north-western part of Upper Bavaria in 1310, but Rudolph refused to surrender any part of the Palatinate. In 1310, on the death of Stephen I., duke of Lower Bavaria, Louis undertook the guardianship of his two young sons. This led to a war between the brothers, which lasted till June 1313, when peace was made at Munich. Frederick III (the Fair), duke of Austria, called in by the nobles of Lower Bavaria, was defeated at Gammelsdorf on Nov. g, 1313.

In Aug. 1313 the German throne had again become vacant, and Louis was chosen at Frankfort on Oct. 20, 1314, and crowned at Aix-la-Chapelle on Nov. 25. War followed between Louis and the rival candidate, Frederick of Austria. Louis's embarrassments were complicated by a new dispute with his brother; but in 1317 Rudolph renounced his claims on Upper Bavaria and the Palatinate in consideration of a yearly subsidy and Louis was able to give undivided attention to the war with Frederick. On Sept. 28, 1322, a battle was fought at Muhldorf, which ended in a complete victory for Louis, owing mainly to the timely aid of Frederick IV. of Hohenzollern, burgrave of Nüremburg. Frederick of Austria was taken prisoner, but the struggle was continued by his brother Leopold until the latter's death in 1326. Attempts to enable the two kings to rule Germany jointly failed, and about 1326 Frederick returned to Austria. Supported by Philip V. of France in his desire to free Italy entirely from German influence, Pope John XXII. refused to recognize either Frederick or Louis, and asserted his own right to administer the empire during a vacancy.

After the battle of Miihldorf Louis sent Berthold of Neifen, count of Marstetten, into Italy with an army, which soon compelled the papal troops to raise the siege at Milan. The pope threatened Louis with excommunication unless he resigned his kingdom within three months. The king thereupon appealed to a general council, and was placed under the papal ban on March 23, 1324, a sentence which he answered by publishing his charges against the pope. In the contest Louis was helped by the Minorites, who were upholding against John the principle of clerical poverty, and by the writings of Marsilius of Padua (who dedicated to Louis his Defensor *pacis*), William of Occam, John of Jandun and others. Taking the offensive, Louis met his Ghibelline supporters at Trent and reached Italy in March 1327; and in May he received the Lombard crown at Milan.

Louis compelled Pisa to surrender and on Jan. 17, 1328, he was crowned emperor in St. Peter's by Sciarra Colonna, a Roman noble; he answered the continued attacks of Pope John by pronouncing his deposition, and proclaiming Peter of Corvara pope as Nicholas V. He then undertook an expedition against John's ally, Robert, king of Naples, but, disunion among his troops and scarcity of money and provisions drove him again to Rome, where, finding that his exactions had diminished his popularity, he left the city, and after passing six months at Pisa, returned to Germany in Jan. 1330. The struggle with the pope was renewed in Germany, and a formidable league had been formed against Louis. He was prepared to assent to very humiliating terms, and agreed to abdicate; but negotiations were interrupted by the pope's death in Dec. 1334. John's successor, Benedict XII., was prevented from coming to terms by the influence of Philip VI. of France. Overtures for peace were made to Philip, but without success; and in July 1337 Louis concluded an alliance with Edward III., king of England, and made active preparations for war. During these years his attention was also occupied by a quarrel with John, king of Bohemia, over the possession of Tirol, by a campaign in Lower Bavaria, and a futile expedition against Nicholas I., bishop of Constance. His position was improved when the electors meeting at Rense in July 1338 banded themselves together to defend their elective rights, and when the diet at Frankfort confirmed a decree which declared that the German king did not need the papal approbation to make his election valid.

The heiress of Tirol, Margaret Maultasch, quarrelled with her husband, John Henry, margrave of Moravia, and fled to the protection of Louis, who seized the opportunity to declare ber marriage void and to unite her in 1342 with his son Louis. The emperor also increased his possessions by his own marriage. In 1322 his first wife, Beatrice, daughter of Henry III., count of Glogau, had died and by his second marriage with Margaret, daughter of William III., count of Holland, he obtained, at the death of her brother, count William IV., in 1345, possession of Holland, Zealand and Friesland. In 1341 he recovered a portion of the Palatinate, and soon deserted Edward of England and came to terms with Philip of France. In the course of a war between Louis and the enemies made by his policy of acquisition which ensued in Germany he was forced to submit to humiliating terms, though he would not accept the election of Charles, margrave of Moravia (afterwards the emperor Charles IV.) as German king in July 1346. Charles consequently attacked Tirol; but Louis died suddenly at a bear-hunt near Munich on Oct. 11, 1347. He was buried in the Frauenkirche at Munich, where a statue was erected to his memory in 1622 by Maximilian I., elector of Bavaria, and where a second was unveiled in 1905. He had seven sons, three of whom were subsequently electors of Brandenburg, and ten daughters.

As a soldier Louis possessed skill as well as bravery, but he lacked perseverance and decision in his political relations; and the fact that he remained almost undisturbed in the possession of Germany in spite of the utmost efforts of the popes, is due rather to the political and intellectual tendencies of the time than to his good qualities. He encouraged trade and commerce and gave a new system of laws to the duchy.

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LOUIS I., king of Bavaria (1786–1868), son of the then prince, afterwards duke and elector, Max Joseph of Zweibrücken and his wife, Princess Augusta of Hesse-Darmstadt, was born at Strasbourg on Aug. 25, 1786. He was educated at home and at the universities of Landshut and Göttingen. Both the classics and contemporary classical poetry took hold upon his receptive mind (he visited Goethe in 1827). As a patron of the arts he proved himself as great as any who had ever occupied a German throne, and he was himself more than a mere dilettante.

The crown prince (his father had become elector in 1799 and king of Bavaria in 1805), became the leader of the small anti-French party in Bavaria. Napoleon sought in vain to win him over, and Louis fell more and more out of favour with him. Their relations continued to be strained, although in the campaigns of 1807 and 1809, in which Bavaria was among the allies of France, Louis won his laurels in the field. He married in 1810 Princess Therese of Saxe-Hildburghausen (1792–1854). Three daughters and four sons were born of this marriage, one of whom succeeded him as Maximilian II., while another, Luitpold, became prince regent of Bavaria on the death of Louis II. Louis resided chiefly at Innsbruck or Salzburg as governor of the circle of the Inn and Salzach. In 1815 he attended the congress of Vienna, where he sought to obtain the restoration of Alsace and Lorraine to Germany; and later in the year he was with the allies in Paris, using his influence to secure the return of the art treasures carried off by the French.

After 1815 also the crown prince maintained his anti-French attitude, and in 1817 his influence secured the fall of Comte Montgelas. Louis took great interest in the work of organizing the Bavarian constitution (1818) and defended it against Metternich and the Carlsbad Decrees (1819); he was also an ardent Philhellene. He succeeded to the crown of Bavaria on Oct. 12, 1825, and at once embarked upon a moderate constitutional policy, in which he found himself in general agreement with the parliament. Although a loyal Catholic he none the less opposed ultramontanism and the Jesuits. He improved the internal administration of the State, and especially that of the finances. He was a warm friend of learning, and in 1826 transferred the University of Landshut to Munich, where he placed it under his special protection. In the course of his visits to Italy he formed friendships with famous artists, notably with Thorwaldsen and Cornelius. He had the assistance of the painter Martin Wagner in procuring works of art for the great Munich collections.

Under the influence of the July revolution of 1830 he began to be drawn into the current of reaction; and though he never took up such a hostile attitude towards constitutional ideas as his brother-in-law, King Frederick William IV., he allowed the reactionary system of surveillance which commended itself to the German Confederation after 1830 to be introduced into Bavaria (*see* BAVARIA: *History*). As a follower of the ideas of Friedrich List, he furthered the foundation of the Zollverein in the year 1833 and the making of canals. Of European importance was his enthusiasm for the liberation of Greece from the rule of Turkey, and his generous financial assistance. After his second son Otto (*q.v.*), had become king of Greece in 1832, Greek affairs became the central point of his foreign policy. In 1862 Otto was forced to abdicate. For this unfortunate issue Louis was not without blame; for he had totally misunderstood the national character of the Greeks and the problems involved in the attempts to govern them by bureaucratic methods. After Karl Abel became the head of the ministry in 1837 the strict Catholic party influenced affairs more and more decisively. For a while, indeed, this opposition did not impair the king's popularity, due to his amiable character, his extraordinary services in beautifying his capital at Munich, and to his lavish charity. But his disastrous *liaison*, beginning in 1846, with Lola Montez, the Spanish dancer, brought him into conflict with his people. She used her great influence against the clerical policy of Abel. The ministry protested against her proposed naturalization in the memorandum of Feb. 11, 1847. The king replaced Abel's Clerical ministry by a more accommodating Liberal one under Zu Rhein under which Lola Montez without more difficulty became comtesse de Lansfeld. The revolutionary movement of 1848 and the pressure of the popular opposition compelled Louis to banish the countess. On March 20, 1848, he abdicated in favour of his son Maximilian.

In his retirement Louis continued to play the Maecenas magnificently. His popularity, shaken by the Montez affair, was partially recovered. To him Munich owes her finest art collections and most remarkable buildings, especially the acquisition of the famous Rhenish collection of the Boisserée brothers; also the Walhalla, the Glyptothek, the two Pinakotheken, the Odeon, the University, and many other magnificent buildings. The rôle of Munich as a great art centre would have been impossible without the splendid munificence of Louis I. He died on Feb. 28, 1868 at Nice, and was buried in Munich.

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LOUIS II., king of Bavaria (1845–1886), son of his predecessor Maximilian II. and Maria, daughter of Prince William of Prussia, was born at Nymphenburg on Aug. 25, 1845. With his brother Otto, Louis received a simple and serious education modelled on that of the German *Gymnasien.* Military instruction, physical exercises and sport, in spite of the crown prince's strong physique, received little attention. He developed a taste for solitude, which was combined with the romantic tendencies and musical and theatrical tastes traditional in his family.

Louis succeeded to the throne on March 10, 1864, at the age of eighteen. The early years of his reign were marked by a series of most serious political defeats for Bavaria. In the Schleswig-Holstein question. though he was opposed to Prussia and a friend of Duke Frederick VIII. of Augustenburg, he had not the material forces necessary effectively to resist Bismarck. Again, in the war of 1866, Louis and his minister, von der Pfordten, took the side of Austria, and at the conclusion of peace (Aug. 22) Bavaria had, in addition to the surrender of certain small portions of her territory, to agree to the foundation of the North German Confederation under the leadership of Prussia. The king's Bavarian patriotism, one of the few steadfast ideas underlying his policy, was deeply wounded, but he faced the inevitable, and wrote a letter of reconciliation (Aug. 10) to King William of Prussia. The defeat of Bavaria in 1866 showed the necessity of army reform. Under the new Liberal ministry of Hohenlohe (Dec. 29, 1866–Feb. 13, 1870) and under Prauckh as minister of war, a series of reforms were carried through which prepared for the victories of 1870. In his ecclesiastical policy Louis strove for a greater independence of the Vatican, and maintained friendly relations with Dollinger (*q.v*); but without extending his protection to the anti-Roman movement of the Old Catholics. Early in 1870 Louis formed a more Conservative cabinet under Count Bray-Steinburg. On the outbreak of the Franco-Prussian War he at once took the side of Prussia, and gave orders for mobilization. In 1871 it was he who offered the imperial crown to the king of Prussia; but not on his own initiative. Bismarck not only determined the king of Bavaria to take the decisive step which put an end to a serious diplomatic crisis, but actually drafted the letter to King William which Louis copied and despatched without changing a word.

In the early years of his reign Louis formed an intimate friendship with Richard Wagner, whom from May 1864 to Dec. 186; he had constantly in his company. He paid 18,000 gulden of debts for him, and granted him a yearly income of 4,000 gulden (afterwards increased to 8,000). A series of performances of the Wagnerian music-dramas was instituted in Munich under the personal patronage of the king, and when the further plan of erecting a great festival theatre in Munich for the performance of Wagner's "music of the future" broke down in the face of the passive resistance of the local circles interested, Louis conceived the idea of building at Bayreuth, according to Wagner's new principles, a theatre worthy of the music-dramas. For a time Louis was entirely under Wagner's influence, and there is extant a series of emotional letters of the king to Wagner. Public opinion in Bavaria turned against Wagner. He was attacked for his foreign origin, his extravagance, his intrigues, his artistic utopias, and last but by no means least, for his unwholesome influence over the king. Louis had to give him up. But in 1866, in the midst of the preparation for war, the king hastened in May to Triebschen, near Lucerne, in order to see Wagner again. In 1868 they were seen together in public for the last time at the festival performances in Munich. In 1876 Wagner's *Ring des Nibelungen* was performed for the first time at Bayreuth in the presence of the king. Later, in 1881, the king formed a brief friendship with Joseph Kainz the actor. In Jan. 1867 he became betrothed to Duchess Sophie of Bavaria (afterwards Duchesse d'Alençon), daughter of Duke Max and sister of the empress of Austria; but the betrothal was dissolved in October of the same year.

Louis presently showed serious signs of an ill-balanced mind, and when ministers sought to check his wild extravagance, which included the building of many magnificent castles, he became violent. The unfortunate king was declared insane on June 8, 1886, and his uncle, Prince Luitpold. assumed the regency. Louis was placed under restraint. On June 13, 1886, he was drowned in the Starnberger See, together with his doctor, von Gudden, who had unwisely gone for a walk alone with his patient, whose physical strength was enormous. Louis's brother Otto, who succeeded him as king of Bavaria, was also incurably insane.

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LOUIS III., king of Bavaria (1845–1921), was born on Jan. 7, 1845, and assumed the regency in succession to his father on Dec. 12, 1912. In accordance with the bill passed by the Bavarian diet he assumed the crown on Nov. 5, 1913. After the proclamation of the republic on Nov. 7, 1918, the king, with the queen and his daughters, left Munich. The royal family resided first at Berchtesgaden, and afterwards at a castle assigned to them on the shores of Chiem See. On Nov. 13 he formally signed his abdication, and relieved all Bavarian officials, officers and soldiers from their oath of allegiance. He died at Sarvar, Hungary, on Oct. 17, 1921.

LOUIS (804–876), surnamed "the German," king of the East Franks, was the third son of the emperor Louis I. When the emperor divided his dominions between his sons in 817, Louis received Bavaria and the neighbouring lands, but did not undertake the government until 825, when he began to fight the Slavs on his eastern frontier. In 827 he married Emma, daughter of Welf I., count of Bavaria, and sister of his stepmother Judith. He interfered in the quarrels arising from Judith's efforts to secure a kingdom for her own son Charles, and the consequent struggles of Louis and his brothers with the emperor Louis I. (*q.v.*). When the elder Louis died in 840 and his eldest son Lothair claimed the whole Empire, Louis in alliance with his half-brother, king Charles the Bald, defeated Lothair at Fontenoy on June 25, 841. By the Treaty of Verdun (August 843), Louis received the bulk of the lands of the Carolingian empire lying east of the Rhine, including a district around Speyer, Worms and Mainz, Bavaria, where he made Regensburg the centre of his government, Thuringia, Franconia and Saxony.

Louis may truly be called the founder of the German kingdom, though his attempts to maintain the unity of the Empire proved futile. In 842 he crushed a rising in Saxony, compelled the Abotrites to own his authority, and undertook campaigns against the Bohemians, the Moravians and other tribes. He did not succeed in freeing his shores from the ravages of Danish pirates. At his instance synods and assemblies were held where laws were decreed for the better government of church and state. From 853 onwards, he attempted to secure the throne of Aquitaine, offered to him by the oppressed subjects of Charles the Bald. But treachery and desertion in his army, and the loyalty of the Aquitanian bishops to Charles prevented success, and Louis renounced his claim by a treaty signed at Coblenz on June 7, 860.

In 8jj the emperor Lothair died, and was succeeded in Italy by his eldest son Louis II., and in the northern part of his kingdom by his second son, Lothair. The weakness of these kingdoms afforded opportunities for intrigue by Louis and Charles the Bald, whose interest was increased by the fact that both their nephews were without male issue. Louis supported Lothair in his efforts to divorce his wife Teutberga, for which he received a promise of Alsace, but in 865 Louis and Charles renewed the peace of Coblenz, and doubtless discussed the possibility of dividing Lothair's kingdom. In 868 at Metz they agreed definitely to a partition; but when Lothair died in 869, Louis was ill, and his armies were engaged with the Moravians. Charles the Bald accordingly seized the whole kingdom; but Louis compelled him by a threat of war to agree to the Treaty of Mersen, which divided it between the claimants.

The later years of Louis were troubled by risings on the part of his sons, the eldest of whom, Carloman, revolted in 861 and in 863; an example followed by the second son Louis, who in a further rising was joined by his brother Charles. A report that Louis II. was dead led to peace between father and sons. The emperor, however, was not dead, but a prisoner; and as he was the nephew and son-in-law of Louis, that monarch hoped to secure both the imperial dignity and the Italian kingdom for his son Carloman. Meeting his daughter Engelberga, the wife of Louis II., at Trent in 872, Louis made an alliance with her against Charles the Bald, and in 874 visited Italy on the same errand. The emperor, having named Carloman as his successor, died in August 875, but Charles the Bald reached Italy before his rival, and by persuading Carloman to return, secured the imperial crown. Louis was preparing for war when he died on Sept. 28, 876 at Frankfort. He was in war and peace alike, the most competent of the descendants of Charlemagne. He obtained for his kingdom a certain degree of security against the Normans, Hungarians, Moravians and others. He lived in close alliance with the Church, to which he was very generous, and supported its missionary schemes.

See *Annales Fuldenses; Annales Bertiniani;* Nithard, *Historiarum Libri,* all in the *Monzimenta Germaniae historica. Scriptores,* Bde i. and ii. (Hanover and Berlin, 1826 *seq.*); E. Dummler, *Geschichte des ostfrankischen Reiches* (Leipzig, 1887–88); Th. Sickel, *Die Urkunden Ludwigs des Deutschen* (Vienna, 1861–62); E. Muhlbacher, *Die Regesten des Raiserreichs unter den Karolingern* (Innsbruck, 1881); and A. Krohn, *Ludwig* der *Deutsche* (Saarbrucken, 1872); and general bibliography in *Camb. Med. Hist.* (vol. 3, 1922).

LOUIS (893–911), surnamed the "Child," king of the Franks, last of the German Carolingians, son of the emperor Arnulf, was born at Ottingen, designated by Arnulf as his successor in Germany in 897, and crowned on Feb. 4, 900. His chief adviser was Hatto I., archbishop of Mainz; and during his reign the kingdom was ravaged by Hungarians and torn with internal strife. He died in August or September 911 and was buried at Regensburg.

See O. Dietrich, *Beiträge zur Geschichte Arnolfs von Kärnthen und Ludwigs des Kindes* (1890).

LOUIS II. (846–879), king of France, called "le Bègue" or "the Stammerer," a son of Charles II. the Bald, Roman emperor and king of the West Franks, was born on Nov. 1, 846. After the death of his elder brother Charles in 866 he became king of Aquitaine, and in October 877 he succeeded his father as king of the West Franks, but not as emperor. He was crowned king by Hincmar, archbishop of Reims, on Dec. 8, following, and in Sept. 878 he was consecrated afresh by Pope John VIII. After an ineffectual reign of eighteen months Louis died at Compikgne on April 10 or 11, 879. By his first wife, Ansgarde, a Burgundian princess, he had two sons, his successors, Louis III. and Carloman; by his second wife, Adelaide, he had a posthumous son, Charles the Simple, who also became king of France.

The emperor Louis I. is counted as Louis I., king of France.

LOUIS III. (*c.* 863–882), king of France, was a son of Louis II. and with his brother Carloman succeeded his father as king in April 879. In consequence of the doubts cast upon the legitimacy of the young princes, it was proposed to offer the crown to the East Frankish ruler Louis, a son of Louis the German. But in September 879 the brothers were crowned at Ferrihres by Anshgisus, archbishop of Sens. A few months later they divided their kingdom, Louis receiving the part of France north of the Loire. They acted together against the Northmen, over whom in August 881 they gained a memorable victory, and against Boso, who claimed sovereignty over Burgundy and Provence. On Aug. 5, 882 Louis died at St. Denis and Carloman became sole king.

LOUIS IV. (921–954), king of France, surnamed "d'Outremer" *(Transmarinus),* was the son of Charles III. the Simple. On his father's imprisonment in 922, his mother Odgiva (Eadgyfu), sister of the English king Aethelstan, fled with him to England—a circumstance to which he owes his surname. But after the death of the usurper Rudolph (Raoul), Ralph of Burgundy, Hugh the Great, count of Paris, and the other French nobles, chose Louis for their king, and the lad was consecrated at Laon on June 19, 936. His reign was marked by a series of rebellions of the French nobles who refused to recognize his authority, and by an irruption of the Hungarians into Burgundy and Aquitaine (937). Backed by the Pope, Louis showed great zeal in quelling these revolts, and by an alliance with Otto the Great, formerly one of his most determined enemies, he gained a temporary success. The powerful vassal, Hugh the Great, was in 948 forced to make submission and to restore Laon to his sovereign; but the last years of the reign were troubled by fresh difficulties with Hugh the Great and also by an irruption of the Hungarians into the south of France. Louis died on Sept. 10, 954, and was succeeded by his son Lothair.

The chief authority for the reign is the chronicler Flodoard. *See* also Ph. Lauer, *La Règne de Louis IV d'Outre-Mer* (1900); and A. Heil, *Die politischen Beziehungen zwischen Otto dem Grossen und Ludwig IV. von Frankreich* (1904).

LOUIS V. (967–987), "le Fainéant" king of France, succeeded his father Lothair in March 986, and finally embroiled the Carolingian dynasty with Hugh Capet and Adalberon, archbishop of Reims. Louis died in May 987, his mother Emma being accused of having poisoned him.

See F. Lot, *Les Derniers Carolingiens* (1891); and the *Recueil des actes de Lothaire et de Louis V., ed. L.* Halphen and F. Lot (1908).

LOUIS VI. (1081–1137), king of France, surnamed "the Fat," "the Wideawake" or "the Bruiser," was the son of Philip I. and Bertha of Holland. He became associated with his father in the government about 1098, and by his victories over the English and the brigands, he won the support of the army against his step-mother, Bertrada, who tried to poison him. On the death of Philip I., in 1108, Louis was faced by powerful and rebellious barons, but after a hurried coronation at Orleans, he continued his policy of putting down feudal brigands and destroying their strongholds in the fle de France. So strong, however, were his enemies, that 24 years of continuous warfare were needed to root out the robber barons who lived on the plunder of the roads leading to Paris. In his opposition to the English, Louis was equally energetic. He supported William Clito, son of Robert of Normandy, against Henry I., and although worsted in the war which followed he continued to uphold the claims of his protegb. To oppose the forces of the emperor, Henry V., who had become the ally of the king of England, Louis even succeeded in gathering a national army under his flag, and thus temporarily consolidated his realm. Not only did he consolidate France, however, but he extended his power by acquiring control over Flanders.

In all his wars Louis fought in person, and for his prowess gained the reputation of a national hero, the protector of the poor, the Church, the peasants and the towns. He encouraged the communal movement on the fiefs of his vassals, and granted privileges to towns on his domains, but the title of "Father of the Communes," by which he is sometimes known, is not deserved. Neither was Louis the author of the movement for the emancipation of the serfs, his attitude being to favour emancipation only when it promised greater chance of profit. He was a great benefactor to the Church, aided the new, reformed monastic congregations of Cîteau, Prémontré and Fontevrault and chose his two chief ministers, Étienne de Garlande and Suger (*q.v.*) from the clergy. Louis died on Aug. 1, 1137.

See A. Luchaire, *Louis le Gros, annales de sa vie et son règne* (1890); and "Les Premiers Capétiens," in E. Lavisse's *Histoire de France;* Thomson, *Development of the French Monarchy under Louis VI. le Gros* (1895).

LOUIS VII. (*c.* 1121–1180), king of France, son of Louis VI. the Fat, was associated with his father and anointed by Innocent II. in 1131. In 1137 he succeeded his father, and in the same year married at Bordeaux Eleanor, heiress of William II., duke of Aquitaine. In the first part of his reign he was vigorous and jealous of his prerogatives, but after his crusade his religiosity developed to such an extent as to make him utterly inefficient. His accession was marked by no serious disturbances, save the risings of the burgesses of Orleans and of Poitiers, but he came into violent conflict with Pope Innocent II. The archbishopric of Bourges became vacant, and the king supported as candidate the chancellor Cadurc, against the pope's nominee Pierre de la

Châtre, swearing upon relics that so long as he lived Pierre should never enter Bourges. This brought the interdict upon the king's lands. He became involved in a war with Theobald, count of Champagne, which lasted two years (1142–44). The royal army occupied Champagne, and captured Vitry, where many persons perished in the burning of the church. Geoffrey the Handsome, count of Anjou, by his conquest of Normandy threatened the royal domains, and Louis VII by a clever manoeuvre threw his army on the Norman frontier and gained Gisors, one of the keys of Normandy.

At his court, which met in Bourges, Louis declared on Christmas day, 1145, his intention of going on a crusade. St. Bernard preached the crusade at Vézelay (Easter, 1146), and Louis set out from Metz in June 1147, on the overland route to Syria. The expedition was disastrous, and he regained France in 1149, overcome by humiliation. He caused a council at Beaugency (on March 21, 1152) to annul his marriage with Eleanor of Aquitaine, under pretext of kinship. Eleanor married Henry II of England in the following May, and brought him the duchy of Aquitaine. Louis VII led a half-hearted war against Henry; but in Aug. 1154 gave up his rights over Aquitaine, and contented himself with an indemnity. In 1154 Louis married Constance, daughter of the king of Castile, and their daughter Marguerite he affianced imprudently by the treaty of Gisors (1158) to Henry, eldest son of the king of England, promising as dowry the Vexin and Gisors. After the death of Constance (1160), Louis VII married Adèle of Champagne. Louis VII gave little sign of understanding the danger of the growing Angevin power, though in 1159 he aided Raymond V, count of Toulouse, against Henry II. At the same time the emperor Frederick I in the east was making good the imperial claims on Arles. When the schism broke out, Louis took the part of the pope, Alexander III. He supported Henry's rebellious sons, but acted slowly and feebly, and so contributed to the break-up of the coalition (1173–74).

Finally, in 1177, the pope intervened to bring the two kings to terms at Vitry. By his third wife, Adble, Louis had an heir, the future Philip Augustus, born on Aug. 21, 1165. He had him crowned at Reims in 1179, and died on Sept. 18, 1180.

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LOUIS VIII (1187–1226), king of France, eldest son of Philip Augustus and of Isabella of Hainaut, was born in Paris on Sept. 5, 1187. Louis left the reputation of a saint, but was also a warrior prince. In 1213 he led the campaign against Ferrand, count of Flanders; in 1214, while Philip Augustus was winning the victory of Bouvines, he held John of England in check, and was victorious at La Roche-aux-Moines. In the autumn of 121; Louis received from a group of English barons, headed by Geoffrey de Mandeville, a request to "pluck them out of the hand of this tyrant" (John), Louis himself prepared to invade England. The expedition was forbidden by the papal legate, but Louis landed at Stonor on May 22, 1216. (See ENGLISH HISTORY.) The pretexts on which he claimed the English crown were set down in a memorandum drawn up by French lawyers in 1215. These claims—that John had forfeited the crown by the murder of his nephew, Arthur of Brittany, and that the English barons had the right to dispose of the vacant throne—lost their plausibility on the death of King John and the accession of his infant son as Henry III in Oct. 1216. The papal legate, Gualo, arrived in England at the same time as Louis. He excommunicated the French troops and the English rebels; and, after the "Fair of Lincoln," in which his army was defeated, Louis resigned his pretensions, though by a secret article of the treaty of Lambeth (Sept. 1217) he secured a small war indemnity.

Louis had assisted Simon de Montfort in his war against the Albigenses in 121j; and after his return to France he again joined the crusade. With Simon's son and successor, Amaury de Montfort, he directed the brutal massacre which followed the capture of Marmande. Philip Augustus dying on July 14, 1223, Louis VIII was anointed at Reims on Aug. 6. He continued his father's policy. His reign was taken up with two great designs: (1) to destroy the power of the Plantagenets; and (2) to conquer the heretical south of France. An expedition conquered Poitou and Saintonge (1224) but did not succeed in securing possession of Aquitaine. In 1226 he led the crusade against the Albigenses in the south, forced Avignon to capitulate and received the submission of Languedoc. While passing the Auvergne on his return to Paris, he died at Montpensier on Nov. 8, 1226. His reign, short as it was, brought gains to the royal domains. He had married in 1200 Blanche of Castile, daughter of Alphonso VIII (or IX) of Castile and granddaughter of Henry II of England, who bore him 12 children; his eldest surviving son was his successor, Louis IX.

BIBLIOGRAPHY.—C. Petit-Dutaillis, *Elude sur la vie et le règne de Louis VIII* (Paris, 1894); E. Lavisse, *Histoire de France,* vol. iii (Paris, 1904); R. Fawtier, *Les Capétiens et la France* (Paris, 1942).

LOUIS IX (1214–1270), king of France, known as Saint Louis, was born on April 25, 1214. His father, Louis VIII, died in 1226, but his mother, Blanche of Castile, secured her son's coronation at Reims on Nov. 29, 1226; and mainly by the aid of the papal legate, Romano Frangipani, bishop of Porto (d. 1243), and of Thibaut (Theobald) IV, count of Champagne, was able to thwart the rebellious plans of Peter of Dreux (Pierre Mauclerc, duke of Brittany) and Philip Hurepel, a natural son of Philip Augustus. Peter and Thibaut were both obliged to go on crusade. Louis IX married Margaret, daughter of Raymund-Berengar IV, count of Provence, in May 1234. The reign was comparatively uneventful. A rising of the nobles of the southwest reached threatening dimensions in 1242, but the king's armies easily overran the lands of the rebel Hugh de Saintonge and defeated Henry III of England, who had come to his aid, at Saintes. Raymond VII, count of Toulouse, yielded without resistance upon the advent of two royal armies and accepted the peace of Lorris in Jan. 1243.

At the end of 1244, during an illness, Louis took the cross. He had already been much distressed by the plight of John of Brienne, emperor at Constantinople, and bought from him the crown of thorns, parts of the true cross, the holy lance and the holy sponge. The Sainte Chapelle in Paris still stands as a monument to the value of these relics to the saintly king. But the quarrel between the papacy and the emperor Frederick II, in which Louis maintained a watchful neutrality—interfering only to prevent the capture of Innocent IV at Lyons—and the difficulties of preparing the crusade delayed his embarkation until Aug. 1248. His defeat and capture at Mansura in Feb. 1250 and the next four years spent in Syria in captivity, in diplomatic intrigues and finally in raising the fortifications of Caesarea and Joppa are events which belong to the history of the crusades (*q.v.*). His return to France was urgently needed, since Blanche of Castile, whom he had left as regent, had died in Nov. 1252, and upon the removal of her strong hand feudal turbulence had begun to show itself.

This period between his first and second crusades (1254–69) is the real age of Saint Louis in the history of France. He imposed peace between warring factions of his nobility by mere moral force, backed up by something like an awakened public opinion. His nobles often chafed under his unrelenting justice but never dared rebel. The most famous of his settlements was the treaty of Paris, drawn up in May 1258 and ratified in Dec. 1259, by which the claims of Henry III of England were adjusted. Henry renounced absolutely Normandy, Anjou, Touraine, Maine and Poitou and received, on condition of recognizing Louis as liege suzerain, all the fiefs and domains of the king of France in the diocese of Limoges, Cahors and Perigueux and the expectation of Saintonge south of the Charente and also Agenais, if they should fall to the crown of France by the death of Alphonse of Poitiers. This treaty was unpopular, since the king surrendered a large part of France that Henry had not won; but Louis was satisfied that the absolute sovereignty over the northern provinces more than equalled the loss in the south.

Louis made a similar compromise with the king of Aragon in the treaty of Corbeil (1258), whereby he gave up the claims of kings of France to Roussillon and Barcelona, which dated from the conquest of Charlemagne. The king of Aragon in his turn gave up his claims to part of Provence and Languedoc, with the exception of Narbonne. Louis's position was strikingly shown in 1264, when the English barons submitted their attempt to bind Henry III by the Provisions of Oxford to his arbitration. His reply in the "Dit," or Mise, of Amiens was a flat denial of all the claims of the barons and failed to avert the civil war.

Upon the whole Louis maintained peace with his neighbours, although both Germany and England were torn with civil wars. He sanctioned the conquest of Naples by his brother Charles, duke of Anjou.

On March 24, 1267, Louis proclaimed his purpose of going on a second crusade. Three years of preparation followed; then on July 1, 1270, he sailed from Aigues Mortes for Tunis, whither the expedition seems to have been directed by the machinations of Charles of Anjou, who, it is claimed, persuaded his brother that the key to Egypt and to Jerusalem was that part of Africa which was his own most dangerous neighbour. After seven days' voyage to Carthage, one month of the summer's heat and plague decimated the army; and, when Charles of Anjou arrived, he found that Louis had died of the plague on Aug. 25, 1270.

Saint Louis stands in history as the ideal king of the middle ages. An accomplished knight, physically strong in spite of his ascetic practices, fearless in battle, heroic in adversity, of imperious temperament, unyielding when sure of the justness of his cause, energetic and firm. he was indeed "every inch a king." Moreover, he was a great saint, devout without excessive bigotry, submissive to the church but interested in the doctrinal controversies of his time. Above all, his constant care of justice and order altered the character of the Capetian monarchy: by submitting the *baillis* to a closer inspection by means of "grandes enquêtes," no less than by promulgating a series of writs (for good morals, against blasphemy, against trials by combat, against forgery, etc.), he reinforced the royal authority, to which his own person imparted a prestige never attained by it before, while his power verged on absolutism. He had neither favourite nor prime minister. Louis was canonized in 1297.

The best contemporary account of Louis IX is to be found in the *Histoire de Saint Louis* by Jean, sire de Joinville (*q.v.*), published in a Modern French version as *La Vie de Saint Louis, by H.* Longnon (Paris, 1929) and in English, as *The History of Saint Louis* by Joan Evans (Oxford, 1938). *See* also C. V. Langlois in *Histoire de France,* ed. by E. Lavisse, vol. iii (Paris, 1904); C. Petit-Dutaillis and P. Guinard, *L'Essor des ttats d'occident (Histoire générale,* ed. by G. Glotz, section "Moyen Age," vol. iv, p. 2, Paris, 1944); R. Fawtier, *Les Capétiens et la France* (Paris, 1942); A. Garreau, *Saint Louis et son voyaume* (Paris, 1949); H. A. Wallon, *Saint Louis et son temps,* 2 vol. (Paris, 1875); E. Berger, *Saint Louis et Innocent IV* (Paris, 1893), *Histoire de Blanche de Castille* (Paris, 1895). (J. T. S.; M. Pac.)

LOUIS X (1289–1316), king of France and Navarre, called LE HUTIN or "the Quarreller," was the eldest son of Philip IV of France and of Joan of Navarre. Born at Paris on Oct. 4, 1289, he took the title king of Navarre on the death of his mother (April 2, 1305); he succeeded his father on Nov. 30, 1314. Baronial reaction against the growth of the royal power under Philip had already shown itself in a number of leagues and provincial assemblies, and Louis had to dismiss most of his father's councillors (Enguerrand de Marigny was hanged) and to grant a number of charters recognizing the nobility's rights (the first to the Normans on March 19, 1315) and similar ones to the clergy. The baronial movement in France was, however, much less serious for the royal power than the contemporary one in England: lacking political ideas and leaders, the nobility asked redress of local grievances only, not against the king but against his officers, and Louis was clever enough to use evasive formulas which in reality conceded nothing but gave to the nobility the illusion that its complaints were most seriously considered. In foreign policy Louis inherited the Flemish problem from his father: Robert of Béthune, count of Flanders, refused to do homage as promised in the treaty of Athis-sur-Orge (1305); an army sent to Flanders in 1315 achieved little because of bad weather. An ordinance of 131j invited the serfs of the royal domains to buy their liberty and even obliged them; for fiscal reasons, to do so. Louis died on June 5, 1316. By his first wife, the notorious Margaret of Burgundy, who was convicted of adultery and died in prison, he had one daughter, Joan, who married Philip, count of Evreux and king of Navarre; by his second wife, Clemence of Hungary, he left a posthumous son, King John I.

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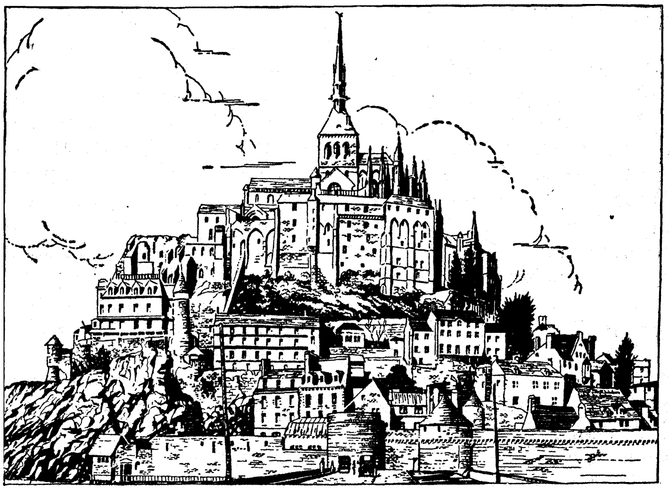
LOUIS XI (1423–1483), king of France, the son of Charles VII and his queen, Mary of Anjou, was born on July 3, 1423, at Bourges. where his father, then nicknamed the "King of Bourges," had taken refuge from the English. At the birth of Louis part of France was in English hands; when he was five years old, Joan of Arc appeared; he was just six when his father was crowned at Reims. But his boyhood was spent apart from these stirring events, in the castle of Loches, where he had as tutors Jean Majoris and Bernard of Armagnac.

In June 1436 Louis was married to Margaret (c. 1425–45), daughter of James I of Scotland. Three years after this unhappy marriage Louis entered upon his stormy political career. Sent by his father in 1439 to direct the defense of Languedoc against the English and to put down the brigandage in Poitou, he was induced by the rebellious nobles to place himself at the head of the Praguerie (*q* v.). Charles VII pardoned him this rebellion, and he was fighting the English in 1440 and aided his father to suppress the revolt of the count of Armagnac in 1443. In 1444 he led an army of from 15,000 to 20.000 mercenaries and brigands—the product of the Hundred Years' War—against the Swiss of the canton of Basle. After an ineffective siege, he made peace with the Swiss confederation and led his robber soldiers into Alsace to ravage the country of the Habsburgs, who refused him the promised winter quarters. Meanwhile, his father, making a parallel campaign in Lorraine, had assembled his first brilliant court at Nancy; and, when Louis returned, he found the king completely under the spell of Agnès Sorel. The death in 1445 of Louis's wife, Margaret, who mas a great favourite of Charles VII's, made the rupture complete. From that year until the death of the king, father and son were enemies. Louis prepared a plot to seize the king and his minister Pierre de Brézé. The plot was revealed to Charles, who banished his son to Dauphiné (1447). Louis never saw his father again.

Louis dismissed the governor of Dauphiné and settled the boundaries between it and the territories of the duke of Savoy and



THE ABBEY OF MONT-ST.-MICHEL, MADE FAMOUS BY LOUIS XI, WHO INSTITUTED THERE THE ORDER OF KNIGHTS OF ST. MICHAEL

of the papacy; and he enforced his authority over perhaps the most unruly nobility in western Europe, both lay and ecclesiastical. He made a secret treaty with the duke of Savoy. which was to give him right of way to Genoa, and made arrangements for a partition of the duchy of Milan. The alliance with Savoy was sealed by the marriage of Louis with Charlotte, daughter of Duke

Ludovico, in 1452, in spite of the formal prohibition of Charles VII. The king marched south but withdrew again, leaving his son unsubdued. Four years later, as Charles came to the Bourbonnais, Louis, fearing for his life, fled to Flanders to the court of Philip the Good, duke of Burgundy, leaving Dauphiné to be definitely annexed to the crown of France. The policy of the dauphin was reversed; his ten years' work was undone. Meanwhile, he was installed in the castle of Genappe, in Brabant, where he waited impatiently for five years for the death of his father, keeping himself posted by spies on every stage of the king's illness and thus laying himself open to the unsubstantiated accusation, believed by Charles himself, that he had hastened the end by poison.

On Aug. 15, 1461, Louis was anointed and crowned at Reims. His first act was to strike at the faithful ministers of Charles VII. Pierre de Brézé and Antoine de Chabannes were captured and imprisoned. But the more serviceable of the officers of Charles VII were for the most part soon reinstated; Louis's advisers a-ere mostly men of the middle class. Among the most prominent of these men, in addition to Brézé, Chevalier and Chabannes, were Tristan Lermite, Jean de Daillon, Olivier Le Daim (the barber) and, after 1472, Philippe de Commines, drawn from the service of Charles the Bold of Burgundy. who became his most intimate adviser and his biographer. This entourage was not a good one; and Louis's complex character, in which piety was combined with a ruthlessness and a dissimulation that earned him the name of *universelle aragne* ("universal spider"), was unlikely to seem attractive. However, he had the high qualities of a king: intelligence, energy and a knowledge of his duty. His advisers were loyal, and he won a great victory over the last feudal lords, enlarged the royal domain, imposed his authority and developed the wealth of the kingdom.

Louis XI began his reign with the same high-handed treatment of the nobles which had marked his rule in Dauphiné, going so far as to forbid them to hunt without his permission. He forced the clergy to pay long-neglected feudal dues and intrigued against the great houses of Anjou and Orleans in Italy. The malcontent nobles soon began to plan revolt. Discharged officers of Charles VII, like Jean Dunois and John II, duke of Bourbon, stirred up hostility to the new men of the king; and Francis II, duke of Brittany, was soon embroiled with Louis over an attempt to assert royal control over that practically independent duchy. The dissatisfied nobility found their greatest ally in Charles the Bold. afterward duke of Burgundy, and in 1465 formed a "league of public welfare" and declared war on their king. The nominal head mas the king's brother Charles, duke of Berry. then 18 years old, a weak character, the tool of the rebels as he was later the dupe of the king. Every great noble in France was in the league, except Gaston of Foix—who kept the south of France for the king—and the counts of Vendôme and Eu.

The whole country seemed on the verge of anarchy. It was saved by the refusal of the lesser gentry to rise and by the alliance of the king with the citizen class. After a successful campaign in the Bourbonnais, Louis fought an indecisive battle with Burgundians who had marched on Paris, at Montlhéry, on July 16, 1465. and then stood a short siege in Paris. On Sept. 28 he made a truce with Charles the Bold, and in October the treaties of Conflans and Saint Maur-les-Fossés ended the war. The king yielded at all points; gave up the "Somme towns" in Picardy, for which he had paid 200,000 gold crowns, to Philip the Good, thus bringing the Burgundians close to Paris and to Normandy. Charles, the king's brother, was given Normandy as an appanage, thus joining the territories of the rebellious duke of Brittany with those of Charles the Bold. The kingdom was plundered both by royal tax-gatherers and by unsubdued feudal lords.

Two months after he had granted Normandy to Charles. Louis took advantage of a quarrel between the duke of Brittany and his brother to take it again, sending the duke of Bourbon "to aid" Charles, while Dunois and Chabannes prepared for the struggle with Burgundy. The death of Duke Philip, on June 1j. 1467, gave Charles the Bold a free hand. He gained over Edward IV of England, whose sister Margaret he married; but while he was celebrating the wedding Louis invaded Brittany and detached Duke Francis from alliance with him. Normandy was completely reduced. The king's triumph was followed by his greatest mistake. After an interview between Charles and Louis at Péronne false news of Charles's death was spread, apparently at Louis's instigation. The king was humiliated and renewed intrigues followed. He attempted a diversion by assisting the Lancastrians in England. A new revolt was planned in 1471 hut came to nothing. The country was saved a desperate civil war by the death of the king's brother Charles, the nominal head of the coalition, on May 24, 1472. Charles the Bold, who had again invaded France, was obliged to make a lasting truce. Louis then forced the duke of Brittany to make peace and turned against John V, count of Armagnac, whose death at the opening of March 1473 ended the power of one of the most dangerous houses of the south. The first period of Louis's reign was closed, and with it closed the danger of dismemberment of France. John of Aragon continued the war in Roussillon and Cerdagne for two years. After the capture of Perpignan on March 10, 1475, the wise and temperate government of Imbert de Batvrnay and Boffile de Juge slowly pacified the new provinces. The death of Gaston IV, count of Foix, in 1472 opened up the struggle for Navarre.

The overthrow of Charles the Bold was the second great task of Louis XI. Charles's ally. Edward IV, invaded France in June 1475, but Louis bought him off on Aug. 29, at Picquigny. In September the invaders recrossed to England. The count of Saint Pol, who had continued to play his double part, was surrendered by Charles to Louis and executed, as was also Jacques d'Armagnac, duke of h'emours. Louis subsidized the Swiss and René II of Lorraine in their war upon Charles. The defeat and death of the duke of Burgundy at Nancy on Jan. 5, 1477, was the crowning triumph of Louis's diplomacy. But he was so eager to seize his rival's whole inheritance that definite peace was not established until after the death of Mary of Burgundy, Charles's daughter, who had married Maximilian of Austria; but by the treaty of Arras (1482) Louis received Picardy, Artois and the Boulonnais, as well as the duchy of Burgundy and Franche Comté. The Austrians were left in Flanders, a menace and a danger. The unification of France was completed (except for Brittany); and the frontiers were extended by the acquisition, upon the death of René of Anjou in 1480, of the duchies of Anjou and Bar and, upon the death of Charles II, count of Maine, in 1481, oi Maine and Provence. Of the Angevin inheritance only Lorraine escaped the king.

Failure in Spain was compensated in Italy. Without waging war Louis made himself virtual arbiter of the fate of the principalities in the north, and his court was always besieged by ambassadors from them. After the death of Charles the Bold, Yolande, duchess of Savoy, was obliged to accept the control of Louis. who was her brother. In Milan he helped to place Ludovico il Moro in power in 1479, but he reaped less from this supple tyrant than he had expected. Pope Sixtus IV, the enemy of the Medici, was also the enemy of the king of France. When Sixtus threatened Florence after the Pazzi conspiracy (1478), Louis aided Lorenzo dei Medici to form an alliance with Naples, which forced the papacy to come to terms. After his victory over the feudal lords. Louis imposed his authority over his other subjects. Ecclesiastical elections were taken under his control. He was continually in violent dispute with the parlement of Paris and made "justice" another name for arbitrary government; yet he dreamed of a unification of the local customary laws (*coutumes*) of France. The states-general met but once in his reign, in 1468, and then no talk of grievances was allowed: his object was only to get them to declare Kormandy inalienable from the crown; he raised his revenue without consulting them. His financial demands were enormously greater than ever before and he drained the land and towns of enormous sums. However, he was supported by the upper bourgeoisie, the aristocracy of the "good cities" which had been his allies against the nobles; for instance, Jean de Beaune and Jean Briçonnet of Tours and Pierre Doriole of La Rochelle. Numerous edicts tended to restrict to certain privileged families the rank of master workman in the guilds. Louis encouraged the cloth and silk industries and the working of mines and favoured the introduction of printing into France. He planned to unify the various systems of weights and measures. The maritime trade and the Lyons fairs took advantage of his treaties with England and the Hansa towns. Louis even dreamed of a company to monopolize the trade of the Mediterranean.

The contemporaries of Louis XI, who did not love him, looked only at his demands. During the last two or three years of his life Louis lived in great isolation, "seeing no one, speaking with no one, except such as he commanded," in the chateau of Plessis-les Tours, 2 mi. S.W. of Tours, that "spider's nest" bristling with watchtowers, and guarded only by the most trusty servitors. A swarm of astrologers and physicians preyed upon his fears and his purse. But, however foolish in his credulity, he still made his strong hand felt both in France and in Italy, remaining to the last "the terrible king." His fervent prayers were interrupted by instructions for the regency which was to follow. He died on Aug. 30,1483, and was buried in the church at Cléry, not at St. Denis. He left a son, his successor Charles VIII, and two daughters.

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LOUIS **XII.** (1462–1515), king of France, was grandson of Louis of Orleans, the brother of Charles VI., and son of the poet prince, Charles of Orleans, who, after the battle of Agincourt, spent twenty-five years of captivity in England. Louis was duke of Orleans until his accession to the throne. He married at fourteen, Joan, daughter of Louis XI. He revolted against Charles VIII., and for three years (1488–91) was a prisoner. In 1494 he held a command in the invasion of northern Italy. He succeeded Charles VIII. in 1499. He enjoyed a genuine popularity, and in 1506 the estates of Tours conferred on him the surname of *Père du Peuple.* He led in person several armies into Italy, and proved as severe and pitiless towards his enemies as he was gentle and clement towards his subjects. Louis had two daughters. After his accession he divorced Joan, and married, in 1499, Anne of Brittany, the widow of Charles VIII. On her death in January 1514, he married in 1514, for political reasons, Mary Tudor, sister of Henry VIII. of England. (See MARY, queen of France.) He died on Jan. 1, 1515.

See Henri Hauser, *Les Sources de l'histoire de France, XVIe siècle,* vol. 1. (1906). The principal secondary authorities are De Maulde, *Histoire de Louis XII.* (1889–93); Le Roux de Lincy, *Vie de* la *reine Anne de Bretagne* (1860); *H.* Lemonnier, *Les Guerres d'Italie* (1903) in the *Histoire de France* by *E.* Lavisse.

LOUIS XIII. (1601–1643), king of France, was the son of Henry IV. and of Marie de' Medici. He became king on his father's assassination in 1610; but his mother at once seized the full powers of regent. She determined to bring France into alliance with Spain and the Austrian house. Louis was to marry Anne of Austria, daughter of the Spanish king, Philip III., and the Spanish prince, afterwards Philip IV., himself was to marry the Princess Elizabeth, the king's sister. The marriages were concluded in 1615. The next years were full of civil war and political intrigue, during which the queen relied upon the Marshal d'Ancre. Louis XIII. was attached to Charles d'Albert, sieur de Luynes; and with his help he arrested Marshal d'Ancre, and on his resistance had him assassinated. From this time to her death the relation between the king and his mother was one of concealed or open hostility. The article on FRANCE must be consulted for the intricate events of the following years.

The decisive incident for his private life as well as for his reign was the entrance of Cardinal Richelieu (*q.v.*) hitherto the queen's chief adviser, into the king's council in 1624. Henceforth the policy of France was directed by Richelieu, who returned to the policy of Henry IV. abroad, and asserted the power of the crown against all rivals at home. This policy brought Louis into unremitting conflict with the Protestants and the nobles of France, but also made him the enemy of his mother, of his brother Gaston of Orleans, who made himself the champion of the cause of the nobles, and sometimes even of his wife. It is not easy to define his relations to Richelieu. He was convinced of his loyalty and of his genius, and in the end always supported his policy. But he disliked the friction with his family circle which this policy produced. For the most part his share in the great events of the reign was a passive one. There were certain occasions when it seemed as if he would oppose Richelieu. The chief of these was what is known as the "Day of Dupes" (1630). Then the queen-mother and the king's brother passionately attacked the minister, and for a moment it was believed that Richelieu was dismissed and that the queen-mother and a Spanish policy had triumphed. But the minister regained his ascendancy over the king, punished his enemies and forced Marie de' Medici and Gaston of Orleans to sue for pardon. In 1631 Gaston fled to Lorraine and the queen-mother to Brussels. Gaston soon returned, to plot, to fail and to sue for pardon again and again; but Marie de' Medici ended her life in exile.

But the last great effort to overthrow Richelieu was the conspiracy of Cinq-Mars (*q.v.*), one of the king's personal favourites. Cinq-Mars believed himself secure of the king's favour. But Richelieu discovered his treasonous relations with Spain, and defeated his plot. Louis was reconciled to his minister. "We have lived too long together to be separated" he is reported to have said (September 1642). Yet when Richelieu died in December of the same year he allowed himself to speak of him in a jealous and satirical tone. He died himself a few months later (May 1643). (*See* also RICHELIEU, ARMAND JEAN DU PLESSIS DE.)

The chief source of information on Louis XIII.'s life is to be found in the contemporary memoirs, of which the chief are: Bassompierre, Fontenay-Mareuil, Gaston d'Orléans, Montrésor, Omer Talon. Richelieu's own Memoirs are chiefly concerned with politics and diplomacy. Of modem works those most directly bearing on the king's personal life are R. de Beauchamp, *Louis XIII. d'après sa correspondance avec le cardinal de Richelieu;* G. Hanotaux, *Histoire du cardinal de Richelieu* (1893–96); Rossignol, *Louis XIII. avant Richelieu;* M. Topin, *Louis XIII. et Richelieu* (1876). *See* too Professor R. Lodge, *Richelieu;* J. B. *H.* R. Capefigue, *Richelieu, Mazarin et la Fronde* (1835–36); and Dr. J. H. Bridges, *Richelieu, Mazarin and Colbert* (1866); Aymes, *La France sous Louis XIII.* (1909); *Lettres de la main de Louis XIII.* (2 pt. 1914).

For full bibliography *see* G. Monod, *Bibliographie de l'histoire de France; Cambridge Modern History,* vol. iv. ("The Thirty Years' War"); Lavisse et Rambaud, *Histoire générale,* vol. v. ("Guerres de religion").

LOUIS **XIV.** (1638–1715), king of France, was born at Saint-Germain-en-Laye on Sept. 5, 1638, the son of Louis XIII. and Anne of Austria. The death of his father made the child of five king on May 14, 1643. Power lay in the hands of the queen-mother and of her minister, Cardinal Mazarin, who had to face the domestic troubles of the Fronde and the last stages of the Thirty Years' War. Twice the court had to flee from Paris; once when there was a rumour of intended flight the populace was admitted to see the king in his bed. The memory of these humiliations played their part in developing later the autocratic ideas of Louis. Mazarin triumphed alike over his domestic and his foreign opponents. The Fronde was at an end by 1653; the peace of Westphalia (1648) and the peace of the Pyrenees (1659) marked the success of the arms and of the diplomacy of France. Louis XIV. was now twenty-one years of age. The peace of the Pyrenees was cemented by the marriage of Louis to his cousin, the Infanta Maria Theresa.

The marriage took place at once, and the king entered Paris in triumph in 1660. Mazarin died in the next year; and the king at once announced his intention of being his own first minister. He built up a thoroughly personal system of government, and presided constantly over the council and many of its committees.

Even the greatest of his ministers found themselves controlled by the king. Fouquet, the finance minister, was overthrown and condemned to perpetual imprisonment. Those who had most of the king's confidence afterwards were Colbert for home affairs; Lionne for diplomacy, Louvois for war; but as his reign proceeded he became more intolerant of independence of judgment in his ministers.

His court was brilliant. In art and in literature, the great period, which is usually called by the king's name, had in some respects passed its zenith when he began to reign. But France was unquestionably the first state in Europe both in arms and arts, and within France the authority of the king was practically undisputed. The nation, proud of its pre-eminence and weary of civil war, saw in the king its true representative and the guarantee of its unity and success. Louis played the rôle of *Grand Monarque* to perfection. His wife Maria Theresa bore him children but there was no community of tastes between them, and the chief influence at court is to be found not in the queen but in the succession of avowed mistresses: Louise de la Vallière, Madame de Montespan and Madame de Maintenon (*q.v.*), who ruled, however, not as mistress but as wife. Through her influence the king was reconciled to his wife, and, when Maria Theresa died in 1683, Madame de Maintenon shortly afterwards (in 1684) became the king's wife, though this was never officially declared. Under her influence the court lost most of its gaiety, and religion came to exercise much control over the life and the policy of the king.

The first years of the king's rule were marked by the great schemes of Colbert for the financial, commercial, industrial and naval reorganization of France, and in these schemes Louis took a deep interest. But in 1667 began the long series of wars, which lasted with little real intermission to the end of the reign. (*See* FRANCE.) The War of Devolution (or the Queen's War) in 1667–68 to enforce the queen's claim to certain districts in the Spanish Netherlands, led to the Dutch War (1672–78), and in both these wars the supremacy of the French armies was clearly apparent. The next decade (1678–88) was the real turning point in the history of the reign, and the strength of France was seriously diminished. The chief cause of this is t~ be found in the revocation of the Edict of Nantes. The French Huguenots found their privileges decreased, and then, in 1685, the edict was altogether withdrawn. The results were ruinous to France, which lost many thousands of her best citizens and, also, Protestant alliances in Europe which had been in the past her great diplomatic support. The English Revolution of 1688 changed England from a wavering ally into the most determined of the enemies of France.

The war with the Grand Alliance, of which King William III. was the heart and soul, lasted from 1688 to 1697; and the treaty of Ryswick, which brought it to an end, deprived France of certain territories on her frontier. But Louis saw in the Spanish question a chance of more than making up for this loss. The Spanish king Charles II. was dying, and the future of the possessions of Spain was doubtful. The astute diplomacy of Louis succeeded in winning the inheritance for his grandson Philip. But this involved France and Europe in an immense war (1700) and by the Peace of Utrecht (1713), though the French prince retained the Spanish crown, France had again to make concessions of territory.

The peace found France burdened with debt; the reforms of Colbert were ruined; and opposition to the king's régime began to make itself felt. Peace brought some relief to France, but the last years of the king's life were gloomy in the extreme. His eldest son, the dauphin, died in April 1711; his eldest grandson the duke of Burgundy in Feb. 1712; and his great-grandson the duke of Brittany in March 1712. The heir to the throne was now the duke of Burgundy's son, the duke of Anjou, afterwards Louis XV. The king died on Sept. 1, 1715, after the longest recorded reign in European history. The judgment of posterity has not repeated the flattering verdict of his contemporaries; but he remains the model of a great king in all that concern the externals of kingship.

The reign Louis XIV. is particularly rich in memoirs describing the life of the court. The chief are Madame de Motteville's memoirs for the period of the Fronde, and the letters of Madame de Sévigné and the memoirs of Saint-Simon for the later period. The king's ideas are best seen in the *Mémoires de Louis XIV. pour l'instruction du dauphin* (edited by Dreyss, 2 vols.). His private life is revealed in the letters of Madame de Maintenon and in those of Madame, Duchesse d'Orléans. *See* also Voltaire, *Siècle de Louis XIV.*; P. Clément, *Histoire de la vie et de l'administration de Colbert;* Blennerhasset, *Louis and Madame de Maintenon* (1910); Martin and Besançon, *Hist. du crédit en France sous le règne de Louis XIV.* (1913); d'Angelo, *Luigi XIV. et la Santa Sede, 1689–93* (1914); M. L. E. Bertrand, *Louis XIV.* (1923); G. Mentz, *Ludwig XIV. Sein Reich und Seine Zeit* (Bonn, 1922), and bibliographies; G. Monod's *Bibliographie de l'histoire de France;* vol. v. ("The Age of Louis XIV.") of the *Cambridge Modern History;* and vol. vi. ("Louis XIV.") of the *Histoire générale* of Lavisse and Rambaud.

LOUIS XV. (1710–1774), king of France, was the great-grandson of Louis XIV. and the third son of Louis, duke of Burgundy, and Marie Adelaide, princess of Savoy. He was five years old when Louis XIV. died. With the help of the parlement of Paris the arrangement for a council of regency made by the late king was set aside, and the duke of Orleans was declared regent with full powers. Fleury, bishop of Fréjus, was appointed the king's tutor. He attained his legal majority at the age of thirteen, shortly before the death of the duke of Orleans. His first minister was the incapable duke of Bourbon, who in 1725 procured his marriage to Maria Leszczynska, daughter of the exiled king of Poland. In 1726 the duke of Bourbon was displaced by the king's tutor, Fleury, who exercised almost absolute power. His administration was successful and peaceful until the year 1734, when France intervened in Poland on behalf of the queen's father. The peace of Vienna (1735) secured to France the possession of Lorraine. In 1740 France drifted into the war of the Austrian Succession as an ally of Frederick of Prussia and the enemy of England, and of Maria Theresa of Austria.

On Fleury's death in 1743 Louis XV. determined to rule alone, but he was not strong enough in will or intellect to rule effectively. The queen for some time seems to have secured his affections, and she bore him seven children. But Louis entertained a series of mistresses. The first to acquire notoriety was the duchess of Châteauroux, the third sister of one family who held this position. He dismissed her in a fit of piety after an illness, but her place was taken in 1745 by Madame de Pompadour, whose influence on public affairs was a fatal one. She had many rivals during her lifetime and on her death in 1764 she was succeeded by Madame du Barry (*q.v.*). To the last Louis maintained the pretence of personal rule, but the machinery of government fell out of gear, and the disorder of the finances was never remedied before the revolution of 1789.

The peace of Aix-la-Chapelle (1748), which ended the war of the Austrian Succession, brought no gains to France in spite of her victories at Fontenoy and Raucoux; and the king was blamed for the diplomatic failure. The interval between this war and the Seven Years' War (1756) saw that great reversal of alliances which is sometimes called the "Diplomatic Revolution"; whereby France repudiated the alliance of Frederick the Great and joined hands with her old enemy Austria. The intrigues of Madame de Pompadour played in this change an important though not a decisive part. It was the cause of immense disasters to France; for after a promising beginning, both by land and sea, France suffered reverses which lost her both India and Canada and deprived her of the leading position which she had so long held in Europe. Her humiliation was declared by the peace of Paris (1763).

The article on the history of France (*q.v.*) shows how there arose during the last years of Louis XV.'s reign a strong reaction against the monarchy and its methods. In the parlements, provincial and Parisian; in religion and in literature, a note of opposition was struck which was never to die until the monarchy was overthrown. France annexed Corsica in 1768, but this was felt to be the work of the minister Chauvelin, and reflected no credit on the king. He died on May 10, 1774.

For the king's life generally *see* the memoirs of Saint-Simon, d'Argenson, Villars and Barbier, and for the details of his private life E. Boutaric, *Correspondance secrète de Louis XV.;* Madame de

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LOUIS XVI. (1754–1793), king of France, was the son of Louis, dauphin of France, the son of Louis XV., and of Marie Joseph of Saxony, and was born at Versailles on Aug. 23, 1754, being baptized as Louis Augustus. His father's death in 1765 made him heir to the throne, and in 1770 he married Marie Antoinette (*q.v.*) daughter of the empress Maria Theresa. He was twenty years old when the death of Louis XV. on May 10, 1774, placed him on the throne. He began his reign under good auspices, with Turgot, the greatest living French statesman, in charge of the disorganized finances; but in less than two years he dismissed him. Turgot's successor, Necker, however, continued the régime of reform until 1781, and it was only with Necker's dismissal that the period of reaction began. Marie Antoinette then obtained that ascendancy over her husband which was partly responsible for the extravagance of the ministry of Calonne.

The third part of his reign began with the meeting of the states-general on May 4, 1789, which marked the opening of the Revolution. The revolt of Paris and the taking of the Bastille on July 14 were its results. The suspicion, not without justification, of a second attempt at a *coup d'état* led on Oct. 6, to the "capture" of the king and royal family at Versailles by a mob from Paris, and their transference to the Tuileries. In spite of the growing radicalism of the clubs, however, loyalty to the king remained surprisingly strong. When he swore to maintain the constitution, then in progress of construction, at the festival of the federation on July 14, 1790, he was at the height of his popularity. Even his attempted flight on June 20, 1791, did not entirely turn the nation against him. Arrested at Varennes, he was maintained as a constitutional king, and took his oath on Sept. 13, 1791.

But already a party was forming in Paris which demanded his deposition. This first became noticeable in connection with the affair of the Champ de Mars on July 17, 1791. Crushed for a time the party gained strength through the winter of 1791–1792. The declaration of war against the emperor Francis II., nephew of Marie Antoinette, was forced upon the king by those who wished to discredit him by failure, or to compel him to declare himself openly an enemy to the Revolution. Their policy proved effective. The failure of the war, which intensified popular hatred of the Austrian queen, involved the king; and the invasion of the Tuileries on June 20, 1792, was but the prelude to the conspiracy which resulted on Aug. 10, in the capture of the palace and the "suspension" of royalty by the Legislative Assembly until the convocation of a national convention in September. On Sept. 21, 1792, the Convention declared royalty abolished, and in January it tried the king for his treason against the nation, and condemned him to death. He was executed on Jan. 21, 1793.

Louis XVI. was weak in character and mentally dull. His courage and dignity during his trial and on the scaffold has left him a better reputation than he deserves. His diary shows how little he understood, or cared for, the business of a king. Days on which he had not shot anything at the hunt were blank days for him. The greater part of his time was spent hunting. He also amused himself making locks, and a little at masonry. On one point only, he actively resisted the Revolution. A devoted and sincere Roman Catholic, he refused at first to sanction a constitution for the church in France without the pope's approval, and after he had been compelled to allow the constitution to become law he intrigued feebly against the Revolution. When he gave in, he delayed his acquiescence until it had the air of a surrender.

Having lost his elder son in 1789 Louis left two children, Louis Charles, usually known as Louis XVII. (*q.v.*), and Marie Thérèse Charlotte (1778–1851), duchess of Angoulême. The "orphan of the Temple," as the princess was called, was in prison for three years, during which time she remained ignorant of the fate which had befallen her parents. She died on Oct. 19, 1851. Her life by G. Lênotre has been translated into English by J. L. May (1908).

See the articles French Revolution and Marie Antoinette. F. X. J. Droz, *Histoire du règne de Louis XVI.* (3 vols., 1860), a sane and good history of the period; and Arsène Houssaye, *Louis XVI.* (1891). *See* also the numerous memoirs of the time, and the marquis de Ségur's *Au couchant de la monarchie, Louis XVI. et Turgot* (1910); de Baissière, *La mort du roi, 21 janvier 1793* (1909); Durfel, *La diplomatie de la France sous Louis XVI.* (1919).

For bibliographies *see* G. Monod, *Bibl. de la France;* Lavisse et Rambaud, *Hist. Univ.*, vols. vii. and viii.; and the *Cambridge Modern History*, vol. viii.

LOUIS XVII., Charles (1785–1795?), titular king of France, second son of Louis XVI., and Marie Antoinette, was born at Versailles on March 27, 1785, and given the title of duke of Normandy, becoming dauphin on the death of his elder brother on June 4, 1789. In 1792 his parents and the rest of the royal party were imprisoned in the Temple—at first in the smaller tower; on Oct. 27 they were moved to the larger tower, and Louis was separated from his mother and aunt to be put in his father's charge, except for a few hours daily, but he was restored to the women when Louis was finally isolated at his trial.

On Jan. 21, 1793, Louis became, for the royalists, king of France, and the comte de Provence gave himself the title of regent. Plots were engineered for the escape of the prisoners by the Chevalier de Jarjayes, the baron de Batz (*q.v.*) and Lady Atkyns (*q.v.*). On July 3 the dauphin was given into the charge of Simon, a cobbler who had been named his guardian by the Committee of General Security. Although the Simons were unfit guardians there is little evidence that the child was actually ill-treated On Oct. 6 Chaumette, Hébert and others visited him, and secured from him admissions of infamous accusations against his mother, and next day he met his sister, Marie Thérèse, for the last time. On Jan. 19 the Simons left the Temple.

Two days after their departure Louis is said by the Restoration historians to have been put in a dark room which was barricaded, while food was passed through the bars; and according to the legend nobody entered the room for six months, till Barras visited him after the 9th Thermidor (July 27, 1794). The child made no complaint to Barras, probably because he feared to do so. After this his condition improved; he was visited during the day by his new attendant, a creole named Jean Jacques Christophe Laurent (1770–1807), who had assistance from a man named Gomin after Nov. 8. From about this time the prisoner was inspected by representatives of the civil committee of the 48 sections of Paris, and on Dec. 19, 1794, he was visited by three commissioners from the Committee of General Security—J. B. Harmand de la Meuse, J. B. C. Mathieu, and J Reverchon—who extracted no word from him. On Laurent's retirement Étienne Lasne was appointed on March 31, 1795, to be the child's guardian. In May 1795 Louis was seriously ill, and a doctor, P. J. Desault, who had visited him seven months earlier, was summoned. Desault died suddenly, not without suspicion of poison, on June 1, and it was some days before Doctors Pelletan and Dumangin were called. Then it was stated that on the 8th Louis Charles had died. Next day an autopsy was held, at which it was stated that a child apparently about ten years of age "which the commissioners told us was the late Louis Capet's son," had died of a scrofulous affection of long standing. He was buried on the 10th in the cemetery of Ste. Marguerite, but no stone was erected to mark the grave.

Immediately on the announcement of the dauphin's death there arose a rumour that he had escaped. Simien Despréaux, one of Louis XVIII.'s own authors, stated in 1814 that Louis XVII. was living, and Eckard left among his unpublished papers a statement that many members of "an assembly of our wise men" named Louis XVII. as the prince whom they wished to have. The royal family made no serious attempt to ascertain the truth, and the removal of Louis XVII. suited the comte de Provence (now Louis XVIII. for the émigrés) as well as it did the Revolutionary

Government.

The most important of some 40 pretenders under the Restoration were Karl Wilhelm Naundorff (*q.v.*) and the comte de Richemont. According to Naundorff, Barras determined to save the dauphin in order to please Joséphine Beauharnais, the future empress, having conceived the idea of using the dauphin's existence as a means of dominating the comte de Provence in the event of a restoration. The dauphin was concealed in the fourth storey of the Tower, a wooden figure being substituted for him. Laurent, to protect himself from the consequences of the substitution, replaced the wooden figure by a deaf mute, who was presently exchanged for the scrofulous child of the death certificate. The deaf mute was also concealed in the Temple. It was not the dead child but the dauphin who left the prison in the coffin, whence he was extracted by his friends on the way to the cemetery. Richemont's tale is that the woman Simon, who was genuinely attached to him, smuggled him out in a basket. Richemont was in prison in Milan for seven years and began to put forward his claims in Paris in 1828. In 1834, he was condemned to 12 years' imprisonment. He escaped after a few months and left the country, to return in 1840. He died at Gleize on Aug. 10, 1853.

If the dauphin did escape, it seems probable that he perished shortly afterwards or lived in a safe obscurity. The account of the substitution in the Temple is well substantiated, even to the names of the substituted. Lady Atkyns was trying by every possible means to get the dauphin out of his prison when he was apparently already in safe hands, if not outside the Temple walls. A child was in fact delivered to her agents, but he was found to be a deaf mute.

The official version of the dauphin's history as accepted under the Restoration was drawn up by Simien Despréaux in his uncritical *Louis XVII.* (1817), and is found, fortified by documents, in M. Eckard's *Mémoires historiques sur Louis XVII.* (1817) and in A. de Beauchesne's *Louis XVII., sa vie, son agonie, sa mort. Captivité de la famille royale au Temple* (2 vols., 1852, and many subsequent editions), contains copies of original documents. L. de la Sicotière, "Les faux Louis XVII.," in *Revue des questions Historiques* (vol. xxxii., 1882), deals with the pretenders Jean Marie Hervagault, Mathurin Bruneau and the rest; *see* also Dr. Cabanes, *Les Morts mystérieuses de l'histoire* (1901), and revised catalogue of the J. Sanford Saltus collection of Louis XVII. books (New York, 1908); also J. H. Hanson, *The Lost Prince* (1854); E. R. Buckley, *Monsieur Charles, The Tragedy of the True Dauphin* (1927).

For De Richemont see *Mdmoires du duc de Normandie, fils de Louis XVI., écrits et publiés par lui-même* (1831), compiled, according to Quérard, by E. T. Bourg, called Saint Edme; Morin de Guérivière, *Quelques souvenirs . . .* (1832); and J. Suvigny, *La Restauration convaincue . . . ou preuves de l'existence du fils de Louis XVI.* (1851).

Since 1905 a monthly periodical has appeared in Paris on this subject. entitled *Revue historique de la question Louis XVII.*

LOUIS XVIII. (Louis le Désiré) (1755–1824). Louis-Stanislas-Xavier, comte de Provence, third son of the dauphin Louis, son of Louis XV. and Maria Josepha of Saxony, was born at Versailles on Nov. 17, 1755. His education was supervised by the devout duc de la Vauguyon, but his own taste was for the writings of Voltaire and the encyclopaedists. On May 14, 1771, took place his marriage with Louise-Marie-Joséphine of Savoy. During the long absence of heirs to Louis XVI., "Monsieur," as heir to the throne, courted popularity and took an active part in politics, but the birth of a dauphin (1781) was a blow to his ambitions. He opposed the revival of the *parlements,* wrote a number of political pamphlets, and at the Assembly of Notables presided, like the other princes of the blood, over a bureau, to which was given the name of the *Comité des sages;* he also advocated the double representation of the *tiers.* At the same time he cultivated literature, entertaining poets and writers both at the Luxembourg and at his chbteau of Brunoy (*see* Dubois-Corneau, *Le Comte de Provence à Brunoy,* 1909), and gaining a reputation for wit by his verses and *mots* in the salon of the charming and witty comtesse de Balbi, one of Madame's ladies, who had become his mistress, and till 1793 exerted considerable influence over him. He did not emigrate after the taking of the Bastille, but, possibly from motives of ambition, remained in Paris. In June 1791, however, at the time of the flight to Varennes, he also fled by a different route, and, in company with the comte d'Avaray—who subsequently replaced Mme. de Balbi as his confidant, and largely influenced his policy—reached Brussels, where he joined the comte d'Artois and proceeded to Coblenz, now the headquarters of the emigration.

Here, living in royal state, he put himself at the head of the counter-revolutionary movement, appointing ambassadors, soliciting the aid of the European sovereigns, and especially of Catherine II. of Russia. Out of touch with affairs in France and surrounded by violent anti-revolutionists, headed by Calonne and the comte d'Artois, he followed an entirely selfish policy, flouting the National Assembly, issuing uncompromising manifestoes (Sept. 1791, Aug. 1792, etc.), and obstructing in every way the representatives of the king and queen. After Valmy he had to retire to Hamm in Westphalia, where, on the death of Louis XVI., he proclaimed himself regent: from here he went south, with the idea of encouraging the royalist feeling in the south of France, and settled at Verona, where on the death of Louis XVII. (June 8, 1795) he took the title of Louis XVIII. From this time onward his life is a record of constant wanderings, negotiations and conspiracies. In April 1796 he joined Condé's army on the German frontier, but was shortly requested to leave the country, and accepted the hospitality of the duke of Brunswick at Blanckenberg till 1797, when, this refuge being no longer open to him, the emperor Paul I. permitted him to settle at Mittau in Courland, where he stayed till 1801. All this time he was in close communication with the royalists in France, but was much embarrassed by the conflicting policy pursued by the comte d'Artois from England, and was largely at the mercy of corrupt and dishonest agents.[1] At Mittau was realized his cherished plan of marrying Madame Royale, daughter of Louis XVI., to the duc d'Angoulême, elder son of the comte d'Artois. From Mittau, too, was sent his well-known letter to Bonaparte (1799) calling upon him to play the part of Monk, a proposal contemptuously refused, though Louis in turn declined to accept a pension from Bonaparte, and later, in 1803, though his fortunes were at their lowest ebb, refused to abdicate at his suggestion and accept an indemnity.

Suddenly expelled from Mittau in 1801 by the capricious Paul I., Louis made his way, in the depth of winter, to Warsaw, where he stayed for three years. All this time he was trying to convert France to the royalist cause, and had a *conseil royal* in Paris, founded at the end of 1799 by Royer-Collard, Montesquiou, and Clermont-Gallerande, but after 1800, and still more after the assumption by Napoleon of the title of emperor (May 1804), the royalist cause appeared hopeless. In Sept. 1804 Louis met the comte d'Artois at Calmar in Sweden, whence they issued a protest against Napoleon's action. Warned that he must not return to Poland, he gained permission from Alexander I. again to retire to Mittau. After Tilsit, however (1807), he was again forced to depart, and took refuge in England, where he stayed first at Gosfield in Essex, and afterwards (1809 onwards) at Hartwell in Buckinghamshire. In 1810 his wife died, and in 1811 d'Avaray died, his place as favourite being taken by the comte de Blacas.[2] After Napoleon's defeats in 1813 the hopes of the royalists revived, and Louis issued a fresh manifesto, in which he promised to recognize the results of the Revolution. Negotiations were also opened with Bernadotte, who seemed willing to support his cause, but was really playing for his own hand.

In March 1814 the allies entered Paris, and thanks to Talleyrand's negotiations the restoration of the Bourbons was effected, Louis XVIII. entering Paris on May 2, 1814, after issuing the declaration of St. Ouen, in which he promised to grant the nation a constitution (*octvoyer une charte*). He was now nearly 60, wearied by adversity, and a sufferer from gout and obesity. But though clear-sighted, widely read and a good diplomatist, his impressionable and sentimental nature made him too subject to personal and family influences. His concessions to the reactionary and clerical party of the *émigrés,* headed by the comte d'Artois and the duchess d'Angoulême, aroused suspicions of his loyalty to the constitution, the creation of his *Maison militaire,* alienated

[1] *See* E. Daudet, *La Conjuration de Pichegru* (Paris, 1901).

[2] Pierre-Louis-Casimir, comte (afterwards duc) de Blacas d'Aulps, was as rigidly royalist as d'Avaray, but more able.

the army, and the constant presence of Blacas made the formation of a united ministry impossible. After the Hundred Days, during which the king was forced to flee to Ghent, the dismissal of Blacas was made one of the conditions of his second restoration. On July 8 he again entered Paris, "in the baggage train of the allied armies," as his enemies said, but in spite of this was received with the greatest enthusiasm by a people weary of wars and looking for constitutional government. He was forced to retain Talleyrand and Fouché in his first ministry, but took the first opportunity of ridding himself of them when the elections of 1815 assured him of a strong royalist majority in the chamber (the *chambre introuvable,* a name given it by Louis himself). At this time he came into contact with the young Élie Decazes (*q.v.*), prefect of the police under Fouché, who now became his favourite and gained his entire confidence. Having obtained a ministry in which he could trust, with the duc de Richelieu at its head, and Decazes as minister of police, the king gave it his loyal support and did his best to shield his ministers from the attacks of the royal family. In Sept. 1816, alarmed at the violence of the *chambre introuvable,* he was persuaded by Decazes to dissolve it. An attempt on the part of the Ultras to regain their ascendancy over the king, by conniving at the sudden return of Blacas from Rome to Paris, ended in failure.

The king's policy throughout was one of prudence and common sense. While Decazes, who succeeded Richelieu as president of the council in Dec. 1818, was still in power, the king's policy to a large extent followed his, and was rather liberal and moderate, but after the assassination of the duc de Berry (1820), when he saw that Decazes could no longer carry on the government, he sorrowfully acquiesced in his departure, showered honours upon him, and transferred his support to Richelieu, the head of the new ministry. In the absence of Decazes a new favourite was found to amuse the king's old age, Madame du Cayla (Zoé Talon, comtesse du Cayla), a protégée of the vicomte Sosthène de la Rochefoucauld and consequently a creature of the Ultres. As the king became more and more infirm, his power of resistance to the intrigues of the Ultras became weaker. The birth of a posthumous son to the duc de Berry (Sept. 1820), the death of Napoleon (May 5, 1821) and the resignation of Richelieu, left him entirely in their hands, and after Villèle had formed a ministry of an ultra-royalist character, the comte d'Artois was associated with the government, which passed more and more out of the king's hands. He died on Sept. 16, 1824. Louis XVIII. had the Bourbon characteristics, their love of power, a certain nobility of demeanor, and a consciousness of dignity. But he was cold, unsympathetic and calculating. He had a talent for intrigue, to which was added an excellent memory and a ready wit. An interesting judgment of him is contained in Queen Victoria's *Letters,* vol. i., in a letter by Leopold I., king of the Belgians, dated Nov. 18, 1836, "Poor Charles X. is dead. . . . History will state that Louis XVIII. was a most liberal monarch, reigning with great mildness and justice to his end, but that his brother, from his despotic and harsh disposition, upset all the other had done and lost the throne. Louis XVIII. was a clever, hard-hearted man, shackled by no principle, very proud and false. Charles X. an honest man, a kind friend." As a personal, rather than a political estimate, this is just.

BIBLIOGRAPHY.—There is no trustworthy or complete edition of the writings and correspondence of Louis XVIII. From his own hand are *Relation d'un voyage à Bruxelles et à Coblentz, 1791* (1823) and *Journal de Marie-Thérèse de France, duchesse d'Angoulême, corrige', et annoté par Louis XVIII.,* edit. Imbert de St. Amand (1894). Some of his letters are contained in collections, such as *Lettres et instructions de Louis XVIII. au comte de Saint-Priest,* edit P. B. de Barante (1845); *Lettres d'Artwel: correspondance politique et privée de Louis XVIII.,* addressed to d'Avaray (1880); *Talleyrand et Louis XVIII. corr. pendant le congrès de Vienne, 1814–1815,* edit. G. Pallain (1881, Eng. trans. 2 vols., 1881); *see* also the correspondence of Castlereagh, Metternich, J. de Maistre, the Wellington Despatches, etc., *Corr. diplomatique de Pozzo di Borgo avec le comte de Nesselrode* (2 vols., 1890–97), the correspondence of C de Rémusat, Villèle, etc. *See* also E. Daudet, *La Terreur Blanche* (1878), *Hist. de fa restauration 1814–1830* (1882), *Louis XVIII. et le duc Decazes* (2 vols., 1899–1903), *Hist. de l'émigration* (3 vols., 1904–07); E. Romberg and A. Malet, *Louis XVZIZ. et les cent-jours à Gand* (1898). L. de Remâcle, *Bonaparte et les Bourbons* (1899); G. Stenger, *Le Retour des Bourbons* (1908). For various episodes, *see* J. B. H. R. Capefigue, *La Comtesse du Cayla* (1866), J. Turquan, *Souveraines et grandes dames: les favorites de Louis XVIII.* (1900), Vicomte de Reiset, "Anne de Caumont-Laforce, comtesse de Balbe" in *Les Reines de l'émigration,* vol. ii. (1908). *See* also the chief memoires of the period, such as those of Talleyrand, Chateaubriand, Guizot, duc de Broglie, Villèle, Vitrolles, Pasquier, L. F. S. de la Rochefoucauld (15 vols., 1861–64), and of the comtesse de Boigne, edit. C. Nicoullaud (1907).

LOUIS II. (1506–26), king of Hungary and Bohemia, was the only son of Wladislaus II., king of Hungary and Bohemia, and the French princess Anne of Candale. Prematurely born at Buda on July 1, 1506, it required all the resources of medical science to keep the sickly child alive, yet he developed so precociously that at the age of 13 he was well bearded and moustached, while at 18 his hair was silvery white. His parts were good and he could speak and write six languages at a very early age, but the zeal of his guardians and tutors to make a man of him betimes nearly ruined his feeble constitution, while the riotous life led by him and his young consort, Maria of Austria, whom he wedded on Jan. 13, 1522, speedily disqualified him for affairs, so that at last he became an object of ridicule at his own court. He was crowned king of Hungary on June 4, 1508, and king of Bohemia on May 11, 1509, and was declared of age when he succeeded his father on Dec. 11, 1521. But during most of his reign he was the puppet of the magnates and kept in such penury that he was often obliged to pawn his jewels to get proper food and clothing, while his guardians and the Hungarian nobles rent the kingdom with their factions. In the last struggle with the Turks, which was brought on partly by Louis's own folly, the young king was deserted by the nobles who should have helped him. His army was utterly defeated at Mohács, Aug. 29, 1526, and he himself is said to have been drowned in his flight from the field (*see* HUNGARY: *History*). After his death the Crowns of Hungary and Bohemia passed to the Habsburg dynasty.

See *Rerum Hungaricarum libri* (vol. ii., ed. Ferencz Toldy, Budapest, 1867); and József Podhradczky, *King Louis* (Hung.) (1860).

LOUIS I. (1326–82), called "the great," king of Hungary and Poland, was the third son of Charles Robert, king of Hungary, and Elizabeth, daughter of the Polish king, Ladislaus Lokietek. On July 21, 1362, he was crowned king of Hungary in succession to his father. He engaged in a prolonged struggle against Venice for the Adriatic sea-board. On July 1, 1346, he was defeated by the Venetians at Zara, which had placed itself under the protection of Hungary. The battle has been immortalized by Tintoretto. In 1357, however, Louis formed a league of all the enemies of Venice, including the emperor, the Habsburgs, Genoa and other Italian towns, and forced her to cede most of the Dalmatian towns and renounce the title of duke of Dalmatia and Croatia, hitherto borne by the doge. (Treaty of Zara, Feb. 18, 1358.) In the same year the republic of Ragusa voluntarily submitted to him, Louis undertaking its defence against an annual tribute. The third Venetian War (1378–81), where Louis was again helped by Genoa, was ended by the congress of Turin (1381), Venice virtually surrendering Dalmatia to Louis and undertaking to pay him an annual tribute of 7,000 ducats. The persistent hostility of Venice is partially attributable to her constant fear lest Louis should inherit the crown of Naples and thus threaten her trade and her sea-power from two sides.

Louis's younger brother Andrew had wedded Joanna, granddaughter and heiress of old King Robert of Naples, on whose death, in 1343, she reigned in her own right, and is strongly suspected of having secured her consort's assassination in 1345. Although Louis claimed the throne, and twice occupied Naples, he could never secure the crown. At last in 1378 Joanna, having made the mistake of recognizing the antipope Clement VII., was promptly deposed and excommunicated in favour of Prince Charles of Durazzo, who had been brought up at the Hungarian court. With the Habsburgs, Louis generally maintained friendly relations, and his differences with Rudolph of Wabsburg were composed without war at the peace congresses of Nagyszombat (1360) and of Pressburg (1360). On the death of his uncle, the childless Casimir the Great of Poland, who had been Louis's lifelong friend, and had appointed him his successor, Louis was crowned king of Poland (Nov. 17, 1370). This personal union of the two countries was more glorious than profitable. Louis was never able to establish real authority over his Polish subjects although in 1374 he compelled them by force to recognize his daughter Maria and her affianced husband, Count Sigismund of Brandenburg, as their future king and queen. Against the Turks, who were now beginning to threaten Europe, Louis took little or no action. He died suddenly at Nagyszombat, Sept. 10, 1382. He left two daughters Maria and Jadwiga (the latter he destined for the throne of Hungary) under the guardianship of his widow. She was the daughter of the valiant ban of Bosnia, Stephen Kotromaric, and she was married in 1353.

See *Rationes Collectorum Pontif. in Hungaria, 1281–1375* (Budapest, 1887); Dano Gruber, *The Struggle of Louis I, with the Venetians for Dalmatia* (Croat.) (Agram, 1903); Antal Pór, *Life of Louis the Great* (Hung.) (Budapest, 1892); and *History of the Hungarian Nation* (Hung.) (vol. iii., Budapest, 1895).

LOUIS, the name of three lungs of Naples.

Louis I., duke of Anjou and count of Maine (1339–1384), was the second son of John II., king of France, and was born at Vincennes on July 23, 1339. As duke of Anjou he led a wing of the French army at the battle of Poitiers. He was a hostage for the treaty of Brétigny in 1360, but he broke his parole in 1363 and so brought about King John's return into captivity. He took part in the war against England which was renewed in 1369, uniting the rival houses of Foix and Armagnac in the common cause, and in other ways rendering good service to his brother, King Charles V. Anjou's entrance into the troubled politics of Italy was one result of the papal schism which opened in 1378. Anxious to secure the support of France, the antipope Clement VII. persuaded the queen of Naples, Joanna I. (*q.v.*), to name Louis as her heir, and about the same time the death of Charles V. (Sept. 1380) placed the duke in the position of regent of France. Neglecting France to prosecute his ambitions in Italy, he collected money and marched on Naples; but although helped by Amadeus VI., count of Savoy, he was unable to drive his rival, Charles, duke of Durazzo, from Naples. His army destroyed by disease, Louis died at Biseglia, near Bari, on Sept. 20, 1384, leaving two sons, his successor, Louis II., and Charles, duke of Calabria.

Louis II., duke of Anjou (1377–1417), born at Toulon on Oct. 7, 1377, took up the struggle for Naples after his father's death and was crowned king by Clement VII. in 1389. After carrying on the contest for some years he took refuge in France. He made other attempts to secure the kingdom of Naples, which was now in the possession of Ladislas, a son of Charles of Durazzo, and he gained a victory at Roccoserra in May 1411. He was again driven back to France, and he died at Angers on April 29, 1417. He married Yolande, a daughter of John I., king of Aragon.

Louis III., duke of Anjou (1403–1434), born on Sept. 25, 1403, son of Louis II., attempted to conquer Naples in 1420; he died at Cosenza on Nov. 15, 1434. In 1424 Louis received from King Charles VII. the duchy of Touraine.

Another titular king of Naples of this name was Louis, a son of Philip, prince of Taranto. In 1346 he became the husband of Joanna I., queen of Naples, and in 1352 he was crowned king. After attempting to conquer Sicily he died on May 26, 1362.

LOUIS, JOE (Joseph Louis Barrow) (1914–), U.S. boxer, held the heavyweight championship of the world longer (1937–49) than any other champion in the division. Born May 13, 1914, at Lexington, Ala., he began his boxing career in Detroit, Mich., winning 43 of 54 amateur bouts by knockouts. In his prime Louis stood 6 ft. 1½ in. and weighed about 200 lb. He had his first professional fight in 1934, and a year later, fought five times in 25 days during one stretch.

Louis knocked out James Braddock in eight rounds to win the world title in Chicago, June 22, 1937, and become the second Negro heavyweight champion. He knocked out six world champions—Primo Carnera, Jack Sharkey, Braddock, Max Baer, Max Schmeling and Joe Walcott. He defended his title 25 times, or more times than the preceding eight champions together. He grossed an estimated $4,225,000 and participated in three of boxing's eight all-time $1,000,000 gates. Louis retired in May 1949, came out of retirement on Sept. 27, 1950, and lost a 15-round decision to Ezzard Charles in a title match. *See* also Boxing.

(J. D. McC.)

LOUIS, JOSEPH DOMINIQUE, Baron (1755–1837), French statesman and financier, was born at Toul, *département* of Meurthe, on Nov. 13, 1755, and was educated for the priesthood. At the outbreak of the French Revolution, the abbé Louis already had some reputation as a financial expert. He was in favour of the constitutional movement, and at the festival federation of July 14, 1790, he assisted Talleyrand, then bishop of Autun, to celebrate mass at the altar erected in the Champ de Mars. In 1790, however, he emigrated to England, where he spent his time studying English institutions and especially the financial system of William Pitt.

Returning to France on the establishment of the consulate, he served successively in the ministry of war, the council of state and in the finance department, both in Holland and in Paris. Made a baron of the empire in 1809, he nevertheless supported the Bourbon restoration and was minister of finance in 1811. Baron Louis served as a deputy from 1815 to 1824 and from 1827 to 1832. He resumed the portfolio of finance in 1815, which he held also in the Decazes ministry of 1819; he was the first minister of finance under the government of Louis Philippe, and held the same portfolio in 1830 and 1831. In 1832 he was made a peer of France. Baron Louis died at Bry-sur-Marne on Aug. 26, 1837.

LOUIS or **LEWIS,** a masculine proper name derived from Frankish *Chlodowîch,* Latinized as *Lodhuvicus,* whence O.Fr. *Lodhuwigs, Loys,* and later *Louis; cf.* Ger. *Ludwig.* It means "famous in fight" and was borne by many sovereigns.

The "Louis" or "Louis d'or" was a term applied to the gold coins of France prior to the Revolution. The franc (*q.v.*) and livre were silver coins which had shrunk in value to such an extent that larger coins were needed, and just as England adopted the guinea so did the French kings have gold coins struck and called after their name. After the Revolution Napoleon continued the practice. but called the coins "Napoleons."

LOUISBURG or Louisbourg, a town and port of entry of Cape Breton, Nova Scotia, Canada, the terminus of the Sydney & Louisburg railway, 39 mi. from Sydney. Pop. (1956) 1,314. Under the French *régime,* Louisburg was second only to Quebec. A fortress was erected at enormous expense, and the city was the centre of the cod fisheries. The fortress was, however, captured in 1745 by the American colonists, under Sir William Pepperell (1696–1759), assisted by the British fleet, and again in 1758 by a British land and sea force under General Jeffrey Amherst (1717–1797) and Admiral Boscawen. The jealousy of the British settlement of Halifax led to its almost utter destruction. and only a few casemates now remain. Under English rule a fishing village grew up on the other side of the harbour. This harbour is deep, and open save for occasional drift ice in the spring. The site of the fortifications is now the Louisburg National Historic park.

LOUISE (Auguste Wilhelmine Amalie Luise) (1776–1810), queen of Prussia. was born on March 10, 1776, in Hanover, daughter of Prince Charles of Mecklenburg-Strelitz and a princess of Hesse-Darmstadt. In 1793 Louise met at Frankfurt the crown prince of Prussia, afterward King Frederick William III, whom she married on Dec. 4. As queen of Prussia she commanded universal respect and affection, and won a great name by the dignity and unflinching courage with which she bore the sufferings inflicted on her and her family during the Napoleonic Wars. After the battle of Jena she went with her husband to Konigsberg, and when the battles of Eylau and Friedland had placed Prussia absolutely at the mercy of France. she made a personal appeal to Napoleon at his headquarters in Tilsit, but without success. Early in 1808 she accompanied the king from Memel to Konigsberg, whence, toward the end of the year, she visited St. Petersburg, returning to Berlin on Dec. 23, 1809. During the war Napoleon attempted to destroy the queen's reputation, but the only effect of his charges in Prussia was to make her more deeply beloved. She died on July 19, 1810, at Strelitz.

LOUISE OF SAVOY (1476–1531). duchess of Angoulême, mother of Francis I of France, was daughter of a cadet of the house of Savoy, Philip, count of Bresse, afterward duke of Savoy, and of Marguerite de Bourbon. At the age of 12 she was married to Charles of Valois, count of Angoulême, great-grandson of King Charles V. The count died in 1496, leaving her the mother of two children, Marguerite (b. 1492) and Francis (b. 1494). The accession of Louis XII, who was childless. made Francis of Angoulême the heir presumptive to the throne of France. Louise brought her children to the court and received Amboise as her residence. She lived henceforth in fear lest Louis should have a son, and in consequence there was a secret rivalry between her and the queen. Anne of Brittany. Finally, her son became king on Jan. 1, 1515, by the death of Louis XII. From him Louise received the county of Angoulême, which was erected into a duchy, the duchy of Anjou, and the counties of Maine and Beaufort. She was then given the title of "Madame."

From 1515 to her death she took the chief share in the government. The part she played has been variously judged and is not yet completely elucidated. It is certain that Louise had a clear head, practical good sense and tenacity. In the critical situation after the battle of Pavia (1525) she maintained order in the kingdom and maneuvered very skillfully to detach Henry VIII of England from the imperial alliance. But she appears to have been passionate, exceedingly rapacious and ever careful of her own interest. In her malignant disputes with the constable de Bourbon on the question of his wife's succession, she goaded him to extreme measures, and her rapacity showed itself also in her dealings with the *surintendant des finances,* J. de Beaune, baron de Samblançay, who diverted the money intended for the French soldiers in Italy into the coffers of the queen, and suffered death in consequence. She died in 1531, and Francis reunited to the crown her domains, which comprised the Bourbonnais, Beaujolais, Auvergne, la Marche. Angoumois, Maine and Anjou.

There is extant a *Journal* of Louise of Savoy, ed. by Guichenon in his *Histoire généalogique de la maison de Savoie,* vol. iv (1778–80).

See *Poésies de François I''' et de Louise de Savoie* . . . , ed. by Champollion-Figeac (1847); De Maulde, *Louise de Savoie et François Ier* (1895); G Jacqueton, *La Politique exte'rieure de Louise de Savoie* . . . (1892); H Hauser, "Étude critique sur le Journal de Louise de Savoie," *Revue historique,* vol 86 (1904).

LOUISE ULRICA, or LOVISA ULRIKA (1720–1782), queen of Sweden, was born in Berlin, the fifth daughter of Frederick William I of Prussia and Sophia Dorothea of Hanover, and educated with her brothers and sisters by French governesses and tutors. Her father's favourite, she was made coadjutor of Quedlinburg in 1738. Her marriage to the Swedish crown prince, Adolphus Frederick, which took place in 1744, was arranged by the empress Elizabeth of Russia; her brother Frederick II would have preferred the prince to marry his youngest sister. Amalia. Her eldest son, the future Gustavus III of Sweden, was born in 1746.

In 1750 Louise Ulrica quarreled with her former friend Count Carl Gustaf Tessin, and on her husband's accession to the throne in 1751 she became the leader of the "court party," seeking to abolish the existing constitution and to strengthen the monarchy against aristocratic feudalism. Her brother Frederick advised her to be more cautious and refused to lend her money to buy support for her plans. After the failure of a coup d'état in 1756, she was unable to prevent Sweden's entering the war against Prussia in 1757 *(see* SEVEN YEARS' WAR); but the disastrous course of the war eventually strengthened her position, and she was instrumental in promoting negotiations for peace in 1762. On her husband's death, early in 1771, she went to Berlin, where she stayed till 1772. Frederick tried to help her in her difficulties with her son, then king of Sweden, who, however, was unwilling to take her advice and showed himself increasingly antagonistic to her till her death in 1782.

Louise Ulrica encouraged the arts and sciences and did much to promote French cultural influence. She was a notable patron of Linnaeus; she invited Voltaire to settle in Sweden; and in 1753 she founded the Royal Academy for Art and Science (from which however the brilliant Tessin was excluded). Her letters (ed by Fritz Arnheim, 2 vol., Gotha, 1909–10) and her memoirs (Halle, 1885) have much in common with those of her sister Wilhelmina, margravine of Bayreuth, but, though partial, are more reliable.

See Olof Jagerskiold, *Lovisa Ulrika* (Stockholm, 1945).

LOUISIADE ARCHIPELAGO, a chain of islands in the Pacific ocean, extending southeastward from the easternmost promontory of New Guinea and included in the Australian territory of Papua. The islands number more than 80 and are interspersed with reefs. They are rich in tropical forest products, while gold is also obtained. The islands were probably observed by Luis Vaez de Torres in 1606, but were named by L. A. de Bougainville in 1768 after Louis XV.

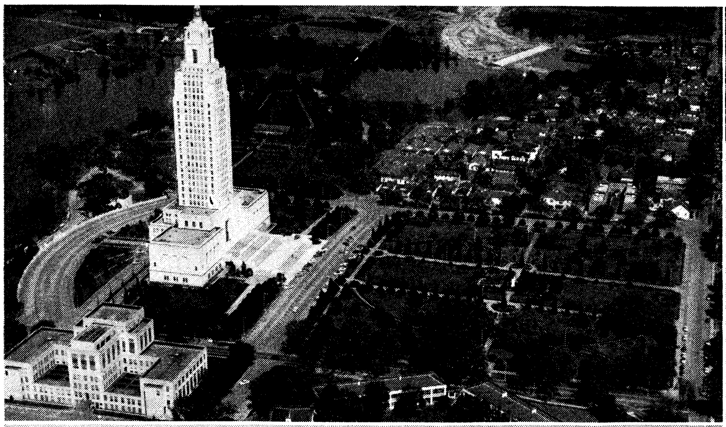
LOUISIANA, one of the west south central states of the United States at the mouth of the Mississippi river, on the north coast of the Gulf of Mexico. Shaped like a boot, it is bounded on the north by Arkansas; on the east by the Mississippi river and the state of Mississippi; on the south by the Gulf of Mexico; on the west by Texas. The state has an area of 48,523 sq.mi., of which 3,417 are water surface (including 1,060 sq.mi. of landlocked bays called lakes). It borders the Gulf of Mexico for 366 mi. It ranks 31st in size among the states and is popularly known as the "Pelican state"; sometimes as the "Bayou state" and the "Creole state." It was admitted to the union April 30. 1812, and was the 18th state to enter. The 64 political subdivisions called parishes correspond to counties in the other states (see *Government,* below). Baton Rouge is the capital. The state flag consists of a field of dark blue bearing a white pelican feeding and protecting her brood and a white ribbon below with the state motto, "Union, Justice and Confidence." The unofficial state bird is the eastern brown pelican; the official state flower is the magnolia.

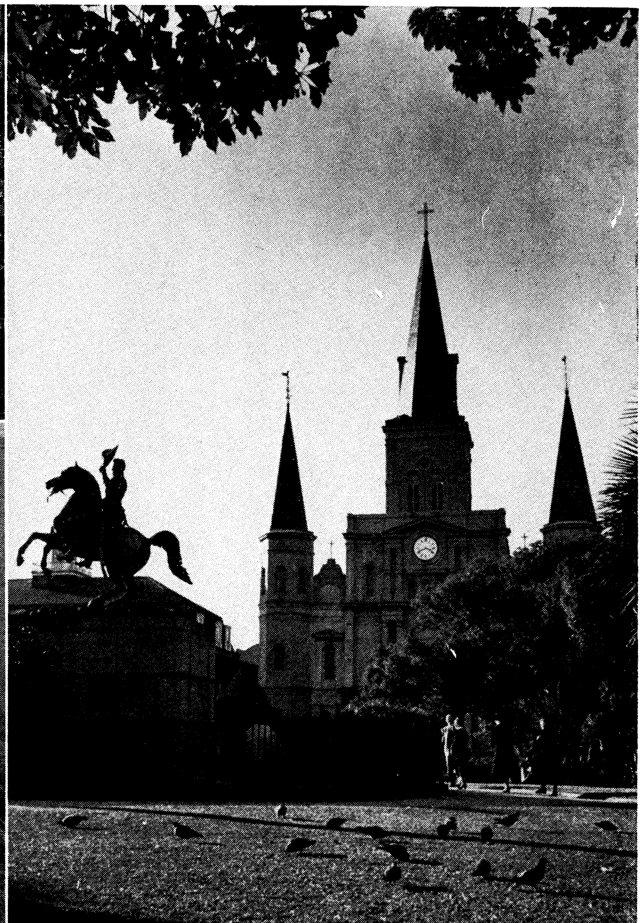
PHYSICAL GEOGRAPHY

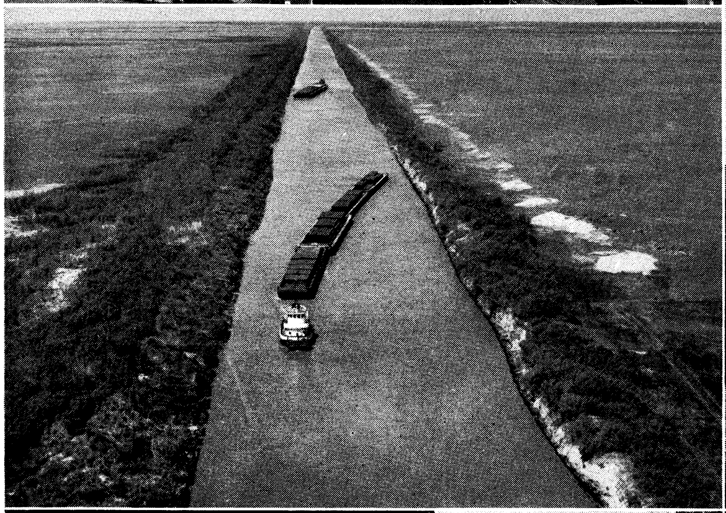
Physical Features. — Louisiana lies roughly between 28° and 33" N. and between 89° and 94° W. Geologically it is a new creation and is classified as a coastal plain province. Its soils were formed as submarine deposits. The average elevation of the state is approximately 100 ft.; the highest point is in Bienville parish, 535 ft. above sea level. The physiographic features may be placed in five classifications: uplands, bluffs, alluvial plains, prairies and coastal marshes. These were successive stages in the geologic process of forming the state. The uplands, or pine hills, are divided into three areas: (1) north of Lake Pontchartrain and east of the Mississippi river; (2) west of Red river; and (3) the north Louisiana uplands lying between the Red and Ouachita rivers. The bluffs run through the second tier of parishes west of the Mississippi above the mouth of the Red river. The alluvial lands are in the flood plains of the rivers, especially the Mississippi, Ouachita and Red. The prairies become increasingly common south of the Red river and constitute the entire south estern part of the state. The prairies are generally treeless except for marginal timber along the sluggish meandering streams. They are generally 20 to 30 ft. above sea level and shade off into the coastal marshes. The coastal marshes are generally 20- to 30-mi. wide but may reach a width of 60 mi. The alluvial lands and the coast swamps comprise about 20,000 sq.mi. or better than 40% of the area of the state,

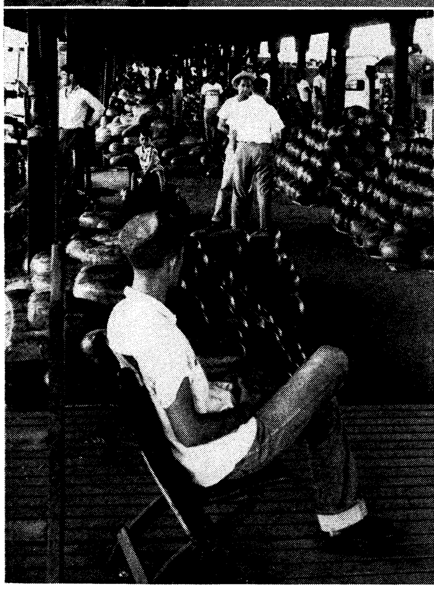
Louisiana has within its borders about 7,500 mi. of navigable waters, including harbours, bays and sounds. The principal rivers are the Mississippi, which flows nearly 600 mi. through and along the border of the state, the Red, the Ouachita, the Tensas, the Atchafalaya. the Calcasieu, the Vermilion, the Sabine and the Pearl. Louisiana is the only state that is divided by the Mississippi river. There are a number of bayous which are of great economic importance for navigation, drainage and scenic beauty. The largest of these are Bartholomew, Dorcheat, Macon, Boeuf, Plaquemine, Lafourche and Teche. The alluvial portion of the state, especially below the mouth of the Red river, is an intricate network of these bayous: before their closure by a levee system they served partially, in time of flood, to carry off the escaping surplus of river waters.

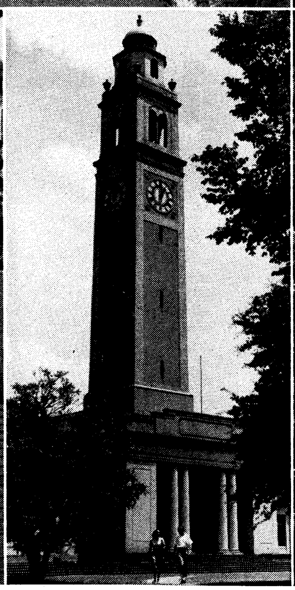
The alluvial region of the state is mainly protected against overflow by a system of levees, or earthen walls, that hold the waters within the stream channels. The state and federal government co-operated in the construction and maintenance of this system,











BY COURTESY OF (TOP LEFT) BATON ROUGE CHAMBER OF COMMERCE. (CENTRE LEFT) NEW ORLEANS DISTRICT CORPS OF ENGINEERS. (BOTTOM CENTRE) LOUISIANA DEPARTMENT OF COMMERCE AND INDUSTRY; PHOTOGRAPHS, (TOP RIGHT, BOTTOM LEFT) A. E. WOOLLEY (BOTTOM RIGHT) BRADLEY SMITH

SCENES IN LOUISIANA

Top left: Aerial view of state capitol at Baton Rouge. The capitol is on the edge of a small lake and surrounded by a 50-acre park

Top right: St. Louis cathedral facing Jackson sauare at New Orleans. Bronze commemorates Gen. Andrew Jackson (1767–1845) who defeated the British here during the War of 1812

Centre left: View of the Gulf-Intracoastal waterway west of the Vermilion river in the south-central part of the state. The waterway provides a protected route from the Rio Grande river to Apalachee Bay, Florida

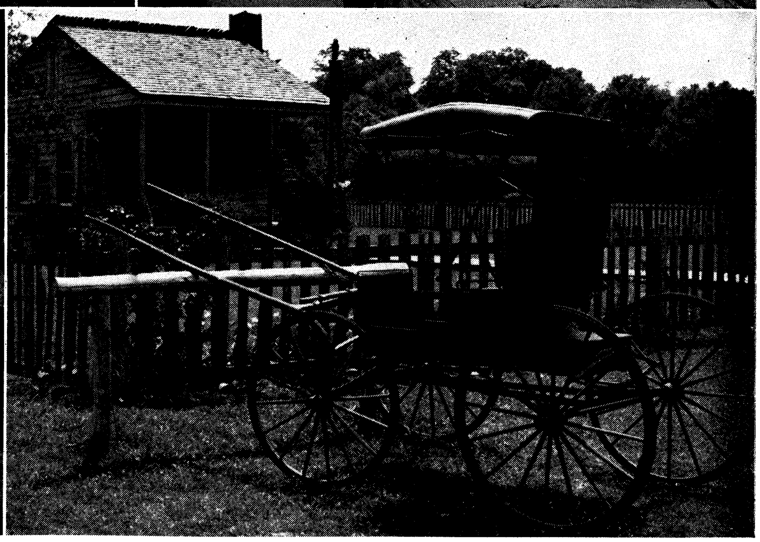
Bottom left: The French market in the Vieux Carré at New Orleans

Bottom centre: World War I memorial tower at Louisiana State university, Baton Rouge

Bottom right: Hunting muskrats from a pirogue in the bayou country of southern Louisiana. The pirogue, a dugout canoe adapted from the Indians, is said "to float on dew"





BY COURTESY OF (TOP RIGHT CENTRE LEFT) LOUISIANA DEPARTMENT OF COMMERCE AND INDUSTRY, (CENTRE RIGHT, BOTTOM LEFT) CITIES SERVICE COMPANY; PHOTOGRAPHS, (TOP LEFT) WALLACE LITWIN (BOTTOM RIGHT) A. E. WOOLLEY

HISTORICAL AND INDUSTRIAL VIEWS OF LOUISIANA

Top left: Industrial chemical plant at New Orleans. Manufacturing of petrochemicals is a major industry in Louisiana

Top right: underground mining of salt. Three of the largest salt mines in the world are located in the southern section of the state

Centre left: Old state capitol at Baton Rouge. It was burned during the Civil War and rebuilt in 1832

Centre right: Shrimp boats at anchorage in Venice, in the delta region of the Mississippi river. Shrimp are an important product of the coastal fisheries

Bottom left: Loading oil at the Calcasieu river docks in the city of Lake Charles, southwestern Louisiana

Bottom right: Museum at St. Martinville which was settled by the Acadians, exiled from Nova Scotia, about 1760 although, the national government did not give aid, except for a grant of swamplands in 1850, until 1879, when it began acting through a board of engineers known as the Mississippi River commission. The levee system and flood-control projects represent an expenditure of upward of $500,000,000. Some of the levees are 50-ft. high with a base 100-ft. wide. There are more than 1,700 mi. of levees in the state along the Mississippi, Red, Ouachita and Atchafalaya rivers and other streams.

Some of the lakes, such as Lakes Pontchartrain, Maurepas, Borgne and Sabine, are merely landlocked salt-water bays, the waters of which rise and fall with the tides. Other lakes are cutoff meanders of the Mississippi and Red rivers, knonn as oxbow lakes. Others are the result of clogging or blocking the outlets of a river, which impeded the flow and forced the water into swamps and low places. Examples are found along Red river.

Climate. — The climate is semitropical and exceptionally equable over large areas. The mean temperature for southern Louisiana is 68.2° F., and is affected by prevailing southerly winds and the network of bays, bayous and lakes. The differences of mean annual temperature are almost wholly caused by differences of latitude or elevation. The mean annual temperature for northern Louisiana is 65.2°. The lowest temperature recorded at New Orleans is 7° and the highest 102". The lowest and highest temperatures recorded at Shreveport, about 300 mi. N.W., are −5° and 110° respectively. New Orleans has an average of 60 in. of rainfall annually and the mild climate makes possible a growing season averaging 330 days per year. Shreveport has an average precipitation of 44.8 in. and the growing season averages about 209 days. The first severe frost seldom comes before Nov. 15 in the Shreveport area, and the last one is usually before March 15.

Soil. — Louisiana lies entirely in the coastal plain and the soil was once marine sediments. The soil of the uplands, or rolling hills, is now relatively low in nutrient level. This soil is relatively coarse and adapted to forest growth, especially pine trees. It requires fertilizers to produce good crops of cotton and corn. The alluvial and bluff soils are fertile and produce abundant crops. The prairie soil is clay and clay-loam and is well adapted to rice culture and to pasturing. The coastal marshes are used primarily for the production of fur-bearing animals and for sanctuaries for birds and migratory fowl, for which the state is well known.

Vegetation. — The state has approximately 150 species of trees. The five varieties of pine are the most valuable. The cypress of the swamps; the tupelo gum, slash pine, sweet and black gums of the lowlands; the shortleaf and longleaf pines, the hickory, 15 varieties of oak and birch on the uplands; plus the trees of minor importance make up the state's forests. Although most of the virgin stands of pine, cypress and tupelo gum have been cut, farmers with woodland plots and onners of cutover tracts have engaged in reforestation and more than half the land area is in forests. The Kisatchie National forest, in the central part of the state, is one of the largest of the reforestation projects. Approximately 12,500,000 pine seedlings were planted there during one 12-month period.

Louisiana has a great variety of wild flowers and shrubs. Azaleas, camellias, crepe myrtles, redbuds and magnolias bloom in profusion, both wild and cultured.

Animal Life. — The variety and number of wild animals and fowl give the state the reputation of being a hunter's paradise. The white-tailed deer is found throughout the state and the black bear and the wildcat inhabit the swamp forests. The smaller mammals include opossum, raccoon, otter, skunk, gray fox, squirrels, cottontail and marsh rabbit, weasel, mink, rats, muskrat and moles. Louisiana leads all other states in the number of fur-bearing animals and formerly led in the value of furs produced, but in the second half of the 20th century the value of Louisiana furs declined considerably.

It has been found that 108 species of amphibians and reptiles are native to the state. There are 42 amphibians with 18 belonging to the salamander group; the remaining 24 are frogs and toads. The native reptiles are represented by 66 species, of which the alligator is the largest. There are ten different kind of lizards and 35 species of snakes. Fortunately, only five species of snakes are poisonous. These are the coral snake, the copperhead, the water moccasin, the ground rattler and the canebrake rattler. Twenty species of turtle are native to the state.

The coastal marshes are the greatest winter resort in North America for mild ducks and geese. The commonest varieties of ducks are the mallard, teal, shoveler, gadwall and pintail. It is thought that most of the blue geese of North America winter in the marsh area of the state. The coastal area is visited by many sea birds, such as the laughing gull, royal tern, brown pelican, plover, black skimmer and sandpiper. The area is the habitat, also, of the marsh wren, seaside sparrow, Louisiana heron, Wilson's snipe, woodcock and red-winged blackbird.

Among the swamp-loving birds are the American egret, wood duck, great blue heron, ivory-billed woodpecker, bald eagle, cardinal and warbler. In addition to the ducks and geese, the principal game birds are the turkey, bobwhite, upland plover and dove. The wild turkey is found on or near the bluffs adjacent to the stream bottoms. In the upland areas can be found the thrasher, wood thrush, blue jay, mockingbird, catbird, southern whippoorwill, flicker, redheaded woodpecker, Baltimore oriole, bluebird, tanager and bunting.

State and National Parks. — The most important of the state parks are Audubon, Abita Springs, Bogue Falaya, Chemin-A-Haut, Chicot, Fontainebleau, Ft. Macomb. Ft. Pike, Lake Bistineau and Longfellow-Evangeline. The state has a number of game preserves for wildlife and migratory fowl in particular. The most important of these are the Louisiana State Wild Life refuge, State Public Game and Fish preserve, the Terzia Wild Life refuge, Sabine Migratory Waterfowl refuge, Lacassine Migratory Waterfowl refuge, Russell Sage Wild Life Refuge and Game preserve, Rockefeller Wild Life Refuge and Delta Migratory Waterfowl refuge. There are a number of fish hatcheries, pine seedling nurseries and the state forest near Alexandria.

Chalmette National Historical park was the scene of part of the battle of New Orleans (*see* also *Historic Sites,* below). The Caney Creek and Cornie Creek parks are recreational and forestry development areas under the supervision of the federal government.

Historic Sites. — The first permanent European settlement in the present state of Louisiana was Fort St. Jean Baptiste (Natchitoches) built in 1714 by Juchereau de St. Denis. Fort Los Adais, near Robeline, was built in 1721 by the Spanish. Its location has been marked or restored and so have Fort Jesup in Sabine parish, Forts Jackson and St. Philip in Plaquemines parish and Fort Humbug in Caddo. Chalmette National Historical park is in the Chalmette battlefield and the Pleasant Hill and the Mansfield battlefields have areas set aside as parks. The *Vieux Carré* in New Orleans contains many historic buildings such as the Cabildo and St. Louis cathedral; the U.S. military barracks in Baton Rouge were constructed in 1822. The most noted Indian sites are the Indian mounds at Jonesville, Marksville and Poverty Point on Bayou Macon near Delhi.

HISTORY

Indians inhabited the northern portion of the state approximately 2,500 years before Columbus' voyages to the new world, as revealed by the mounds at Poverty Point on Bayou Macon. At the time and for a few hundred years preceding the arrival of Europeans in the region, various tribes of the Caddoan confederacy occupied the northern half of the state. At the time white men came remnants of various other tribes were found in the eastern and southern portions of the state.

The Spanish knew of the land on the northern shores of the Gulf of Mexico by 1510 and it is possible that one or more Spanish explorers saw the mouth of the Mississippi river before the followers of Hernando De Soto. Alonso Álvarez de Piñeda was in the region in 1519, as was the expedition led by Pánfilo de Narváez, 1529–31, but there is no positive proof that either saw the Mississippi. De Soto crossed the river below Memphis and it is probable that he entered the present state of Louisiana before he died. Survivors of his expedition descended the river to its mouth in 1543. Having found no gold or silver mines, the Spanish made no effort to plant colonies on or near the Mississippi river. In *1682* René Robert Cavelier, sieur de La Salle went down the river from the French possessions in Canada and claimed all the land drained by the river and its tributaries for Louis XIV of France and named it Louisiana. La Salle obtained permission to establish a colony in *1684,* failed to find the mouth of the river and landed on the coast of Texas. His efforts to locate the river were futile and he was slain by some of his men in 1687. Eleven years later Pierre le Moyne sieur d'Iberville *(1661–1706)* took up the task of colonizing Louisiana and in *1699* built a fort near the present city of Biloxi, Miss. The next year he erected a fort on the Mississippi *18* leagues (about *40* mi.) above its mouth. This was the first settlement in what is now the state of Louisiana. Antoine Crozat (1655–1738) was granted possession of Louisiana in *1712* for a period of 15 years. The proprietary contract was terminated in 1717, but the first permanent settlement in the present state was made at Natchitoches, on the Red river, in 1714. Louisiana was too much of a drain on the royal treasury and the territory was granted in *1717* to a company organized by John Law (*q.v.*), who did much for the colony before surrendering Louisiana to the crown in *1731.* Jean Baptiste le Moyne, sieur de Bienville *(1080–* 1768), a younger brother of D'Iberville, was the guiding spirit of the colony from *1699* until *1743.* It was he who founded New Orleans in *1718.* The French began the cultivation of rice, tobacco and sugar cane, but it was not until *1795* that sugar cane became a commercial crop.

The Spanish Period. — The secret treaty of Fontainebleau, Nov. 3, 1762, transferred Louisiana from France to Spain. The next year England received that portion of Louisiana lying east of the Mississippi and Iberville rivers and Lakes Maurepas and Pontchartrain. Many colonists were unhappy over the transfer to Spain and the leaders resisted Spanish possession. When the director of Louisiana, D'Abbadie, issued the proclamation of transfer in *1764* the colonial leaders petitioned to remain French. The first governor Spain sent over, Antonio de Ulloa (1716–95), never took formal possession and was ordered to leave in *1768.* Alexander O'Reilly, an Irish officer in the Spanish army was sent to the colony with a force of about *3,000* men. His affability caused suspicion to subside until he had ascertained the identity of the leaders who opposed Spanish rule. He then invited them to a reception, arrested them, executed five and sent the others to prison in Havana, Cuba. The succeeding Spanish rulers were liberal and tolerant. While Spanish was the official language, the colony remained French in manners and customs. The Spanish governors, while neglecting to enforce the regulations of commerce, instituted a number of reforms that proved beneficial to the people and in the course of time the populace came to appreciate the benefits of Spanish rule. The Spanish officials received the French exiles from Acadia and granted them lands along Bayou Teche. These Acadians made a distinct contribution to the cultural and economic life of the state.

Some of the Spanish governors endeavoured to induce the people living in the region east of the Mississippi river and west of the Appalachian mountains to secede and join Spanish Louisiana. The river, as the highway of transportation, was used as a bargaining weapon in these efforts.

In *1800* Napoleon coerced Spain into ceding Louisiana to France. The United States frowned upon the transfer because free navigation of the Mississippi was imperative to the people who lived in the valley. Xapoleon sold Louisiana,to the United States, which took formal possession Dec. *20, 1803.* William C. C. Claiborne was appointed by President Jefferson to receive Louisiana from the French official, Pierre Clement de Laussat. A short time thereafter Claiborne was made governor of the territory. (See LOUISIANA PURCHASE.)

Territory and Statehood. — Congress provided a government for the territory on March *25, 1804.* The act divided the Louisiana Purchase into two territories. The portion south of 33° N. became the Territory of Orleans, with an estimated population of *30,000.* The act forbade importing slaves from foreign countries, made English the official language and provided a government less democratic than if the inhabitants had been Anglo-Saxon. The people desired immediate statehood. After the census of *1810,* the people in the territory of Orleans held a convention to frame a state constitution and Louisiana became a state April *30, 1812.*

Spain refused to surrender the area east of the Mississippi river, and this area south of 31° N., east to the Pearl river and north of Lake Pontchartrain, revolted in Sept. *1810* and established the Republic of West Florida. Three months later, however, it came under the jurisdiction of Governor Claiborne. A few days after Louisiana was admitted to the union, congress added Rest Florida to the state. This area is often referred to as the "Florida parishes."

Claiborne was elected the first governor of the state in *1812* and in that year the first steamboat descended the Mississippi river to New Orleans. Gen. Andrew Jackson's forces defeated a British army under Gen. Edward Pakenham at Chalmette, near New Orleans, Jan. *8, 1815,* two weeks after the treaty of Ghent was signed ending the War of *1812.*

Up to *1860* the state increased in population and prospered from agriculture and commerce. During this period the sugar-cane and cotton plantations were flourishing. The river steamboats dominated transportation and New Orleans was the gateway for the trade of the Mississippi valley. The capital was moved from New Orleans to Donaldsonville, *1828–31,* and to Baton Rouge, 1849–64. After *1882* Baton Rouge was the capital but a number of state offices remain in New Orleans.

Civil War and Reconstruction. — Louisiana formally seceded from the union Jan. *26, 1861* and six weeks later joined the Confederate States of America. During *1861,* many of the young men in military units were sent to Tennessee, Kentucky and Virginia to defend the borders of the Confederacy. New Orleans was taken in April *1862* by a naval force under Adm. D. G. Farragut and an army commanded by Gen. B. F. Butler. Butler's military administration became so notorious that he was replaced in Dec. *1862* by Gen. N. P. Banks. The capture of Vicksburg and Port Hudson by Union forces in July *1863* opened the Mississippi to navigation. The attempt to capture Shreveport on the Red river resulted in the defeat of General Banks by the Confederates under Gen. Richard Taylor at Sabine CrossRoads, near Mansfield, April *8, 1864.*

The reconstruction of the state began in Dec. *1862,* when President Lincoln ordered the Union military government to hold elections for congress. Those chosen were seated in Feb. *1863.* Civil government superseded military rule in March *1864* and during the year a convention assembled to rewrite the state constitution. The reconstructed government represented half of the area, two thirds of the population of the state and was backed by the army.

The Confederate government under Gov. Thomas O. Moore *(1860–64)* and Gov. Henry W. Allen (1864–65), was at Shreveport. Thus Louisiana had two governments during most of the war. The people of Louisiana accepted military defeat and by *1866* the former Confederates had succeeded in gaining possession of most of the local government and most of the state offices, although not of the governorship. The radicals were not pleased with the situation and wanted to convene a convention to rewrite the constitution. Unable to call a convention through the medium of state government, they endeavoured to reconvene the constitutional convention of *1864.* The effort to disperse the illegal convention in *1866* resulted in the death of almost *50* persons, mostly Negroes. The incident was used by politicians to overthrow presidential reconstruction and institute congressional reconstruction in *1867.* The state constitution of *1868* gave suffrage to the Negroes and disfranchised a large number of white citizens. Probably no other southern state suffered as much as Louisiana under the corrupt carpetbag government of *1868–76,* during the administrations of Henry Clay Warmoth (1868–72), P. B. S. Pinchback (one month in *1872)* and William Pitt Kellogg *(1872–76).* The Democrats claimed the election of John McEnery in *1872,* but the federal government supported the Republican, Kellogg. A number of clashes occurred between the factions, the most noted of which was Sept. *14, 1874,* in New Orleans, when the White league briefly wrested control of the city from the Republican police. In *1876* the Democrats claimed that Gen. Francis T. Nicholls was elected but the Republicans claimed that S. B. Packard had won. Their claims were intertwined with the choice of presidential electors for that year. The Republicans manipulated the state returning board and sent two sets of election returns to congress and the Democrats sent their returns. The electoral commission accepted the Republican electors, just as it did those in dispute from South Carolina, Florida and Oregon. Both Nicholls and Packard took the oath as governor in Jan. 1877 and set up rival governments which continued until President Hayes ordered the withdrawal of federal troops from the capital on April 20, 1877, and the white Democratic party was left in control.

After 1877 the state began to reconstruct its economy. Efforts were made to attract settlers; a new constitution was written in 1879; the channel of the Mississippi river was deepened at its mouth by the construction of jetties to increase maritime shipping, and railroads were built to facilitate overland transportation; levees were constructed to prevent floods; and efforts were made to curb the ravages of malaria and yellow fever. By 1900 the state had made some headway and was on the threshold of spectacular economic developments through the exploitation of the state's abundant natural resources of oil, gas, sulfur, salt and timber.

20th Century. — In the spring of 1927 the most devastating flood in the history of the state inundated 1,300,000 ac., drove 300,000 people from their homes and destroyed millions of dollars' worth of property. The catastrophe proved the inadequacy of the existing levees and demonstrated that flood control of the Mississippi river was a responsibility of the federal government. In 1928 congress responded by appropriating $325,000,000 for that purpose.

The government of Louisiana was dominated by landed gentry until 1928 when the election of Huey P. Long as governor challenged the old regime and a tumultuous political era began with the rural and working classes pitted against the urban leaders. Long won a vast following and built a formidable political machine. In the U.S. senate (1930–35) he attracted national attention with his Share the Wealth program before he was assassinated in 1935. He had modernized the highway system; expanded the Louisiana State university and hospitals; provided free textbooks for school children; constructed a new state capitol and governor's mansion; and built a sea wall, an airport, a bridge over the Mississippi river and a spillway at New Orleans. His political machine lost in the governor's election of 1940, after Oscar K. Allen and Richard W. Leche had been elected governor in 1932 and 1936, respectively, and Alvin O. King (Jan. to May 1932), James A. Noe (Jan. to May 1936) and Earl K. Long (June 1939 to May 1940) had served to fill unexpired terms.

The so-called reform administrations of governors Sam H. Jones and James H. Davis appeared to achieve some improvement. Earl K. Long, brother and political heir of Huey, was elected in 1948 and expenditures for education, hospitals and welfare were greatly increased. Robert F. Kennon defeated Long's candidate, Judge Carlos G. Spaht, in 1952 but Long was elected again in 1956. Governor Long. in three mental institutions within a period of a month in 1959. sought to circumvent the constitutional provision that a governor could not succeed himself but eventually filed as a candidate for lieutenant governor on the ticket of James A. Noe. The ticket was defeated in the primary. Long was subsequently elected to congress from the 8th district but died suddenly on Sept. 5, 1960. Governmental expenditures in Louisiana increased precipitously after 1930, in greater proportion than did those of neighbouring states.

In national politics the traditionally Democratic state was carried by the Dixiecrats in a three-cornered fight among the States' Rights Democrats, Democrats and Republicans in 1948. In 1952 both Democratic and Republican presidential candidates campaigned in the state for the first time in many decades. The Democratic candidate. Adlai Stevenson, carried the state. In 1956, with less than 40% of the electorate voting, a Republican presidential candidate, Dwight Eisenhower, carried the state for the first time since Reconstruction (1877) but in 1960 Louisiana returned to the Democratic fold, casting its vote for John F. Kennedy.

GOVERNMENT

The Roman law was the basis of legal procedure in Louisiana under both French and Spanish regimes. The French and Spanish had divisions of territory for religious administration. These religious divisions, known as parishes, were conveniently used for civil administration, hence the names of saints in parish nomenclature. The territorial act of 1804 used "county" to designate governmental subdivisions. In 1807 the nomenclature for these units was changed back to "parish" and that term still is used for 64 local units of government.

Louisiana has had ten constitutions since becoming a state in 1812; the present constitution, adopted June 18, 1921, has been amended more than 300 times.

The legislative branch of government consists of two houses—the senate with 39 senators elected from 33 districts and the house of representatives of 101 members. The regular session of the legislature, convening in May of the even-numbered years, is limited to 60 days. The session convening in May of the odd-numbered years, is limited to 30 days and can only consider financial legislation unless three-fourths of the members consent.

The judicial authority is vested in a supreme court, 7 courts of appeal and 25 judicial district courts, with each police jury (parish governing body) authorized to establish justice of peace courts. and with municipalities having the power to create juvenile and municipal courts. The supreme court is composed of a chief justice and six associate justices, elected from five supreme court districts (district one elects two). Their term is for 14 years with the term of two expiring every two years. The state, exclusive of the parish of Orleans, is divided into two circuits, with three courts of appeal in each and an additional court for Orleans parish. Each court of appeal has three judges elected for a term of 12 years. There are 25 judicial districts, with one judge elected for a period of six years to serve each judicial district court, except three districts that have two or three judges each.

The executive branch of government consists of the governor, lieutenant governor, auditor, treasurer, secretary of state, registrar of the land office, commissioner of agriculture and labor, commissioner of conservation, attorney general and superintendent of public instruction.

Suffrage is granted to every citizen of the state who has attained the age of 21 and who has resided in the state two years, in the parish one year and in the precinct three months preceding the election; who is legally enrolled as a registered voter; and who is of good character.

Real-estate taxes have become a minor source of state revenue. The chief source of revenue is the general sales' tax; other sources of revenue are severance taxes; mineral leases and royalties, gasoline, income, tobacco, beverage and gas-gathering taxes; vehicle licences and fees; corporation franchise taxes; excise licence taxes; and insurance licences and fees. The chief expenditures are for education, public welfare, highways, hospitals and institutions, homestead exemptions, debt service and general government.

Law. — Louisiana civil law is based to a great extent on the French and Spanish laws and especially the Code Napoléon. The other states base their laws on the common law of England. Louisiana was first of the southern states to abolish the poll tax and the first state to provide free textbooks and free lunches for elementary-school students. A law was enacted in 1936 to exempt from taxation homesteads up to a valuation of $2,000.

POPULATION

The descendants of the French are found in the area bounded roughly by a line from the southwest corner of the state to the juncture of the Red and Mississippi rivers and from that point along the Mississippi to the Gulf of Mexico. Few Spanish came during the 35 years the colony belonged to Spain. St. Bernard has the largest Spanish influence. The Italians, the most numerous of the modern immigrant groups, are principally in the cities. Hungarians are found in the strawberry belt, Slovenians in the fishing and citrus-fruit districts and Germans in and near New Orleans.

The population of Louisiana has increased steadily since 1810 when it was 76,556; in 1850 it was 517,762; in 1900, 1,381,625;

*Louisiana: Places of 5,000 or More Population (1960 census)**

Place	Population				
	1960	1950	1940	1920	1900
Total state	3,257,022	2,683,516	2,363,880	1,798,509	1,381,625
Abbeville	10,414	9,338	6,672	3,461	1,536
Alexandria	40,279	34,913	27,066	17,510	5,648
Bastrop	15,193	12,769	6,626	1,216	787
Baton Rouge	152,419	125,629	34,719	21,782	11,269
Bogalusa	21,423	17,798	14,604	8,245	—
Bossier City	32,776	15,470	5,786	1,094	—
Bunkie	5,188	4,666	3,575	1,743	873
Covington	6,754	5,113	4,123	2,942	1,205
Crowley	15,617	12,784	9,523	6,108	4,214
Daigleville	5,906	4,809	—	—	—
Denham Springs	5,991	2,053	1,233	500	—
De Ridder	7,188	5,799	3,750	3,535	—
Donaldsonville	6,082	4,150	3,889	3,745	4,105
Eunice	11,326	8,184	5,242	3,272	316
Franklin	8,673	6,144	4,274	3,504	2,692
Goosport	16,778	8,318	—	—	—
Gretna	21,967	13,813	10,879	7,197	—
Hammond	10,563	8,010	6,033	3,855	1,511
Harahan	9,275	3,394	1,082	—	—
Houma	22,561	11,505	9,052	5,160	3,212
Jeanerette	5,568	4,692	3,362	2,512	1,905
Jefferson Heights	19,353	—	—	—	—
Jennings	11,887	9,663	7,343	3,824	1,539
Kaplan	5,267	4,562	2,838	876	—
Kenner	17,037	5,535	2,375	1,882	1,253
Lafayette	40,400	33,541	19,210	7,855	3,314
Lafayette Southwest	6,682	—	—	—	—
Lake Charles	63,392	41,272	21,207	13,088	6,680
Lake Providence	5,781	4,123	3,711	1,917	1,256
Mansfield	5,839	4,440	4,065	2,564	847
Minden	12,783	9,787	6,677	6,105	1,561
Monroe	52,219	38,572	28,309	12,675	5,428
Morgan City	13,540	9,759	6,969	5,429	2,332
Natchitoches	13,924	9,914	6,812	3,388	2,388
New Iberia	29,062	16,467	13,747	6,278	6,815
New Orleans	627,525	570,445	494,537	387,219	287,104
North Shreveport	7,701	—	—	—	—
Oakdale	6,618	5,598	3,933	4,016	—
Opelousas	17,417	11,659	8,980	4,437	2,951
Pineville	8,636	6,423	4,297	2,188	617
Plaquemine	7,689	5,747	5,049	4,632	3,590
Port Allen	5,026	3,097	1,898	920	—
Rayne	8,634	6,485	4,974	2,720	1,007
Reserve	5,297	4,465	—	—	—
Ruston	13,991	10,372	7,107	3,389	1,324
Saint Martinville	6,468	4,614	3,501	2,465	1,926
Shreveport	164,372	127,206	98,167	43,874	16,013
Slidell	6,356	3,464	2,864	2,958	1,129
Springhill	6,437	3,383	2,822	748	—
Sulphur	11,429	5,996	3,504	1,714	—
Tallulah	9,413	7,758	5,712	1,316	—
Thibodaux	13,403	7,730	5,851	3,526	3,253
Ville Platte	7,512	6,633	3,721	1,364	163
West Monroe	15,215	10,302	8,560	2,240	775
Westwego	9,815	8,328	4,992	4,083†	1,763†
Winnfield	7,022	5,629	4,512	2,975	—

*Populations are reported as constituted at date of each census. †Ward 4 of Jefferson parish, which includes Westwego.

Note: A dash indicates place did not exist during reported census or data not available.

in 1950, 2,683,516; and in 1960 was 3,257,022. The population per square mile in 1960 was 67.1 as compared with 55.3 in 1950 and with 49.6 for the U.S. in 1960. The 1960 census gave 63.3% of the population living under urban conditions as compared to 54.8% in 1950 and 41.5% in 1940 which indicates a marked acceleration of the urbanization trend first noted about 1900. The three standard metropolitan statistical areas (Baton Rouge, New Orleans and Shreveport) in 1960 contained about 42% of the total population of the state. The number of Negroes is not increasing in population as rapidly as the white race and the Negroes are moving to urban areas. Negroes constituted 33% of the population in 1950 and 28% in 1940. The number of people over 65 and the number under 15 years of age constitute a larger relative percentage of the total population; that is. the age group. 15 to 65, is not increasing in numbers as rapidly as the younger and older age groups. The number of births per 1,000 population in 1950 was 29.7% and in 1940 it was 24.9%. The number of deaths per 1,000 population in 1950 was 8.8% and in 1940 was 10.8%.

EDUCATION

Elementary and Secondary.—Education was the function and responsibility of the church during the French period. During the Spanish period, although the church exerted the most powerful influence, the government did make a pretense of establishing a free public-school system in 1771 when four professors were sent from Spain and Governor Unzaga was ordered to pay their salaries out of the general fund until permanent taxes for the purpose could be provided. Only one such school was opened (in 1772) and it never enrolled more than 30 students.

During the early years of the American period the people were too busy developing the new country to devote much energy and attention to schools. This was especially true of the Anglo-Saxon Protestants who settled the uplands of northern Louisiana before 1860. The Anglo-Saxons who settled in the southern portion of the state, were, generally speaking, sons of slave owners of Virginia and the Carolinas, who believed that education was the responsibility of parents and who hired tutors or sent their children to private schools. This class; together with the older French settlers, who considered education to be a function of the church, usually controlled the government of the state and never made a sincere effort, such as New England made, to establish a free tax-supported school system. Hence education received only token support and few free schools were opened outside New Orleans. John McDonogh, a wealthy New Orleans merchant and financier who died in 1850, left half his fortune for the promotion of education in New Orleans. Before the American Civil War most of the free schools there were supported from this fund.

A few tax-supported schools were opened in the 1880s but the economic conditions of the state did not make possible the development of a free-school system until 1910. Tremendous progress has been made since that time in the number of children in school; the number and training of the teachers; the financial expenditures; and the construction of school plants. Although earlier statutes authorized parish police jurors to provide free textbooks for the children of parents unable to purchase them, Governor Long in 1928 sponsored a free-textbook law for all the children of the state. Later governors instituted free-lunch programs and paper, pencils and other materials were provided from tax funds. The automobile and the development of good roads made possible the consolidation of schools so that better-trained teachers and modern library, laboratory and classroom facilities became generally available. The one-room school has disappeared. In the second half of the 20th century approximately 94% of the children between 6 and 18 years of age attend school; public high schools enroll a larger proportion of the elementary school graduates than ever before and a greater proportion of high-school graduates enter college. Education is the most important enterprise in the state and takes the largest portion of the tax dollar. The annual state budget for education increased precipitously in the decade after 1950, reaching more than $175,000,000 or about $55 per child for the more than 900,000 children of school age in the state; expenditures per pupil in average daily attendance reached $330.

Administration.—The head of the public-school system is the state superintendent of public education who is elected for a term of four years by popular vote. An 11-member state board of education, elected by popular vote for overlapping terms, has general jurisdiction over all tax-supported elementary, high, special and trade schools and institutions of higher learning except Louisiana State university, its branches in New Orleans and Chambers and its medical school, also in New Orleans, which are under the supervision of a special board of 15 members appointed by the governor for a term of 14 years, the term of two members expiring every two years. In addition, each of the parishes and three of the cities have school boards, with a superintendent.

In the second half of the 20th century there were about 24,000 teachers and principals in the tax-supported elementary and secondary schools. Of these approximately 16,000 were white, staffing about 850 schools with approximately 400,000 students; about 8,000 were Negroes staffing about 550 Negro schools with approximately 126,000 students. The salary schedule is the same for all teachers of equal training and experience. After World War II the state made impressive efforts to provide equal facilities for white and Negro children.

Private and parochial schools for white children number about 240 with about 3,000 teachers and approximately 95,000 students. There are about 100 such schools for about 23,000 Negro students, taught by about 650 teachers.

Segregation.—The first compulsory school attendance laws were enacted in 1916. By 1950 attendance in elementary schools was compulsory for children between the ages of 7 and 15, inclusive.

Following the U.S. supreme court decision (1954) declaring racial segregation in the public schools to be unconstitutional the Louisiana legislature in 1956 exempted from the compulsory attendance laws any school ordered by the federal courts to desegregate and the state constitution was amended, authorizing the legislature to maintain segregation. The 1960 legislature enacted additional measures but court decisions that same year indicated that all such acts would be held unconstitutional, and while they might delay integration they could not prevent it.

Higher Education. — The growth and development of higher education was dependent upon the elementary- and secondary-school system and therefore lagged behind it. The State Seminary of Learning and Military institute opened near Alexandria in 1860 with William T. Sherman as president and eventually grew into the Louisiana State University and Agricultural and Mechanical college. It is one of the state's two land-grant schools, the other being Southern University and Agricultural and Mechanical college (for Negroes). The buildings burned in 1869 and the institution was moved to Baton Rouge where it was housed in the State School for the Deaf until 1885. The Agricultural and Mechanical college was moved from Donaldsonville to Baton Rouge in 1877, to be operated in conjunction with the university because of limited finances; the temporary union has proved to be permanent. Two brothers, David French Boyd and Thomas Duckett Boyd, directed the institution for most of the period, 1884–1927, the latter serving as president from 1896 to 1927. Gov. John Milliken Parker advocated a greater Agricultural and Mechanical college in 1920 and purchased a plantation for the site. The university rejoined the college on its 4,700 ac. campus in 1925. The buildings and equipment represent an investment in excess of $50,000,000. The medical school was established in New Orleans (1934) as a branch of the university and in 1958 Louisiana State university in New Orleans was opened as another branch. A junior-college branch was established at Chambers in 1959. The university was ordered by the U.S. courts to admit Negroes to its graduate and professional schools (1951) and then to its undergraduate branch at New Orleans (1958). At various dates the courts ordered Negro admission to Southeastern Louisiana college, Southwestern Louisiana institute and McNeese State college. The institution is divided into various colleges and offers programs for advanced degrees.

The Louisiana State Normal school, opened at Natchitoches in 1884, was made a four-year college in 1917 and the name was changed accordingly. For 30 years it enjoyed a monopoly of training teachers for the public schools. After the other state colleges began training teachers, the Normal college expanded its services and the name was changed to Northwestern State College of Louisiana. It is divided into five schools: arts and sciences, applied arts and sciences, education, nursing and the graduate school.

Louisiana Polytechnic institute, Ruston, was established in 1895 as the Louisiana Industrial Institute and college. It was made a four-year college in 1917 and its name was changed in 1926. The organization consists of six schools: arts and sciences, agriculture and forestry, business administration and economics, education, engineering and home economics. The teacher-training program began in 1917 and a graduate program for the master's degree in 1958.

The Southwestern Louisiana institute, Lafayette, was opened in 1901 as the Southwestern Louisiana Industrial institute. It is organized into schools of agriculture, commerce, engineering, home economics, liberal arts and nursing. With over 5,000 students, it has the second largest enrollment of any state-supported college. It began a graduate program for the master's degree in 1956. In 1960 the name was changed to University of Southwest Louisiana.

Southeastern Louisiana college, Hammond, operated as the Tangipahoa junior college in the early 1920s, then as the Florida Parishes junior college and was taken over by the state and made a four-year college in the late 1930s. It is organized into three schools: liberal arts, applied sciences and education.

Northeast Louisiana State college, Monroe, had its origin in the Ouachita Parish Junior college in the early 1930s. It was taken over by the Louisiana State university in 1934 and operated as a branch junior college. In 1950 the legislature made it a four-year college and placed it under the jurisdiction of the state board of education with the name changed to the Northeast Louisiana State college. It has schools of arts and sciences, pure and applied sciences, education, fine arts and pharmacy.

McNeese State college, Lake Charles, began as a junior-college branch of Louisiana State university in 1939. The legislature, in 1950, changed its name, made it a four-year college and placed it under the jurisdiction of the state board of education.

The Francis T. Nicholls State college was authorized in 1946 as the Francis T. Nicholls junior college of Louisiana State university. In 1956 the legislature designated it as a four-year college and placed it under the state board of education. The instruction is divided into three divisions designated as colleges: applied sciences, arts and sciences and education.

The state operates two institutions of higher education for its Negro citizens: Southern University and Agricultural and Mechanical college and Grambling college. Southern university was founded in 1880 in New Orleans and was moved to Scotlandville (near Baton Rouge) in 1914. Progress was slow during the early years because the state was not in a financial condition to support higher education until around 1920 and relatively few students sought a college education before that date. Increasing prosperity enabled the state to provide more funds for buildings, equipment and salaries, the increase in funds being precipitous in the period 1940–60. The institution has divisions of arts and science, agriculture, home economics and industrial and technical education (formerly mechanic arts), health and physical education, business, music, a graduate school and a law school. The enrollment is more than 5,000.

Grambling college had its origin in 1900 when Booker T. Washington, president of Tuskegee institute, sent one of his recent graduates, Charles Adams, to establish a private school for Negroes at Grambling. Lincoln parish assumed support of the school in 1915 and the state took it over in 1928 and operated it as a normal school to train teachers and leaders in agriculture. It was made a four-year college of liberal arts and a teachers college in 1940 and has had a phenomenal growth since the end of World War II. The institution is operated by departments under the immediate supervision of the dean of the college.

Private institutions of higher learning include four Roman Catholic schools in New Orleans: Loyola university (for men, founded 1912); Notre Dame seminary (for men, 1923); St. Mary's Dominican college (for women, 1920); and Xavier University of Louisiana (1925). Also in New Orleans are Dillard university (Congregational Christian and Methodist, 1930); Tulane university nonsectarian, 1834 and Newcomb college (The H. Sophie Newcomb Memorial College of Tulane university) (for women, 1886). Centenary College of Louisiana (Methodist, 1840) is at Shreveport and Louisiana college (Louisiana Baptist convention, 1906) is at Pineville.

HEALTH AND WELFARE

Beginning about 1906 Louisiana made rapid progress in eradicating and controlling disease. Laws were passed and enforced to destroy the breeding places of mosquitoes, thereby reducing malaria and yellow fever; rats were exterminated to reduce the spread of such diseases as bubonic plague; the hookwork disease was attacked; houses were screened; public drinking cups were outlawed to help control the spread of tuberculosis; and other measures in the interest of better health were enacted.

Hospitals. — The first charity hospital was built in New Orleans in 1736 with the bequest of a sailor, Jean Louis. This was the forerunner of the Charity hospital there constructed by the state in 1930 at a cost of $13,000,000. Additions costing approximately $7,500,000 have been made. Charity hospitals are found in all the larger urban centres, as, for example, the Confederate Memorial hospital in Shreveport, the E. A. Conway hospital in Monroe and the Huey P. Long Charity hospital in Pineville. The East Louisiana hospital for the mentally ill at Jackson is the oldest (1847) and largest of its kind in the state. The mentally ill also are provided for in the Central Louisiana State hospital at Pineville and the Southeast Louisiana hospital at Mandeville and there are sections and wards for the mentally ill in most of the state hospitals. The federal government has two magnificent hospitals for veterans of the armed forces, at Pineville and Shreveport.

The Spanish Governor Miro (1785–92) was responsible for establishing a hospital for lepers (Hansen's disease) in New Orleans. This was the beginning of a state leprosarium, established at Carville in 1894 and taken over by the federal government in 1921. Officially designated the U.S. Marine Hospital No. 22, it is the only leprosarium in the continental United States.

In addition to the tax-supported hospitals there are a number of private- and church-supported institutions. The Roman Catholic Church has had unusual success in operating hospitals and the Protestant denominations, the Baptist in particular, have entered this field of service.

Welfare. — A state-wide poor law was passed as early as 1880 requiring every parish in the state to provide for its poor and infirm through local taxation. Various laws after 1900 provided pensions for dependent mothers, compensation to incapacitated workers and child welfare. The first state-wide system of relief grew out of the need resulting from the depression of the early 1930s. In 1932 an unemployment relief committee was set up to supervise the distribution of relief funds provided by the federal Reconstruction Finance corporation. Within a period of three years a local welfare agency was in existence in every parish. A state department of public welfare was created by act of the legislature June 26. 1936.

The welfare services have expanded to enormous proportions. The budget of the welfare department in the second half of the 20th century was almost equal to the budget for education. The largest items of expenditure were for old-age assistance. for dependent children, for the permanently and totally disabled and for general assistance. By the 1960s, 70% of the population age 65 and over were receiving some form of relief.

THE ECONOMY

Louisiana has a mild climate and more and more people have been attracted to the state to live, as is borne out by the number of adults who move into the state and by the growing population. The state also has attracted a number of industries since passing in 1946 a law granting new industry tax exemption for a period of ten years.

The trend toward better homes was pronounced after 1935. New construction was of better quality and more of the rural homes were painted. By the second half of the 20th century practically all urban homes had electricity, running water and indoor plumbing and an increasing number of rural homes had these conveniences. Electricity made possible radios, television and artificial refrigeration, thus bringing education and entertainment and recreation into the home; refrigeration helped to preserve meats, fruits and vegetables. Most of the homes, even in the rural areas, were heated by natural or manufactured gas. The wood formerly burned for heating and cooking was sold for pulpwood and other uses.

Agriculture. — Agriculture was the chief occupation and the main source of income for the people until World War II. Agriculture is still important although it has been superseded by manufacturing as the leading industry in the state. The number of farm workers declined from about 200,000 at the end of World War II to about 150,000 in the second half of the 20th century. The number of farms also decreased from about 150,000 to about 110,000 while the average value of farms rose from about $3,500 to almost $10,000 and the size of the average farm increased from about 65 ac. to more than 100 ac. (but about 46% of the farms were less than 30 ac. in size). At the same time the number of acres that were harvested decreased from almost 3,500,000 ac. to about 2,500,000 ac. This trend was evident in the reduction of acres in row crops and the increasing acreage in pasture for livestock and for growing forests. In the second half of the 20th century the total annual value of Louisiana agricultural products reached $320,000,000, of which livestock products accounted for about $140,000,000, plus $30,000,000 in government payments.

The major crops, ranked according to value, were cotton lint and cottonseed, rice, sugar cane, corn, hay and sweet potatoes. In the ten years after World War II the average acreage planted in cotton was about 825,000 ac. with an average production of about 600.000 bales (500 lb. per bale) worth more than $100,000,000. The acreage planted in cotton. however, was decreasing, in some years dropping to fewer than 400,000 ac. planted and a production of less than 300.000 bales. Louisiana has led all the states in the production of rice. During the post-World War II years an average of about 600,000 ac. were planted nith the annual production exceeding 1,000,090,000 lb. worth approximately $60,000,000. Louisiana produces most of the sugar from sugar cane in continental United States, with Florida producing a small amount. The average acreage planted in sugar cane in the post-World War II period was about 250,000 ac. which produced more than 5,000.000 tons of sugar worth more than $33,000,000. The corn planted during the period averaged almost 800.000 ac. and production was about 14,000,000 bu. valued approximately at $20.000.000; the hay crop averaged about 350.000 ac. with 434,000 tons valued at $10,000,000. Louisiana ranks first in the productian of sweet potatoes. The crop averaged about 90,000 ac. and produced 500,000.030 lb. worth more than $15,000,000. Rice and sugar cane are the only field crops with restricted areas of production. The sugar-cane region is confined, almost exclusively, to the Mississippi delta and Bayou Teche regions, while the chief area of rice production is the prairie region of the southwestern part of the state.

The rice farms were almost the only farms irrigated until the second half of the 20th century. The water was procured from the streams flowing through the rice-growing area and from deep wells. During the 1950s light-weight aluminum pipe became available and enabled vegetable and even cotton and corn crops to be irrigated during dry years. The nater was procured largely from streams and ponds.

The groning of vegetables has not been exploited to any great extent to utilize the soil and climate. It has developed most in the vicinity of New Orleans. With the growth of other large urban centres, the groaing of vegetables in these vicinities has increased. Louisiana ranks first among the states in the production of strawberries. The stranberry area is in the Florida parishes. east of Baton Rouge, but the plant can be gronn in most of the state. Other commercial vegetable crops are Irish potatoes, snap beans, green peppers, shallots, cabbages, tomatoes. watermelons, onions and cucumbers. The crop of oranges, grown south of New Orleans, is important. Peach growing in north Louisiana has proven profitable. Other important farm products are pecans, peanuts, figs, tung oil nuts and soybeans.

Livestock is playing an increasing role on Louisiana farms notwithstanding the rapid decline in the number of horses, mules, hogs and sheep. Mechanization is rapidly replacing the horse and the mule. In the ten years after World War II they numbered an average of 210,000. valued at $12,402.000. By 1960 the number decreased to less than 100,000. Hogs averaged 574,000 head in the post-World War II period. By 1960 the number was below 400,000. Sheep dropped from an average of almost 120,000 to feu-er than 100.000 head, but the value increased from less than $1,000,000 to more than $1,100.000. In livestock, cattle led in value followed by commercial broilers, hogs, horses and mules, chickens and sheep.

Industry. — The industries of Louisiana are those associated, for the most part, with petroleum, lumbering, sugar, rice and cottonseed. Manufacturing could be classified, also, as those processing: (1) food and kindred products; (2) petroleum; (3) forest products; and (4) chemical and allied products. Industries processing agricultural raw material are seasonal. Examples are cottonseed oil mills, sugar refineries, syrup mills and canning plants. Manufacturing increased at a rapid rate after World War II, especially in the rubber, petroleum-chemical, aluminum making and papermaking industries. In the second half of the 20th century there were more than 2,000 manufacturing plants operating in the state with almost 150.000 production workers and an annual payroll of more than $600,000,000. The value added by manufacturing amounted to approximately $1,500,000,000 annually.

While the amount of board feet of lumber produced declined in the second half of the 20th century the amount of wood pulp increased from 590,000 tons annually before World War II to approximately 1,500,000 tons. Louisiana has approximately 16,-000,000 ac. in forests with 41,436,000,000 board feet of standing timber; the annual growth is approximately equal to the amount harvested. The pine and cypress forests make up most of the softwoods while the leading hardwoods are oak, red gum and tupelo gum. It has been demonstrated that pine trees grow faster in Louisiana than anywhere else in the world. The soil, rainfall and long growing season of the state are ideally adapted to the growth and manufacture of timber and timber products.

Mining. — The principal minerals of the state are petroleum (including gas), salt, sand and gravel, and sulfur. The value of minerals produced in the second half of the 20th century was more than $1,500,000,000 a year. Louisiana ranks third of all the states in the value of minerals and produces more than 8% of the total value of all minerals in the nation. Nine-tenths of the total labour force in the mineral industry was producing petroleum, natural gas and natural-gas liquids. Petroleum production increased from 23,000,000 bbl. (42 gal. per barrel) to more than 323,000,000 bbl. in the quarter century following 1930. Natural-gas production increased from about 700,000,000,000 cu.ft. after World War II to about 2,000,000,000,000 cu.ft. in the second half of the 20th century and natural-gas liquids rose from 17,000,000 bbl. to 26,000,-000 bbl. The total proved reserves in the second half of the 20th century were petroleum, 3,858,000,000 bbl., natural gas, 51,436,-000,000,000 cu.ft., and natural-gas liquids, 1,019,000,000 bbl.

Only Texas and California produce more petroleum and natural gas than Louisiana and they are the only states that have more proved reserves. Louisiana ranks fourth among the states in the production of salt, and sulfur production for industrial use began in the state. Louisiana has been surpassed by Texas, but the opening in 1933 of the Grande Écaille mine, about 50 mi. S. of New Orleans, greatly increased sulfur production in Louisiana. The mining of sulfur along the gulf coast by the Frasch process is accomplished by pumping superheated steam into the sulfur rock, melting and forcing it to the surface through pipes. The sulfur is often hundreds of feet beneath the surface of the earth and sometimes there is a layer of quicksand above the sulfur. The annual average production of sulfur, about 1,000,000 tons before 1950, after 1950 reached more than 2,000,000 tons valued at more than $50,000,000. Sulfur and petroleum form the base for the growing petroleum-chemical industry in the state. The average annual production of salt, about 2,000,000 tons before 1950, after 1950 rose to approximately 3,500,000 tons. There are a number of known untouched salt domes in the state. The best-known mines are at Avery Island. Jefferson Island and Winnfield. The average annual production of cement, about 4,500,000 bbl, before 1950, after 1950 increased to about 7,500,000 bbl. The cement is procured from clays and oyster shells. The mining of miscellaneous clays, which previously averaged about 300,000 tons, more than doubled in the second half of the 20th century.

The value of all mineral production in the state exceeds $1,500,-000,000 annually, with petroleum the most valuable, accounting for $1,000,000,000, natural gas for $250,000,000 and natural-gas liquids, for $80,000.000. The number of producing oil wells, fewer than 10,000 in 1948, increased to more than 20,000 ten years later. The average daily production per well, however, had decreased from 54.7 bbl. to 41.3 bbl. for the same period.

Fisheries and Wildlife. — Louisiana is widely known for the quality and great variety of its fresh- and salt-water fish. The value of the annual catch is approximately $33,000,000 and 31,000 persons are employed in the industry. The leading salt-water fish are shrimp, oysters, crabs, pompanos, redfish, bluefish, Spanish mackerel, flounder, grouper (yellow bass) and drumfish. The fresh-water streams abound in perch, basses, barfish, catfish, gaspergou (a fresh-nater drumfish), sacalait (also known as crappie, warmouth and killfish), bullfrogs and buffalo fish. The annual catch of buffalo fish approaches 12,000,000 lb. and that of catfish approximates 5,000,000 lb. Louisiana supplies approximately 34,-000.000 lb. of shrimp annually worth about $10,000,000. The 10.000.000 lb. of oysters taken annually from 477.000 ac. of oyster beds have a value approximating $3,000,000. The oyster shells are important as a source of lime for making cement, and for liming or "sweetening" acid soils. The state is the leading producer, also, of diamondback terrapins, crabs and bullfrogs.

The original French settlers came to Louisiana for the fur trade and the state leads all others in the number but not in the value of furs produced. The annual yield approaches 2,500,000 pelts worth approximately $3,000,000. The muskrat leads in number and value, followed in value by mink, nutria, otter, raccoon and opossum. The wildlife and fisheries commission spends approximately $500,000 annually supervising the wildlife and fisheries.

Trade. — New Orleans ranks second among the ports of the U.S. in value of exports and imports; approximately 10% of the national foreign trade passes through the port. More than 100 steamship lines offer regular sailings from the port. Approximately 65 firms in the towing barge business operate through New Orleans with 15.000 mi. of commercial waterways converging on the city bringing over 150,000.000 tons of freight annually. The port annually handles more than 10,000,000 tons of foreign goods valued at more than $1,500,000,000. The most valuable imports are bananas, coffee and molasses.

The ports of Lake Charles, Baton Rouge and Morgan City have, in the second half of the 20th century, become increasingly important in the foreign trade of the state. In the second half of the 20th century about 25,000 retail firms annually sold more than $2,225,000.000 worth of merchandise and about 3,500 wholesale firms approximately $150,000,000 worth. Business activity by 1960 was 70% above the average of ten years earlier. Over 600,-000 persons nere employed in the state, with average weekly earnings of about $83; the per capita income for the state was a little over $1,500 compared to the national average of about $2.000.

Transportation and Communication. — In the second half of the 20th century there were ten major railroads, with 6,000 mi. of track; nine commercial airlines and approximately 100 airports; 5,000 mi. of navigable streams; 1,100 mi. of intercoastal canals; and almost 50.000 mi. of vehicular roads, of which more than 15,000 mi. were under state control, and of these approximately 14,000 mi. were paved with asphalt or concrete. There are over 5,000 bridges in the highway system. Two bridges at New Orleans, one at Baton Rouge and one at Natchez span the Mississippi river. Other important bridges span the Red, Ouachita and Atchafalaya rivers at important points.

There are 18 daily newspapers with paid circulation of more than 700.000. Practically every town of a few thousand population has a radiobroadcasting station and the larger cities have one or more televising stations.

Culture and Recreation. — Most of the larger urban centres have little theatre groups for the performance of amateurs on the stage. The New Orleans Opera association and similar organizations at most of the colleges and universities stage plays. produce operas and give concerts of creditable quality. A number of musical groups such as the New Orleans Symphony orchestra, the Shreveport symphony and others give excellent group and solo performances. The educational extension department of Louisiana State university has attempted to preserve the folklore, folk dances and artcrafts of the Xcadians. The Louisiana State library has promoted the establishment of parish libraries with bookmobiles to transport the books directly to rural families. The university, through its agricultural extension department, has endeavoured to organize "communities" of farm families throughout the state for recreational purposes.

There are a number of fairs to teach and demonstrate improved machinery, utensils, livestock and poultry. The largest of these is the state fair at Shreveport. There are a number of festivals nith colourful pageants and ceremonies, such as the Shrimp festival at Morgan City, the Rice festival at Crowley, the Forest festival at Winnfield, the Yambilee at Opelousas and the Peach festival at Ruston. The Mid-Winter Sports carnival at New Orleans, which sponsors the Sugar Bowl football game on New Year's day and the Christmas festival at Natchitoches are well known. The oldest and most famous of the festivals is Mardi Gras in New Orleans. See also Index references under "Louisiana" in the Index volume.

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LOUISIANA PURCHASE. In 1803 the United States purchased from Napoleonic France the then vaguely delineated western half of the Mississippi river basin. This region was then known as "Louisiana." and its acquisition by the United States is referred to as the Louisiana Purchase. The term is commonly applied to the territory involved as n·ell as to the act of purchase.

The Louisiana territory had been the object of old world interests ior many years before 1803. Explorations and scattered settlements in the 17th and 18th centuries had given France control over the river itself and title to most of the Mississippi valley. The first serious disruption of French control over Louisiana came during the Seven Years' War (*q.v.*). In 1762 France ceded Louisiana west of the Mississippi river to Spain and in 1763 transferred virtually all of its remaining possessions in North America to Great Britain. This arrangement. however, proved temporary. French power rebounded under the subsequent military leadership of Napoleon Bonaparte and on Oct. 1, 1800, Napoleon induced a reluctant King Charles IV of Spain to agree for a consideration to cede Louisiana back to France. King Charles gave at least his verbal assent on the condition that France would never alienate the territory to a third power. And with this treaty of retrocession. known as the treaty of San Ildefonso. would go not only the growing and commercially significant port of New Orleans but the strategic mouth of the Mississippi river.

Reports of the supposed retrocession soon were received by official Washington—and with deep misgivings. During the preceding i2 years, Americans had streamed westward into the valleys of the Cumherland. Tennessee and Ohio rivers. The very existence of these new settlers depended on their right to use the Mississippi river freely and to make transshipment of their exports at New Orleans. By terms of the treaty of San Lorenzo, Spain in 1795 had granted to the United States the right to ship goods originating in American ports through the mouth of the Mississippi without paying duty and also the right of deposit, or temporary storage, of American goods at New Orleans for transshipment. But in 1802 Spain in effect revoked the right of deposit. and so it was in an atmosphere of growing tension in the west that Pres. Thomas Jefferson was confronted with the prospect of a new, wily and more powerful keeper of the strategic window to the Gulf of Mexico.

The news of the retrocession remained unconfirmed for months. and understandably so. Quite apart from persistent and conflicting rumours that would naturally surround secret negotiations of this magnitude. it was subsequently revealed that King Charles had put off signing the retrocession order until Oct. 15, 1802. But even though it was extremely difficult for American agents in Paris to ascertain the exact facts pertaining to the status of Louisiana. the information that did reach President Jefferson was disquieting. The president, sensitive to America's growing interests in the west. would look upon any foreign power that controlled the Mississippi river mouth as a "natural and habitual enemy" of the United States, and he was quick to view the possible possession of this region by Napoleon with added misgivings. "The day that France takes possession of New Orleans," the normally pro-French Jefferson wrote Robert R. Livingston. the U.S. minister at Paris, ". . . we must marry ourselves to the British fleet and nation."

Jefferson meanwhile instructed Livingston to take two steps: (1) to approach Napoleon's minister, Charles Maurice de Talleyrand. with the object of preventing the retrocession in the event this act had not yet been completed; (2) to try to purchase at least New Orleans if the property had actually been transferred from Spain to France. Direct negotiations with Talleyrand. however. appeared to be all but impossible. For months Livingston had to be content with tantalizing glimmerings of a possible deal between France and the United States. But even these faded as news of the Spanish governor's revocation of the right of deposit reached the U.S. minister. With this intelligence he had good reasons for thinking the worst: that Napoleon Bonaparte may have been responsible for this unfortunate act; that his next move might be to close the Mississippi river entirely to the Americans. Livingston had hut one trump to play and he played it with a flourish. He made it known that a *rapprochement* with Great Britain might. after all. best serve the interests of his country, and at that particular moment an Anglo-American *rapprochement* was about the least of Napoleon's desires.

No one can write with certainty of the mental deliberations of the first consul. But there are good reasons for believing that French failure in Santo Domingo. the imminence of renewed war with Great Britain and financial stringencies may all have prompted Napoleon in 1803 to offer for sale to the United States the entire Louisiana territory. At this juncture. James Monroe arrived in Paris as Jefferson's minister plenipotentiary: and even though the two American ministers possessed neither instructions nor authority to purchase the whole of Louisiana. the negotiations that followed, with Barbé-Marbois acting for Napoleon, moved swiftly to a conclusion. A treaty was signed on May 2, but was antedated to April 30. By its terms the Louisiana territory, in the form France had received it from Spain, was sold to the United States. For this vast domain the United States agreed to pay $11,-250.000 outright and assumed claims of its citizens against France in the amount of $3,750,000. Interest payments incidental to the final settlement made the total price $27,267,622.

Minister Livingston, with the help of Monroe, had bargained well, and he knew it. As he was about to affix his signature to the documents. Livingston is reported to have said: "We have lived long, but this is the noblest work of our whole lives. . . . From this day the United States take their place among the powers of the first rank . . ." Napoleon, too. reflected upon what he had done and remarked to Barbé-Marbois: "This accession of territory (by the Americans) affirms forever the power of the

United States, and I have just given England a maritime rival that sooner or later will lay low her pride."

But what had the Americans really bought? According to art. I of the terms of sale, "The colony or province" of Louisiana consisted of the "same extent" that it had under Spain at the time of the retrocession (1800) and that it had when France possessed it (prior to 1762); art. II specifically took in all adjacent islands (and this would, of course, include the vital Isle of Orleans); "all public lots and squares, vacant lands and all public buildings. fortifications, barracks, and other edifices which are not private property," and archives.

The wording of art. I was vague; it did not precisely describe the boundaries. It gave no assurances that West Florida was to be considered a part of Louisiana; neither did it delineate the southwest boundary. The American negotiators were fully aware of this. When Livingston later questioned Talleyrand on the matter, the reply was: "I do not know . . . I can give you no direction; you have made a noble bargain for yourselves, and I suppose you will make the most of it."

But before the United States could establish fixed boundaries to Louisiana there arose a basic question concerning the constitutionality of the purchase. Did the constitution of the United States provide for an act of this kind? The president, in principle a strict constructionist, thought that an amendment to the constitution might be required to legalize the transaction; but, after due consideration and considerable oratory, the senate approved the treaty by a 24 to 7 vote.

The setting of fixed boundaries awaited negotiations with Spain and Great Britain. The exasperating dispute with Spain over the ownership of West Florida and Texas was finally settled by the purchase of the Floridas from Spain in 1819 and the establishment of a fixed southwest boundary line. This line followed the Sabine river from the Gulf of Mexico to the parallel of 32° N.; ran thence due north to the Red river, following this stream to the meridian 100° W.; thence north to the Arkansas river and along this stream to its source; thence north or south as the case might be (the source of the Arkansas was not then known) to the parallel of 42° N. and west along this line to the Pacific ocean. The northern boundary was amicably established by an Anglo-American convention in 1818. It established the 49° parallel N. between the Lake of the Woods and the Rocky mountains as the American-Canadian border. The Rocky (then referred to as "Stony") mountains were accepted as the western limit of the Louisiana territory, and the Mississippi river was considered for all practical purposes the eastern boundary of the great purchase. The new territory, which comprised 828,000 sq.mi. and doubled the size of the United States, was acquired at a cost of less than three cents per ac. Much of the territory turned out to contain rich mineral resources, productive soil, valuable grazing land, forests and wildlife resources of inestimable value. Out of this empire were carved in their entirety the states of Louisiana, Missouri, Arkansas, Iowa! North Dakota, South Dakota, Nebraska and Oklahoma; in addition, the area included most of the land in Kansas, Colorado, Wyoming, Montana and Minnesota.

The acquisition of the Louisiana territory greatly strengthened the United States, materially and strategically. It provided a powerful new impetus to westward expansion of the American people, and in a constitutional sense it established in practice the doctrine of implied powers of the federal constitution. The Louisiana Purchase was what often has been said of it, the greatest bargain in American history. *See* also LOUISIANA: *History*.

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LOUIS OF NASSAU (1538–1574), son of William, count of Nassau, and Juliana von Stolberg, and younger brother of William the Silent, was one of the leaders of the league of nobles who signed the document known as the Compromise in 1566, and was a member of the deputation that presented the petition of grievances called the Request to the regent, Margaret of Parma. On the arrival of Alva at Brussels. Count Louis, with his brother William, withdrew from the Netherlands and raised a body of troops in defense of the patriot cause. In the spring of 1j68 Louis invaded Friesland, and at Heiligerlee, on May 23, completely defeated a Spanish force under Count Aremberg, who was killed. Alva annihilated the levies of Louis at Jemmnigen (July 21), Louis himself escaping by swimming across an arm of the Ems. He now joined William, who in October had to beat a hasty retreat before Alva's superior skill. The brothers then made their way to the camp of Admiral Coligny.

Louis took an active part in the Huguenot campaign and fought heroically at Jarnac and Moncontour. In 1572 Louis raised a small force in France and, suddenly entering Hainaut, captured Mons (May 23). There he was besieged by Don Frederick of Toledo, Alva's natural son: who blockaded all approach to the town. William made an attempt to relieve his brother, but failed, and Mons surrendered (Sept. 17). Louis withdrew to his home, Dillenburg, to raise money and troops for another invasion of the Netherlands. In the hope of diverting the Spaniards from the siege of Leyden, Louis with his brothers John and Henry, at the head of a mixed force, crossed the frontier near Maastricht and advanced to the Mookerheide near Nijmegen. There he was attacked by Sancho d'Avila and routed. Both Louis and his younger brother Henry were killed.

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LOUIS PHILIPPE I, king of the French (1773–1850), was the eldest son of Louis Philippe Joseph, duc d'Orléans (known during the Revolution as Philippe Egalité), and of Louise Marie Adelaide de Bourbon, daughter of the duc de Penthièvre, and was born at the Palais Royal in Paris on Oct. 6. 1773. The legend that he was a supposititious child is dealt with elsewhere. (See MARIA STELLA, countess of Newborough.) The godparents of the duc de Valois, as he was entitled till 1785, were Louis XVI and Queen Marie Antoinette; his governess was the famous Madame de Genlis, to whose influence he doubtless owed his wide if superficial knowledge: his orderliness and perhaps his parsimony. Known from 1785 as the duc de Chartres. he was 16 at the outbreak of the Revolution. with which, like his father. he at first identified himself. In 1790 he joined the Jacobin club. in which the moderate elements still predominated, and attended the debates of the national assembly. Hc thus became a *persona grata* with the party in power; he was already a colonel of dragoons. and in 1792 he was given a command in the army of the north. As a lieutenant general, at the age of 18, he was present at Valmy (Sept. 20) and Jemappes (Nov. 6).

The republic had meanwhile been proclaimed, and the duc de Chartres, now like his father surnamed Egalité, posed as its zealous adherent. Fortunately for him, he was too young to be elected to the Convention, and while his father was voting for the death of Louis XVI he was serving under Dumouriez in the Netherlands. He shared in the defeat of Neerwinden (March 18. 1793), was implicated with Dumouriez in the plot to overthrow the republic and on April j escaped with him into the Austrian lines. He went first, with his sister Madame Adelaide, to Switzerland. where he obtained a situation as professor in the college of Reichenau under the assumed name of Chabaud de la Tour, mainly in order to escape from the fury of the *émigrés*. The execution of his father in Nov. 1793 had made him duc d'Orléans, and he now became the centre of the intrigues of the Orleanist party. In 179j he was at Hamburg with Dumouriez, who still hoped to make him king. With characteristic caution Louis Philippe refused to commit himself, and announced his intention of going to America; but in the hope that something might happen in France to his advantage, he postponed his departure, travelling instead through the Scandinavian countries. But in 1796, the Directory having offered to release his mother and his two brothers, who had been kept in prison since the Terror, on condition that he go to America, he set sail for the United States, and in October settled in Philadelphia, where in Feb. 1797 he was joined by his brothers the duc de Montpensier and the comte de Beaujolais. The news of the coup d'état of 18 Brumaire decided them to return to Europe. They returned in 1800, only to find Napoleon Bonaparte's power firmly established. Immediately on his arrival, in Feb. 1800, the duc d'Orléans, at the suggestion of Dumouriez, sought an interview with the comte d'Artois, through whose instrumentality he was reconciled with the exiled king, Louis XVIII. The duke, however, refused to join the army of Condé and to fight against France, an attitude in which he persisted, while maintaining his loyalty to the king. He settled with his brothers at Twickenham.

On May 18, 1807, the duc de Montpensier died at Christchurch in Hampshire of consumption. The comte de Beaujolais was ill of the same disease, and in 1808 the duke took him to Malta, where he died on May 29. The duke now, in response to an invitation from King Ferdinand IV, visited Palermo, where, on Nov. 25, 1809, he married Princess Maria Amelia, the king's daughter. He remained in Sicily until the news of Napoleon's abdication recalled him to France. He was cordially received by Louis XVIII; his military rank was confirmed, he was named colonel general of hussars, and such of the vast Orléans estates as had not been sold were restored to him by royal ordinance. This made him enormously rich.

Meanwhile, his sympathy with the Liberal opposition brought him again under suspicion. His attitude in the house of peers in the autumn of 1815 cost him a two years' exile to Twickenham; he courted popularity by having his children educated *en bourgeois* at the public schools; and the Palais Royal was the rendezvous of that middle class by which he was to be raised to the throne.

His opportunity came with the revolution of 1830. During the three "July days" the duke kept himself discreetly in the background, retiring first to Neuilly, then to Raincy. Meanwhile, Thiers issued a proclamation pointing out that a republic would embroil France with all Europe, while the duc d'Orléans, who was "a prince devoted to the principles of the Revolution" and had "carried the tricolour under fire," would be a "citizen king" such as the country desired. This view was that of the rump of the chamber still sitting at the Palais Bourbon, and a deputation headed by Thiers and Laffitte waited upon the duke to invite him to place himself at the head of affairs. He returned with them to Paris on July 30, and was elected by the deputies lieutenant general of the realm. The next day, wrapped in a tricolour scarf, he went on foot to the *hôtel de ville*—the headquarters of the Republican party—where he was publicly embraced by Lafayette as a symbol that the republicans acknowledged the impossibility of realizing their own ideals and were prepared to accept a monarchy based on the popular will. Hitherto, in letters to Charles X, he had protested the loyalty of his intentions, and the king now nominated him lieutenant general and, abdicating in favour of his grandson the comte de Chambord, appointed him regent. On Aug. 7, however, the chamber by a large majority declared Charles X deposed, and proclaimed Louis Philippe "king of the French, by the grace of God and the will of the people."

For the trappings of authority he cared little. To conciliate the revolutionary passion for equality he was content to veil his kingship for a while under a middle-class disguise. He erased the royal lilies from the panels of his carriages; and the Palais Royal, like the White House at Washington, stood open to all and sundry who cared to come and shake hands with the head of the state. This pose served to keep the democrats of the capital in a good temper and so leave him free to consolidate the somewhat unstable foundation of his throne and to persuade his European fellow sovereigns to acknowledge in him not a revolutionary but a conservative force. But when once his position had been established, it became clear that he possessed all the Bourbon tenaciousness of personal power.

When a "party of resistance" came into office with Casimir-Périer in March 1831, the speech from the throne proclaimed that "France has desired that the monarchy should become national, it does not desire that it should be powerless"; and the migration of the royal family to the Tuileries symbolized the right of the king not only to reign but to rule. Republican and Socialist agitation, culminating in a series of dangerous risings, strengthened the position of the king as defender of middle-class interests; and since the middle classes alone were represented in parliament, he came to regard his position as unassailable. Little by little his policy became more purely dynastic. His position in France seeming assured, he sought to strengthen it in Europe by family alliances. The fact that his daughter Louise was the consort of Leopold I, king of the Belgians, had brought him into intimate relations with the English court. Broken in 1840 during the affair of Mohammed Ali, the *entente* with Great Britain was patched up in 1841 by the Straits convention, and recemented by visits paid by Queen Victoria and Prince Albert to the Château d'Eu in 1843 and 1845 and of Louis Philippe to Windsor in 1844, only to be irretrievably wrecked by the affair of the "Spanish marriages," a deliberate attempt to revive the traditional Bourbon policy of French predominance in Spain. If in this matter Louis Philippe had seemed to sacrifice the international position of France to dynastic interests, his attempt to re-establish it by allying himself with the reactionary monarchies against the liberals of Switzerland finally alienated from him the French Liberal opinion on which his authority was based. When, in Feb. 1848, Paris rose against him, he found that he was isolated.

Charles X, after abdicating, had made a dignified exit from France. Louis Philippe was less happily situated. Escaping with the queen from the Tuileries by a back entrance, he made his way with her in disguise to Honfleur, where the royal couple found refuge in a gardener's cottage. They were smuggled out of the country by the British consul at Havre as Mr. and Mrs. Smith, arriving at Newhaven "unprovided with anything but the clothes they wore."

They settled at Claremont, placed at their disposal by Queen Victoria, under the incognito of count and countess of Neuilly. There on Aug. 26, 1850, Louis Philippe died.

Louis Philippe had eight children. His eldest son, the popular Ferdinand Philippe, duc d'Orléans (b. 1810), who had married Princess Helena of Mecklenburg, was killed in a carriage accident on July 13, 1842, leaving two sons, the comte de Paris and the duc de Chartres. The other children were Louise, consort of Leopold I, king of the Belgians; Marie, who married Prince Alexander of Württemberg and died in 1839; Louis Charles, duc de Nemours; Clementine, married to the duke of Coburg-Kohary; François Ferdinand, prince de Joinville; Henri Eugène, the duc d'Aumale; and Antoine Philippe, the duc de Montpensier, who married the younger sister of Queen Isabella II of Spain.

Bibliography.—F. A. Gruyer, *La Jeunesse du roi Louis-Philippe, d'après les pourtraits et des tableaux* (1909), de luxe edition, with beautiful reproductions of portraits, miniatures, etc.; Denys Cochin, *Louis-Philippe* (1918). Of general works on Louis Philippe's reign may be mentioned G. Weill, *La France sous la monarchie de juillet* (1902); and the relevant chapters in Lavisse and Rambaud's *Histoire Générale* (1898) and the *Cambridge Modern History* (1907 and 1909), in which further works will be found in the bibliographies attached by Emile Bourgeois to his chapters (vol. x, p. 844; vol. xi, p. 874). Louis Philippe himself published the *Journal du duc de Chartres, 1790–91; Mon Journal, événements de 1815*, 2 vol. (1849); *Discours, allocutions et réponses de S. M. Louis-Philippe, 1830–46;* and after his death was issued his *Correspondance, mémoire et discours inédits* (1863).

(W. A. P.)

LOUIS STYLES refer to the artistic trends during the reigns of Louis XIII, XIV, XV and XVI of France; the styles coincide roughly with the broader classifications of late Renaissance, baroque, rococo and neoclassical art (*qq.v.*), respectively. With Louis XIII (1610–43) the contemporary Italian influence, as exemplified in the Luxembourg palace, was strong. Under Louis XIV (1643–1715) the building of the Versailles palace, establishment of the academies and royal manufactury of tapestries, furniture and ceramics gained cultural hegemony for France. The sober restraints of the baroque grand manner were cast off with Louis XV (1715–74) in favour of the capricious, graceful rococo, which flourished in such smaller Parisian residences as the Hôtel Soubise. The simple classic ideal, as seen in the Petit Trianon, once again reasserted itself in Louis XVI's reign (1774–93).

See S. F. Kimball, *The Creation of the Rococo (1943).* (WM. F.)

LOUISVILLE, the largest city and seat of Jefferson county, Ky., U.S., is the metropolitan centre of the state. It is located on the south bank of the Ohio river opposite the Falls of the Ohio, the rock ledge which divides the water levels, about 90 mi. S.W. of Cincinnati. The city spreads across the broad level shoulder of the Ohio flood plain between the river and the rim of knobs. This plain is a fertile area, which was once overflowed and enriched by the Ohio river. In the past the city had recurrent floods which caused heavy damage to property, notably the great flood of Jan.–Feb. 1937. In 1956, a 17-mi. levee was completed along the river front to seal out floodwaters.

Metropolitan Louisville spreads over almost three-quarters of the 375 sq.mi. of Jefferson county. In 1960 the standard metropolitan statistical area, comprising Jefferson county in Kentucky and Clark and Floyd counties in Indiana, had a population of 725,139 persons, 390,639 in the city and 610.947 in Jefferson county. This represented an increase of 25.7% since 1950.

History. — Legend has it that the sieur de La Salle visited the site in 1669, but this is indeed doubtful. French and British traders stopped at the Falls of the Ohio before the middle of the 18th century, but details of their visits are unrecorded. On July 8, 1773, Capt. Thomas Bullitt reached the falls with a commission from William and Mary college in Virginia to survey the lands in this area. Though the county surveyor refused to approve this survey, Lord Dunmore, the governor of Virginia, conveyed it in Dec. 1773 to his friend John Connolly. In June 1774 Daniel Boone and Michael Holsteiner came from Virginia to warn the survey party of the outbreak of Lord Dunmore's War against the Indians.

In May 1778, George Rogers Clark (*q.v.*) landed his militia company on Corn Island opposite the mouth of Beargrass creek and began preparation for the conquest of the British-held Old Northwest. Clark built blockhouses for his stores, and cabins ior some of the colonists who had come with him. Most of the settlers moved to the mainland the following winter and established themselves in Fort-on-Shore (Ft. Nelson) within the present limits of Louisville. Trustees were appointed to lay out a town and a town government was organized in April 1779; on May 14, 1780, the Virginia legislature, petitioned by the townsfolk, declared that Connolly had forfeited his title (he had been actively pro-British during the American Revolution) and incorporated the settlement under the name of Louisville, in recognition of the assistance given by Louis XVI of France to the colonies in the Revolutionary War. Between 1580 and 1811 Louisville became an important frontier and flatboat trading place, and its growth was greatly stimulated by the successful introduction of steam navigation. Nicholas Roosevelt docked the "New Orleans:" the first steamboat on the western waters, in 1811 and inaugurated the steamboat era which was one of the town's most dramatic moments. By 1820 Louisville had become a major river port and its facilities were further stimulated by the construction (1825–30) of the canal around the Falls of the Ohio. The steamboat spread the city's commercial influence over a vast area. Louisville merchants were engaged in trade with both the south and the middle west and cotton planters depended upon them for supplies. The town's printers furnished books and periodicals to an ever-widening educational trade area, and its newspapers were read from Alabama to Illinois.

In 1828 the town was chartered as a city and received successive charters in 1851, 1870, 1893 and 1926.

In the American Civil War, Louisville was early occupied by Federal troops who made it a military headquarters and a major supply depot throughout the struggle. Though no fighting took place in the city, its war history constitutes one of its most exciting chapters. Except for the disruption of trade and the normal intercourse with the rest of Kentucky, Louisville escaped the ravages of war. Large numbers of slaves flocked to the town from the plantations seeking passes to enable them to cross the river to Indiana and freedom.

Immediately after the war, Louisville businessmen began a campaign to reclaim the South's trade. The Louisville and Nashville railroad was already directed toward the heart of the south, and this important rail line nas extended to Mobile. Xla.. and New Orleans, La., and then to Jacksonville, Fla. Both merchant and railway officials helped locate store sites in the south as outlets for goods transported by rail from Louisville distributors.

In March 1890 a tornado caused the loss of more than 100 lives and did extensive property damage. Louisville's economy remained stabilized but was given a boost during World War I with the building of Camp Zachary Taylor just outside the city and the influx of thousands of soldiers. Later the enlargement of nearby Ft. Knox (*q.v.*) had a similar effect. By mid-20th century newer industries, notably the 1,000-ac. manufacturing plant called Appliance Park, quickened the city's economic pulse.

Industry. — Since 1865 Louisville manufacturers have produced a highly diversified assortment of goods. Traditional manufactures are processed meats, flour, wagons and carriages, whisky, beer, tobacco products, plumbing fixtures, processed foods, wood products, chemicals, textiles, sporting goods, musical instruments, metal goods and clothing. Newer industries include automobiles, tractors, farm implements, rubber goods, electrical machinery and aluminum products. Louisville is still an important printing centre producing large numbers of magazines, comic books, catalogues, commercial brochures and beer and whisky labels. The American Printing House for the Blind which publishes books in braille, is located there.

Culture and Recreation. — From its beginning Louisville was an important cultural centre. Its newspapers, especially the Louisville *Journal*, edited by George D. Prentice, 1830–68, and the Louisville *Courier-Journal*, edited 1868–1918, by "Marse" Henry Watterson, are distinguished in the history of U.S. journalism. Among the cultural institutions which have given the city character are the Louisville Free Public library. the Speed Memorial Art museum and the Filson club (founded 1884 as a historical library and museum).

The city's system of public education began in 1829. The University of Louisville (founded in 1798 as Jefferson seminary and chartered under its present name in 1846) has, among others, faculties of law, medicine and engineering, and is municipally owned. Among the other educational institutions are the Roman Catholic colleges Bellarmine (1950), Nazareth (1920) and Ursuline (established in 1921 as Sacred Heart junior college and chartered under its present name in 1938); and the Southern Baptist Theological seminary (1859) and the Louisville Presbyterian Theological seminary (1901). The Louisville public school system was one of the first large southern city systems to abandon the practice of racial segregation in compliance with the 1954 supreme court decision, which held segregation to be unconstitutional.

Louisville has abundant recreational facilities. Cherokee park, a 406-ac. woodland in the rolling hills east of the city, is a fine natural playground. Adjoining this tract is Seneca park which contains a golf course: a small lake and public playgrounds. Central park, in the heart of the city, has tennis courts, wading pools, a natural amphitheatre and other recreational facilities.

Louisville is a well-known sporting centre. Since 1875 it has been the scene of the annual Kentucky Derby, America's horse-racing classic, run at Churchill Downs. The Kentucky state fair, one of the oldest agricultural fairs in the U.S., features an annual horse show which almost rivals the derby in interest. The large armoury building and Freedom hall have been the scenes of numerous amateur and professional sporting events, including basketball, prize fights, wrestling matches and ice hockey. The Louisville Colonels, an American association .baseball team. has a history which goes back to 1867 when the Louisville Eclipse team was organized. The city played an important part in the organization of the National league in 1856. Babe Browing, an early professional player, is credited with introducing the design for the famous "Louisville slugger" baseball bat which is manufactured there. (T. D. C.)

LOUNSBURY, THOMAS RAYNESFORD (1838–1915), U.S. scholar, was born at Ovid, N.Y., on Jan. 1, 1838, and educated at Yale university (A.B., 1859; A.M., 1877). He was on the editorial staff of the *American Encyclopaedia* 1860–62, and then enlisted in the 126th N.Y. volunteers to serve through the Civil War. In 1870 he became instructor and in 1871 professor of English language and literature in the Sheffield Scientific school of Yale university. In 1906 he was retired as professor emeritus. He was also librarian of the Sheffield Scientific school 1873–1906. He won recognition as a scholar in both branches of his subject: study of the English language and study of its literature. His *History of the English Language* (1879) is characterized by Brander Matthews as "a little masterpiece of carefully controlled information, and of marvellously lucid exposition." He followed this with later studies of pronunciation, usage and spelling no less authoritative: *The Standard of Pronunciation in English* (1904); *The Standard of Usage in English* (1908); *English Spelling and Spelling Reform* (1909). He was one of the most influential of those who advocated spelling reform and was one of the organizers, and later president, of the simplified spelling board. His studies in literature show him a master of his successive subjects. His first was a *Life of James Fenimore Cooper* (1882). *Studies in Chaucer* in three impressive volumes (1891) remains an enduring work. His *Shakespeare as a Dramatic Artist* (1901), *Shakespeare and Voltaire* (1902), and *The Text of Shakespeare* (1906) marked him as one of the foremost writers on Shakespearian subjects. He also wrote *The Early Literary Career of Robert Browning* (1910) and edited the complete works of Charles Dudley Warner.

Lounsbury died on April 9, 1915.

LOURDES, a town of southwestern France in the *département* of Hautes-Pyrénées, at the foot of the Pyrénées, 12 mi. S.S.W. of Tarbes on main line of Southern railway between that town and Pau. Pop. (1954) 14,110. The origin of Lourdes is uncertain. From the 9th century onward it was the most important place in Bigorre, largely owing to its famous fortress. In 1360 it passed by the treaty of Brétigny from the French to the English, who lost it to the French in 1406. During the religious wars the castle held out successfully against the Protestant troops. From the reign of Louis XIV to the beginning of the 19th century the castle was used as a state prison. After the visions of Bernadette Soubirous, a peasant girl, in 1858, their authentication by a commission of enquiry appointed by the bishop of Tarbes, and the authorization by the pope of the cult of Our Lady of Lourdes, the quarter on the left bank of the Gave sprang up, and thousands of pilgrims annually visit the town, August being the favourite month.

Several religious communities have been named after Our Lady of Lourdes. Of these one, consisting of sisters of the third order of St. Francis, called the Congregation of Our Lady of Lourdes (founded 1877), has its headquarters in Rochester, Minnesota. Another, the Order of Our Lady of Lourdes, was founded in 1883 for work in the archdiocese of New Orleans. Lourdes is divided into an old and a new town by the Gave de Pau, which at this point leaves the valley of Argelès and turns abruptly to the west. The old quarter on the right bank surrounds a scarped rock, on which stands the fortress with its large square 14th century keep. A tower of the 13th or 14th century, surmounting a gateway known as the Tour de Garnabie is part of the old fortifications. The old quarter is united with the new by a bridge which is continued in an esplanade leading to the basilica. the church of the Rosary and the Grotto, with its spring of healing water, where the Virgin Mary is believed in the Roman Catholic world to have revealed herself repeatedly to Bernadette Soubirous. A statue of the Virgin stands on a rock projecting above the grotto, the walls of which are covered with crutches and other votive offerings; the spot is marked by a basilica built in 1876 above the grotto. The Byzantine church of the Rosary was built in front of and below the basilica from 1884 to 1889. Near the grotto are other caves, where prehistoric remains have been found.

Lourdes is the seat of the tribunal of first instance of the *arrondissement* of Argeles. There are slate quarries and the pastures support a breed of valuable Aquitaine cattle

LOURENÇO MARQUES, capital of Mozambique, on Delagoa bay, and 396 mi. by rail via Pretoria from Johannesburg. A census completed in 1950 gives the population as 93,265. The large majority of non-Europeans are Africans, but there are also many Indians. Foreigners are employed in the town, which is built upon a low-lying spit of sand, formerly surrounded by swamps which have now been filled in, providing a large area for business and other occupation, and on the hills behind it. The streets are regularly laid out, and most of them are tar-surfaced: in the town and suburbs are several fine buildings, among which are the railway station. municipal market, post and telegraph offices, the treasury, the residency, the British consulate, offices of the attorney general and the palatial Polana hotel. There are Roman Catholic, Anglican and Wesleyan Methodist churches, and the large church of the Mission Suisse Romande. The handsome Avenida Aguiar, in which are situated the fine municipal gardens, adjacent to which is the municipal museum, leads to the upper town. The electric tram system was replaced by a municipal bus service, and motor buses ply between the lower and the upper town.

At Ponta Vermelha (Reuben point), which marks the spot where the river enters the bay, were built cavalry barracks, the wireless station and many private residences of the wealthier citizens. The climate is almost ideal in the winter months and sea breezes temper somewhat the summer heat. The mean annual temperature (14 years) was 72° F. There is a large military and civil hospital in the town and also several nursing homes. Water, brought from the Umbeluzi river 18 mi. away, is of excellent quality.

Trade. — There is safe entrance to the harbour, the minimum depth in the Cockburn channel being 29 ft. At its mouth, the river is about 2 mi. across. Lourenqo Marques is the nearest port to the Rand gold mines. It is 7.308 mi. from London via Capetown, and 8,460 mi. via the Suez canal. The wharf of reinforced concrete is about a mile long, and can accommodate 12 large steamers at once. There are large warehouses, in addition to the transit shed and national warehouse. Telegraph, telephone and railway booking offices are on the wharf; and a clock gives the official time, a three-hour signalling device giving the time to shipping.

There are regular services of British, Portuguese, German, American, and other lines. The great bulk of the traffic of the port is that in transit to the Union of South Africa. Over 50% of the import trade of Johannesburg is with Lourenqo Marques. (For convention regulating this traffic, *see* PORTUGUESE EAST AFRICA.) Union duties can be paid in Lourenço Marques. The port possesses two coaling plants, capable of handling respectively 400 and 600 tons an hour. Great Britain, Portugal and Germany, in that order, long had the bulk of the import trade. Most of the imports, being forwarded to the Transvaal, figure also as exports.

A great proportion of the trade of the town, the forwarding trade especially, is in the hands of British firms. The retail trade and the native trade is very largely in the hands of Indians. The chief articles imported are foodstuffs and liquors, iron, mineral oils, inks and dyes, timber and livestock. These all form part of the transit trade. There is little export trade by sea except in coal, chiefly from the collieries at Middelburg, Transvaal. The chief import for local consumption is wine.

History. — For the early history of the town *see* DELAGOA BAY. The existing town dates from about 1850, the previous settlement having been entirely destroyed by natives. In 1871 the town was described as a poor place, with narrow streets, fairly good flat-roofed houses, grass huts, decayed forts and rusty cannon, enclosed by a wall 6 ft. high then recently erected and protected by bastions at intervals. The growing importance of the Transvaal led, however, to greater interest being taken in Portugal in the port. A commission was sent by the Portuguese government in 1876 to drain the marshy land near the settlement, to plant the blue gum tree, and to build a hospital and a church. It was not, however, until the end of the 19th century that any marked development took place in the town, and up to 1903 cargo had to be discharged in tugs and lighters. Later, a wooden wharf preceded the present reinforced concrete one. The settlement was declared a village in 1876, a corporate town in 1887, and in 1907 became the capital of the province.

In 1873–77 the president of the Transvaal endeavoured, unsuccessfully, to get a railway built from Pretoria to Delagoa bay. Later, a company was organized which built a line from the coast to the frontier as marked on maps of 1883, and this railway was opened in 1888. The Portuguese government insisted that the line must be continued another 5 mi. to the frontier as fixed after 1883. This led to disputes, seizure of the line, etc., and a long arbitration. Meantime, however, the railway had been completed and was opened for through traffic to Pretoria on July 8, 1895.

In 1906–10 another railway (47 mi. long) was built from Lourenço Marques due west to the Swaziland frontier, being a link in a new line to shorten the distance by rail between the Rand and the sea by some 60 mi.

The text of the railway arbitration award was published in French at Berne in 1900. Annual reports on the trade of Lourenço Marques are issued by the British foreign office.

LOUSE, a name commonly applied to small wingless insects parasitic upon birds and mammals and belonging to the orders Mallophaga (biting lice) and Anoplura (sucking lice). The word louse is also applied in a popular sense to many animals other than the true lice, *e.g.,* wood louse, fish louse (see CRUSTACEA), book louse of the insect order Psocoptera (*q.v.*), plant louse (see APHIDES) and bark louse (see SCALE INSECT). The true lice are hairy. flattened insects with short, three- to five-segmented antennae; the eyes may be reduced or wanting; and the tarsi are one- or t o-segmented with strongly developed claws for clinging to their hosts. The eggs are attached to hairs, feathers or clothing, and the young lice are active as soon as they emerge. In structure and habits the immature lice resemble the adults, but they pass through several molts before reaching sexual maturity. When lice are numerous they cause great irritation to the hosts, upon whose bodies their whole life is passed.

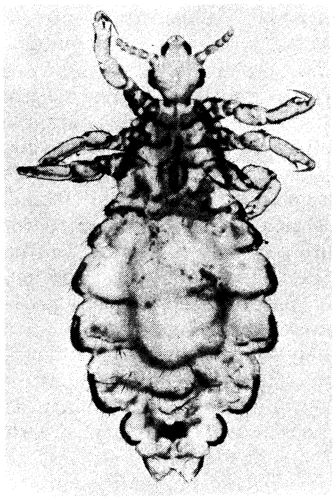
The Mallophaga or biting-lice constitute a separate order of insects although they were previously classed as a suborder of the Anoplura. Biting lice attack birds chiefly, and some mammals; however, they are not parasites of man, except perhaps accidentally and then only temporarily. They are rarely over one-fourth inch in length, and range in colour from whitish, through yellow, red and brown, to black (see MALLOPHAGA).

The order Anoplura (also known as the Siphunculata) is restricted to the sucking lice, all of which have extrusible mouthparts adapted for piercing and sucking. They live by imbibing the blood or tissue fluids of mammals. None are parasitic on birds or reptiles. They are usually smaller than biting lice, all being less than one-third inch in length, and range in colour from whitish to yellow.

Sucking lice show distinct host specificity; that is, one species of louse is restricted to a species or a small group of species of hosts, usually within a single genus. Genera of lice are characteristic of certain families or related families of mammals. The louse family Pediculidae is peculiar to the primates (monkeys, apes, man), the Echinopthiriidae to the marine carnivores (seals, sea lions, walruses) and the Haematopinidae to the rodents, rabbits and ungulates with very few exceptions. Vernon L. Kellogg has suggested that the presence of related lice on related groups of hosts is evidence of parallel evolution of parasites and hosts.

In addition to man and his domestic mammals a wide variety of wild mammals are infested by these insects, each host, genus or species having its own characteristic parasites. A few hosts such as man, the domestic cow and some rodents have two characteristic species of sucking lice, but usually only one species is found on a host. Although sucking lice are largely restricted to old world primates, marine carnivores, rodents, rabbits and ungulates, several species are known from insectivores. The domestic dog is one of the few land carnivores parasitized by sucking lice. No species of Anoplura are known from monotremes (platypus, etc.), Australian marsupials (kangaroo, etc.), bats, elephants or cetaceans (whales, dolphins, etc.).

The best-known species of louse is the sucking louse of man, *Pediculus humanus*, which infests the human race wherever modern hygienic practices have not been instituted. Its distribution is almost coextensive with that of the human race and the antiquity of this association is demonstrated by the presence of lice on ancient mummies from Egypt and the southwestern United States. This species has apparently been inherited by man from his remote primate ancestors. There are two varieties of the common human louse, viz., *Pediculus humanus* var. *capitis,* the head louse, and *P. humanus* var. *corporis,* the body louse or "cootie." The human louse in heavy infestations may cause serious skin irritations, but far more serious is its role as the carrier from man to man of the pathogenic agents of epidemic typhus fever (see TYPHUS FEVER), trench fever of World War I and louse-borne relapsing fever (in contrast to tick-borne relapsing fever) (see RELAPSING FEVER).



ROSS E. HUTCHINS

HUMAN BODY LOUSE (PEDICULUS HUMANUS), ABOUT 20 TIMES ENLARGED

The terrible role of these diseases in the history of man is related by Hans Zinsser in Rats, Lice *and* History (1935). Epidemic typhus fever has been a scourge whenever populations have been disrupted or concentrated by war, famine or floods and the attendant insanitary conditions.

The only other louse which infests man is the pubic or crab louse, *Phthirus* inguinalis (pubis), which is occasionally found in the hair of the armpits, in the eyebrows and beard as well as in the pubic regions. It is not known to be an important disease vector.

Related species of lice are *Pediculus schäffi,* of the chimpanzee: and *Phthirus gorillae* of the gorilla. The other lice from old world primates are included in the genus *Pedicinus*. Pediculus *mjöbergi,* which is almost indistinguishable from the human louse, is recorded from several species of new world monkeys. It is generally considered that these monkeys have acquired the parasite by contact with man, although it may be established on wild monkeys.

Some of the common lice of domestic animals are *Haematopinus* suis of the pig, H. asini of the horse, H. eurysternus and *Linognathus vituli* of the cow and L. setosus of the dog.

In infestations on man, DDT, lindane and other chemical dusts have proved effective insecticides for lice, and poisonous gases, chemical solutions and heat sterilization have been used to delouse infested clothing. Chemical dips or sprays are used on infested domestic animals.

See INSECT; see also Index references under "Louse" in the Index volume.

See C. F. Craig and E. C. Faust Clinical Parasitology, thoroughly rev. by E. C. Faust and P. F. Russell, 6th ed., chap. 38 (1957); U.S. Department of Agriculture, "Insects," *1952* Yearbook *of Agriculture* (1952).

(W. L. J.; X.)

LOUTH, a maritime county in the province of Leinster, Ireland, bounded northeast by Carlingford bay and County Down, east by the Irish sea. southwest by Meath, and northwest by Monaghan and Armagh. It is the smallest county in Ireland, its land area being 202,806 ac. or 316.8 sq.mi. Pop. (1961) 67.284.

Much of the county is occupied by an undulating lowland of much-folded Silurian shales and fine-grained sandstones; but Carboniferous limestone overlies these rocks north and east of Dundalk. Igneous rocks form a mountainous promontory, approaching 2,000 ft. in height on the border of Carlingford lough. A raised beach provides a flat terrace at Greenore. As in the adjacent parts of Armagh and Monaghan, lead is worked.

Apart from the promontory of Clogher head, which rises abruptly to 180 ft., the coast is mostly low and sandy. Carlingford lough is navigable beyond the limits of the county, and Carlingford and Greenore are watering places on the Co. Louth shore. The Bay of Dundalk stretches to the town of that name and affords convenient shelter.

The principal rivers, the Fane, the Lagan, the Glyde and the Dee, flow eastward. The Boyne is navigable for large vessels as far as Drogheda.

The territory which afterward became County Louth was included in the principality of Uriel, Orgial or Argial, which embraced also the greater part of Meath, Monaghan and Armagh. The chieftain of the district was conquered by John de Courcy in 1183, and Louth or Uriel was among the shires generally considered to have been created by King John, and peopled by English settlers. Until the time of Elizabeth I it was included in the province of Ulster. The cromlech of Ballymascanlan lies between Dundalk and Greenore. Danish raths and other forts are numerous. The most interesting monastic ruins are at Monasterboice and Mellifont, both near Drogheda. At the former site are two churches, the larger dating probably from the 9th century, the smaller from the 13th; a round tower, 110 ft. high; and three crosses, two decorated. Ardee, incorporated in 1376, has a 13th-century castle. At Dunbar a charter of Charles II (1679) granted the right to elect a sovereign. Louth, $5\frac{1}{2}$ mi. S.W. from Dundalk, gave its name to the county, and contains ruins of an abbey to which was attached one of the most noted early schools in Ireland.

In the lower regions the soil is a rich deep mold, adapted for cereals and green crops. Agriculture generally is in an advanced condition, and the farms are well drained. Oats, wheat, barley, potatoes and turnips are cultivated. Cattle, sheep, pigs and poultry represent the bulk of the livestock. Linen manufactures are of some importance. The deep-sea and coast fishery has its headquarters at Dundalk, and the salmon fisheries at Dundalk (Castletown river) and Drogheda (River Boyne). The county is traversed by the Northern railway and Dundalk is connected with Greenore by railway.

Louth returns three members to Dáil Eireann. Although the county is part of the province of Leinster, Louth is included in the Roman Catholic archdiocese of Armagh.

LOUTH, a market town and municipal borough in the Parts of Lindsey and the Louth parliamentary division of Lincolnshire, England, on the river Lud where it flows out of the Wolds, 26 mi. E.S.E. of Lincoln by road. Pop. (1951) 11,135. Area 4.4 sq.mi. Louth is first mentioned in Domesday as a borough held, as it had been in Saxon times, by the bishop of Lincoln, who had a market there. The see surrendered the manor to Henry VIII who granted it to Edward, earl of Lincoln; it was recovered by the crown before 1562. Louth owed its early prosperity to the adjacent Cistercian abbey, founded in 1139 by Alexander, bishop of Lincoln. A manor court under the presidency of the bishop's high steward governed the town, the reeve being elected by 18 ex-reeves. During the 13th and 14th centuries nine religious guilds were founded in the town. The markets. said to have been held from ancient times, and the three fairs, on the third Sunday after Easter and the feasts of St. Martin and St. James, were confirmed in 1551. Louth was a centre of the wool trade as early as 1297. The Perpendicular church of St. James was completed about 1515, and the grammar school was refounded and endowed by Edward VI in 1551. Louth is the centre of a large agricultural area with a well-known cattle market. Industries include malting and the manufacture of preserves and agricultural implements.

LOUTHERBOURG (LUTHERBURG), **PHILIPPE** JACQUES DE (1740-1812), landscape painter, engraver and especially successful theatrical scene designer of Polish origin who became a naturalized Englishman, was born at Fulda, Ger., on Oct. 31, 1740. He received his first training under his father, a miniature painter. Later, about 1755, he worked at Paris under Carle van Loo and Francesco Casanova. He was received into the academy in 1767 and exhibited battle scenes, landscapes and marine paintings at the Salon, where he won the praise of Diderot who considered him as an inferior Vernet with an admixture of Berghem. In 1771 he went to London with an introduction to David Garrick who paid him £500 a year as his regular adviser on scenic effects at Drury Lane theatre from 1773. In 1781 he turned his talents to the Eidophusikon, an elaborate moving panorama combined with dramatic lighting effects and music, which enjoyed considerable success. Later he retired to Hammersmith where he practised as a faith healer. He also devised a system for reproducing paintings in colour which occasionally deceives even modern critics. He died on March 11, 1812. Loutherbourg had a marked talent for ingenious dramatic effects in oil paintings, but as he seldom referred to nature, his theatrical work was probably better adapted to his abilities than landscape painting.

See W. T. Whitley, *Artists and Their Friends in England 1700–1799*, vol. 2 (1928); E. K. Waterhouse, *Painting in Britain 1530 to 1790* (1953). (F. J. B. W.)

LOUVAIN (Flem. *Leuven*), a town of Belgium in the province of Brabant, of which it was the capital in the 14th century before the rise of Brussels. Pop. (1955 est.) 34,206. Local tradition attributes the establishment of a camp here to Julius Caesar, but Louvain only became important in the 11th century as a residence for the dukes of Brabant. In 1356 Louvain was the scene of the famous *Joyeuse Entrée* of Wenceslas, the principal charter of Brabant. At that time it had a population of at least 50,000 and was the centre of the wool trade in central Belgium. The guild of weavers numbered 2,400 members. The old walls of Louvain, $4\frac{1}{2}$ mi. in circumference, have been replaced by boulevards, but within them is much cultivated ground. Soon after the *Joyeuse Entrée* a feud began between citizens and patricians, and eventually the duke threw in his lot with the latter. After a struggle of over twenty years' duration the White Hoods, as the citizens called themselves, were crushed. In 1379 they massacred seventeen nobles in the town hall, but this brought the vengeance of the duke, to whom in 1383 they made the most abject surrender. Many weavers fled to Holland and England, the duke took up residence in the strong castle of Vilvorde, and Brussels prospered at the expense of Louvain. What it lost in trade it partially recovered as a seat of learning, for in 1426, Duke John IV of Brabant founded there a university, and ever since Louvain university has enjoyed the first place in Belgium. It has always prided itself most on its theological teaching. In 1432 the university was established in the old Cloth Workers' Hall, a building dating from 1317, with long arcades and graceful pillars supporting the upper stories. In the 16th century there were 6,000 students, and four residential colleges are attached to the university. The aula and the university library were burnt in the German invasion of 1914. A new library was built (1921–28) by gifts from citizens of the United States, and books and fittings came from many nations. The library had more than 600,000 volumes. It was again destroyed by fire during the German attack in May 1940. The town hall is one of the richest examples of pointed Gothic. Mathieu de Layens, master mason, built it (1448 to 1463) in three stories, each with ten pointed windows facing the square.

The church of St. Peter (1425–97), damaged in 1914, was restored. It has seven chapels, in two of which are fine pictures by Dierik Bouts formerly attributed to Memling. Much of the iron and brass work is by Jan Matsys. There are other interesting churches in Louvain, viz., Ste. Gertrude, St. Quentin, St. Michael and St. Jacques, the last with a fine De Crayer (St. Hubert).

LOUVER (LOUVRE, LUFFER), in architecture, was originally a lantern or cupola built on the ridge of the roof of the great hall of a medieval house to let out the smoke. The term was later generally applied to a system of slanting boards, sheets of metal or glass, or other material, so arranged as to permit the passage of air while restricting the view, the sun, rain water, or any combination thereof. 'Three large adjustable horizontal louvers were used in each room of the Ministry of Education building in Rio de Janeiro (Oscar Niemayer, 1936) as sun protection. Immense, adjustable, vertical aluminum louvers, one story high (repeated on each story) serve as sun protection on all four sides of the Pan American Life Insurance building, New Orleans, La. (Skidmore, Owings and Merrill, 1951). Since louvers are practical, simple and usually attractive they have become a popular feature of contemporary architecture. (H. Mn.)

LOUVET DE COUVRAI, JEAN BAPTISTE (1760–1797), French writer and politician, was born in Paris on June 12, 1760. He became a bookseller's clerk, and published two novels, *Les Amours du chevalier de Faublas* (1787–89), and *Emilie de Varmont,* which attracted some attention. *Paris justifié,* a reply to Mounier's proposal that the court should be established elsewhere (Oct. 1789), led to Louvet's election to the Jacobin club, and he energetically opposed the moderate constitutional royalty advocated by Lafayette and others. On Dec. 25, 1791 he presented at the bar of the assembly his *Pétition contre les princes.*

Louvet was elected deputy to the assembly, and attached himself to the Girondists, publishing, at Roland's expense, a biweekly *journal-affiche* called *La Sentinelle* (March-Nov. 1792). On Aug. 10 he became editor of the *Journal des Débats,* in which he violently attacked Robespierre, Marat and the other Montagnards. His violent invective, coupled with his courageous attitude at the trial of Louis XVI, discredited the Girondists, and he fled after the crisis of May 31, 1793. *(See* Girondists.)

After Robespierre's fall, Louvet was recalled to the convention and elected a member of the committee of the constitution, president of the assembly, and a member of the committee of public safety. He advocated union among republicans in *La Sentinelle,* which he revived. Under the directory (1795) he was elected member and secretary of the Council of Five Hundred. The bookseller's shop which he had again set up in the Palais Royal was attacked, and Louvet and his wife again fled from Paris. He was appointed consul at Palermo, but died on Aug. 25, 1797, before taking up his post.

Louvet published a part of his memoirs in 1795 under the title *Quelques notices pour l'histoire et le récit de mes périls depuis le 31 mai 1793,* giving a vivid picture of the sufferings of the proscribed Girondists. The first complete edition was published in 1889, ed. F. A. Aulard, *Mémoires de Louvet de Couvrai.*

LOUVOIS, FRANCOIS MICHEL LE TELLIER, Marquis de (1641–1691), French statesman, war minister of Louis XIV, was born at Paris on Jan. 18, 1641. He was the son of Michel le Tellier, whom he succeeded as war minister in 1666. His talents were perceived by Turenne in the war of Devolution (1667–68), who gave him instruction in the art of providing armies. After the peace of Aix-la-Chapelle, Louvois organized the French army. The work of Louvois in the years 1668–72 is bound up with the historical development of the French army and of armies in general. *(See* Army.) Louvois reorganized the military orders of merit, founded the Hôtel des Invalides, and enrolled the nobility and gentry of France for service in the army or at court. The success of his measures is to be seen in the victories of the great war of 1672–78. After the peace of Nijmwegen Louvois was high in favour, his father had been made chancellor, and the influence of Colbert was waning. The surprise of Strassburg in 1681 in time of peace was planned and executed by Louvois and Monclar.

A saving clause in the revocation of the Edict of Nantes, which provided for some liberty of conscience, if not of worship. Louvois sharply annulled. He claimed the credit of inventing the dragonnades, and mitigated their rigour only in so far as licence was prejudicial to discipline. Colbert died in 1683, and Louvois took the ministry for public buildings. Louvois died suddenly on July 16, 1691. Louvois was a war minister only equalled by Carnot. Both organized old armies on a new system, both were admirable contrivers of campaigns, and both devoted themselves to the material well-being of the soldiers. In private life and in the means employed for gaining his ends, Louvois was unscrupulous. His sudden death caused a suspicion of poisoning.

The principal authority for Louvois's life and times is Camille Rousset's *Histoire de Louvois* (1872), a great work founded on the 900 volumes of his despatches at the Depôt de la Guerre. Saint-Simon from his class prejudices is hardly to be trusted, but Madame de Sévigné throws many side lights on his times. *Testament politique de Louvois* (1695) is spurious; L. André, M. *Le Tellier de Louvois et l'organisation de l'armée monarchique* (1906).

LOUYS, PIERRE (1870–1925), French novelist and poet, was born at Paris on Dec. 10, 1870. When he was 19 he founded a review. *La Conque,* which brought him into contact with the leaders of the Parnassians, and counted Swinburne, Maeterlinck, Mallarmé and others among its contributors. He won notoriety by his novel *Aphrodite* (1896), which gave a vivid picture of Alexandrian morals at the beginning of the Christian era. His *Chansons de Bilitis, roman lyrique* (1894), which purported to be a translation from the Greek, is a glorification of Sapphic love, whose delicate decadent prose is typical of a modern French literary school. Some of the "songs" were set to music by Debussy and others. Later books are: *La Femme et le pantin* (1898) ; *Les Aventures du roi Pausole* (1900); *Sanguines* (1903); *Archipel* (1906) He died on June 4, 1925.

See Gaubert, *Pierre Louys* (1904).

LOVAT, SIMON FRASER, 12th Baron (c. 1667–1747), Scottish chief and Jacobite intriguer, was born about 1667 and was the second son of Thomas Fraser, third son of the 8th Lord Lovat. Young Simon was educated at King's College, Aberdeen, and one of his first acts on leaving college was to recruit 300 men from his clan to form part of a regiment in the service of William and Mary, in which he himself was to hold a command. Among other outrages in which he was engaged about this time was a rape and forced marriage committed on the widow of the 10th Lord Lovat with the view apparently of securing his own succession to the estates. A prosecution having been instituted against him by Lady Lovat's family, Simon retired first to the Highlands, and afterward (1702) to the court of St. Germain.

He planned to land 5,000 French troops at Dundee. where they might reach the northeastern passes of the Highlands in a day's march, and divert the British troops till the Highlands should have time to rise. Immediatelv afterward 500 men were to land on the west coast, seize Fort William or Inverlochy. and thus prevent the access of any military force from the south to the central Highlands His plan was continuously kept in view in all future attempts of the Jacobites, and finally acted on in the outbreak of 1745 Lovat was despatched (1703) on a secret mission to ascertain what forces the chiefs might bring into the field. He found little disposition to rebellion. and he then decided to reveal all that he knew to the government of Queen Anne. He persuaded the duke of Queensberry that his rival, the duke of Atholl, was in the Jacobite plot, and that if Queensberrp supported him he could obtain evidence of this at St. Germain. Queensberry foolishly entered into the intrigue with him against Atholl, but when Lovat had gone to France with a pass from Queensberry the affair was betrayed to Atholl by Robert Ferguson, and resulted in Queensberry's discomfiture. The story is obscure, and is complicated by partisanship on either side; but Lovat was certainly playing a double game. Suspicions got afloat as to Lovat's proceedings, and on his return to France he was imprisoned in the castle of Angoulême. He remained nearly ten years under supervision, until in Nov. 1714 he made his escape to England.

For about 25 years after this he was chiefly occupied in lawsuits for the recovery of his estates and the re-establishment of his fortune. The intervals were filled by Jacobite and Anti-Jacobite intrigues, in which he betrayed both parties. When the rebellion of 1745 broke out, Lovat represented to the Jacobites that his weak health and advanced years prevented him from joining the standard of the prince in person, while to the Lord President Forbes he professed his cordial attachment to the house of Hanover, and expressed regret that his son had joined the Pretender and taken with him a strong force from the clan of the Frasers. The truth mas that the lad was unwilling to go, but was compelled by his father, After the battle of Culloden he was obliged to retreat to the Highlands. Lovat, after enduring extreme hardships in his wanderings, was at last arrested on an island in Loch Morar. He was conveyed in a litter to London, and after a trial of five days sentence of death was pronounced on March 19, 1747. He was beheaded on April 9.

His son Simon Eraser, Master of Lovat (1726–1782) (not to be confused with another Simon Fraser who saw somewhat similar service and was killed in 1777 at the battle of Saratoga), was a soldier, who at the beginning of the Seven Years' War raised a corps of Fraser Highlanders for the English service, and at the outbreak of the U.S. War of Independence raised another regiment which took a prominent part in it. He fought under Wolfe in Canada, and also in Portugal, and rose to be a British major-general. The family estates were restored to him, but the title was not revived until 1837.

See *Memoirs of Lord Lovat* (1746 and 1767); J. Hill Burton, *Life of Simon, Lord Lovat* (1847); J. Anderson, *Account of the Family of Frizell or Fraser* (Edinburgh, 1825); A. Mackenzie, *History of the Frasers of Lovat* (Inverness, 1896); Mrs. A. T. Thomson, *Memoirs of the Jacobites* (1845–46); and W. C. Mackenzie, *Simon Fraser, Lord Lovat* (1908); *Papers relating to Simon, Lord Lovat* edited by J. R. N. Macphail (1924).

LOVEBIRD, a name bestowed, chiefly by dealers and their customers, on some of the smaller short-tailed parrots, from the affection which examples of opposite sexes exhibit towards each other. They belong to the genera *Forpus* (5 spp.) and *Agapornis* (9 spp.), the former being South American, the latter African. One of the birds most commonly called lovebird, which, however, bears no near relationship to the above, but is a small, long-tailed parrot, is the budgerigar (*Melopsittacus undulatus*) now familiar throughout the world, being bred by hundreds in aviaries. Its native country is Australia.

LOVEJOY, ELIJAH (1802–1837), U.S. abolitionist, was born at Albion, Me., on Nov. 9, 1802, and graduated at Waterville college in 1826. The following year he moved to St. Louis, Mo., where he established a school and entered journalism. Later he began to publish a religious paper called *The Observer* in which he strongly condemned slavery and recommended gradual emancipation. A letter in 1835 signed by a number of the important men of St. Louis requested him to moderate the tone of his editorials. He replied in an editorial reiterating his views and his right to publish them. Threats of mob violence forced him to move his press across the Mississippi river to Alton, Ill. There his press was destroyed by mobs several times in one year, and on the night of Nov. 7, 1837, when a mob attacked the building, Lovejoy was killed in its defense. The news of his death stirred the people of the north profoundly and led greatly to the strengthening of abolitionist sentiment.

LOVELACE, RICHARD (1618–1657), described by Edward Phillips in *Theatrum Poetarum* (1675) as "Souldier, Gentleman & Lover, and a fair pretender to the Title of Poet," came of an old Kentish family but was probably born in Holland, where his father was in the Dutch military service, in 1618. He was educated at Charterhouse and at Gloucester hall, Oxford, when, according to Anthony à Wood's *Athenae Oxonienses*, he was "accounted the most amiable and beautiful person that ever eye beheld." After leaving Oxford he retired "in great splendor to the Court." At 16, according to Wood, but possibly a little later, he wrote *The Scholars*, a comedy acted at Whitefriars, of which the prologue and epilogue survive. He took part in the two expeditions to Scotland (1639–40) and during the second wrote *The Soldier*, a tragedy never acted and now lost.

Returning to his estates in Kent, Lovelace, who had torn up a disloyal petition at the quarter sessions at Maidstone, was chosen to present (1642) a royalist petition to a hostile house of commons. For this he was imprisoned in the Gatehouse, London, where he wrote "To Althea, from Prison." Released "upon good Security" after about seven weeks, he probably went to Holland. He passed much of the next four years abroad and was wounded fighting for the French against the Spaniards at Dunkirk in 1646.

On Oct. 26, 1647, with Thomas Rawlins and Peter Lely, Lovelace, now a colonel, was admitted to the freedom of the Painters company—an unusual and significant honour. In 1648 he was again imprisoned. James Thompson, a lawyer, writing on Oct. 26, said that soldiers searching for Lovelace's brother Francis seized "divers Delinquent Jewells" in Richard's cabinet and that the incensed poet, taking it upon him "stiffly to argue property," was arrested on the pretense that something had been found in his papers (see *The Oxinden and Peyton Letters, 1642–70*). During his imprisonment, Lovelace prepared Lucasta (1649) for the press. Wood identified Lucasta with one Lucy Sacheverell, but if a real person, as is probable, she is as likely to have been a Lucas.

Lovelace continued to write commendatory verses for various publications, a practice he began at 20. Wood says he died in misery and poverty in 1658 and was buried in St. Bride's church, London, but an elegy on him was printed in 1657. He had certainly sold much of his estates, and he who was noted for generosity to ingenious men was himself helped in need by Charles Cotton, but none of the elegies supports John Aubrey's story of his unhappy death.

That Lovelace was himself planning a second volume is shown by Eldred Revett's lines "On his second poems," but *Lucasta. Posthume Poems* of *Richard Lovelace* Esq. (1659) was edited by his brother Dudley, assisted by Revett, and includes *Elegies*, dated 1660.

Lovelace was the friend of musicians, painters and writers such as Henry Glapthorne, who named his daughter Loualis after him, James Howell, Alexander Brome, Andrew Marvell and John Hall, the last of whom liked people who were "celebrated for some excellent endowment," but was so far from being a royalist that *Mercurius Elencticus* (1648) asked if he could be a fit associate for such ingenious and candid souls as Lovelace. John Sherburne, James Shirley or Thomas Stanley, who includes the other three in his "Register of Friends." Lovelace was scholarly and cultured, interested in languages, literature, music, painting, hunting, falconry and everything thought befitting a gentleman.

In his poems Lovelace generally follows the "conceited" fashions of his time, though his best songs owe much to a simplicity of thought and diction which possibly led Sir Walter Scott, when misquoting "To Lucasta. Going to the Warres" in *The Talisman*, to claim it for the earl of Montrose. Obvious criticism is summed up by John Ferriar's "Lovelace strikes, by fits a note divine," but even when Lovelace's verses are only exercises in ingenuity there is audible the voice of one whose conversation was "witty and incomparably graceful," and who succeeded in giving to plain emotions the utterance that is most effective and memorable in song.

See *The Poems of Richard Lovelace*, with an introduction by C. H. Wilkinson, 2 vol. (1925). (C. H. Wn.)

LOVELL, FRANCIS LOVELL, Viscount (1454–1487?), English politician, was a son of John, 8th Baron Lovell. As a young man he served under Richard of Gloucester in the expedition to Scotland in 1480. He had been created a viscount on Jan. 4, 1483, and while still a viscount Protector Richard made him chief butler. As soon as Richard became king, Lovell was promoted to be lord chamberlain. Lovell helped in the suppression of Buckingham's rebellion, and as one of Richard's most trusted ministers was gibbeted in Collingbourne's couplet with Catesby and Ratcliffe:

> The catte, the ratte and Lovell our dogge
> Rulyth all England under a hogge.

He had command of the fleet which was to have stopped Henry Tudor's landing in 1485, but fought for Richard at Bosworth and after the battle fled to sanctuary at Colchester. Thence he escaped next year to organize a revolt in Yorkshire. When that failed he fled to Margaret of Burgundy in Flanders. As a chief leader of the Yorkist party he had a foremost part in Lambert Simnel's enterprise. With John de la Pole, earl of Lincoln, he accompanied the pretender to Ireland and fought for him at Stoke on June 16, 1487. He was seen escaping from the battle, but was never afterward heard of. More than 200 years later, in 1708, the skeleton of a man was found in a secret chamber in the family mansion at Minster Lovell in Oxfordshire. It is supposed that Francis Lovelf had hidden himself there and died of starvation.

Collingbourne's couplet is preserved by Fabyan, *Chronicle*, p. 672. For the discovery at Minster Lovell see *Notes and Queries*, 2nd ser. i and 5th ser. x.

LOVER, SAMUEL (1797–1868), Irish novelist, artist, song writer and musician, was born in Dublin on Feb. 24, 1797. Lover began life as an artist, and was elected in 1828 a member of the Royal Hibernian academy. His love for music showed itself at an early age. At a dinner given to the poet Tom Moore in 1818 Lover sang one of his own songs, which elicited special praise from Moore. One of his best-known portraits mas that of Paganini, which was exhibited at the Royal Academy. He went to London about 1835, where his gifts rendered him popular in society; and he appeared often at Lady Blessington's evening receptions. There he sang several of his songs, later published as *Songs and Ballads,* 1839. Lover wrote some popular novels, among them *Rory O'More,* a *National Romance* (1837) and *Handy Andy, an Irish Tale* (1842). In 1844 he began to give entertainments, "Irish Evenings," illustrative of his own works. He died on July 6, 1868.

His *Life* mas written in 1874 by Bayle Bernard.

LOW, SETH (1850–1916), U.S. municipal reformer, university builder and philanthropist, was born in Brooklyn, N.Y., Jan. 18, 1850. He graduated as valedictorian of Columbia college in 1870, thereupon entering his father's prosperous importing business and becoming a leader in the silk trade.

Low was twice elected mayor of Brooklyn, and his administration (1882–85) was characterized by civil service reform, administrative efficiency, public school reorganization and advocacy of home rule, all of which attracted national attention.

Low served as president of Columbia from 1890 to 1901, transforming Columbia from a small college on a crowded city block to a large university on an impressive campus on Morningside heights. He gave coherent form to the university spirit, organized the university council, the graduate faculties of philosophy and pure science, and by absorption or alliance brought the College of Physicians and Surgeons, Barnard college, Teachers college and other important components more closely into the Columbia university system. He set an example of philanthropy by his gift of the imposing central building on the new campus, by his support of professorships and by his aid, through Barnard, of education for women. In 1899 he was a delegate to the first Hague Peace conference.

Elected mayor of greater New York in 1901, Low eliminated plaguing paternalism and demonstrated municipal administration on business principles. Failing re-election in 1903, he nonetheless continued outstanding public service, furthering education for Negroes as chairman of the trustees of Tuskegee institute from 1907 until his death, and labour-management relations as arbitrator in major disputes. He served also as president of the National Civic federation and the New York Chamber of Commerce.

Low died Sept. 17, 1916, at his home in Bedford Hills, N.Y.

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(R. G. HE.)

LOWBOY, a small table with one or two rows of drawers, so called in contradistinction to the tallboy, or double chest of drawers. Both were favourite pieces of the 16th century, both in England and America; the lowboy was most frequently used as a dressing table, but sometimes as a side table. It is usually made of oak, walnut or mahogany, with brass handles and escutcheons. The more elegant examples of the Chippendale period have cabriole legs, claw-and-ball feet and carved knees, and are sometimes sculptured with the favourite shell motif beneath the centre drawer.

LOWDEN, FRANK ORREN (1861–1943), U.S. lawyer and politician, governor of Illinois from 1917 to 1921, was a nationally prominent advocate of reforms in governmental administration and of improvements in the social and economic condition of farmers. He was born at Sunrise City, Minn., Jan. 26, 1861, but from the age of seven grew to manhood in Hardin county, Ia. There he worked as farm hand and schoolteacher, and graduated from the state university in 1885. Quick success as an attorney followed his move to Chicago in 1886 and his graduation the next year from the Union College of Law. His marriage in 1896 to Florence, daughter of George M. Pullman (*q.v.*), had an important influence on his career. During the next decade, while counseling, directing or organizing business corporations, he established his home at "Sinnissippi," an estate near Oregon, Ill. There and on his Arkansas plantations he experimented with field crops, livestock and forestation.

His long apprenticeship in Chicago politics ended in 1904 in an unsuccessful bid for the Republican gubernatorial nomination. From then to 1912 he was a moderately progressive national committeeman of his party. In congress, 1906–11, he sponsored measures to improve the foreign service and benefit agriculture.

As governor of Illinois, in addition to vigorously upholding Pres. Woodrow Wilson's war policies, Lowden initiated a widely-imitated state budgetary and administrative structure, centralized under executive control. Although his political career climaxed in a deadlock with Leonard Wood for the Republican presidential nomination in 1920, which resulted in their both being by-passed in favour of Sen. Warren G. Harding, Lowden declined the vice-presidential nomination in 1924, sought the presidential nomination in 1928, and, as "Sage of Sinnissippi," often advised politicians and political scientists until his death at Tucson, Ariz., March 20, 1943.

Following 1920, however, farmers' welfare was Lowden's principal concern. In frequent speeches and articles and through many organizations he championed marketing co-operatives, purebred dairy cattle, and improved methods of tillage. After 1925, with the agricultural depression deepening, he supported the McNary-Haugen bills for extending federal aid to farmers. The Domestic Allotment law of 1936 embodied his proposal, made seven years previously, to tie in government assistance with soil restoration.

Lowden's papers are in Harper Library, The University of Chicago.

See William T. Hutchinson, *Lowden of Illinois,* 2 vol. (1957).

(W. T. HN.)

LOWE, SIR HUDSON (1769–1844), English general, was the son of an army surgeon, John Lowe, and was born at Galway on July 28, 1769 and was gazetted ensign in his 12th year. After the outbreak of war with France early in the year 1793, Lowe was almost continuously on active service: holding many important commands, throughout the Napoleonic Wars. Charged with the duties of quartermaster general of the army in the Netherlands in 1814–15, he was about to take part in the Belgian campaign when he was offered the command of the British troops at Genoa; but while still in the south of France he received (on Aug. 1, 1815) news of his appointment to the position of custodian of Napoleon, who had surrendered to H.M.S. "Bellerophon" off Rochefort. Lowe was to be governor of St. Helena, the place of the ex-emperor's exile.

Friction soon arose between Lowe and his prisoner. The news that rescue expeditions were being planned by the Bonapartists in the United States led to the enforcement of stricter regulations in Oct. 1816, Lowe causing sentries to be posted round Longwood garden at sunset instead of at 9 P.M. He was accused of unnecessary harshness in carrying out his instructions. It may, however, be noted that Lowe recommended that the government allowance of £8,000 a year to the Longwood household should be increased by one-half. After the death of Napoleon in May 1821, Lowe returned to England and received the thanks of George IV. In 1825–30 he commanded the forces in Ceylon, but was not appointed to the governorship when it fell vacant in 1830. In 1842 he became colonel of his old regiment, the 50th; he also received the G.C.M.G. He died in 1844.

See W. Forsyth, *History of the Captivity of Napoleon at St. Helena,* 3 vols. (18j3); Gourgaud, *Journal inédite de Sainte-Hélène* (1815–18; 2 vols., 1899); R. C. Seaton, *Napoleon's Captivity in relation to Sir Hudson Loue* (1903); Lieut.-Col. Basil Jackson, *Notes and Reminiscences of a Staff-Officer* (1903); the earl of Rosebery, *Napoleon; the Last Phase* (1900); J. H. Rose, *Napoleonic Studies* (1904); *see* also NAPOLEON I.

LOWELL, ABBOTT LAWRENCE (1856–1943), U.S. educator, president of Harvard university from 1909 to 1933, was born in Boston, Mass., on Dec. 13, 1856. He graduated from Harvard, A.B. 1877, LL.B. 1880, and practised law in Boston for 17 years before turning to teaching at Harvard. In 1909 he succeeded Charles William Eliot as president. Within a few years he had realized a new scheme of "concentration and distribution" to modify Eliot's "free elective" system, devised general examinations to de-emphasize isolated course-credits, and set up a tutorial plan to supplement undergraduate lectures. During his administration Harvard more than doubled student enrollments, nearly trebled the faculty, increased endowments from $22,000,000 to $130,000,000, and added new professional schools of architecture. business administration. education and public health. Beginning in 1930 he reorganized the Harvard undergraduate body of about 3,200 students into seven separate, self-contained residential "Houses." He also originated and endowed the Society of Fellows, a selected group of younger research scholars, freed from conventional restrictions on graduate study. Author of several textbooks on European governmental systems, his influence on U.S. education is better typified by *Conflicts of Principle* (1932, rev. ed. 1956) and *At War with Academic Tradition in America* (1934), both illustrative of his lifelong concern for academic freedom. He died in Boston on Jan. 6, 1943. (N. M. Py.)

LOWELL, AMY (1874–1925), U.S. poet, critic and lecturer, was born on Feb. 9, 1874, in Brookline, Mass., of a prominent and public-spirited family. She was educated by her mother and in private schools. afterward traveling widely abroad. At 28 she began to devote herself seriously to poetry, but published nothing until 1910, when a poem appeared in the *Atlantic Monthly*. Her first volume! *A Dome of Many-Coloured Glass* (1912), was succeeded by *Sword Blades and Poppy Seed* (1914), which included her first poems in *vers libre* and "polyphonic prose"; *Six French Poets* (1915); *Men, Women and Ghosts* (1916); *Tendencies in Modern American Poetry* (1917); *Can Grande's Castle* (1918); *Pictures of the Floating World* (1919), which reflected her new preoccupation with oriental poetry; *Legends* (1921); *Fir-Flower Tablets* (1921), with Florence Ayscough; *A Critical Fable* (1922); a biography of John Keats (1925); *What's o'clock* (1925); *East Wind* (1926); and *Ballads for Sale* (1927). Throughout this period she wrote critical articles for periodicals and frequently lectured. After several years of illness, she died suddenly on May 12, 1925, at Brookline.

During her later years Miss Lowell was the most striking figure in American poetry. Her vivid and powerful personality, her independence and zest made her a conspicuous and unique figure. She epitomized her scorn of convention in such defiant gestures as smoking cigars. She replaced Ezra Pound as the leader of the poetic group called the Imagists. which Pound promptly restyled the "Xmygists" in tribute to her domineering qualities. A bold experimenter in form and technique, she remained conservative at the core, retaining conventional verse forms and in her last years severing connections with all radical schools of poetry. Characteristic qualities of her work include her mastery of the free verse (*q.v.*) technique, her brilliant use of sensuous impressions in depicting the external world, and the restrained beauty of many of' her shorter poems.

Bibliography.—For Miss Lowell's own definitions of the principles of *vers libre* and "polyphonic prose" *see* the preiaces to *Sword Blades and Poppy Seed* and *Can Grunde's Castle*, articles in *North American Review* (Jan. 1917) and *Dial* (Jan. 17, 1918). *See* also W. Bryher, *Amy Lowell: A Critical Appreciation* (1918); R. Hunt and H. Snow, *Amy Lowell* (1921); S. F. Damon, *Amy Lowell: A Chronicle* (1935); Horace Gregory, *Portrait of the Poet in Her Time* (1958).

LOWELL, JAMES RUSSELL (1819–1891), U.S. poet, critic and diplomat. who wrote extensively on a wide variety of subjects, but whose major significance probably lies in the interest in literature he helped develop through his writing. editing and teaching. Born in Cambridge, Mass., Feb. 22, 1819, he was the grandson of John Lowell and a member of the distinguished New England family which in the 20th century produced the poets Amy Lowell (*q.v.*) and Robert Lowell. His lifelong love of nature was nurtured by his rearing in the open countryside, and he had read avidly in Alexander Pope as well as in Spenser, Scott and the old ballads before he entered Harvard, where he followed his enthusiasms more than the instructions of the faculty. He graduated in 1838 and in 1840 took his degree in law, which helped fit him for his later diplomatic posts, although he did not care to practise law as a profession.

His first period. up to about 1850, was dominated by humanitarian interests, notably abolition. in accord with the pressures of the era in New England. In 1844 he was married to the gifted poet Maria White, who was also an ardent humanitarian and who had helped inspire his poems in *A Year's Life* (1841). After a three-months' editorship (with Robert Carter) of the abortive periodical *The Pioneer* in 1843, attracting work by Hawthorne, Poe and Whittier; Lowell published the appreciative *Conversations on Some Old Poets* (1845) in which literary discussion did not exclude sentimental pleas for freeing the slave and for utopianism transcending nationalism. From 1845 to 1850 he wrote about 50 antislavery articles for such periodicals as the *Pennsylvania Freeman*, the *London Daily News* and the *National Anti-Slacery Standard*. Even more effective were his *Biglow Papers* which he began to serialize June 17, 1846 (the first series of which was collected in book form in 1848); written in New England dialect, these satirized the Mexican War as an attempt to extend the area of slavery. This "miraculous year" 1848 also saw the publication of the somewhat Tennysonian *Vision of Sir Launfal*, with its humanitarian theme that "the gift without the giver is bare," and the rollicking and witty *Fable for Critics*, urging American readers to "forget Europe wholly" in glorifying native humanitarian poets such as Whittier.

Lowell's second period, roughly from 1850 to 1867, shows him gradually turning from his earlier antitraditional humanitarianism to nationalism or Unionism, in response to new pressures of the time, notably secession. A trip to Italy and England (July 1851–Oct. 1852) made him less antitraditional, as "Leaves from My Italian Journal" (1854) suggests; and the death of three of his children, followed by the death of his beloved wife in 1853, gave him a taste of sorrows beyond the remedy of legislative reform. In 1855 his lectures on English poets before the Lowell institute led to his appointment as Smith professor of modern languages at Harvard, succeeding Longfellow; these lectures were richly appreciative of the older poets but centred (as "The Function of the Poet") on the theme that America has ample resources to inspire great poetry. Again he went to Europe to study in Germany and Italy, returning in Aug. 1856 for his fruitful professorship of 20 years. In 1857 he married Frances Dunlap, who had cared for his only remaining child, Mabel; and in that year he began his four years' editorship of the new *Atlantic Monthly*, to which he attracted nearly all the major New England authors who (partly through association at the Saturday club) provided mutual stimulation and ushered in a golden day of American literature. As editor. Lowell encouraged them to find the ideal in the real, in the "simply natural" American scene and vernacular as he tried to illustrate in his second series of *Biglow Papers*, devoted to Unionism and collected from the periodicals in 1867. These include "Sunthin' in the Pastoral Line" which, along with "New England Two Centuries Ago" (1865), illustrates the way in which, in the face of the threat to the Union he drew upon his native Puritan heritage of ordered liberty, which he contrasted to what seemed to him the program of anarchy involved in disunion. His central hope in this period was that "a strong nation begets strong citizens," that (as he says in the "Ode Recited at the Harvard Commemoration" of her dead) the mutable many might find worthy perpetuation in the immutable One, a coercive Union, which he glorified in essays such as "E Pluribus Unum." "Washers of the Shroud" (1862) had warned that the nation could be preserved only if Americans subordinated "the Many's plaudits" and "Opinion's Wind" to "Knowledge, Will," and especially to obedience to the divine "Law before all time." The "Commemoration Ode," glorifying "the pith and marrow of the nation," had included the moving tribute to the martyred Lincoln in whom there was "nothing of Europe" — Lincoln who was the product of "the unexhausted West" which was to interest Lowell increasingly as one of the chief nurseries of what he regarded as distinctive national traits—self-reliant individualism, equality and optimism.

Lowell's third period, from about 1867 to the end, was inspired by the growing proof, in the corruptions of the Grant administration, that the Union's having been preserved did not automatically beget morally strong citizens. He saw that he must now change emphasis again and centre his work on ways and means of making the individual man "sole sponsor of himself," on self-mastery in the midst of greed and perpetual temptation. One of the chief means Lowell used to help a nem people, which he thought unduly optimistic and without steadying aids, was tradition, the examples of the heroes of the entire past, especially as embodied in literature. Thus, partly through his editorship (with C. E. Norton) of the *North American Review* (1864–72), Lowell published his successive critical essays on the great masters such as Dante, Chaucer, Spenser. Shakespeare. Cervantes, Calderon, Milton, Dryden, Pope. Fielding,,Lessing, Gray, Wordsworth, Carlyle and Emerson. Guided by Edmund Burke's view of an organic tradition and by Coleridge (the "first of critics"), Lowell sought to winnow and sift ideas of the past which could fruitfully be brought to bear with all their "plastic force" on the needs of contemporary Americans. Thus he exalted the Greeks' "sense of proportion, their distaste for the exaggerated"; Dante's sense of free-willed responsibility in the face of the individual's inward conflict between appetite and aspiration; and Shakespeare's view that this conflict can be resolved not so much on the theological as on the sunlit human plane. Historical tradition ("clarified experience") teaches "the value of personal character as a chief factor in what used to be called destiny." In his long reflective poem, "The Cathedral," in which he spoke of God as being "so far above, yet in and of me." Lowell wistfully concluded that the supernatural faith of the middle ages is "irrecoverable," but he concluded that modern science, agnostic as it seems, can be made to accord with a modified religious faith, that the "cure-all equality" and the "brute's license of unfettered will" need the reinforcement of "private virtue strong in self-restraint." His "Three Memorial Odes" held that true freedom is the fruit of self-control guided by the human ideal synthesized by culture and a sense of the steadying power of traditioc: these lofty "public" poems called for "symmetry of self-control." for self-discipline, for "making man sole sponsor of himself," for "rounding a whole life to the circle fair of orbed fulfillment." His achievement was rewarded by honorary degrees from Oxford (1873) and Cambridge (1874).

Lowell's literary cosmopolitanism was crowned by diplomatic responsibilitie~:Pres. Rutherford Hayes rewarded his support in the Republican convention in 1876 by appointing Lowell minister to Spain (1877–80) and ambassador to England (1880–85). Few diplomats have had Lowell's personal success in creating international good will and understanding. In England he served as president of the Wordsworth society. succeeding Matthew Arnold, with whom he is often coinpared in his idealism and many-sided social criticism; he was popular as a speaker on many notable cultural occasions, and as president of the Birmingham and Midland institute in 1884 he delivered his remarkably wise and persuasive discourse on "Democracy;" centring on the elements common to the British and U.S. governmental traditions which he contrasted in the vein of Burke with the antitraditionalism of the French Revolution. His only difficulty during his responsibility in England was with a small number oi Irishmen in English prisons (during the Fenian turmoil) who tried to get Lowell to intercede on the pretense that they had been U.S. citizens. In the change of administrations Pres. Grover C. Cleveland appointed a successor and Lowell returned home in June 1885, his wife having died in February. He made four more summer visits to England. He died in the house of his birth in Cambridge, Mass., on Aug. 12, 1891.

Lowell's tolerant defense in reviews of such realists as W. D. Howells and Henry James (who wrote two eulogistic essays on him). his long succession of critical disciples such as Barrett Wendell. George Woodberry and Clarence Stedman, not to mention writers devoted to the use of the racy vernacular such as George Eggleston and J. C. Harris, attest to the vitality of his influence. Norman Foerster in 1928 concluded that in combining impressionism. historical understanding and judicial criticism. Lowell's literary creed "is the most representative of man's artistic experience through the ages yet attained in America."

Bibliography.—The most comprehensive collection of his works is the Elmwood edition of The *Complete Writings of James Russell Lowell,* 16 vol. (1904), ed. by C. E. Norton, including the *Letters* (3 vol.); *Lowell: Representative Selections* (1947) edited by H. H. Clark and N. Foerster, contains an extensive critically annotated bibliography of studies about Lowell, as well as a documented introduction of about 140 pages including Foerster's essay on his criticism. H. E. Scudder's *Lowell: 4 Biography* (1901) is supplemented by Leon Howard's *Victorian Knight-Errant* (1952), which covers the period up to 1855 arid makes use of fresh manuscript material and by R. C. Beatty's *James Russell Lowell* (1942) which reflects the southern attitude toward his political work. (H. H. Cl.)

LOWELL, PERCIVAL (1855–1916), U.S. astronomer and founder of the Lowell observatory, was born in Boston. Mass., on March 13, 1855. A member of a brilliant family, he graduated with honours at Harvard in 1876 and after a year of travel returned to Boston where he was active in business. From 1883 to 1893 his energies were chiefly devoted to literature and travel, much of the time in the far east, which he pictured in *Choson* (1885), *The Soul of the Far East* (1888), *Noto* (1891) and *Occult Japan* (1895).

During part of this period he was counselor and foreign secretary to the special mission from Korea t~ the United States. In the 1890s, inspired by Schiaparelli's discovery of the canals on Mars. he determined to devote his fortune and energy to a study of the planets and after careful scrutiny of desirable sites founded the great observatory which bears his name at Flagstaff. Ariz.

Lowell held the theory that intelligent inhabitants of dying Mars are struggling to keep alive by a planet-wide system of irrigation from the water of the melting polar snowcaps and that the canals are bands of cultivated vegetation dependent on such irrigation, Among his books on this subject, *Mars and Its Canals* (1906) is a good example. Early in the 20th century he made an elaborate mathematical study of the perturbations of Uranus which he attributed to the action of an unseen planet beyond Neptune (*Memoir on a Trans-Neptunian Planet,* 1915); and in 1905 he organized a systematic search for such a planet by the staff of his observatory. Fourteen years after his death. this search culminated successfully in the discovery of Pluto (1930). Although Lowell's Martian theory met with opposition, the value and sincerity of his work were recognized and he received numerous honours.

Lowell died at Flagstaff. Nov. 12, 1916.

See L. Leonard: *Percival Lowell* (1921); J. A. Paterson, "Percival Lowell—His Life and Work," *Journ. Roy. Ast. Soc. Canada,* vol. 16, pp. 230 ff. (1922); A. Lawrence Lowell, *Biography of Percival Lowell* (1935). (J. C. Dx.)

LOWELL, a city and one of two seats of Middlesex county (the other is Cambridge) in the northeast section of Massachusetts, U.S. 25 mi. N.W. of Boston and 7 mi. from the New Hampshire boundary, is on the Merrimack river at the mouth of the Concord river. It is a leading manufacturing city, one of the oldest in the United States, and is the centre of a standard metropolitan statistical area including Billerica, Dracut. Tyngsborough, Chelmsford and Tewksbury. Population (1960) of city 92,107; of standard metropolitan statistical area 157,982.

At the close of the 18th century there was only a small village at the juncture of the Merrimack and Concord rivers. A carding mill was built in 1801, and in 1801 the Middlesex canal was completed around Pawtucket falls. where the Merrimack drops 35 ft. Water power provided by these falls was an important factor in the city's location and industrial development. The town was incorporated in 1826 and named for Francis Cabot Lowell. regarded as the originator of American cotton manufacturing. In 1836 the town was chartered as a city. A city-manager form of local government was adopted in 1944. The canal system. important in the growth of Lowell, comprises about 15½ mi. of waterways, parts of which run at right angles to the rivers and divide the city into sections. The waterways, along with a network of highways, compose an interrelated transportation system for industry and commerce.

In the 19th century, large numbers of foreign workers were attracted by the textile industry which reached its peak in the early 1920s and decreased thereafter. Many mills had moved to the southern states by mid-20th century, causing a decline in population. However, new industries began to replace textiles and Lowell's economy became more diversified.

About 200 ac. were set aside as an industrial park under control of a commission, and new factories located there include electronics, plastics and light metals. Other manufacturing establishments produce a wide range of goods including chemicals, machine parts, electronic equipment, fabricated rubber, household tools, cloth and art supplies.

Lowell as an early 19th-century industrial city aroused the interest of Europeans and prompted many to journey across the Atlantic to visit and write of their impressions. Michel Chevalier, the French scholar, came in 1834. Two English observers, Charles Dickens and Anthony Trollope, followed a decade later. For a greater part of the 19th century Lowell was known as the "spindle city*' and the "Manchester of America." Although best known for its pioneering textile industries, Lowell is also famous as the birthplace of the American artist, James Abbott McNeill Whistler, whose house has been converted into a museum. The city has provided two governors for hlassachusetts — Benjamin F. Butler (1883–84). and Francis T. Greenhalge (1894–96).

Lowell has a state teachers college (1894), Lowell Technological institute (1895) which offers research facilities to local industry, a city hospital and two private hospitals, one of the largest city libraries in New England and a city memorial auditorium used for community cultural and civic assemblies. (L. G. H.)

LOWESTOFT, a municipal borough, seaport and holiday town in the Lowestoft parliamentary division of Suffolk, Eng., 44 mi. N.E. of Ipswich and 27 mi. S.E. of Norwich by road. Pop. (1951) 42,834. Area 7.5 sq.mi. In 1086 Lowestoft was a hamlet in the demesne of the royal manor of Lothingland. A weekly market on Jt'ednesdays was granted in 1308 to John, earl of Richmond, together with an eight days' fair. In 1442 William de la Pole. earl of Suffolk, received a further grant of the same market and also two yearly fairs. In 1643 Lowestoft supported the royalist cause but Cromwell carried. off the chief supporters. For several centuries Lowestoft was in dispute with Yarmouth over the herring fisheries until the matter was finally settled in the house of lords in 1662. In 166j the Dutch under Adm. Jacob Opdam were defeated off Lowestoft by the English fleet commanded by the duke of York. Lowestoft china. of soft-paste porcelain, specializing in table and tea wares often bearing Chinese patterns. was made in the town from 1757 to 1802. The old town stands on high ground to the north of the present harbour which was constructed by the Norwich and Lowestoft Navigation company in 1831 and considerably extended by Samuel Morton Peto in 1846. Following the improvement of the harbour and the opening of the railway link with Norwich and London in 1847 Lowestoft developed rapidly as a port and coastal resort. The population increased from 4.671 in 1831 to 21,905 in 188j when it was granted borough status. There are good sands as well as a fine esplanade and two piers; South pier has a pavilion. Oulton Broad within the borough boundary provides yachting, motorboating and a swimming pool.

The outer and inner harbours have quays for the herring and trawl industry which is fifth in importance in the United Kingdom. and for general trade. On the south bank of the inner harbour six construction slips for vessels up to 300 ft. in length were added to the shipbuilding facilities of the port in 1954–55. Canning and food preservation, television, marine radio, electrical apparatus, vehicles. boot and shoe manufacture are other industries.

LOWIE, ROBERT HARRY (1883–1957), U.S. anthropologist, a leading figure in the development of cultural anthropology, was born June 12, 1883, in Vienna, and was brought to New York at the age of ten. He graduated from the College of the City of New York at 18 and, while teaching elementary school for three years, studied under Franz Boas at Columbia, where he received his Ph.D. in anthropology in 1908. From then until 1921 he was affiliated with the American Museum of 'Natural History in New York and undertook many of his major field trips to the Plains tribes, *inter alia* to the northern Shoshone! Assiniboine, Blackfoot and Crow. From 1921 to 1950 he was professor of anthropology at the University of California in Berkeley, serving as chairman of the department for 14 years. His honours and duties included: editorship of the *American Anthropologist* (1924–33); presidency of the American Folklore society (1916–17), the American Ethnological society (1920–21) and the American Anthropological association (1935); election to the National Academy of Sciences (1931). Awards were the Viking medal (1947) and the Huxley medal (1948).

Lonie's most original ethnographic contributions are contained in about 18 monographs on American Indians. Of these his studies on the Crow Indians engaged his most enduring interest and became classic. Later in life he turned to South American ethnography and then to the German culture in which he had been steeped in his youth. Although strongly empiric by conviction, he made distinguished theoretical contributions to the fields of kinship and social organization and folklore and religion. In his younger years he had a strong philosophical bent and wrote widely for liberal, intellectual journals. He died on Sept. 21, 1957, in Berkeley, Calif.

His outstanding books are *Culture and Ethnology* (1917), *Primitive Society* (1920), *Primitive Religion* (1924), *Origins of the State* (1927), *Crow Indians* (1935), *The History of Ethnological Theory* (1937). *Social Organization* (1948), *Toward Understanding Germany* (1954), and, published posthumously (1959), *R. H. Lowie, Ethnologist: a Personal Record,* and *Selected Papers in Anthropology* edited by Cora Du Bois (1960).

See P. Radin. "R. H. Lowie," *American Anthropologist,* vol. 60, no. 2, p. 3j8 ff. (April 1958), with a complete bibliography. (C. D. B.)

LOWIN, JOHN (1576–1653), English actor and a colleague of Shakespeare, was baptized on Dec. 9, 1576; the son of a carpenter. A goldsmith's apprentice for eight years, he joined Worcester's men as an actor in 1602. By 1603 he was a member of the King's company. He is known to have specialized in the roles of comic soldiers as well as downright villains. He created Bosola in Webster's *The Duchess of Malfi.* Shakespeare is said to have coached him in the part of Henry VIII. Lowin was also remembered for his Falstaff and the Jonsonian parts of Morose *(Epicoene)*, Volpone and Mammon *(The Alchemistj.* After the death of John Heminges, Lowin became, with Joseph Taylor, co-manager of the King's company. As such he received payments for the company's appearances in court performances. He also acquired shares as a housekeeper in the Globe and Blackfriars theatres. At the outbreak of the Great Rebellion, after the theatres' closing, Lowin became an innkeeper at Brentford. He was buried on Aug. 24, 1653. (A. M. N.)

LOWNDES, THOMAS (1692–1748), founder of the Lowndean professorship of astronomy at Cambridge university, Eng., was born in 1692. In 1725 he was appointed provost marshal of South Carolina, a post he preferred to fill by deputy. In 1727 Lowndes claimed to have taken part in inducing the British government to purchase Carolina. but he surrendered his patent when the transfer of the colony to the crown was completed. His patent was renewed in 1730, but he resigned it in 1733. He then brought various impractical commercial and financial schemes before the government. He died on May 12, 1748. By his mill he left his inherited Cheshire properties to the University of Cambridge, to be used for the foundation of a chair of astronomy and geometry.

LOW SUNDAY, first Sunday after Easter. It is called in Latin *Dominica in albis (depositis)*, "Sunday in white garments (laid aside)," in allusion to the fact that those who were baptized on Easter have put aside their white robes.

LOW-TEMPERATURE PHYSICS (CRYOGENICS) is that branch of physics which is concerned with the measurement and the interpretation of natural phenomena at low temperatures. This definition cuts across the classification of physics according to the kind of system under investigation; *e.g.,* one speaks of low-temperature nuclear physics, low-temperature solid state physics, etc.

Strictly speaking any measurement below room temperature falls into one of these categories, but it has become customary to restrict the term low-temperature physics (often called cryogenics, although this word more correctly refers to the production of low temperatures) to physical research carried out at temperatures at or below the boiling point of oxygen; *i.e.,* at temperatures below about 90° K. (All temperatures in this article will be given on the absolute scale in degrees Kelvin (° K.). The reader is reminded that on this scale the absolute zero of temperature is at 0° K.. corresponding to −459.6° F., or −273.2" C. *(See* THERMOMETRY.)

Basic Phenomena. — The discovery of techniques for reaching and sustaining very low temperatures opened a new frontier in the study of matter.

Since heat is created by the random motion of molecules (see HEAT), the elimination of it involves bringing matter as close to a static and ordered condition as nature permits. In the close-to-absolute-zero state, the opportunity for new investigation is comparable to the one that was opened when the content of the bulb used in cathode-ray experiments was brought close to a perfect vacuum.

At extremely low temperatures, the electric, magnetic and thermal properties of most substances are found to be greatly altered. Among the phenomena sometimes encountered perhaps the most striking are superfluidity and superconductivity. Some metals, when cooled below a characteristic critical temperature, are perfect conductors of electricity; a current induced in them will continue indefinitely without being maintained. Liquid helium, below a certain temperature, can flow without apparent viscosity through channels a few millionths of an inch in width.

Energy Levels and Order. — Some basic theories commonly accepted up to the turn of the 20th century mere casualties of low-temperature physics. The most striking example is the classical law of P. Dulong and A. Petit, according to which the specific heat of solids should remain constant at all temperatures, It is indeed reasonably constant at high temperatures. However, it decreases with lowering temperature and finally vanishes in the limit of the absolute zero of temperature. The article QUANTUM MECHANICS describes this more fully and discusses how first A. Einstein and subsequently P. Debye drew up quantum models to explain this unexpected low-temperature behaviour.

These models, together with other valid theories of low-temperature phenomena, form part of the modern view that the microscopic components of any physical system can have only certain discrete amounts of energy; *i.e.*, they can occupy only certain definite energy levels. This means that at the absolute zero, where a system must necessarily contain the smallest possible amount of energy, its components must all either occupy the single lowest energy level available to them, or at least, if this is not permitted by the Pauli exclusion principle, they must occupy the fe est possible and lowest possible levels. In quantum mechanical terms, the degree of disorder of a system is related to the number of energy levels occupied by the system's components in excess of the allowed minimum. According to this, therefore, the absolute zero of temperature is the point at which a system achieves its state of highest order. This is equivalent to the statement of the third law of thermodynamics (*q.v.*) that the entropy of any system vanishes at absolute zero, since the entropy is a measure of the disorder of a system. The rise in temperature of a system above the absolute zero is equivalent to its gradual disordering as its microscopic components occupy an increasing number of energy levels above the lowest possible ones. The manner in which this occurs depends uniquely on the values of these energy levels, which in turn are determined by the detailed nature and behaviour of the individual components of the system in question. Thus the importance of cryogenic research arises from the fact that experimental observation of the low-temperature characteristics of a system furnishes vital clues to its spectrum of energy levels, an understanding of which necessarily forms part of a complete theoretical analysis of the system.

A system will become disordered when the thermal energy available to its components becomes comparable to the spacing between their energy levels. This thermal energy is equal to kT, where T is the absolute temperature and k, Boltzmann's constant, is about 10– [illegible] electron volt (ev) per degree. The spacing between the levels, however, depends, as was just mentioned, on the characteristics of the system and will thus be different for different systems. Thus what is a low temperature for one system may be a high temperature for another; *e.g.*, in the absence of an external magnetic field the spacing between the levels of a system of nuclear magnetic dipoles is of the order of 10^{-7} ev, that between the levels of a system of ionic magnetic dipoles at least 10^{-5} ev. As a result, the thermal energy available at about 0.01° K. (10^{-6} ev) is high enough to distribute nuclear dipoles almost equally among the available levels, but is barely sufficient to excite a few ionic dipoles. This means that for the former system 0.01° K. is a high temperature, while for the latter it is a low one.

Experimental **Details.**—When it is desired to measure the properties of a substance at a certain temperature it is necessary to place this substance in good thermal contact with a reservoir at the desired temperature. The simplest and most convenient kind of reservoir is of course a bath of liquid. and indeed low-temperature measurements are carried out as much as possible by this means, using the liquefied form of one of the substances listed in Table I.

TABLE I.—*The Substances Commonly Used as Liquid Baths in Low-Temperature Research*

In liquefaction, the cooling of the gas to its boiling point occurs by two methods, used singly or in combination. After a gas has been compressed isothermally, it can be cooled either by adiabatic expansion, in which the gas pushes against a piston while it is thermally isolated, or by Joule-Thomson (isenthalpic) expansion, in which the gas expands through a throttle valve into a low-pressure space. The amount of gas cooled a small amount by either of these processes then precools the next batch of incoming, compressed gas in a counterflow heat exchanger, so that the next expansion begins at a slightly lower temperature and cools a little further. This process is repeated until the boiling point is finally reached. A thermodynaiaic discussion of the two expansion processes can be found in THERMODYNAMICS; detailed descriptions of various liquefiers are given by J. G. Daunt and S. C. Collins in their contributions to vol. xiv of the Encyclopedia of **Physics** (see Bibliography).

For experimental purposes the liquid which has been obtained is transferred into a so-called Dewar vessel, a double-walled, silvered glass (or highly polished metal) flask, with an evacuated space between the walls, very similar except for size to the conventional Thermos bottle. Liquid air, oxygen, nitrogen and even hydrogen can be kept in such a vessel without further thermal protection for several hours; liquid helium has such a low specific heat that it can be kept for any length of time only if the Dewar flask is in turn surrounded by a similar, larger flask containing liquid nitrogen or air.

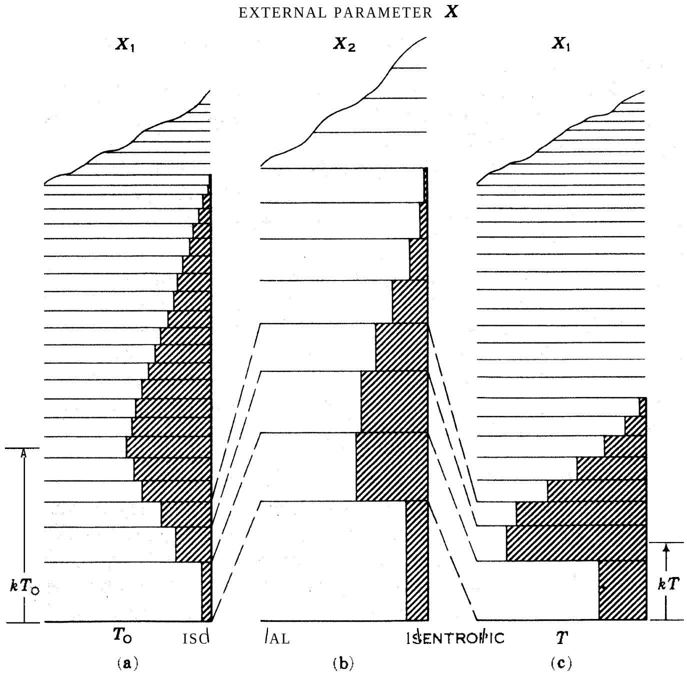
If provisions are made to seal the flask containing the liquid hermetically; *e.g.*, by means of a metal cap and neoprene O-ring gaskets, the pressure over the liquid can be reduced with large vacuum pumps, resulting in a decrease of the temperature of the liquid, down to the freezing point of all the substances listed in Table I except helium. Temperatures between the freezing point of one substance and the melting point of the next lower one can be obtained with apparatus in which the flow of heat in and out of the sample under investigation can be controlled and varied. Helium, as will be discussed in some detail in a later section of this article, does not freeze at all under any pressure less than about 25 atm., so that in principle the liquid could be pumped down to arbitrarily low temperatures. However, the vapour pressure of the liquid becomes so low at about 1" K. that this temperature represents approximately the lower limit which can be achieved by this means.

Thus it is seen that various liquids, under atmospheric or reduced pressure, provide readily available experimental tempera: tures down to about 1° K. Although the bulk of low-temperature research is being carried out in this range. tve have mentioned that for certain systems 1° K. is actually a rather high temperature, so that it is a matter of considerable physical interest to cool them further. In order to understand how this can be done it is well to return to the considerations of the state of order of a system.

The Principle of Cooling. — Consider an arbitrary system in equilibrium at some temperature T such that the thermal energy is large enough to excite most of the system's components into energy levels above the ground state. The distribution of the components among the different energy levels depends on the product of two factors, one the exponent of the ratio of the energy of a level to kT, the other an increasing function of this energy. This means that the level the energy of which is most nearly equal to kT will be most heavily populated, with a gradually lessening number of components occupying the levels of higher and lower energy on either side, as illustrated in fig. 1(A). If now there exists some external variable, such as the volume or the magnetic field, by means of which the spacing of the energy levels can be varied, then a change of this variable such as to increase the spacing of the levels will result in a redistribution of the components of the systems among fewer levels, as shown in fig. 1(B). Hence the order of the system has been increased. If this process has occurred while the system was in thermal equilibrium with some external bath at a fixed temperature, this means thermodynamically that the entropy of the system has been decreased isothermally. As discussed in THERMODYNAMICS, a system can change its entropy only by absorbing or releasing an amount of heat. Thus if the system is now isolated from its surroundings so that it cannot absorb any heat, and the external variable is then returned to its original value. the spacing of the energy levels is again what it was in fig. 1(A), but the entropy or the degree of order is still that in fig. 1(B), since the entropy has not changed in the second part of the process. Hence the system has been returned to the original external conditions with a lower degree of disorder, which means that the temperature of the system has been decreased.

This two-step operation is basic to all physical cooling processes. For a system consisting of a given number of gas molecules, the external parameter affecting the spacing of the energy levels is the volume in which the system is contained. Isothermal compression of the gas lowers its entropy, and its subsequent expansion to its original volume under conditions such that its entropy remains constant will leave the gas at a lower temperature than the initial one. For a variety of reasons, it is often both more convenient and more efficient to expand a gas under conditions such that its entropy changes by a small amount during the second step, as in Joule-Thomson expansion. However, the final state of the gas is always one of lower entropy than its initial value. In general, any cooling process involves the change of some external variable, first one way and then back to its original value, in such a way that the spacing of the energy levels is first increased and then returned to its initial configuration. All this is done so that the final degree of order of the system is higher, which corresponds to a lower temperature.

Adiabatic Demagnetization.— In the case of the isothermal compression and adiabatic expansion of a gas, the ordering of the molecules is due to their taking up increasingly regular positions and to the fact that there is less room for movement. But the disorder of microscopic particles can be due not only to their random location, but also to varying orientation of certain directional quantities, such as the electric or magnetic dipoles which may be associated with the particles. Consider, for example, a crystal of a paramagnetic salt in which associated with each molecule there is a magnetic dipole. Although the spatial disorder of the molecules has to all intents and purposes disappeared at 1° K., the orientation of the magnetic dipoles in the absence of an external magnetic field is still completely random. This is so because the spacing between the finite number of energy levels associated with the possible directions of the dipoles is so small compared with the thermal energy that all these levels are essentially equally populated. This situation, however, can be changed by applying an external magnetic field of 5–10,000 oersted, which will increase the spacing of the energy levels so much that most particles will occupy the lowest one. In terms of direction this simply means that the external magnetic field has aligned the majority of the magnetic dipoles parallel to itself. This corresponds to a high degree of order. If the salt is thermally isolated and the external field is then removed, the energy levels return to their original spacing without a change in the degree of order, which corresponds to a very low temperature for the system of dipoles. If good thermal contact exists between this and the salt as a whole, the salt will thus achieve a temperature which, depending on experimental details and the kind of paramagnetic salt used, can lie anywhere between 0.0015° and about 0.3° K. This method of cooling, called adiabatic demagnetization, was independently suggested by P. Debye and W. Giauque.



AFTER F SIMON ET AL., "LOW TEMPERATURE PHYSICS" (LONDON, 1952)

FIG. 1.—SCHEMATIC REPRESENTATION OF THE COOLING PROCESS.

The horizontal lines represent the values of the energy that the components of the system may have, the lowest line corresponding to the lowest allowed energy. The width of the shaded areas indicates the population of the energy levels. The external parameter X is changed from the value X_1 to X_2 isothermally, and back to the original value X isentropically, reducing the temperature from T_0 to T. The values of the corresponding thermal energies are shown by the length of the vertical arrows

Limits of Low-Temperature Research.—We have seen that any cooling process requires two things: some system which at the initial temperature is still in a high degree of disorder, and some external variable by means of which the spacing of the energy levels of that system can be increased. At the lowest temperatures reached by adiabatic demagnetization of a paramagnetic salt with its system of ionic magnetic dipoles, there is still the system of nuclear magnetic dipoles which even at 0.01° K. are quite randomly oriented. Furthermore, this system is affected in the same manner as the ionic dipole system by the application of an external magnetic field, so that in principle the adiabatic demagnetization of a system of nuclear dipoles can be used to achieve much lower temperatures, estimated to be of the order of 0.00001° K. or even lower. In spite of considerable technical difficulties much progress is being made in this field, especially as nuclei whose magnetic dipoles are ordered in this fashion can be used for much fundamental research; *e.g.,* research on the degree of symmetry of the physical universe.

Inevitably the question of even lower temperatures arises, and the answer is clearly that if at a temperature reached by nuclear demagnetization there is still some as yet unsuspected system with much disorder, *i.e.,* high entropy, and in addition if this system can be ordered by means of some external variable, then even lower temperatures could be achieved. The reason for trying to achieve them would be to discover this as yet unknown system, as it is always true that much can be found out about a system from studies of that range of temperature in which it changes from great disorder to a high degree of order. If, on the other hand. there is no system which is still disordered at nuclear demagnetization temperatures, then not only would it be impossible to achieve lower temperatures, but it would be quite pointless to try, as nothing further could be found out about any system or set of systems once a perfect degree of order had been achieved.

The Measurement of Temperature.— The thermometers used at low temperatures are in principle the same as those used in any other range: they contain or consist of some substance of which one readily measurable parameter varies with temperature in a systematic and reproducible fashion. At room temperature such a device is the mercury thermometer, in which the length of the column of mercury varies linearly with temperature. Thermometers used at lower temperatures include the liquid bath itself, with its temperature-dependent vapour pressure: an amount of gas kept either at constant volume or at constant pressure; and thermocouples, electrical resistors or a paramagnetic salt. The details of these devices, their accuracies and their limitations, are discussed in THERMOMETRY.

Each of these thermometers must of course initially be calibrated, which requires that for each range of temperature one must at one time or another determine the absolute temperature of some thermometric substance from first principles. Sometimes this can be done from a detailed understanding of the substance in question, from which one can then calculate the absolute temperature corresponding to any measured value of the temperature-dependent property. If such an understanding does not exist, it is necessary to invoke the fundamental thermodynamic definition of temperature, namely, that it is the ratio of the amount of heat put into a system at that temperature to the resulting change in the entropy of the system, and to determine the temperature by measuring these changes.

AREAS OF LOW-TEMPERATURE RESEARCH

As was indicated in the introductory paragraph of this article, low-temperature physics includes theoretical and experimental research on all natural phenomena at temperatures below about go° K. It therefore covers so many areas of investigation that it is impossible to give an adequate description of the entire field in this article. This is especially true as the relevance and importance of much low-temperature work can be understood only in terms of an over-all description of behaviour at all temperatures. The following, therefore, constitutes only a brief and inadequate summary of the principal areas of low-temperature physics. Technical but still general background information can be found in the reviews by D. K. C. MacDonald, P. G. Klemens, P. H. Keesom and J. van den Handel in the *Encyclopedia* of *Physics* (see *Bibliography)*, and these articles in turn contain the references needed for a thorough study.

Low-Temperature **Specific** Heats.— The specific heat of any substance is, by definition, the temperature times the derivative of entropy with respect to the temperature. For a single system, therefore, the specific heat will be appreciable only in that region of temperature in which the entropy changes; *i.e.*, in that range in which the system changes its degree of disorder. Most substances contain several such systems, and their specific heat is the sum of the specific heats of the individual systems. In order to separate the individual contributions it is necessary to extend specific-heat measurements to sufficiently low temperatures so that one or more of the systems reaches a state of order and thus an essentially vanishing specific heat. For example, the specific heat of a metallic conductor consists of two parts, one due to the metal lattice and one due to the conduction electrons. Although at normal temperatures the former is much larger than the latter, it becomes quite small at temperatures of the order of 10° K. This makes it possible to obtain the electronic specific heat of a metal.

Electronic Transport Phenomena.— In a metal at room temperature, the current and heat-carrying motion of the electrons is impeded by the vibration of the lattice even in a perfect crystal. As is indicated by the decrease of the lattice specific heat, the spacing of the vibrational energy levels of the lattice is such that at temperatures of the order of 10° K. a considerable degree of order is attained. At such low temperatures, therefore, the scattering of the electrons by the lattice is much decreased, and both the electric and thermal resistivities are due mostly to the presence of lattice imperfections, impurities and strains. Low-temperature measurements of these resistivities make possible the separate evaluation of these various contributions, and have shown the great effect which crystal defects have on the characteristics of a metal and, for that matter, of any solid. Such investigations, together with specific-heat measurements, are among the most important in the continuing attempt to reach a satisfactory understanding of the solid stale.

Magnetic Phenomena.— At various times in the preceding material we have spoken of systems of magnetic dipoles associated with microscopic particles. It is these which determine the magnetic behaviour of a substance. The low-temperature study of magnetism concentrates on two aspects of the characteristics of a magnetic dipole system. There are, in the first place, extensive investigations in which the direction of these dipoles becomes ordered when the thermal energy becomes small compared to the spacing of their directional energy levels. This spacing, in the absence of any external fields, depends on the strength and the kind of interaction of these dipoles with the electric and magnetic fields created by the surrounding microscopic particles. The determination of the temperature at which the system changes from complete disorder (even distribution of the dipoles over all available levels) to some degree of order (preferential occupation of a few of these levels) thus yields information about the strength of these interactions. Depending on the kind of interaction there are different ways in which this directional ordering can occur. In addition to the kind of ordering of the dipoles into a single direction which gives rise to ferromagnetism and occurs at the temperature called the Curie point, after its discoverer, the dipoles can line up in more complicated patterns to give rise to antiferromagnetism, as predicted by L. Neel, or ferrimagnetism, as discovered by J. L. Snoek, E. J. W. Verwey and others.

It is, of course, also possible to change the degree of order of the magnetic dipoles by means of an externally applied magnetic field. Once this field is again removed the dipole system finds itself at a temperature different from that of the surrounding medium. It will then tend to return to the temperature of the surroundings by exchanging with the latter sufficient energy to re-establish a suitable degree of disorder. This process is called relaxation. The time necessary for complete relaxation clearly depends again on the interaction of the dipole system with its surrounding, and this interaction will in turn be affected by the degree of order of the various systems which make up the surrounding. Much useful information not only about the dipole system but also about the neighbouring systems can thus be obtained from a study of magnitude and the temperature dependence of these relaxation times.

In addition to the many areas of physical research in which the use of low temperatures forms only a part of a general investigation and analysis of a basic phenomenon, there exist two fields of study unique to cryogenics: the behaviour of liquid helium and the phenomenon of superconductivity. A detailed description of these two is, therefore, particularly germane to this article.

The Behaviour of Liquid Helium.— When H. Kamerlingh Onnes achieved the liquefaction of helium in 1908, he did not expect this element to have much intrinsic interest, and was mainly concerned with the extension of the experimentally available temperature range to lower values. It soon became apparent. however, that liquid helium was not only very useful to cool other substances, but had itself such unusual and unexpected properties as to warrant extensive and detailed investigation. In fact, these investigations, carried out for almost 20 years exclusively at Leyden, and later in cryogenic laboratories in many other countries, uncovered behaviour so unlike that of any other substance that a full theoretical understanding is still lacking. This behaviour and its possible explanations will be discussed in terms of three aspects: the fluidity of helium under moderate pressures down to absolute zero; the existence of a phase transition to a second liquid phase; and the highly anomalous transport characteristics of this phase.

The Fluidity of Helium at 0° K.—Fig. 2 shows the phase diagram of helium. uhich is quite different from that of a normal substance. At atmospheric pressure the latter is in the gaseous

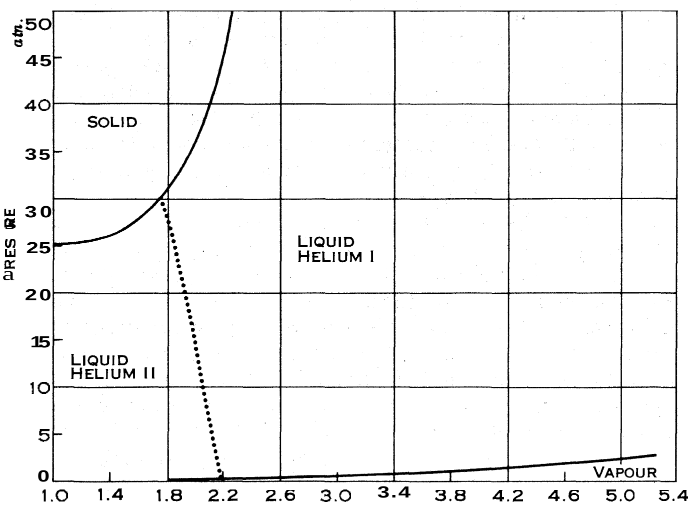


FIG. 2.—PHASE DIAGRAM OF HELIUM

phase at sufficiently high temperatures, condenses into a liquid upon cooling and finally freezes into a solid at some rather low temperature. This is, of course, to be expected from the concept of the relation between the temperature and the degree of disorder of a substance, from which one would conclude that with decreasing temperature, the molecules of a substance would acquire increasing order in space. The phase diagram of helium, however, shows that for pressures below about 25 atm., helium remains liquid down to the absolute zero. In fact, the horizontal melting-pressure curve shows, by application of the Clausius-Clapeyron equation (*see* THERMODYNAMICS), that at sufficiently low temperatures the entropy and therefore the degree of order of the liquid is the same as that of the solid phase.

Clearly this cannot be an order in space, which is precluded by the high mobility of the molecules even in a normal liquid. Instead there must occur, in liquid helium, an ordering of velocities, a possibility which follows from and is in this case actually dictated by the fundamental principles of quantum mechanics (*q.v.*). According to this modern view of the physical universe, the velocity and the position of any particle are of equal importance, and our instinctive emphasis on position is really only due to the fact that spatial ordering is more common and easier to visualize than ordering of velocities. The basic Heisenberg uncertainty principle of quantum mechanics goes one step further in stating that it is impossible to determine simultaneously the position and the velocity of a particle with arbitrary precision, and that the more accurately we measure the one, the more uncertain we become about the other. This means, therefore, that the close definition of the position of molecules upon freezing is accompanied by an uncertainty about their velocity; *i.e.,* the more narrowly a molecule is confined to a certain location, the greater the magnitude of the velocity with which it oscillates about this point. Another way of saying this is that any attempt to minimize the potential energy of a particle, by placing it in the most favourable position with respect to other bodies which either repel or attract it, is accompanied by an increase in the kinetic energy of the particle, which is the greater the more the particle is localized.

This means that at absolute zero a substance still has some potential and kinetic energy, adding up to what is called the zero-point energy. This is in sharp contrast to the classical view that at absolute zero a substance has lost all energy by having all its particles immobile in the position of minimum potential.

The increase in the particle's kinetic energy due to localization can easily be shown to be inversely proportional to the mass of the particle. With a helium atom, therefore, this energy is unusually large, while at the same time the weak forces existing between helium atoms render quite small the decrease in potential energy gained by having an atom in its most favourable position. It is thus energetically not favourable to localize the helium atoms, and thereby to create order in space; instead a lower total energy can be obtained by minimizing the kinetic energy, which is equivalent to reducing and hence ordering the velocity, at the cost of a small increase in potential energy.

The Phase Transition (λ *point.*)—When liquid helium is cooled under its own vapour pressure, it undergoes a transition from one liquid phase into another at about 2.18° K. These phases are designated by Roman numerals, and one speaks, respectively, of liquid helium I and liquid helium II, the latter denoting the phase existing at lower temperatures. Several of the characteristic variables of the liquid undergo an abrupt change at this transition; in particular its specific heat has a discontinuity, as shown in fig. 3. The resemblance of the shape of this curve to a reversed Greek letter lambda has led to the designation of the transition point as the λ point. The dotted line in fig. 2 is called the λ line and indicates the different pressures and temperatures at which phases I and II are in equilibrium with one another. The highly unusual behaviour of liquid helium II will be discussed presently.

Certain features of the λ transition led F. London (1935) to suggest that it is a so-called order-disorder transition, similar to the Curie point of ferromagnetic substances. Between the normal boiling point and the λ point the ordering which occurs in liquid helium is much like that occurring in any liquid with decreasing temperature: the molecules are distributed over fewer and fewer of the energy levels corresponding to different velocities. At all these temperatures, however, the distribution is such that only an infinitesimal number of the molecules occupy the lowest or ground state. Below a certain quite sharply defined temperature, however, a finite number of the molecules are "condensed" into the ground state, corresponding to the lowest permitted velocities.

It is well to remember that this so-called zero-point velocity is not zero, since the partial localization of the atoms by the walls of the box in which they are contained precludes, according to the uncertainty principle, a vanishing and hence sharply defined velocity.

Below this transition, therefore, the liquid can be considered as consisting of two entirely intermixed components, one comprising all the atoms still distributed over the higher energy levels, and the other consisting of the atoms in the ground state. The former component is qualitatively similar to any liquid, and is therefore in this phenomenological view called the normal component.

The second component, however, should exhibit very astonishing features, since by inverting the uncertainty principle argument just used to show that the ground state velocity is finite, it is clear that the position of these atoms in the ground state is only defined by the walls containing the liquid as a whole. In a way, therefore, these ground-state atoms must be considered as being everywhere in the container at once, and hence should be able to move throughout the container without any friction. Because of this, this component is called the superfluid one. As the temperature decreases from the transition point an increasing number of atoms are condensed into the ground state and hence the superfluid component comprises an increasing fraction of the liquid as a whole, until at the absolute zero the entire liquid is superfluid.

London's phenomenological model of the λ transition received much support with the discovery, isolation and investigation of a rare isotope of helium of mass 3. The condensation of many atoms into the ground state is possible only if these atoms follow Bose-Einstein statistics, and such a process is called Bose-Einstein condensation. The atoms of the prevalent isotope of helium, with mass 4, do follow such statistics, but the atoms of He^3 follow Fermi-Dirac statistics for which; according to the Pauli exclusion

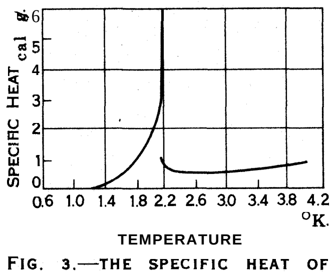


FIG. 3.—THE SPECIFIC HEAT OF LIQUID HELIUM UNDER ITS VAPOUR PRESSURE AS A FUNCTION OF TEMPERATURE

principle, any energy level can only be occupied by a single particle. Thus, according to London, He^3 should not have a λ transition, although it too should remain liquid down to the absolute zero since the arguments for this fluidity are independent of statistics.

Indeed it has been found experimentally that down to the lowest temperatures at which it has been investigated (about 0.29° K.) He^3 does remain liquid but does not change into a superfluid phase.

At sufficiently low temperatures there begins to occur instead spontaneous alignment of the atomic magnetic dipoles.

These highly qualitative arguments of course do not constitute an explanation for the behaviour of liquid helium but at best indicate a possible mechanism for the λ transition and the peculiarities of helium II. In particular it must be remembered that the division of this liquid into two components is highly artificial, as of course it is not possible to label any one atom as normal and some other as superfluid. The only distinction between them is that one carries a quantum of energy which the other does not. Any interaction between such atoms results in the transfer of this quantum from the one to the other, with a resulting exchange of identity with respect to being normal or superfluid. In fact. a most fruitful systematic approach to a theory of liquid helium from first principles is that of L. Landau, who considers these freely interchangeable quanta of energy (generally called elementary excitations) separately as an independent system superimposed on a sea of particles all in the ground state.

The Characteristics of Helium 11.—The principal features of liquid helium II are its ability to flow through narrow slits and capillaries without apparent viscosity, its almost unlimited thermal conductivity and its formation of thin films by means of which it flows over the rims of beakers, etc.. to the lowest attainable level. Qualitatively, at least, the mechanism for most of these effects can be deduced from the two-component model described above. The nonviscous flow through narrow apertures is a consequence of the frictionless flow of the superfluid component. This also explains the film flow. The anomalously high ability to conduct heat arises from the fact that at any given temperature the liquid can be thought of as containing a certain fraction of superfluid which decreases with increasing temperature. If some heat is introduced into the liquid at one place, the fraction of superfluid there will decrease, with a corresponding increase in the number of normal atoms. Equilibrium will be re-established by an internal convection process in which superfluid atoms will travel toward the hot spot, and normal atoms away from it. As this counterflow occurs without viscosity due to the nature of the superfluid, it is all but impossible to establish a thermal gradient in liquid helium II. *A* spectacular demonstration of this is the fact that whereas liquid helium I in a Dewar vessel boils violently, the liquid becomes completely quiescent as soon as the λ point is passed. This is because the boiling in a normal liquid is due to bubbles created at local hot spots, and these do not exist in liquid helium II.

Full descriptions and illustrations of the fascinating and often amusing behaviour of liquid helium II can be found in the first two books listed in the bibliography.

The Phenomenon of Superconductivity.— One of the first experimental uses to which Kamerlingh Onnes put his newly acquired liquid helium was the investigation of metallic conductivity at low temperatures. While measuring the electric resistance of mercury he found, in 1911, that this variable at first decreased gradually with decreasing temperature. as expected, but that at about 4° K. the resistance fell very abruptly to a very low value. All attempts to measure this resistance failed, and Onnes concluded that below this transition point mercury was what came to be called a superconductor with vanishing electric resistance.

Extensive experimental work since that time in many different laboratories has established that 22 metallic elements and a large number of intermetallic compounds become superconductive at temperatures ranging from about 17° K. down to about 0.1° K. The superconductive elements and their transition temperatures are listed in Table II. There is some reason to believe that at temperatures below 0.1° K. five more elements become superconducting, namely molybdenum, tungsten, ytterbium, scandium and protactinium.

TABLE II.—*The Superconducting Elements and Their Transition Temperatures* (T_c)

Element	T_c(° K.)	Element	T_c(° K.)
Aluminum	1.197		3.729
Titanium	0.387	Lanthanum	5.4
Vanadium	4.89	Hafnium	0.37(?)
Zinc	0.905	Tantalum	4.38
Gallium	1.103	Rhenium	1.699
Zirconium	0.546	Osmium	0.71
Siobium	8.70	Mercury	4.173
Technetium	11.2	Tellurium	2.392
Ruthenium	0.47	Lead	7.2
Cadmium	0.560	Thorium	1.37
Indium	3.396	Uranium	0.8

While there is no room here for a detailed description of the characteristics of a superconductor, it is possible to discuss briefly the three major experimental discoveries which ultimately led to an understanding and theoretical analysis of the phenomenon.

Destruction of Superconductivity by a Magnetic Field.—A few years after the initial discovery of superconductivity Onnes and co-workers at Leyden found out that the superconducting properties of a substance below its transition temperature could be destroyed by the application of an external magnetic field. Detailed investigation showed that this so-called threshold field increased from a zero value at the transition temperature to a maximum at the absolute zero. varying in this range approximately as the square of the difference between the transition temperature and the temperature of measurement.

It was realized several years later that this property made possible a thermodynamic treatment of superconductivity with the assumption that the transition from the normal to the superconductive state is reversible, but without any further knowledge of the details of the superconducting mechanism. If one considers the normal and the superconductive state of a metal as two phases which are in equilibrium at any point on the threshold magnetic-field curve, then the free energies of the two phases must be equal at any point on this curve. This makes it possible to relate the difference of the free energies of the two phases to the threshold field, and in turn allows one to express the difference in the entropies and the difference in the specific heats of the normal and superconductive phases in terms of the temperature derivatives of the threshold field: which can be experimentally determined. The relation for the entropy difference immediately shows that the superconductive entropy is less than the normal one at all finite temperatures below the transition, which means: as expected. that the degree of order of a superconductor is higher than that of the same metal in the normal phase. *A* further consequence, also experimentally verified, is that the specific heat shows a discontinuity at the transition.

The Meissner Effect.—The application of a simple thermodynamic treatment to superconductivity depends, as was mentioned, on the reversibility of the transition. This condition is not fulfilled for a perfect conductor, as indicated in the following example. Consider a potential superconductor at some temperature above the transition, and in an external magnetic field. When the temperature is lowered below the transition and the magnetic field removed, the sample will be superconductive, and if the transition is indeed reversible it should make no difference which of these steps is taken first. With a perfect conductor, however, it does matter: if the temperature is lowered in the presence of the field, and the field is then removed, Faraday's law of induction, together with the ability of the substance to maintain currents without dissipation, requires that the magnetic induction inside the sample remain at the value which it had when the external field reached the threshold value. If, on the other hand, the field is first removed, and only then the temperature lowered, the magnetic induction inside the sample will be zero.

W. Meissner and R. Ochsenfeld showed in 1933 that in a superconductor the magnetic induction is zero regardless of the path along which the transition has occurred. They concluded that the vanishing of the magnetic induction inside a superconductor (called the Meissner effect) is a basic characteristic. It has, in fact, come to be considered more fundamental than the property of infinite conductivity.

The Meissner effect not only ensures the reversibility of the superconductive transition and thus allows the application of simple thermodynamic treatment, but has also enabled F. and H. London to draw up a set of very successful phenomenological equations governing the electromagnetic characteristics of superconductors.

The Isotope Effect. — Our understanding of superconductivity was further greatly increased when C. Reynolds, B. Serin and coworkers, and E. Maxwell discovered independently in 1950 that the superconductive transition temperature of an element depends on its isotopic mass. As this mass is a property only of the metallic lattice, and the superconductive behaviour obviously involves the conduction electrons, this so-called isotope effect indicates beyond any doubt that the fundamental mechanism responsible for superconductivity involves the interaction between these electrons and the lattice. H. Frohlich had suggested this possibility in 1950 on theoretical grounds without being aware of the concurrent experiments.

That this interaction should be responsible for superconductivity is in a sense quite remarkable, for it was mentioned earlier that it is just this interaction which in normal metals inhibits conductivity and is responsible for electrical resistance. However, J. Bardeen and co-workers in 1957 were able to show from first principles that under certain conditions and at sufficiently low temperatures this interaction affects the electronic energy levels in such a way as to make energetically favourable a type of condensation into low-lying levels with a resulting ordering of the velocities. The behaviour of these condensed electrons had previously been shown by Bardeen to lead to the basic superconductive characteristics, including the vanishing of the magnetic induction and the perfect conductivity.

See also REFRIGERATION.

BIBLIOGRAPHY.—By far the best nontechnical discussion of low-temperature physics is F. Simon *et al., Low Temperature Physics* (1952). The best starting point for a more detailed study of any of the subjects mentioned in this article are vol. xiv and xv of the *Encyclopedia of Physics (Haizdbuch der Pkysik)*, ed. by S. Fluegge (1956). These volumes contain articles in English on the production of low temperatures, low-temperature transport, thermal and magnetic properties of solids, superconductivity and liquid helium. Each of these articles in turn contains a full list of more detailed references. Of interest also are the regularly published volumes of "Progress in Low Temperature Physics," ed. by C. J. Gorter, which contain up-to-date reviews of current research. (E. A. L.)

LOWTH, ROBERT (1710–1787), English bishop and student of Hebrew poetry, was born at Winchester on Nov. 27, 1710. He was educated at Winchester college, and New college, Oxford, and in 1741 was appointed professor of poetry at Oxford. Lowth was consecrated bishop of St. David's in 1766 and in the same year was translated to Oxford and in 1777 to London. He died at Fulham palace on Nov. 3, 1787.

Lowth's *Lectures on the Sacred Poetry of the Hebrews* (Eng. trans. from Latin, with notes, 1793), his chief work, had a great influence in England and on the continent. Their chief importance lay in the idea of looking at the sacred poetry as poetry, and examining it by the ordinary standards of literary criticism. He described the typical forms of Hebrew poetry as these occur in the Psalms. Lowth defined the principle of parallelism as the fundamental principle in Hebrew poetry, in contrast with the principle of metre which is fundamental in European poetry.

See P. Hall (ed.), *Sermons and Other Remains of Robert Lowth* (1834), with introductory memoir.

LOXODROME, the line on the earth's surface making a constant angle with the meridian.

LOYALISTS (TORIES), AMERICAN, the names given to colonists who retained their allegiance to Great Britain during the American Revolution. Contemporaries bitterly called them "Tories" but their descendants in Canada and elsewhere and later generations of Americans have referred to them as "Loyalists." According to the most generally accepted estimate; about one third of the North American colonists were Loyalists. Scholars have tried to determine just what classes comprised the Loyalists but have not agreed on any precise classification. Loyalists were not confined to particular groups; they were in every section, every calling and every class of the thirteen colonies. In general, loyalism was strongest among officeholders and others who served the crown or proprietors; Anglican clergymen and their parishioners in the north; Quakers and other conscientious pacifists, such as members of German religious sects; large landholders, particularly in the north; and wealthy merchant groups in New York, Philadelphia, Baltimore, Charleston and elsewhere whose businesses and property were affected by the war. A considerable proportion of the professional and intellectual talent, mainly physicians, lawyers, teachers and writers, also opposed the revolutionary movements.

Motivations. — Colonial officeholders, usually men of eminence and power, had a vested interest in upholding the authority of the crown. Many had been born in England and lived in the colonies only because of their employment. Upon entering their positions, they had, moreover, taken special oaths of allegiance to the crown, oaths they considered binding. The Anglican clergy had likewise vowed allegiance and obedience to their king; many had been born in Britain, all had been ordained there, and large numbers received part of their incomes from England. Throughout the Revolutionary War most of them preached obedience and submission to authority and they undoubtedly influenced the political attitudes of their parishioners. This was not true in the south, however. There many of the most distinguished Patriots, or Whigs as they called themselves, were adherents of the established church and men chose sides with little reference to their church affiliation. Among Quakers many deplored the measures of the British government but as a matter of religious conviction abstained from violence and resistance and their leaders counseled obedience and respect for authority.

Among men of status and property who resisted change, detested the "vulgar mob," were appalled by the destruction of property and feared an uncertain future of independence, self-interest was the dominant motive in loyalism. But the most commonly shared trait among all Loyalists appeared to be an innate conservatism coupled with a deep devotion to the mother country and the crown. Numerous Loyalists at first urged moderation in the struggle for colonial rights; some sided with Great Britain slowly, others were driven into active loyalism by their radical fellow colonists who denounced as Tories all who would not join them. The Revolutionary War left no place for moderates or those who wished to remain neutral. More than any other single factor, apparently, the resort to violence by the radicals confirmed the conservatives in their position.

Loyalists were most numerous in the south, New York and Pennsylvania. New York, the most aristocratic of the colonies, was the Loyalist stronghold and contained more of them than any other colony. Two thirds of its land belonged to the Loyalists or the crown. New Jersey, Delaware, Maryland and Virginia had large Loyalist minorities. In North Carolina the Loyalists and Patriots were about equally divided. South Carolina and particularly Georgia contained Loyalist majorities. New England had fewer than any other section.

Loyalist War Efforts. — Even though Loyalists did not rise in a body in support of the British army, as British authorities had hoped they would, some joined the army and others organized guerrilla bands who, with Indian allies, terrorized the frontier from New York to Georgia. New York alone furnished some 23,000 Loyalist fighters, perhaps as many as all the other colonies combined. A few Loyalist units, such as Patrick Ferguson's "American Riflemen," Banastre Tarleton's "Legion," Sir John Johnson's "Loyal Greens," and Walter Butler's "Tory Rangers," fought effectively. The Loyalist fighters aroused a vengeful hatred among the Patriots and when taken in battle were treated as traitors. George Washington detested them, saying as early as March 1776 that "they were even higher and more insulting in their opposition than the regulars." (Lorenzo Sabine, *A Historical Essay on the Loyalists of the American Revolution*, p. 14, The Walden Press, Springfield, Mass., 1957). When Gen. Charles

Cornmallis surrendered at Yorktown in 1781, Washington would grant no terms to the Loyalists who had fought against him, saying they were guilty of treason and deserved its penalties.

Congress recommended repressive measures against the Loyalists and all states passed severe laws against them, usually forbidding them to hold office, disenfranchising them and confiscating their property or taxing it heavily. Practically every state struck at them with a test act requiring citizens to renounce allegiance to George III and to promise to support the state against the crown. Some Patriots took the position that, as the late George M. Wrong wrote in *Canada and the American Revolution* (1935), "a Tory is a thing whose head is in England and its body in America and its neck ought to be stretched." Almost everywhere the Loyalists suffered persecution. Beginning in March 1776 when Sir William Howe evacuated Boston for a safer base at Halifax, Nova Scotia, with about 1,000 Loyalists, some 100,000 Loyalists fled into exile. (This was between 3% and 4% of the total number of settlers in the colonies, estimated at 2,500,000—3,000,000 during the Revolutionary period.) The majority of those who fled (about 60,000) ultimately went to Canada, where they and their descendants became known as "United Empire Loyalists." The remainder spread to the Bahamas, the West Indies, Florida and England.

Postwar Settlements. — The peace treaty of 1783 brought the Loyalists little comfort, even though it provided that congress would "earnestly recommend" to the states the restitution of Loyalist property and that there should be no further prosecutions of Loyalists or confiscations of their estates. Americans greeted those terms with flurries of protest and state legislatures refused to heed the recommendations of congress. In the first two years after the peace, returning Loyalists were sometimes tarred and feathered, mobbed and even hanged. Finally, by the beginning of the new government under the federal constitution in 1789, many regained their estates, but the confiscation laws were not repealed by the states, and in fact all the laws against the Loyalists were not erased until after the War of 1812. The British, meantime, had used the continued mistreatment of the Loyalists as one excuse for retaining certain military posts on American territory in the old northwest until 1796 in violation of the peace treaty.

Beginning during the war, the British government tried to care for exiled Loyalists by giving them lucrative positions, food, clothing, shelter and new homes in Canada and by compensating them for losses in property and income. At the end of the war, Loyalist officers received pensions at half pay and grants of land according to rank. In July 1783 parliament appointed commissioners, numbering ultimately five, to investigate Loyalist claims and establish schedules for compensation. As late as 1792 the British government was still meeting claims by grants of land. In all, it expended some $30,000,000 in behalf of the Loyalists.

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LOYALTY, as a general term, signifies a person's devotion or sentiment of attachment to a particular object, which may be another person or group of persons, an ideal, a duty or a cause. It expresses itself in both thought and action and strives for the identification of the interests of the loyal person with those of the object. Loyalty turns into fanaticism when it becomes wild and unreasoning; and into resignation when it displays the characteristics of reluctant acceptance. A man without loyalty does not exist. It stirs and arouses him, brings meaning, direction and purpose into his life and unifies his activities. At the same time, loyalty has a social function. Only by man's willingness, in co-operation with others, to invest his intellectual and moral resources generously and wholeheartedly in something beyond his own narrow circle has it been possible for communities of various kinds to emerge and continue to exist; among them, family, church and nation. Both man and community are unthinkable without loyalty.

Political loyalty is devotion to, and identification with, a political cause or a political community, its institutians, basic laws, major political ideas and general policy objectives. A cause to which persons are loyal is often considered "lost" by those who do not share the loyalty; in the face of what seemed to others fearful odds, the Irish, Poles and Zionists never wavered in their loyalty to the cause of their national independence, which they ultimately regained. Loyalty to the laws of Athens, which brought him into the world and nurtured and educated him, was the chief motive of Socrates in accepting death at the hands of a regime that he had opposed and ridiculed, rather than fleeing from prison when given the chance to do so.

The nature and content of political loyalty has varied greatly through the ages. In Greek political thought the principle of unity in life tended to preclude the possibility that a variety of important loyalties might lay claim to the individual and alienate him from the polis, the city-state. Aristotle's famous dictum that man is by nature a political animal stated well the conviction that man could realize his aspirations only by active participation in the affairs of the city-state, which was the highest of all communities because it aimed at a more comprehensive good than any other, and at the highest good, the perfection of human development. A man was expected to be loyal to the city-state and no one else.

Occasionally, however, a conflict of loyalties did arise. Loyalty to the vague concept of a Greek commonwealth of nations, standing over and above individual city-states and overriding local loyalties, inspired Athens' rejection of an alliance with Persia. In Sophocles' *Antigone* the heroine counters the ruler's decree forbidding the burial of her brother with a moving appeal to the moral law of Zeus, which, she believes, has more valid claims to her loyalty than the duly constituted government. Plato's *Republic* expressed concern that the enjoyment of family life and private property by the governing guardian class would result in a conflict of loyalties from which the state would emerge second best.

Other people in antiquity also searched for unity through the state. The Romans, extolling the virtue of political duty, proudly professed their loyalty in the saying *civis Romanus sum*, "I am a Roman citizen." In the Hebrew theocratic state, ruled by the agents of Yahweh, the very essence of life consisted in serving and preserving the state, which was equivalent with obedience to God.

Christianity rejected the classical principle of unity in life through the state. While the state, as a divine institution. exercised powers originating with God and was therefore entitled to loyalty as long as it functioned within its natural limits, man could never hope to fulfill his spiritual destiny within the framework of a political organization. To achieve this end, man had to turn elsewhere. The dualism of loyalty postulated by Christianity is affirmed in Jesus' famous dictum, "Render unto Caesar the things that are Caesar's but unto God the things that are God's." Man was, as St. Augustine put it, a citizen of two cities, the city of man and the city of God. Political theorists have often given support to this concept of dual loyalty by defending, for example, the right to resist arbitrary or tyrannical governments, especially if the right is claimed in consequence of one's loyalty to God and the moral law. The Niirnberg and Adolf Eichmann trials have shown that absolute loyalty to the state may be demanded only if the state is guided by principles of right and justice.

The efforts of the rulers of the slowly emerging nation-states to enlist nationwide loyalties took place within the framework of feudalism. On the continent of Europe the result was often disappointing. In France, for example, vassals would owe loyalty only to their immediate lords rather than to the king; the latter. therefore, had no direct contact with the lesser vassals, who even retained the right to make war against him.

In England William I, determined to be a true sovereign rather than one feudal lord among many, imposed an oath upon all the important landowners. In 1086 at Salisbury they swore that they would be faithful to him against all other men. This oath, repeated under later monarchs and extended to all people, even the peasants, by Henry II (1176), was a "national act of homage and allegiance."

Allegiance, later defined by William Blackstone as "the tie or *ligamen,* which binds the subject to the King, in return for that protection which the King affords the subject," has become a powerful legal weapon in the hands of governments, especially those of English-speaking peoples, to promote loyalty and to punish disloyalty. Allegiance assisted the integration of the Norman "foreigners" with the English natives; formed the basis of British nationality; played a part in transforming the British empire into the Commonwealth of Nations, a result foreshadowed by the Balfour report of the 1926 imperial conference, according to which Britain and the self-governing dominions were "united by a common allegiance to the Crown"; and has been crucial in the definition of treason, which is a breach of the allegiance owed to the king in person.

In deference to the commonwealth countries, allegiance lost some of its legal significance; under the British Nationality act of 1948 a British subject is a commonwealth citizen. "Allegiance is no longer a source of British nationality but it may be a consequence of it" (O. H. Phillips, The *Constitutional Law of Great Britain and the Commonwealth,* p. 473 [1957]); and since 1949, nations also qualify for membership in the commonwealth when they accept the monarch "as the symbol of the free association of its independent member nations and as such as the Head of the Commonwealth."

Under the influence of nationalism Englishmen developed a second loyalty, one to the kingdom itself as distinguished from allegiance to the king as a person. On occasion, such as in 1399, 1689 and 1936, the conflict between the old allegiance and the new loyalty resulted in the victory of the latter over the former and the king's deposition or abdication. Thus, the new loyalty was certainly an important political factor. Yet, the law, refusing to take comprehensive cognizance of changes affecting the sovereign, continued to recognize allegiance to him rather than the newly discovered loyalty to his realm. Thus, treason has technically never ceased to be a crime against the king, although actually the state rather than the sovereign himself has been involved.

However. in Britain, as elsewhere, prosecution for treason is only one of the weapons to combat disloyalty. Especially in the era of fascist and communist world-wide conspiracies, loyalty investigations have been considered necessary for survival by executive departments and legislatures, in the United States notably by the house un-American activities committee and the internal security subcommittee of the senate judiciary committee.

Penal laws directed against disloyal individuals imperiling security include those dealing with espionage, sabotage, sedition, the advocacy of the overthrow of the government by force and violence (United States Smith act, 1940), and trading with the enemy.

Among measures designed to prevent disloyalty of individuals are oaths of allegiance for such purposes as naturalization and holding public office; detention, as provided by the British Emergency Powers Defence act (1939) and Regulation 18B issued thereunder and by the United States Internal Security act (1950); the denial of passports; and deportation of aliens.

Disloyal organizations are outlawed either by legislation, such as the United States Communist Control act (1954), which keeps the Communist party off the election ballots. or by judicial determination, such as the decision of the German federal constitutional court, which in 1956 declared the Communist party unconstitutional. At times, prohibitive legislation is restricted to reprehensible practices rather than outlawing the organizations themselves; this approach is found in Britain's Public Order act (1936), which makes it an offense to wear publicly uniforms signifying association with political parties.

President Truman's loyalty program (1947) was intended to afford the United States maximum protection against infiltration of disloyal government employees and to protect loyal employees from unfounded accusations. As the standard for the refusal of, or removal from, employment, the existence of reasonable grounds for believing that a person was disloyal was changed in 1951 to reasonable doubt concerning his loyalty. To administer the program, a loyalty review board heard appeals from loyalty boards established in each department. President Eisenhower's program (1953) substituted security for loyalty as the new standard. No person should be employed unless such employment was clearly consistent nith the interests of national security. All loyalty boards were abolished, with the head of an agency making the final decision in each case.

Both the U.S. programs, including loyalty oaths, and their counterparts abroad have been criticized on the ground that they deny basic individual rights. Defending the Canadian system, Prime Minister Louis Stephen St. Laurent asserted in a personnel security case in 1951 that the sole question was whether a certain person could or could not be trusted with secret defense material. "Assessment of character may be the only consideration in some instances. That is not a matter of charge, or trial or of proof. It is a matter of judgment."

Similarly, in 1956 a British conference of privy councilors stated that, while some of the measures that the state was driven to take to protect its security were distasteful and alien to tradition, it was right to continue the practice of tilting the balance in favour of greater security for the state rather than in the direction of safeguarding the rights of individuals.

In the effort to secure loyalty, totalitarian systems have accepted Rousseau's recommendations that there should be no independent associations within the state because they are formed at its expense.

By contrast, in democracies a wide variety of such groups is not only tolerated but encouraged because they all, subversive~excepted, contribute to the formation of national loyalty—as illustrated by the British party out of power, called "her majesty's loyal opposition." Loyalties to nonnational groups, such as Jehovah's Witnesses, may even be permitted to take precedence over the highest symbol of national loyalty, as evidenced by the U.S. supreme court's opposition to compulsory flag salutes in public schools.

Those who, like the historian Arnold Toynbee, take a dim view of nationalism believe that national loyalties must be ultimately transferred to mankind as a whole. Only then will it be possible to realize not necessarily a new international organization but what the American philosopher Josiah Royce called "the hope of the great community." See also TREASON AND SEDITION.

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(W. Fl.)

LOYALTY ISLANDS (Isles Loyauté), a group in the Sodth Pacific ocean belonging to France, about 60 mi. E. of New Caledonia. with a total land area of about 800 sq.mi. Pop. (1956) 10,946. There are three large islands, Uea or Uvéa (the northernmost), Lifu (Lifou) the largest island, with an area of 650 sq.mi., Maré or Nengone, and several small islands. They are coral islands of comparatively recent elevation, and in no place rise more than 250 ft. above the level of the sea.

The Loyalty islanders are Melanesians; the islands have separate languages, and in Uea one tribe uses a Samoan and another a New Hebridean form of speech. The Loyalty group was discovered at the beginning of the 19th century, and Dumont d'Urville laid down the several islands in his chart. Christianity was introduced into Maré by native teachers from Rarotonga and Samoa. Enough of the rocky surface is covered with a thin coating of soil to enable the natives to grow yams, taro and bananas. Fresh water, rising and falling with the tide, is found in caverns in Lifu, and by sinking to sea level a supply may be obtained in any part of the island. Coconuts are the chief product; copra and rubber the chief exports. The Loyalty Islands are political dependencies of New Caledonia; *see* Pacific Islands: *The French* Union *in the Pacific.*

LO-YANG, an ancient city in the lower valley of the Lo Ho, a right bank tributary of the Yellow river, in northern Honan province, China. Pop. (1953) 171,200. Possibly the first true city at the site was built in the 11th century B.C., about 10 mi. E. of the present city. This served as the eastern capital of the Chou dynasty until about 770 B.C., when it became the chief capital, remaining so until 2jj B.C. It was the eastern Han dynasty capital from 2j to 221 A.D. 'The Tu'pa (Toba) removed their capital southward to Lo-yang at the end of the jth century, and Sui rulers resided there at intervals during the 6th century. Lo-yang was a Buddhist centre during the 6th and 7th centuries. After the 10th century the city declined to a position as a local administrative and trade centre. Thus Lo-yang occupies an important historical niche in Chinese culture and, because of its many ruins, tombs and walls, was for centuries one of the historic tourist centres of China. It was called Honanfu until 1913.

In 1955 a tractor factory was constructed amid the tombs and ruins on the western outskirts of the city. A new steam electric plant and mining machinery plants followed. Hard coal deposits near the city were mined. Cotton. wheat and other staple crops are grown and processed in this region, and the city regained importance as a regional trade centre. Since Lo-yang is on the east-west Lunghai railway, with north-south connections close by, its location is favourable to development. (J. E. Sr.)

LOYOLA, SAINT IGNATIUS OF (Íñigo López de Loyola) (1491–1556), founder of the Society of Jesus, was born in the ancestral castle of the Loyolas in the Basque province of Guipuzcoa, Sp., in 1491. His life falls into four periods. The first (1491–1521) covers the years when secular ideals dominated him; the second (1521–24) is the critical period of reorientation; the third (1524–38) comprises the years of his belated studies; and the fourth (1539–56) those during which he founded and governed the Society of Jesus.

Ignatius, the youngest son in a noble and wealthy family. became in 1506 a page in the service of a relative, Juan Velázquez de Cuéllar, treasurer of the kingdom of Castile. In 1517 Ignatius passed as a knight into the service of another relative, Antonio Manrique de Lara. duke of Nájera and viceroy of Navarre, who employed him in military undertakings and on a diplomatic mission. While defending the citadel of Pamplona against the French, Ignatius was hit by a cannonball on May 20, 1521, sustaining a bad fracture of his right leg and damage to his left. This ends the first period, during which he was, on his own admission, "a man given to the vanities of the world. whose chief delight consisted in martial exercises, with a great and vain desire to win renown" *(Autobiography,* 1). Although his morals were far from stainless, Ignatius uas in his early years a proud rather than sensual man. He stood just under five feet two inches in height and had in his youth an abundance of hair of a reddish tint. He delighted in music, especially sacred hymns.

The second period of Ignatius' life is perhaps the best known. After treatment at Pamplona. he nas transported to Loyola in June 1521. There his condition became so serious that for a time his life was despaired of. When out of danger, he chose to undergo painful surgery to correct blunders made when the bone was first set. The result was a convalescence of many weeks during which he read a life of Christ and a book on the lives of the saints, the only reading matter the castle afforded He also passed time in recalling tales of martial valour and in thinking of a great lady nhom he admired In the early stages of this enforced reading his attention was centred on the saints. The anonymous version of the lives of the saints he was reading contained prologues to the various lives by a Cistercian monk nho conceived the service of God as a holy chivalry This view of life profoundly moved and attracted Ignatius After much reflection, he resolved to imitate the holy austerities of the saints in order to do penance for his sins.

In Feb. 1522 Ignatius bade farewell to his family and went to Montserrat, a place of pilgrimage in northeastern Spain. He spent three days in confessing the sins of his whole life, hung his sword and dagger as symbols of his abandoned ambitions near the statue of the Virgin Mary, and, clothed in sackcloth, spent the night of March 24 in prayer. The next day he went to Manresa, a town 30 mi. from Barcelona, to pass the decisive months of his career, from March 2j, 1522, to mid-Feb. 1523. He lived as a beggar, ate and drank sparingly, scourged himself and for a time neither combed nor trimmed his hair and did not cut his nails. Daily he attended mass and spent seven hours in prayer, often in a cave outside Manresa.

The sojourn at Manresa was marked by spiritual trials as well as by joy and interior light. While sitting one day on the banks of Cardoner river, "the eyes of his understanding began to open and, without seeing any vision, he understood and knew many things, as well spiritual things as things of the faith" *(Autobiography,* 30). At Manresa Ignatius sketched the fundamentals of his little book *The Spiritual Exerczses.* Until the close of his studies at Paris (1535) he made some additions to it. Thereafter there mere only minor changes until Pope Paul III approved it in 1548. *The Spiritual Exercises* are a manual of spiritual arms, containing a vital and dynamic system of spirituality. During his lifetime Ignatius used it to give spiritual retreats to others, especially to his followers. The booklet is indeed an adaptation of the Gospels for such retreats.

The remainder of the decisive period was devoted to a pilgrimage to Jerusalem. Ignatius left Barcelona in March 1523 and traveling by way of Rome, Venice and Cyprus, reached Jerusalem on Sept. 4. He would have liked to settle permanently there, but the Franciscan custodians of the shrines of the Latin church would not listen to this plan. After visiting Bethany, the Mount of Olives, Bethlehem, the Jordan and Mount of Temptation, Ignatius left Palestine on Oct. 3 and, passing through Cyprus and Venice, reached Barcelona in March 1524.

"After the pilgrim had learned that it was God's will that he should not stay in Jerusalem, he pondered in his heart what he should do and finally decided to study for a time in order to be able to help souls" (*Autobiography,* 50). So Ignatius, who in his *Autobiography* refers to himself as the "pilgrim," describes his decision to acquire as good an education as the circumstances permitted. He probably could have reached the priesthood in a few years. He chose to defer this goal for more than 12 years and to undergo the drudgery of the classroom at an age when most men have long since finished their training. Perhaps his military career had taught him the value of careful preparation. At any rate he was convinced that a well-trained man would accomplish in a short time uhat one without training would never accomplish.

Ignatius studied at Barcelona for nearly two years. In 1526 he transferred to Alcalá. By this time he had followers, and the little group assumed a distinctive garb. Ignatius fell under suspicion of heresy, was imprisoned and tried. Although found innocent, he left Alcalá for Salamanca. There not only was he imprisoned but his companions were also apprehended. Again he won acquittal but was forbidden to teach until he had finished his studies. This prohibition induced Ignatius to leave his disciples and Spain.

He arrived in Paris on Feb. 2, 1528, and remained there as a student until 1535. He lived on alms and in 1528 and 1529 went to Flanders to beg from Spanish merchants. In 1530 he went to England for the same purpose. In Paris Ignatius soon had another group of disciples whose manner of living caused such a stir that he had to explain himself to the religious authorities. This episode finally convinced him that he must abstain from public religious endeavour until he reached the priesthood.

During his long stay in the French capital, Ignatius won the coveted M.A. of the famous university. He also gathered the companions who were to be cofounders with him of the Society of Jesus, among them Francis Xavier (*q.v.*), Peter Favre, Diego Laynez (*q.v.*) and Alphonsus Salmeron. On Aug. 15, 1534, he led the little band to nearby Montmartre, where they bound themselves by vows of poverty, chastity and obedience, though as yet without the express purpose of founding a religious order.

Early in 1535, before the completion of his theological studies, Ignatius left Paris for reasons of health. He spent more than six months in Spain and then went to Bologna and Venice where he studied privately. On Jan. 8, 1537, his Parisian companions joined him in Venice. All were eager to make the pilgrimage to Jerusalem, but war between Venice and the Turkish empire rendered this impossible. Ignatius and most of his companions were ordained on June 24, 1537. There followed 18 months during which they acquired experience in the ministry while also devoting much time to prayer. During these months, although he did not as yet say mass, Ignatius had one of the decisive experiences of his life. He related to his companions that on a certain day while in prayer he seemed to see Christ with the cross on his shoulder and beside him the Eternal Father, who said, "I wish you to take this man for your servant," and Jesus took him and said, "My will is that you should serve us." On Christmas day 1538 Ignatius said his first-mass at the Church of St. Mary Major in Rome. This ends the third period of his life, that of his studies, which were far from a formality. Diego Laynez, a clever man, judged that despite handicaps Ignatius had as great diligence as any of his fellow students. He certainly became in the difficult field of ascetical and mystical theology one of the surest of Catholic guides.

The final period of Loyola's life was spent in Rome or its vicinity. In 1539 the companions decided to form a permanent union, adding a vow of obedience to a superior elected by themselves to the vows of poverty, chastity and obedience to the Roman pontiff which they had already taken. In 1540 Pope Paul III approved the plan of the new order. Loyola was the choice of his companions for the office of general.

The Society of Jesus developed rapidly under his hand. When he died there were about 1,000 Jesuits divided into 12 administrative units, called provinces. Three of these were in Italy, a like number in Spain, two in Germany, one in France, one in Portugal and two overseas in India and Brazil. Loyola was in his last years much occupied with Germany and India, to which he sent his famous followers Peter Canisius and Francis Xavier (*qq.v.*). He also dispatched missionaries to the Congo and to Ethiopia. In 1546 he secretly received into the society Francis Borgia (*q.v.*), duke of Gandia and viceroy of Catalonia. When knowledge of this became public four years later it created a sensation. Borgia organized the Spanish provinces of the order and became third general.

Loyola left his mark on Rome. He founded the Roman college, embryo of the Gregorian university, and the Germanicum, a seminary for German candidates for the priesthood. He also established a home for fallen women and one for converted Jews.

Although at first Loyola had been somewhat opposed to fixing his companions in colleges as educators of youth, he came in the course of time to recognize the value of the educational apostolate and in his last years was busily engaged in laying the foundations of the system of schools which was to stamp his order as largely a teaching order.

Probably the most important work of his later years was the composition of the *Constitutions* of the Society of Jesus. In them he decreed that his followers were to abandon some of the traditional forms of the religious life, such as chanting the divine office, corporal penances of rule and penitential garb, in favour of greater adaptability and mobility; they also renounced capitular government with its democratic character in favour of a more monarchial regime; and their vows were in general of such a nature that separation from the order was easier than had been usual in similar Catholic groups. The Society of Jesus was to be above all an order of apostles "ready to live in any part of the world where there was hope of God's greater glory and the good of souls." Loyola insisted on long and thorough training of his followers. Convinced that women are better ruled by women than by men, after some hesitation he resolutely excluded a female branch of the order. The special vow of obedience to the pope Loyola called "the cause and principal foundation" of his society.

Loyola and his work were much admired during his lifetime. But he also met with opposition in the church and outside it. His innovations in the religious life were criticized and, while Protestant leaders early came to look on him as one of their principal opponents, some Catholics accused him and his followers of being secret Protestants.

As general Loyola was frequently sick. In Jan. 1551 he became so ill that he begged his associates, though to no purpose, to accept his resignation as superior. Despite his condition he continued to direct the order until his death on July 31, 1556. Since his days at Manresa, Loyola had practised a form of prayer which in his last years appears to have rivaled that of the greatest mystics.

Ignatius Loyola was beatified by Pope Paul V in 1609 and canonized by Pope Gregory XV in 1622; his feast day is July 31. In 1922 he was declared patron of all spiritual retreats by Pope Pius XI. His enemies no less than his friends agree that Ignatius Loyola was a maker of history. Scores of books could be cited in proof of this statement. The spirit of Loyola lives on in the Society of Jesus and in the Jesuit *Constitutions,* which still regulate the lives and aspirations of over 30,000 Jesuits, scattered through most countries of the world. The *Spiritual Exercises* molded 27 canonized saints, three of them, Francis Xavier, Peter Canisius and Francis Borgia, intimates of the saint. His achievements and those of his followers form a chapter in the history of the Roman Catholic Church which cannot be neglected by those who desire to understand that institution. *See* also JESUS, SOCIETY OF.

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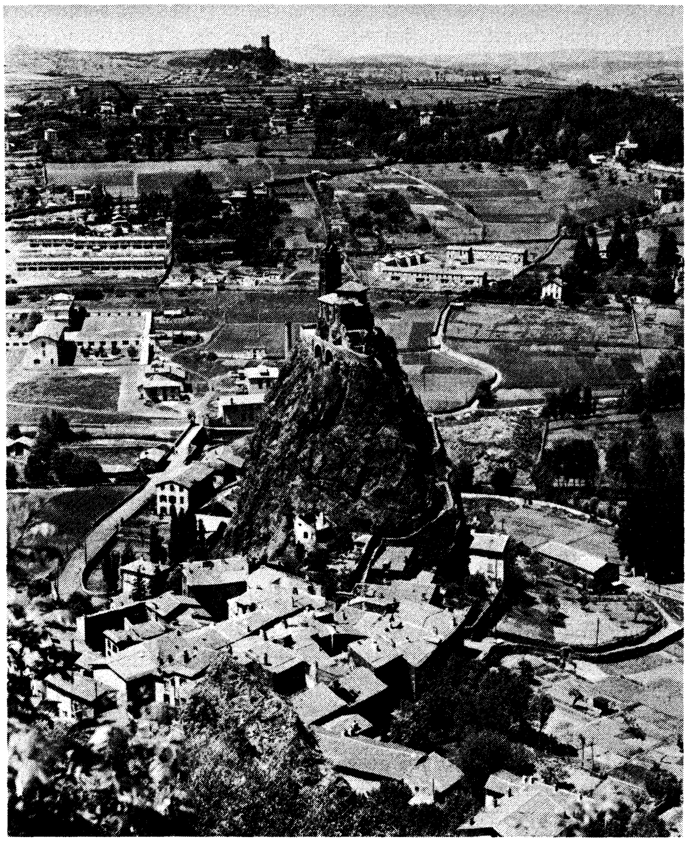
LOZÈRE, a *département* of southeastern France belonging to the central plateau, composed of almost the whole of Gévaudan and of some portions of the old dioceses of Uzès and Alais, districts all formerly included in the province of Languedoc. Pop. (1954) 82,391. Area 2,000 sq.mi. It is bounded north by Cantal and Haute-Loire, east by Ardèche and Gard, south by Gard and Aveyron and west by Aveyron and Cantal. The north of this mountainous *département* includes the granitic mountains of La Margeride, reaching 5.098 ft. and wooded on their lower slopes, and the volcanic range of Aubrac (4,826 ft.), both orientated north-north est and south-southeast. South of these the Lot crosses the *département* on its way from the Cévennes in the southeast. The southwest of the *dkpartement* is occupied by the arid, cal-



JEAN ROUBIER FROM RAPHO GUILLUMETTE

CHAPEL OF SAINT MICHEL D'AIGUILLE, LE PUY, HAUTE-LOIRE, NEAR LOZÈRE, FRANCE

careous Jurassic plateau (3,000 ft. average) called the *causse* de Sauveterre and the *causse* de Méjan, the two causses being separated by the beautiful Tarn gorge. On the Mediterranean versant there are 76 in of rain; in the Garonne basin 46 in. and in that of the Loire only 28 in. Sheep and cattle raising and cheese making are the chief occupations Bees are kept and, among the Cévennes, silkworms. Large quantities of chestnuts are exported from the Cévennes

In the valley of the Lot wheat and fruit are the chief products; elsewhere rye is the chief cereal, and oats, barley, meslin and potatoes are also grown. There is much terrace cultivation. Silver, lead, copper and antimony are found. Sawmilling, wool spinning, the manufacture of wooden shoes and of woolen goods are carried on. Of mineral springs, those of Bagnols-les-Bains are most frequented.

The arrondissements are Mende and Florac: the cantons number 24, the communes 198. Lozère forms the diocese of Mende and part of the ecclesiastical province of Albi. It falls within the region of the 16th army corps (Montpellier), the acadtmie (educational division) of Montpellier and the appeal court of Kimes. Mende (*q.v.*) is its most important town.

LOZI (MALOZI): see BAROTSE.

LUANG-PRABANG, a province in northwest Laos. Population (1959 est.) 322,100. Area 14,363 sq.mi. Luang-Prabang town (pop., 1957 est.. 18,000) is the site of an important airfield. At the head of Mekong river navigation, it has a small trade in rice. silk, wax, sticklac and a wide variety of timbers. gums, resins and other forest products. The Chinese and Shans carry on most of the trade. The Mekong is much less important as a trade artery than other large oriental rivers, for as many as eight transshipments between Saigon and Luang-Prabang are made necessary by the rapids, at low water.

The French projected a highway from Saigon to Luang-Prabang, and in 1943 the Japanese broadcast claims to having completed the 1.049-mi. project.

For centuries Luang-Prabang was the centre of a great kingdom, covering much of Laos (*q.v.*) and some of Thailand. Thai-Annamite rivalry in the 18th and 19th centuries established the sovereignty of the former, although the king of Luang-Prabang was not deposed. The French took the two-thirds of Luang-Prabang on the Mekong's east bank in 1893 and the remainder in 1904.

In 1941 the Thai won back the western part in a border war, re-establishing the Mekong as boundary. (J. R. A.)

UNITED PRESS INTERNATIONAL PHOTO

BRONZE STATUES OF BUDDHA AT SMALL FOUNDRY NEAR ROYAL PALACE. LUANG-PRABANG, LAOS

LUANSHYA, known as "the garden town of the copper belt," in the western province of Northern Rhodesia, Federation of Rhodesia and Nyasaland, situated 4,250 ft. above sea level, 21 mi. S.W. of Ndola. Pop. (1956) 8,080 (non-Africans and employed Africans). The public township contains residential, business and industrial areas and there is a separate mine township (Roan Antelope).

A rail terminus, Luanshya is also connected by macadamized roads to the other copper belt towns and has an airfield; the nearest airport is Ndola. Besides copper mining there are steel. welding and general machine shops, and concrete, furniture and clothing industries. (L. R. B.)

LUBA. The Luba people, or Baluba, are a Bantu group of the southeastern Republic of The Congo. They inhabit a wide area extending from the extreme south of Rivu province through the major part of Katanga province to the southeast of Kasai province. The name Luba applies to a variety of tribes which, although of different origins, speak closely related languages, exhibit many common cultural traits and participate in a common political history founded on the beginnings (16th century) and breakdown (17th century onward) of the Luba empires. The present population amounts to more than 1,500,000. Three main subdivisions may be recognized: the Baluba-Shankaji of Katanga, the Baluba-Bambo of Kasai (both patrilineal and viripatrilocal and speaking respectively Kiluba and Ciluba) and the Baluba-Hemba of northern Katanga and southern Rivu who are either matrilineal or bilineal, practice virilocal marriage and speak Kiluba. All are historically. linguistically and culturally linked with other Congo peoples. such as the Benalulua, the Bakwaluntu, the Benakanyok and the Basonge. The Shankaji branch is also connected with the early founders of the Luunda dynasty. Luba tribes are also mixed with other groups of miscellaneous origin. Finally, since the 17th century there has been an ever-growing expansion of Luba-Bambo in the Rasai province.

The Luba are savanna and forest dwellers; they practise hunting, food gathering and agriculture (manioc. maize) and keep small livestock; they fish the Congo and its main tributaries intensively. High marriage payments (bride-service) are common. Polygyny, leviratic marriage and sororate exist, but not cross-cousin marriage; parallel and cross-cousins are called by the same terms as brothers and sisters. Luba are subdivided into large dispersed clans and localized lineages; the latter form exogamous units and may be linked by an elaborate system of political and ritual status. In the 16th and early 17th centuries most of the Luba were ruled by a paramount chief (*mulopwe*), although smaller independent chiefdoms already existed. The breakdown of the empire resulted in the development either of smaller chiefdoms or of small autonomous local lineage groups.

Luba practise circumcision and women's initiation; they have associations for hunting, magic and medicine. They have a strong belief in a Supreme Being and worship ancestors and natural spirits. Literature, including epic cycles, is well developed. The

Shankaji and Hemba are renowned wood carvers, especially of anthropomorphic figures, ceremonial axes and headrests.

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LUBBOCK, seat of Lubbock county, is the industrial, financial and commercial hub of the south plains area of western Texas, G.S., about 100 mi. S. of Amarillo. The first settlers were ranchers who arrived in the late 1870s. The town, laid out in 1891, when Lubbock county was created out of Bexar territory and named for Tom S. Lubbock, a Confederate soldier, was incorporated in 1909, and adopted a mayor-commission-manager form of government in 1917.

Although Lubbock has a diversified economy, regional agriculture (cotton, grain sorghums, Sudan grass, wheat and vegetables) supported by irrigation from underground water is its base. In the late 1950s the south plains produced almost a fifth of the nation's cotton. Lubbock is one of the world's leading inland cotton markets and cotton oil centres. Other major industries include poultry and dairy products, feed mills, cattle feeding. irrigation pipes and oil. The city is also the regional centre for government offices and medical care.

Cultural institutions include Texas Technological college (1923), Lubbock Christian Junior college, the West Texas museum and two public libraries. The annual Panhandle South plains fair, a large coliseum, a number of city parks, Mackenzie State park (548 ac., with its "prairie dog town") and Buffalo lakes provide recreational facilities.

After World War II, Lubbock witnessed a rapid growth with its population increasing from 31.895 in 1940 to 128,691 in 1960. Population (1960) of its metropolitan area, which comprises Lubbock county, was 156.271. (E. WE.)

LÜBECK, a city and former state of Germany. The former state of Liibeck was situated on an arm of the Baltic between Holstein and Mecklenburg-Strelitz. The state consisted of the city of Liibeck. the town of Travemunde, villages and the country districts. Liibeck in 1937 lost its status as a state, and became a city in Schleswig-Holstein.

The constitution of the former state was republican, and by the constitution of 1925 consisted of two assemblies: (1) the house of burgesses (*Bürgerschaft*) consisting of 80 members elected by free suffrage. This was the supreme authority and elected (2) the senate executive which consisted of 12 members.

At the first rise of the town justice was administered by the *Vogt* (*advocatus*) of the count of Holstein. Simultaneously with its incorporation by Henry the Lion, duke of Saxony, there appeared a magistracy of six, chosen probably by the *Vogt* from the *Schöffen*. By the middle of the 13th century the number of magistrates had increased, ranging from 20 to 40 and upward. In the face of so much self-government the *Vogt* presently disappeared. There were three classes of inhabitants: full freemen, half freemen and guests or foreigners. People of Slav origin being considered unfree: all intermarriage with them tainted the blood: hence, nearly all surnames point to Saxon, especially Westphalian. and even Flemish descent. The magistracy was for two centuries almost exclusively in the hands of the merchant aristocracy, who formed companies such as the *Bergen-fuhrer*, *Novgorod-fahrer*, *Riga-fuhrer* and *Stockholm-fahrer*. Tradesmen and handicraftsmen who had settled in the town, though not eligible for the council, shared to a certain extent in the self-government through the aldermen of each corporation or guild, of which some appear as early as the statutes of 1240.

After an attempt to upset the merchants had been suppressed in 1384, the guilds succeeded in 1408. In 1416, however, because of the pressure brought to bear by the Hansa, by the emperor Sigismund and by Eric, king of Denmark, there was a restoration. The aristocratic government was again expelled under the dictatorship of Jurgen Wullenweber (c. 1492–1537), till the old order was re-established in 1535. In the constitution of 1669, under pressure of debt, the great companies yielded a specified share in the financial administration to the leading guilds of tradesmen. From 1813 the popular representatives had some share in the management of the finances. But the reform committee of 1814, whose object was to obtain an extension of the franchise, had made little progress when the events of 1848 led to the establishment of a representative assembly of 120 members, elected by universal suffrage.

The City.—Liibeck was formerly the head of the Hanseatic league. It lies between the rivers Trave and Wakenitz, 10 mi. S.W. of the mouth of the former in the bay of Liibeck, 40 mi, by rail N.E. of Hamburg, at the junction of lines to Eutin, Biichen, Travemünde and Kleinen and consists of an inner town and three suburbs. Pop. (1950) 238,276. Its five chief churches are Gothic. Of them, the *Marienkirche* (13th century), is one of the finest specimens of early Gothic in Germany. The cathedral, or *Domkirche*, founded in 1173, contains some curious sarcophagi and a fine Memling altarpiece. The *Rathaus* (town hall), dating from the middle ages, is famous for its staircase, the vaulted wine cellar of the city council beneath and wood carving.

Its position as the first German emporium of the west end of the Baltic was impaired by Hamburg and Bremen after the construction of the North Sea and Baltic Canal, and by the growth of Stettin. In order to counterbalance their rivalry, the quays were extended and a canal was opened in 1900 between the Trave and the Elbe.

The chief imports are coal, grain, timber, copper, steel and wine, and the exports are fertilizers, gypsum and manufactured goods.

HISTORY

Old Liibeck, which stood on the left bank of the Trave where it is joined by the river Schwartau, was destroyed in 1138. Five years later Count Adolphus II of Holstein founded new Liibeck, a few miles farther up, on the Baku peninsula, where the Trave is joined on the right by the Wakenitz. An excellent harbour, sheltered against pirates, it became almost at once a competitor for the commerce of the Baltic. Henry the Lion, duke of Saxony, who, about 1157, had forced his vassal, the count of Holstein, to give up Liibeck to him, issued the first charter to the citizens and constituted them a free Saxon community. The population grew rapidly in wealth and influence by land and sea, so that, when Henry was attainted by Frederick I, who came in person to besiege Liibeck in 1181, the emperor, "in consideration of its revenues and its situation on the frontier of the Empire," fixed by charter (Sept. 19, 1188) the limits, and enlarged the liberties, of the free town. By the end of the next century the statutes of Liibeck had been adopted by most Baltic towns with a German population: it was the court of appeal for nearly all these cities and even for the German settlement in Novgorod. From the beginning of the 14th century Liibeck presided over a league of cities, including Wisbeck, Rostock, Stralsund and Greifswald. Liibeck was the leading spirit in the nominally federal armament directed against Waldemar IV, the destroyer of Visby, which captured Copenhagen and enforced the peace of Stralsund (May 24, 1370); the burgomaster of Liibeck, Brun Warendorp, commanding the combined naval and land forces and dying on the field of battle. The seal of the city was in 1368 adopted as the common seal of the confederate towns. Though the power of the Hanseatic league was hemmed in at the end of the 15th century by.the rise of the power of Burgundy, of Poland and Russia, and of Scandinavia, Lubeck was able to carry on war against Denmark (1501–12) and Sweden (1536–70) and under its democratic burgomaster, Jiirgen Wullenweber, was in 1534 and 1535 a powerful force in the north of Europe.

From this time the power of Liibeck began to decline. The herring, a great source of early wealth, had begun to forsake the Baltic as early as 1425. The last Hanseatic diet was held in 1630. Signs of some small recovery began to appear at the end of the 18th century, but the Danes occupied the town in 1801; in 1803 it was sacked by the French and in 1810 annexed to Napoleon's empire. It was declared a free and Hanse town of the German Confederation, after his fall, by the Act of Vienna (June 9, 1815). Liibeck joined the North German Confederation in 1866.

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LUBLIN, a province of Poland, bounded north by Bialystok, east by the U.S.S.R. (the Bug forming the boundary), south by Rzeszów, and west by Kielce (the Vistula separating the two) and Warsaw. Area 9,584 sq.mi. The surface is an undulating plain of Cretaceous deposits, 800 to 900 ft. in altitude, reaching in one place 1,050 ft. It is largely covered with forests of oak, beech and lime, intersected by ravines and thinly inhabited. A marshy lowland extends between the Vistula and the Wieprz. The area is drained by the Vistula and the Bug and by their tributaries, the Wieprz, Liwiec and Tanev. Parts of the province, being of black earth, are fertile, but other parts are sandy. Agriculture is in good condition. Many Germans settled in the area before immigration was stopped in 1887; in 1897 they numbered about 26,000.

Rye, oats, wheat, barley and potatoes are the chief crops, rye and wheat being exported. Flax, hemp, buckwheat, peas, millet and beetroot are also cultivated. Horses are carefully bred. Pop. (1960) 1,799,900. Industrial establishments consist chiefly of distilleries, sugarworks, steam flour mills, tanneries, sawmills and factories of bentwood furniture.

The province is divided into 16 districts, the chief towns of which are Lublin, capital of the province (180,700), and Chelm (31,000).

The province was overrun by German troops in the early stages of World War II.

LUBLIN, a town of Poland, capital of the province of the same name, 109 mi. by rail S.E. of Warsaw, on a small tributary of the Wieprz. Pop. (1960) 180,700. It is one of the centres of the manufacture of thread yarn, linen and hempen goods and woolen stuffs; there is also trade in grain and cattle. It has an old citadel, a university, several palaces of Polish nobles and many interesting churches and is the see of a Roman Catholic bishop. The cathedral dates from the 16th century. Of the former fortifications nothing remains except the four gates, one dating from 1342.

Lublin was in existence in the 10th century and has a church which is said to have been built in 986. During the time the Jagellon dynasty ruled over Lithuania and Poland it was the most important city between the Vistula and the Dnieper, having 40,000 inhabitants (70,000 according to other authorities) and all the trade with Podolia, Volhynia and red Russia. Indeed, the present town is surrounded with ruins, which prove that it formerly covered a much larger area. But it was frequently destroyed by the Tatars (*e.g.,* 1240) and Cossacks (*e.g.,* 1477). In 1568–69 the union of Poland and Lithuania was decided there. In 1702 another convention was held in Lublin, in favour of Augustus II and against Charles XII of Sweden, who carried the town by assault. In 1831 Lublin was taken by the Russians. Returned to Poland in 1918, it was taken by Germany in 1939 and returned again to Poland in 1945.

LUBRICATION concerns itself with the reduction of frictional resistance between two contacting surfaces forced to slide over one another. As secondary objectives lubrication tends to minimize wear and prevent corrosion. Lubrication is accomplished by inserting a thin film of lubricant between the sliding surfaces; thus lower fluid friction is substituted for the higher dry, metal friction. Any material placed between the surfaces to lessen friction is a lubricant. (See FRICTION.)

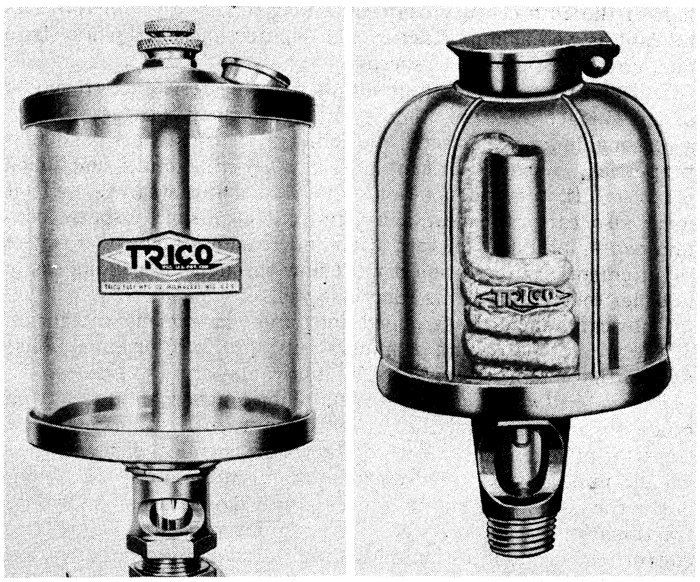
In a machine civilization, lubrication is vitally important. Friction wastes energy. It has been estimated that over 30% of the energy generated is consumed in friction; *i.e.,* heat. As an art lubrication probably commenced when primitive man noted the eased skidding that resulted, because of sap lubrication, when the bark was removed from the trunk. From this crude start to the operation of delicate instruments on a man-made satellite, man's most persistent problem has been the reduction of friction and wear. He began, however, only in the 20th century to understand the mechanism of friction and lubrication.

As man continued to analyze the phenomena, the art of lubrication gradually evolved into an exact science. Not long ago the task of lubricating the crude machines of industry was just a messy chore. A low-rated employee equipped with little more than an oil can would irregularly proceed to oil all bearings with often only a single oil. Mass production, higher speeds, larger machines, long space flights, all these have changed the chore into a scientifically engineered phase of preventive maintenance. Better lubricants, special additives, automatic dispensing systems, all are receiving continuous attention.

Dispensing.—The best lubricant is useless until it is applied properly to the bearing, or gear, or guideway needing it. Where points to be lubricated are few and frequency of application is not critical, manual methods are sufficient. Modern machines, however, contain many bearings, precision-built to operate under severe conditions. The lubricant must, therefore, be applied with regularity, according to a precisely controlled plan: it is essential to get the right lubricant to the right place at the right time. Consequently, application by use of mechanical means is common procedure.

Many varieties and types of dispensing devices are available, ranging from simple units that lubricate a single bearing to fully automatic central systems capable of lubricating all the machines in a plant.

The oil can, though providing unreliable, inefficient and irregular lubrication is proper in some cases. Rough units such as chains, hoists and farm machinery are appropriate for oil can lubrication. Where it is wise to partly control the oil fed to the bearing, drop feed, wick feed, bottle oilers, ring oiling and such shown in fig. 1 are used. Bath and splash methods are effective in heavy, slow machinery.



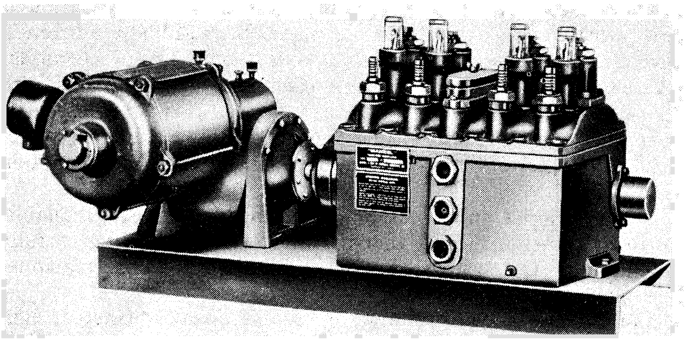
BY COURTESY OF TRICO FUSE MANUFACTURING CO., INC

FIG. 1.— SEMIAUTOMATIC LUBRICANT DISPENSERS: LEFT, GRAVITY FEED OILER: RIGHT, WICK FEED OILER

For positive, adjustable, reliable lubrication mechanical force feed systems (fig. 2) are best. Oil fog lubrication is one of the latest techniques being developed to get the lubricant to the surface needing lubrication.

History. — The major portion of industrial lubricants are derived from crude petroleum. The history of lubrication, therefore, closely parallels the growth of the petroleum industry. Actually petroleum is not a new discovery. Ancient Assyrians and Egyptians, and later Greeks and Romans, all used petroleum for lighting and embalming.

American Indians used petroleum medicinally. The colonists, however, when coming across it while drilling for salt, considered it a nuisance and poured it away as waste. In 1859 the Drake well in Pennsylvania was drilled to 69 ft. and produced 25 bbl. of crude daily; in 1901 the Lucas gusher, drilled in the Spindletop field, emitted up to 100,000 bbl. daily, and signaled the abundant availability of petroleum and its products. This order of production marked the beginning of a new era that was to see petroleum rise to become mankind's major source of lubricants. Thus, the internal combustion engine. the automobile. the airplane, the diesel train. the turbojet were all made possible, by the use of petroleum both as a fuel and as a lubricant. It also became possible to design production machinery for larger capacity and higher speed because improved lubricants could be tailored to satisfy more severe operation conditions.



BY COURTESY OF MANZEL DIVISION HOUDAILLE INDUSTRIES INC

FIG. 2.—MULTIPLE-FEED AUTOMATIC MECHANICAL LUBRICATION SYSTEM

The history of lubrication has followed closely and at times even determined the industrial progress of many nations. From the crude lubricants of yesteryear and the engineered oils of the second half of the 20th century has been a long road, with numerous significant as well as important events—elation and heartaches, strife and harmony, failure and success.

Lubricants.— If this function of reducing resistance to sliding of one surface over the other is to be performed satisfactorily for a reasonable length of time, the lubricant must possess particular properties. Thus, a lubricant must be a versatile, multi-functioned product. It must reduce not only friction but wear as well; it must also carry the heat away, prevent corrosion, disperse contaminants, inhibit foam formation and remain intact under severe requirements. In addition it must flow through the bearing easily in order to perform all its functions well.

Lubricants may be grouped into five convenient categories. These are (1) petroleum or mineral oils; (2) fixed or animal oils; (3) synthetic lubricants; (4) solid lubricants; and (5) greases.

Petroleum Lubricants.—Petroleum lubricants are produced from crude oil, a complex mixture of hydrogen, carbon and oxygen plus traces of nitrogen and sulfur. Clay, water, chemical elements, resins and mineral salts are also often present in the crude oil. Obviously then, refining becomes necessary. Distillation, known as fractionation, is the key step in the refining process. In order to convert the crude into the finished lubricant many other steps are performed. Dewaxing, filtering, solvent refining to remove asphalts, cracking to convert heavy into light oils, blending to meet the many specia! requirements, and the addition of chemical compounds to enhance, improve or impart desirable characteristics to the lubricant stock are other steps.

Each of the crude oils originating in many petroleum fields scattered over our planet differs somewhat in composition from every other. Many variations in refining are therefore needed. However. the process is so advanced that by the time the finished lubricant is ready for the bearing, the distinction between crudes has mostly vanished. Thus the changing and varied lubrication requirements that accompany advances in machines, in engines (see INTERNAL-COMBUSTION ENGINES), in delicate instruments, in nuclear reactors, in space missiles are satisfied.

Fixed Oils.—These are animal and vegetable extracts. Animal oils (tallow, neat's-foot, whale, lard, cod-liver, degras) are produced by heating the fatty tissue. Vegetable oils, on the other hand, are extracted by pressing and chemically dissolving seeds of castor, rape, olive, cotton, peanut, coconut and palm. These oils can seldom be used directly as lubricants because they are quite unstable at ordinary operating temperatures, oxidizing into a varnishlike sludge. Their principal use is in the manufacture of greases and as agents or additives in mineral oils.

Fatty oils contain oxygen and fatty acids in addition to the basic hydrocarbon constituents. When mixed with mineral oils, the fatty acids appear to activate the mineral oil molecules into more effectively oriented layers, an action that results in a higher oiliness property with the tendency to wet and adhere to the metal surface even under high pressure.

Oiliness is particularly important in thin-film lubrication where it helps to better prevent direct metal-to-metal contact and so reduces friction and wear.

Synthetic Lubricants.—Although costlier, synthetic oils have found extensive use in the second half of the 20th century. Better stability at higher temperatures and an improved viscosity index (the higher this index the smaller the change in viscosity with temperature) at ordinary temperatures are the principal reasons. Furthermore when many of these synthetic oils undergo thermal decomposition, the resulting products are fluids quite similar to the original product or, otherwise, are volatile materials that evaporate without depositing gummy residues.

Five general types of synthetic lubricants and lubricant agents are in common use. These are the polyalkylene glycols, the silicones, the polymer oils, the organic chlorine compounds and the diesters. Of these the polyalkylene glycols are probably most used because of their inherently wide temperature tolerance, their low solvent action on rubber and their high resistance to sludge formation. A widespread application exists in this group—from 400° to 500° F. temperatures in industrial kiln cars to low temperatures in liquified hydrocarbon gas pumps. An interesting experience illustrating the unusual antiwear property of glycols is illustrated by their use on highly loaded gears. In a controlled test, gears lubricated with a mineral oil pitted severely in six months while similar gears lubricated with a glycol lubricant showed only traces of wear after a full year of operation.

The silicones also possess good thermal stability and general chemical inertness. The silicones are primarily alkyl polymethyls and polymethyl phenyl siloxanes. Use over the 10° F. to 500° F. temperature range is common. They are more critical, however, than mineral oils with respect to metal combinations. On the other hand, they inhibit foaming almost magically.

The polymer oils, derived from the polymerization of low molecular weight paraffines, are used primarily as carriers of active lubricating ingredients. They are so used extensively because of their very clean burn-off properties at temperatures as high as 750° F.

The chlorine lubricants or aroclors are not good lubricants by themselves but are most effective additives as extreme pressure agents. The esters of dicarboxylic acids, the fifth group, serve well in various demanding applications. To date their major use has been in high quality instrument oils and specialized greases.

Solid *Lubricants.*—The solid lubricants are of mineral and chemical compound origin. Graphite, talc, soapstone and mica are representative of the mineral group. Molybdenum disulfide is the most important chemical compound type. The solid lubricants are good for temperatures at which liquids become impractical. The direct application of solid lubricants is, in general, quite difficult. They are therefore usually .suspended in volatile, liquid carriers that flash off at elevated temperatures, leaving a thin deposit of the solid lubricant.

Satural graphite, a black, lustrous mineral is usually used in the dry form. Sometimes a binder is mixed in to form a paste that is pressed in grooves or layers in bronze and babbitt bearing sleeves (see fig. 3). Colloidal graphite is a soft, greasy substance, almost 'chemically pure. It is much easier to "carry" in this small particle size and proves itself a good lubricant in the high-temperature range.

The soft molybdenum disulfide is extracted from a natural ore. The favoured solid lubricant over a wide temperature range, it has been used successfully in liquid nitrogen valve systems at temperatures as low as $-300°$ F. Its use has been reported at 1.600° F. in a vacuum and at 2,400° F. in argon atmospheres. In normal atmospheres it is stable up to 7j0° F. The National Aeronautics and Space administration (NASA), formerly the National Advisory Committee for Aeronautics (NACA), claims the most effective molybdenum disulfide (molykote) surface to be one that is obtained when a bearing is smeared with the molykote suspended in a fluid. baked at around 650° F., and finally buffed to a high finish.

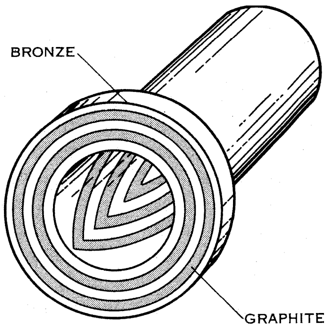


FIG. 3.—GRAPHITE LUBRICANT PRESSED IN BRONZE BEARING

Certain metallic dispersions can also be considered solid lubricants. Finely powdered lead and indium have been dispersed in oil and other vehicles with interesting lubricating results. Metallic, thin platings of copper, indium and aluminum have also been tried with some success. In addition several chemical coatings, deposited as reaction products, have been found to possess lubricating properties.

Greases.—Grease is a plastic solid, a mixture of saponified fat in a liquid lubricant. Plastic solids (see Theory below) do not flow at ordinary temperatures. Officially the American Society for Testing Materials (A.S.T.M.) defines greases more broadly, "Lubricating Grease: A solid to semisolid product of dispersion of a thickening agent in a liquid lubricant. Other ingredients imparting special properties may he included." (American Society for Testing Materials, *Standard* Definitions of *Terms Relating* to *Petroleum*, 1959.) Greases vary extensively both in composition and in physical properties.

Many different soap bases—calcium. lithium, sodium. barium. silica—are used in combination nith various petroleum oils. as well as some of the synthetic lubricants.

In general, greases are inferior wherever liquid lubricants can be used. Greases suffer greater power losses because of the thickening soap. For the same reason greases are used where a liquid lubricant cannot be constantly supplied and where lubricant leaks or spattering may be objectionable or even detrimental to the product, such as food or cloth. Also in rough, heavy machinery, where boundary conditions are likely to exist, grease lubrication is preferred. Comparative advantages of grease and oil are shown in Table I.

The lubricating power of greases depends on both the liquid and soap constituents. The soap base acting as a sponge absorbs the oil to release it to the bearing during operation by squeeze action. On the other hand the soap molecules are adsorbed into the metal to hold the rubbing surfaces separated and thus lubricated. Probably where bearing clearances are comparatively large the liquid constituent is more important while at smaller clearances the molecular soap layers provide the lubrication.

Table I.—*Comparative Advantages of* **Grease** *and* **Oil in** *Bearings*

Advantages of Grease	Advantages of Oil
1. Maintenance may be reduced. no oil level to maintain; regreasing is infrequent.	1. Oil is easier to drain and refill. Thii is Important ii lubricating intervals are close together.
2. Proper grease quantity is easily confined in housing Simplifies design of bearing enclosure.	2. Use of oil makes it eaiier to control the correct amount of lubricant,
3. Freedom from leakage is important in food, textile and chemical industries.	3. Same lubricant may be used on other types of bearings on the same machine.
4. Improves efficiency of labyrinth enclosures, gives better bearing c i o n	4. If bearing must operate under high temperatures, conditions favour oil

Adapted irom J. J. O'Connor, "Bearings and Lubrication," *Power* (Dec. 1951)

Greases may be divided into five groups: (1) the water-resistant; (2) the water-soluble; (3) the multipurpose; (4) the synthetic; and (5) the special purpose greases.

(1) Calcium forms the base of the water-resistant group. Lube oil and a small amount of stabilizing water are the other constituents. In general these water-resistant greases are satisfactory up to about 200° F. as a maximum. Above this temperature the water will boil off allowing the oil to separate and "bleed" off, leaving the sticky, gummy soap.

When not stabilized with water the grease may work at slightly higher temperatures. Aluminum oleate or palmitate is also used as the base.

(2) The water-soluble greases contain a sodium hydroxide base. Since these greases offer very little resistance to water washing, they cannot be used where water or steam is present. However, because of the absence of water they may be used at temperatures up to 300° F.

(3) The multipurpose members contain either a barium or a lithium base. Both bases make the grease reasonably water resistant—better than sodium but not quite as good as the calcium greases. In continuous service the multipurpose greases may be used up to about 350° or 400° F. The need for this group arises, of course: from the desire to have a single grease serve many purposes. a good example being automobile servicing.

(4) The synthetic greases are the latest development in the industry. Some contain standard soaps in synthetic oils, while others are mixtures of synthetic thickeners (bases) in petroleum oils.

The silicones, on the other hand, are greases in which both the base and the oil are synthetic. The synthetic greases are made in water-soluble and water-resistant forms. As a result they may be used over a wide temperature range. In addition the synthetics can be used in contact with natural or other rubbers because they are quite inert to these materials.

(j) In the attempt to obtain some especially desirable characteristic two or more soap bases are used to produce the special purpose greases.

In some cases additives, like extreme pressure agents, are used to gain the special property.

Additives.—Chemical compounds are added to lubricants to improve certain properties or impart new ones. Some additives affect the lubricant chemically, others physically. Most compounds are interdependent. complementing and supplementing each other. In some cases additives affect each other adversely. As a result, additive compounding is a most complex problem. This complexity. in turn, adds much value to procedures developed and facts learned; the latest information is, therefore, seldom published or otherwise publicly expounded.

Better-known addition agents include oxidation inhibitors, detergents, dispersants. anticorrosives, foam inhibitors, antiwear agents, oiliness compounds, pour point depressors and viscosity index improvers (see Viscosity and *Viscometry* below). Many different organic compounds, mettalo organics and soaps in various proportions are used. Each lubricant producer has his own formulas and compounding techniques. Compounds containing sulfur and phosphorus, amines, phenols and naphthanates, silicone and methacrylate polymers, soaps of calcium, barium: cobalt and strontium are all typical additives.

A special group of additives are contained in boundary range lubricants. When speed is too low. high loads exist, or excessive temperatures reduce viscosity, the oil film is difficult to maintain; thus metal-to-metal contact occurs. Satisfactory lubricants are expected to remain in at least molecular thickness under these conditions. Proper additives appear to bring this about by either adsorption or reaction. In either case a layer of lower shear strength is "bonded" to the metal providing at least minimum lubrication.

The additives of polar structure, such as lard oil, are identified as extreme pressure or (EP) agents. In turn the product itself is called an EP lubricant.

Viscosity.—The internal friction between molecules of a fluid-liquid or gas—is, in general, viscosity. The viscosity of a lubricant is of vital importance. The friction developed in a bearing in which the rubbing surfaces are separated by a fluid film depends directly upon the viscosity of the fluid. Viscosity also impedes the flow through the bearing.

When two surfaces, moving with a velocity v relative to each other, are separated by a fluid film, the velocity of film layers is as shown in fig. 4. The velocity of the layer in contact with the fixed surface is zero; that of the layer in contact with the moving layer is v. The velocity in between varies linearly.

A pull (force) must be applied to the upper plate if it is to move. Shear between successive layers of the film results from the pull. Sir Isaac Newton established in 1668 the mathematical relationship describing the shearing stress. He wrote

$$S_r = \frac{F}{A} = \mu \frac{v}{h}$$

where F is force in pounds, A is area of the film, v is velocity of upper plate in feet per second, and h is the film thickness in inches. In turn (see fig. 5) the viscosity becomes algebraically

$$\mu = \frac{Fh}{Av}$$

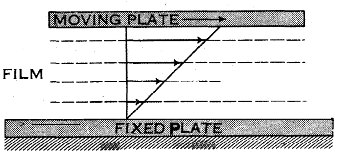


FIG. 4.— STREAMLINE FLOW OF FLUID BETWEEN TWO PLATES VELOCITIES ARE PROPORTIONAL TO DISTANCE FROM FIXED PLATE

A unit of viscosity is thus the viscosity which requires one unit force to move one unit surface at unit velocity when one unit length away from the fixed surface. A unit viscosity in the metric system is called a poise in honour of J. L. M. Poiseuille who investigated extensively the flow of liquids in capillaries in the 1840s. Because of the size of a poise a smaller unit, one-hundredth the size, called a centipoise is customarily used. It so happens, and quite conveniently, that the viscosity of water at 68.4° F. is one centipoise. In the English system a unit of viscosity is measured in pound-second per square inch. It is called a reyn in honour of Sir Osborne Reynolds, father of hydrodynamic lubrication.

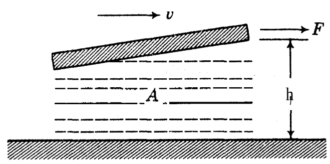


FIG. 5.—PLATE MOVING ON OIL FILM

Obviously the measurement of viscosity—viscometry—is quite essential. Literally hundreds of kinds of viscometers have been built and used. The most popular is the capillary tube type, which uses the principle first recognized by Poiseuille. The viscosity is obtained indirectly by measuring the pressure needed to force the liquid through the small tube, the tube dimensions and the rate of flow. An example of such an instrument, depending upon gravity as the driving force, is the A.S.T.M. modified Ostwald viscometer.

Another type of viscometer is based on Newton's viscosity law or the measurement of the force needed to pull one surface past another with a liquid between them. The rotational viscometer, in which torque is the measured quantity, is probably the best known Newton type.

Great skill is required to manipulate the above mentioned instruments. Because of this fact and the delicacy of such instruments, industry has found them unsuited for use outside the laboratory. More rugged devices simpler in operation, have been standardized for general use. The time taken by a given volume of oil to flow through a standard orifice is measured in seconds and recorded as an arbitrary expression of viscosity. Of such efflux viscometers, the Saybolt is popular in America, the Redwood in Britain and the Engler in Germany.

Viscosity of fluids varies greatly with temperature. Because of the difficulty of mathematical expression, charts are used to present this variation. A special logarithmic ordinate scale makes the viscosity-temperature plot a straight line.

Where the viscosity of liquids decreases as the temperature increases, that of gases increases, curiously enough. Viscosity of a gas is determined with viscometers very similar to those already described. The viscosity of some better known fluids, lubricants included, is given in Table II.

Lubricants change viscosity with pressure as well, the viscosity increasing with an increase in pressure. The increase does not, however, become large until very high pressures are reached. At commonly used bearing pressures, therefore, the change is low enough to be negligible and so is not accounted for.

A greatly simplified, but convenient, indication of the change in viscosity within the temperature range common in bearing operation is the viscosity index (VI), which is used extensively by the lubricant industry. The oil having the smallest change in viscosity between 100° F. and 210° F. is assigned a VI of 100, that having the largest change has a VI of 0 (zero). A new oil, falling somewhere in between, will carry a number proportionately between 0 and 100. Since lubricants being developed in the second half of the 20th century are quite different from those used to establish the VI scale in 1929, it is possible to have a VI larger than 100 or less than 0.

Lubricant Analysis.— Lubricating oils must be tested at every step of their manufacture if the quality of the finished product is to be ascertained. Tests must also be conducted to check and insure the ability of a specific lubricant to meet particular requirements. As already indicated, the most significant test is the viscosity measurement.

TABLE II —*Viscosity of Some Better-Known Materials*

Material	Viscosity at 70° F. Centipoise
Honey	1,500
SAE 50 Oil	800
Glycerin	500
SAE 30 Oil	300
SAE 10 Oil	70
Ethylene Glycol	20
Kerosene	2
Water	1
Gasoline	0.4
Air	0.018
Hydrogen	0.009

Other tests regularly used are pour point, specific gravity, ash content, flash point and neutralization. Most of these tests are conducted according to A.S.T.M. procedures. The pour point is the lowest temperature at which an oil just barely flows. For application at reduced temperatures or outside, winter use, this reading is most important. The specific gravity, its weight relative to water, defines its bulkiness and gives some indication of its heavier constituents.

A measure of the amount of metal contained in an oil is obtained in the ash test.

The flash point test determines the lowest temperature to which the lubricant must be raised to evolve enough vapour to ignite when brought in contact with a flame in the presence of air. It is a safety test but it also indicates the presence of contaminants. The neutralization number, milligrams of potassium hydroxide used in neutralizing one gram of oil, is a measure of the corrosive acid or base content. This test also determines the presence of certain additives.

Other tests are conducted to check properties useful in particular applications. The colour test indicates the nature and extent of refining. The carbon residue test determines the hydrocarbon base. The foam test indicates how readily the lubricant mixes with air to form objectionable foam. How easily the lubricant will absorb oxygen is measured in the oxidation test. Rust-preventive characteristics are found in the rust test.

Greases are also similarly examined. Major tests are penetration, ash content, oxidation stability and evaporation. The penetration of a standard cone classifies greases into grades. It is a kind of viscosity measure. The amount of nonvolatile metallic compound present in the grease is measured in the ash test. Oxidation stability determines resistance to oxidation under storage conditions.

The evaporation test measures the rate at which the grease loses oil. Tests used primarily in manufacture control are the water test, soap test, oil test, alkali test and drop point.

In research and in development of new or improved lubricants, analyses other than control and application tests are essential. Lubricants are here studied by microchemical, instrumental and even radioactive techniques. Microanalysis is the technique that makes use of very small samples, ten milligrams or less. Such micro techniques aid research greatly because large sample quantities can then be made after more favourable materials have been proven.

Fast methods of testing, which instrumental procedures permit, eliminate the tedious, time-consuming process of net-chemistry. Furthermore, instruments often give more accurate results because much personal error is eliminated. X-ray, absorption, mass and emission spectroscopy are major instrumental devices. Spectroscopy, concerned with relationships between radiant energy and matter, dates from 1672 when Sir Isaac Newton discovered the spectrum of primary colours into which white light is diffracted when passed through a prism.

Nuclear fission, discovered during World War II, made available many radioactive isotopes. 'They can be used as tracers in wear studies. The mechanism of basic lubrication phenomena can also be studied for better understanding.

Theory.—Rheology is the science that deals with the intrinsic flow of materials. When a shearing force is applied, the material assumes a shearing strain. If the shearing stress—force per unit area—is plotted against the rate of shearing strain—strain per unit thickness—the flow phenomenon is graphically defined. Such a chart is shown in fig. 6. The "true" or Newtonian liquid (see VISCOSITY: The *Coefficient* of Viscosity) is represented by a straight line starting at the origin. The slope of this line determines the very important property called viscosity. The non-Newtonian fluid starts at the origin also, but is partly or wholly a nonlinear curve—the viscosity is not constant. In general, real liquids are non-Newtonian; but, if the graph is exactly or very nearly straight over the range of operation, the fluid is assumed Newtonian. When some initial shearing stress must be applied before flow begins, the material is a plastic solid. The general plastic solid will have curved portions while the ideal or Bingham plastic solid is all straight. Greases are usually considered plastic solids. The Pascal fluid is a material, not found in nature, but theoretically interesting, which has zero viscosity; *i.e.,* it intrinsically spreads out indefinitely. Hydraulic fluids are sometimes assumed as such.

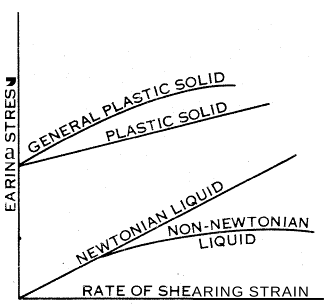


FIG. 6.—RHEOLOGY CHART (*see* TEXT)

All materials used as lubricants, whether gas, liquid or solid, are considered either Newtonian fluids or Bingham plastic solids. *See* also Index references under "Lubrication" in vol. 24.

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LUCAN (MARCUS ANNAEUS LUCANUS) (A.D. 39–65), Latin poet who wrote the Bellum *Civile,* better known as the *Pharsalia,* a historical epic more remarkable for rhetoric than poetry though with flashes of poetic fire. Born at Corduba (Cordova). Sp., grandson of the older, and nephew of the younger, Seneca, he was educated at Rome, among his teachers being the Stoic, Cornutus, who also taught the satirist Persius. He was given a quaestorship by Nero, but it was not long before his republican opinions were outraged by Nero's tyrannous conduct, and in the year 65 he was one of the leaders (*paene signifer,* says Suetonius in his life of Lucan) in Piso's conspiracy to assassinate Nero (although Tacitus says that he was also embittered because Nero had forbidden him to give public recitations of his poetry). When the conspiracy was discovered, he was compelled to commit suicide by opening a vein. While he was dying, Tacitus records: "he remembered a poem composed by himself, in which he had told of a wounded soldier dying by the same kind of death. He repeated the lines, and that was his last utterance."

The Bellum Civile, his only surviving poem, is an epic of the war between Caesar and Pompey, carried down to the arrival of Caesar in Egypt after the murder of Pompey, until in the tenth book it abruptly stops. Lucan was not a great poet, but he was a great rhetorician and had remarkable political and historical insight for so young a man, though it must be admitted that his hatred of Caesar and his admiration for Pompey are both excessive. The work is naturally imitative of Virgil, his predecessor in Latin epic, but Lucan dismisses the gods from his scene, a wise precaution in a poet dealing with not too distant history.

The narrative is not always clear and is marred by overlong speeches and digressions, particularly on geographical matters, although his interest in geography does not often enable him to make his battles intelligible. He is not as dramatic as Virgil; sometimes, as in the account of Pompey's murder, because the writing is perfunctory and sometimes because he exaggerates or strains after rhetorical effect. Although the style and vocabulary are usually commonplace and the metre is monotonous, the rhetoric is often lifted into real poetry by its energy and fire, like Byron's, and appears at its best in the magnificent funeral speech of Cato on Pompey. Pompey's parting with his wife (in book v) is also very fine; and scattered through the poem are noble sayings and telling comments, expressed with the terse vigour and directness of which the Latin language has such command. As the poem proceeds, the poet's republicanism becomes more and more marked, no doubt because, as Nero's tyranny grew, he began to look back with greater longing to the old Roman republic; yet it is true that he does not make the republicanism of Pompey seem either attractive or effective. It has been said that Cato, who appears very little until after Pompey's death, is the real hero of the epic, and certainly the best of Lucan's own Stoicism appears in the noble courage and endurance of his Cato, in continuing the hopeless struggle after Pompey had failed.

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LUCANIA (or Basilicata), a region of southern Italy, comprising the provinces of Matera and Potenza, part of the ancient Lucania. It is bounded on the north by the province of Foggia, northeast by those of Bari and Lecce, east by the Gulf of Taranto (for a distance of 24 mi.), south by the province of Cosenza and west by the Mediterranean and the provinces of Salerno and Avellino. Area 3,856 sq.mi. The region is mountainous, with Mt. Pollino (7,375 ft.), the highest peak in the southern Apennines, on the boundary of Cosenza; Mt. Vulture (4,354 ft.) at the northwestern extremity, is an extinct volcano. The mountains descend by a gradual slope to the coastal plain of the Gulf of Taranto. Five rivers, the Bradano (anc. Bradanus), Basento (Casuentus), Cavone or Salandrella, Agri (Aciris) and the Sinni (Siris) run southeast or east into the gulf. The railway from Naples to Taranto and Brindisi passes through Potenza and meets the east coast line from Taranto to Reggio di Calabria at Metaponto. Branch lines run elsewhere through Lucania. The mountains are still to some extent clothed with forests; in places the soil is fertile, especially along the Gulf of Taranto. Olive oil is the most important product. Pop. (1951) 627,586. There are no large towns.

The ancient Lucania extended from the Tyrrhenian sea on the west to the Gulf of Tarentum on the east. To the north it adjoined Campania, Samnium and Apulia and to the south it was separated by a narrow isthmus from the district of Brutii. It thus comprised almost all the area of the modern Lucania together with the greater part of the province of Salerno and a part of Cosenza. As in the modern region, almost the whole of ancient Lucania was occupied by the Apennines. Two important rivers of the ancient province, the Crathis (mod. Crati), forming its southern limit and the Silarus (Sele), constituting its northern boundary, are not included in the smaller modern Lucania.

Lucania was so-called from the Lucani (Lucanians) who conquered it about the middle of the jth century B.C. Before that it was included under the general name of Oenotria, applied by the Greeks to southernmost Italy. The mountainous interior was occupied by Oenotrians and Chones, while on the coasts on both sides were powerful Greek colonies which doubtless exercised a protectorate over the interior (see MAGNA GRAECIA). The Lucanians were a southern branch of the Samnite or Sabelline group, who spoke Oscan (*q.v.*). After much intertribal conflict they fought the Tarentines and Alexander, king of Epirus, who was called in by that people to their assistance, 326 B.C. In 298 B.C. they made alliance with Rome, and Roman influence was extended by the colonies of Venusia (291 B.C.), Paestum (273) and above all Tarentum (272). On the landing of Pyrrhus in Italy (281 B.C.) they were among the first to declare in his favour and found themselves exposed to the resentment of Rome when the departure of Pyrrhus left his allies at the mercy of the Romans. After several campaigns they were reduced to subjection (272 B.C.). They sided with Hannibal during the Second Punic War (216 B.C.), and their territory during several campaigns was ravaged by both armies. The country never recovered from these disasters, and under the Roman government fell into decay, to which the Social War, in which the Lucanians took part with the Samnites against Rome (90–88 B.C.) gave the finishing stroke. For administrative purposes under the Roman empire, Lucania was always united with the district of the Bruttii. The two together constituted the third region of Augustus.

The towns on the east coast were Metapontum, a few miles south of the Bradanus; Heraclea, at the mouth of the Aciris; and Siris, on the river of the same name. Close to the southern frontier stood Sybaris, destroyed in 510 B.C., but subsequently replaced by Thurii. On the west coast stood Posidonia, known under the Romans as Paestum; below came Elea or Velia, Pyxus, called by the Romans Buxentum, and Laus, near the frontier of the province toward Bruttium. Of the towns of the interior the most considerable was Potentia, still called Potenza. To the north, near the frontier of Apulia, was Bantia; due south from Potentia was Grumentum, and still farther in that direction were Nerulum and Muranum. In the upland valley of the Tanagrus, a tributary of the Silarus, were Atina, Forum Popilii and Consilinum; Eburi (Eboli) and Volceii (Buccino), though to the north of the Silarus, were also included in Lucania. The Via Popillia traversed the district from north to south, entering it at the northwest extremity; the Via Herculia, coming southward from the Via Appia and passing through Potentia and Grumentum joined the Via Popillia in the southwest of the district; another nameless road followed the east coast. (T. A.; X.)

LUCARIS, CYRILLOS (1572–1637), Greek prelate and theologian, was a native of Crete. In his youth he travelled, studying at Venice and Padua, and at Geneva coming under the influence of the reformed faith as represented by Calvin. In 1602 he was elected patriarch of Alexandria, and in 1621 patriarch of Constantinople. He was the first great name in the Orthodox Eastern Church since 1453 and dominates its history in the 17th century. The great aim of his life was to reform the church on Calvinistic lines, and to this end he sent many young Greek theologians to the universities of Switzerland, Holland and England. In 1629 he published his famous *Confessio,* Calvinistic in doctrine, but as far as possible accommodated to the language and creeds of the Orthodox Church. It appeared the same year in two Latin editions, four French, one German and one English, and in the Eastern Church started a controversy which culminated in 1672 in the convocation by Dositheos, patriarch of Jerusalem, of a synod by which the Calvinistic doctrines were condemned. Lucaris was several times temporarily deposed and banished at the instigation of his orthodox opponents and of the Jesuits, who were his bitterest enemies. Finally, when Sultan Murad was about to set out for the Persian War, the patriarch was accused of a design to stir up the Cossacks, and to avoid trouble during his absence the sultan had him killed (June 163;).

See the article "Lukaris" by P. Meyer in Herzog-Hauck, *Realencyklop.,* 3rd ed (Leipzig, 1902), which gives further authorities.

LUCARNE, a French architectural term for a dormer window; in English usage. applied to the dormer windows of spires.

LUCAS, CHARLES (1713–71), Irish physician and politician, was an apothecary in Dublin. He issued in 1748–49 a series of political addresses; the house of commons voted him an enemy to the country and issued a proclamation for his arrest. Lucas escaped to the continent and qualified in medicine at Leyden in 1;52. In 1753 he started practice in London. He was elected member for the city of Dublin in 1761, his colleague in the representation being the recorder, Henry Grattan's father. On the appointment of Lord Halifax as lord lieutenant in the same year Lucas wrote him a long letter (Sept. 19, 1761, manuscript Irish State Paper office) setting forth the grievances which Ireland had suffered in the past. His contributions to the press and his *Addresses to the Lord Mayor* and other political pamphlets made him one of the most popular writers in Ireland. He died on Nov. 4, 1771.

See R. R. Madden, *History of Irish Periodical Literature from the End of the 17th to the Middle of the 19th Century,* 2 vol. (1867); Francis Hardy, *Memoirs of the Earl of Charlemont,* 2 vol. (1812); W E H Lecky, *History of Ireland in the 18th Century,* vol. i, ii (1892).

LUCAS, EDWARD VERRALL (1868–1938), British man of letters, was born at Brighton and educated at University college. London. He then started journalism, working first on a Sussex newspaper. then in London with the *Globe,* and became a frequent contributor to *Punch* and later its assistant editor. He acted for many years as publisher's reader to the firm of Methuen and became head of this company after the death of its founder (1925). He is best known as a light essayist. His edition of the *Letters of Charles and Mary Lamb* (1903–05) and his *Life of Lamb* (1905) showed how congenial was his talent with that of Elia. He wrote many charming books of travel impressions, among these being *A Wanderer in Holland* (1905), *A Wanderer in London* (1906) and *A U7anderer in Paris* (1909), and his books on art showed powers of wide appreciation, as in *The British School* (1913), *Vermeer of Delft* (1922), *John Constable* (1924). *Vermeer the Magical* (1929).

LUCAS, JOHN SEYMOUR (1849–1923), English painter, was born in London, Dec. 21, 1849, and was a student at the Royal Academy schools. He was elected A.R.A. in 1886 and R.A. in 1898, and was a constant exhibitor of pictures of historical and domestic incidents, notably of the Tudor and Stuart periods. One of his works is a panel in the Royal exchange, representing William the Conqueror granting the first charter to the city (exhibited R.A. 1898); and one of his earlier pictures, "After Culloden: Rebel Hunting" (R.A. 1884), is in the Tate gallery. He died at Southwold. Suffolk, May 8, 1923.

LUCAS VAN LEYDEN (LUCAS HUGENSZ or JACOBSZ; known in Italy as LUCA D'OLANDA) (1494–1533), Dutch painter and engraver, has been described as the greatest of the Dutch artists who laid the foundation of 17th-century Dutch painting. He was probably born at Leyden, where, according to Karel van Mander, he was taught by his father Huygh Jacobsz before entering the studio of Cornelis Engelbrechtsen. According to the same author, he painted at the age of 12 a "Legend of St. Hubert," for which he was paid a dozen florins He was only 14 when he finished a plate representing Mohammed taking the life of Sergius, the monk. At 15 he produced a series of nine plates for a "Passion," a "Temptation of St. Anthony," and a "Conversion of St. Paul." The list of his engravings in 1510 includes subjects as various as a celebrated "Ecce Homo," "Adam and Eve expelled from Paradise," a herdsman and a milkmaid with three cows and a "Woman with a Dog." According to Albrecht Durer's diary, Dürer met Lucas at Antwerp and exchanged the Dutchman's prints for his own and drew his portrait (British museum). The effect of this contact with the great German artist is traceable in Lucas' drawings. He is likely to be the "Lucas de Hollandere, scildere," who registered at the Antwerp guild in 1522. In 1527 he made a tour of the Netherlands, giving dinners to the painters of the guilds of Middleburg. Ghent. Malines and Antwerp. The journey ruined his health; after a long illness he died at Leyden in 1533.

After Durer, Lucas was the most important engraver of his time. Existing engravings ascribed to him number 172. He also designed a number of woodcuts. and about 20 pictures by him are in public and private collections. Early works are the "Chess Players" in the Berlin museum; the "Beheading of John the Baptist" in the Johnson collection. Philadelphia; the triptych of the "Epiphany" in the Barnes collection, Philadelphia; the triptych of the "Last*Supper" in the Aachen museum; "Lot and his Daughters" at the Louvre, Paris; the "Temptation of St. Anthony" in the Brussels gallery; and a remarkable self-portrait in the Brunswick museum. Then follow the paintings in a more fluent style—"St. Jerome" and "The Virgin Enthroned" in Berlin;

the "Card Players" at Wilton house; the "Predication" in the Rijksmuseum, Amsterdam, and a portrait in the National gallery.

In 1522 he painted the "Virgm and Child With the Magdalen and a Kneeling Donor" (gallery of Munich). His manner was then akin to that of Mabuse. The "Last Judgment" (commissioned in 1526), in the town gallery of Leyden, is composed on the traditional lines yet some of the heads are painted with great delicacy and modeled with exquisite feeling. His last important work was a triptych now at the Hermitage at Leningrad (executed, according to Van Mander, in 1531),.representing the "Blind Man of Jericho Healed by Jesus Christ." Here may be observed great finish and warm flesh tints with a gaudy scale of colours.

BIBLIOGRAPHY.—Martin Conway, *The Van Eycks and Their Followers* (1921); M. Friedlaender, *Die Altn. Malerei*, vol. 10 (1932). and *Lucas van Leyden* (1932).

LUCCA, town and archiepiscopal see of Toscana, Italy (anc. Luca), capital of the province of Lucca, 13 mi. N.E. of Pisa by rail. Pop. (1957 est.) 86,995 (commune). It is 62 ft. above sea level, in the valley of the Serchio. and looks out for the most part on hills and mountains. The fortifications, pierced by four gates, begun in 1504 and completed in 1645, are well preserved and picturesque, with projecting bastions planted with trees.

The city is well built and has numerous churches, mainly of well-marked basilican type, having richly decorated exteriors, fine apsidal ends and quadrangular campaniles, in some cases with battlemented summits, and windows increasing in number as they ascend. They follow Pisan style. The cathedral of St. Martin was begun in 1060 by Bishop Anselm (later Pope Alexander II); but the apse with its tall columnar arcades and the campanile are probably the only remnants of the early edifice, nave and transepts having been rebuilt in Gothic style (14th century), while the west front is by Guidetto (identified with Guido Bigarelli of Como) (1204) and "consists of a vast portico of three magnificent arches, and above them three ranges of open galleries." The ground plan is a Latin cross, the nave being 273 ft. in length and 84 ft. in width, and the transepts 144 ft. in length. In the nave is a little octagonal shrine for the most precious of the relics of Lucca, a cedarwood crucifix, carved, according to legend, by Nicodemus, and miraculously conveyed to Lucca in 782. The Sacred Countenance *(Volto Santo)* of the Saviour is shown three times a year. The chapel was built in 1484 by Matteo Civitali, a local sculptor (1436–1501). The cathedral contains several other works by him —the tomb of P. da Noceto, and the altar of S. Regulus as well as the tomb of Ilaria del Caretto by Jacopo della Quercia of Siena. In the cathedral choir is good stained glass of 1485. The church of St. Michael, founded in the 8th century, and built of marble within and without, has a magnificent western façade (12th–13th century, as that of the cathedral)—an architectural screen rising much above the roof of the church. The interior is good but rather bare. The basilican church of S. Martino at Arliano near Lucca belongs to the first half of the 8th century. S. Frediano or Frigidian dates originally from the 7th century, but was built in Romanesque style in 1112–1147, though the interior, originally with four aisles and nave, shows traces of the earliest structure; the front occupies the site of the ancient apse; in one of its chapels is the tomb of Santa Zita, patroness of servants and of Lucca itself. In S. Francesco, a fine Gothic church, is the tomb of Castruccio Castracane (d. 1328). San Giovanni (originally of the 12th century), S. Cristoforo, S. Giusto, San Romano (rebuilt in the 17th century, by Vincenzo Buonamici), and Santa Maria Forisportam (of the 12th century) also deserve mention.

Among secular buildings are the old ducal palace, begun in 1578 by Ammanati, and later the residence of the prefect and seat of the provincial officers and the public picture gallery; the early Renaissance Palazzo Pretorio. or former residence of the podestà, the seat of the civil and correctional courts; the palace, erected in the 15th century by a member of the Guinigi family, of brick. in Italian Gothic, the 16th-century palace of the marquis Guidiccioni, a depository for the archives. the earliest documents going back to A.D. 790. The Palazzo Mansi contains a collection of Dutch pictures. There are several other fine late 16th-century palaces. The principal marketplace in the city has taken possession of the arena of the ancient amphitheatre, the outer arches of which can still be seen in surrounding buildings. The whole building, belonging probably to the early Empire, measured 135 by 105 yd., and the arena 87½ by 58 yd. The outline of the ancient theatre can be traced in the Piazza delle Grazie, and some substructure walls are preserved. The ancient forum was on the site of the Piazza S. Michele. Remains of the city walls have also been found. The rectangular disposition of the streets in the centre of the town is a survival of Roman times. The archiepiscopal library and archives are also important, while the treasury contains some fine goldsmith's work, including the 14th-century Croce dei Pisani, made by the Pisans for the cathedral.

The river Serchio affords water power for numerous factories. The most important industries are the manufacture of jute goods (carried on at Ponte a Moriano in the Serchio valley, 6 m. N. of Lucca), tobacco, silks and cottons. The silk manufacture was introduced about the close of the 11th century, and in the early 16th formed the means of subsistence for 30,000 of its inhabitants. The bulk of the population is engaged in agriculture. The water supply is maintained from the Pisan mountains by an aqueduct with 459 arches, built in 1823–32.

The ancient Luca, commanding the valley of the Serchio, is first mentioned as the place to which Sempronius retired in 218 B.C. before Hannibal, after his defeat at the Trebia (*q.v.*). It was there that Julius Caesar in 56 B.C. held his famous conference with Pompey and Crassus; Luca was then still in Liguria, not in Etruria. In the Augustan division of Italy Luca was assigned to the 7th region (Etruria); it was a meeting point of roads—to Florentia, Parma, Luna and Pisae. Though plundered and deprived of part of its territory by Odoacer, Luca appears as an important city and fortress at the time of Narses, who besieged it for three months in A.D. 553, and under the Lombards it was the residence of a duke or marquis and had the privilege of a mint.

The dukes gradually extended their power over all Tuscany, but after the death of the famous Matilda the city began to constitute itself an independent community, and in 1160 it obtained from Welf VI, duke of Bavaria and marquis of Tuscany, the lordship of all the country for 5 mi. around. on payment of an annual tribute. Occupied by the troops of Louis of Bavaria, sold to a rich Genoese Gherardino Spinola, seized by John, king of Bohemia, pawned to the Rossi of Parma, by them ceded to Martino della Scala of Verona, sold to the Florentines, surrendered to the Pisans, nominally liberated by the emperor Charles IV and governed by his vicar, Lucca managed, at first as a democracy, and after 1628 as an oligarchy, to maintain "its independence alongside of Venice and Genoa, and painted the word Libertas on its banner till the French Revolution." In 1546 Francesco Burlamacchi made a noble attempt to give political cohesion to Italy, but perished on the scaffold (1548); his statue by Ulisse Cambi was erected on the Piazza San Michele in 1863. As a principality formed in 1805 by Napoleon in favour of his sister Elisa and her husband Felice Baciocchi, Lucca was for a few years wonderfully prosperous. It was occupied by the Neapolitans in 1814; from 1817 to 1847 it was governed as a duchy by Maria Luisa, queen of Etruria, and her son Charles Louis; and it afterward formed one of the divisions of Tuscany.

(T. A.)

LUCCA, BAGNI DI (Baths of Lucca), town of Toscana, Italy, province of Lucca, containing a number of famous watering places in the valley of the Lima. a tributary of the Serchio. Pop. (1957 est.) 11,471 (commune). Ponte a Serraglio (16 mi. north of Lucca by rail) is the principal village, but there are warm springs and baths also at Villa and Bagni Caldi. The springs do not seem to have been known to the Romans. The temperature of the water varies from 98° to 130" F.; in all cases it gives off carbonic acid gas and contains lime, magnesium and sodium products. In the valley of the Serchio, 3 mi. below Ponte a Serraglio, is the medieval Ponte del Diavolo (1322), with its lofty central arch.

LUCCEIUS, LUCIUS, Roman orator and historian, friend and correspondent of Cicero. Disgusted at his failure to become consul in 60, he retired from public life and devoted himself to writing a history of the social and civil wars. Cicero wrote to him asking him to write a history of his (Cicero's) consulship and offering to supply the material.

Nothing remains of any such work or of his history. In the civil war he took the side of Pompey but was pardoned by Caesar and returned to Rome.

See Cicero's *Letters* (ed. Tyrrell and Purser), especially *Ad Fam.* v. 12; and Orelli, *Onomasticon Tullianum.*

LUCCHESI, ANDREA (1741–*c.* 1800), Italian musician and composer, was born in hiotta, Venice. on May 28. 1741. In his youth he studied under Paolucci. Seratelli and Cocchi. In 1771 he went to Bonn, Ger.. and in 1774 he succeeded the grandfather of Ludwig von Beethoven as conductor of the court orchestra. Under him Beethoven, then only a boy, played the viola in the orchestra. Lucchesi composed eight operas, two symphonies, six sonatas for violin and cembalo, four piano quartets and some church music.

LUCCHESINI, GIROLAMO (1751–1825), Prussian diplomatist, was born at Lucca on May 7. 1751, the eldest son of Marquis Lucchesini. In 1779 he entered the service of Frederick the Great in Berlin. Frederick William II sent him in 1787 to Rome to obtain the papal sanction for the appointment of a coadjutor to the bishop of Mainz, with a view to strengthening the German Fiirstenbund.

In 1788 he was sent to Warsaw and brought about a rapprochement with Prussia and a diminution of Russian influence at Warsaw. Frederick William was at that time intriguing with Turkey, then at war with Austria and Russia. Lucchesini was to rouse Polish feeling against Russia and to secure for Prussia the concourse of Poland in the event of war with Austria and Russia. He concluded a Prusso-Polish alliance in March 1790, and in the autumn of that year was sent to Sistova. where the terms of peace between Austria and Turkey were being discussed. Before he returned to Warsaw his treaty was a dead letter and Prussia was contemplating the second partition of Poland. Lucchesini was recalled and employed on the Rhine in liquidating the intervention in the French Revolution.

In 1793 he was appointed ambassador to Vienna, with the ostensible object of securing financial assistance for the Rhenish campaign. His anti-Austrian bias made him extremely unpopular with the Austrian court. which began asking for his recall in 1795. The request was granted in 1797.

In 1800 he was sent by Frederick William III on a special mission to Paris. Napoleon, too, sought his recall but eventually (in 1802) accepted him as regular ambassador. He consistently sought friendly relations between France and Prussia but was unsuccessful and was superseded as ambassador just before the outbreak of war between the two countries in 1806. After the Prussian defeat at Jena he tried to negotiate terms of peace, but his first draft was refused by Napoleon and his second by Frederick William.

He was dismissed from the Prussian service and joined the court of Elisa, grand duchess of Tuscany and after Napoleon's fall devoted himself to writing. He died on Oct. 20, 1825.

He published in 1819 three volumes, *Sulle cause et gli effetti della confederazione rhenana,* at Florence. His memoirs remained in ms. His dispatches were edited by Bailleu in *Preussen und Frankreich* (1887, *Publikationen aus den preussischen Staatsarchiven).*

LUCE,. CLARE BOOTHE (1903–), U.S. playwright and public official, was born in New York. N.Y., April 10, 1903. Privately educated in Garden City and Tarrytown, N.Y., she was associate editor of *Vogue* in 1930; associate editor and managing editor of *Vanity Fair* from 1930 to 1934. After having been divorced from her first husband. George Tuttle Brokaw, in 1929, she married Henry R. Luce (*q.v.*) in 1935. Mrs. Luce wrote a number of plays. including *The Women* (1936) and *Kiss the Boys Goodbye* (1938), satires on two phases of American life; and *Margin for Error* (1939), an anti-Fascist play. She also wrote the books *Stuffed Shirts* (1931) and *Europe in the Spring* (1940). She was Republican congresswoman from Connecticut in the 78th and 79th congresses. In Feb. 1953 Pres. Dwight D. Eisenhower appointed her ambassador to Italy, from which post she resigned in 1956 because of ill health.

LUCE, HENRY ROBINSON (1898–), U.S. magazine editor and publisher, was born in Tengchow, China, on April 3, 1898. son of Henry Winters Luce, a Presbyterian missionary. He was sent to the United States at 15 to attend Hotchkiss school, graduated from Tale in 1920 and later studied for a year at Oxford. After a brief reporting career on Chicago and Baltimore newspapers. Luce and a Yale classmate Briton Hadden. founded the weekly news magazine *Time* in 1923 on an investment of $86.000 and with 12,000 subscribers. Attracting attention by brightness, eccentricities of style, accent on personalities and editorial orderliness, *Time* was an immediate success. Hadden died in 1929.

Heading Time Inc., Luce founded *Fortune,* a monthly magazine of business, in 1930; *Life,* a weekly with its main emphasis on pictures in 1936; and *Sports Illustrated,* a weekly, in 1954. The newsreel "March of Time" was produced from 1931 to 1953. Time Inc, purchased *Architectural Forum* in 1932, and 20 years later split from it *House & Home*. The gross income of Time Inc. by 1955 was $200,000,000; it was one of the most influential and profitable publishing concerns in the world.

After divorce from his first wife, the former Lila Ross Hotz, Luce married in 1935 Clare Boothe *(see* LUCE, CLARE BOOTHE).

(F. L. MT.)

LUCE, JOHN (1870–1932), British admiral, was born Feb. 4, 1870, in England. In the Battle of Falkland Islands in World War I, he commanded the light cruiser H.M.S. "Glasgow," which, with the nelp of another British ship, sank the German cruiser "Leipzig." From 1921 to 1924, he was admiral superintendent of the Malta dockyard. In 1925 he was retired and in 1930–31 he served as high sheriff of Wiltshire. Luce died Sept. 22, 1932.

LUCE, STEPHEN BLEECKER (1827–1917), U.S. naval officer, first president of the Naval War college, was born in Albany, N.Y., March 25, 1827, and became a midshipman in Oct. 1831. As a young officer he became interested in the training of seamen for the navy and for the merchant marine; this interest developed into practical plans and methods for the improvement of naval education in general.

Luce was chosen for duty at the U.S. Naval academy, where he produced an excellent textbook on seamanship. A practical and efficient seagoing officer as well as a teacher of theories, he was a successful commanding officer of fighting ships, during the Civil War, and of training vessels. He is best known for the development of the Naval War college, at Newport, R.I., becoming the first president. Oct. 6, 1884. The U.S. army and many foreign navies afterward copied this idea of higher professional education for officers. When he became a rear admiral in 1886, Luce was succeeded as head of the War college by Alfred Thayer Mahan (*q.v.*), whom he had chosen for the faculty. After his retirement, in 1889, he continued as a special adviser at the War college until 1910. He died July 28, 1917. (J. B. HN.)

LUCENA, a municipality (with administrative centre and 15 *barrios* or districts) and capital of Quezon (the second largest province in Luzon, called Tayabas until 1946), Philippine Islands, located near Tayabas bay along the route of the Manila-Hondagua railway line, and 133 mi. from Manila. Pop. (1948) 33,092.

Lumbering is an important industry, and a planing and sawmill were established there. Good automobile roads lead to other towns, and Lucena is a commercial centre.

The inhabitants represent various Malay strains and some of the aboriginal Negritos are found in the adjacent region. Tagalog and Bikol are the leading vernaculars, but other dialects are also used.

LUCENA, a town of Spain, in the province of Cbrdova, 37 mi. S.S.E. of Cbrdova, on the Madrid-Algeciras railway. Pop. (1950) mun., 36,181. Lucena is situated on the Cascajar, a minor tributary of the Genil. The parish church dates from the beginning of the 16th century.

The chief industries are the manufacture of matches, brandy and pottery, especially the large earthenware jars (*tinajas*), used throughout Spain for the storage of oil and wine. There is considerable trade in agricultural produce, and the horse fair is famous throughout Andalusia. Lucena was taken from the Moors early in the 14th century. King Boabdil of Granada was taken prisoner in 1483 in the attempt to recapture it.

LUCERA, town and episcopal see, Apulia, Italy, province of Foggia $12\frac{1}{2}$ mi. W.N.W. of the town of Foggia by rail. Pop. (1936) 17,472 (town), 18,447 (commune). It is upon a lofty plateau, the highest point of which (823 ft.), projecting west, was the ancient citadel, which is occupied by the immense and well-preserved castle of Frederick II (1233), who lived there in oriental splendour. It was later enlarged by Charles I of Anjou. It is the largest mediaeval fortress in Apulia, and within it was the palace, the treasury, the mint, the harem and a menagerie of wild beasts. The cathedral, originally Romanesque but restored after 1300, is in the Gothic style. The interior was restored in 1882. The town occupies the site of the ancient Luceria, the key of the whole country. According to tradition the temple of Minerva, founded by Diomede, contained the Trojan Palladium, but in history it is first heard of as on the Roman side in the Samnite Wars (321 B.C.), and in 315 or 314 B.C. a Latin colony was sent there. It is mentioned in subsequent military history, and its position on the road from Beneventum, via Aecae (mod. Troja) to Sipontum, gave it some importance.

Its wool was also renowned. It contains no ancient remains above ground, though mosaic pavements have been found and there are traces of the foundations of an amphitheatre outside the town on the east. The town hall contains a statue of Venus, a mosaic and some inscriptions.

In 663 it was destroyed by Constans II and was only restored in 1223 by Frederick II, who transported 20,000 Saracens thither from Sicily. They were at first allowed religious freedom, but many were slaughtered and the rest became Christians under compulsion in 1300. Up to 1806 Lucera was the capital of the provinces of Basilicata and Molise.

See A. Haseloff, *Bauten der Hohenstaufen in Unteritalien,* vol. i, pp. 97 ff. (1914).

LUCERNE (Ger. Luzern), a canton of Switzerland. Its total area is 575 sq.mi., of which about 90% is classed as productive (forests covering nearly one-fifth of the total). It contains no glaciers or eternal snows, its highest points being the Brienzer Rothhorn (7,710 ft.) and Pilatus (6,959 ft.), the Rothstock summit (5,453 ft.) and the Kaltbad inn, both on the Rigi. The northern portion of the Lake of Lucerne, the lakes of Sempach and Baldegg and small portions of those of Hallwil and of Zug are in the canton.

Its chief river is the Reuss, which flows through it for a short distance only, receiving the Kleine Emme that flows down through the Entlebuch. In the northern part the Wigger, the Suhr and the Wynen streams flow through shallow valleys, separated by low hills. The canton is fairly well supplied with railways. (For the city of Lucerne, see LUZERN.)

In 1950 the population numbered 223,249 of which the great majority were German-speaking Roman Catholics. Its capital is Luzern; the other towns are Kriens, Willisau, Ruswil, Littau, Emmen and Escholzmatt.

The density of the population is 387 per sq.mi. The peasants, outside the chief centres for foreign visitors, have retained many local customs.

The canton ranks officially third in the Swiss confederation, next after Zurich and Berne. It was formerly in the diocese of Constance and is now in that of Basle. It contains 5 administrative districts and 107 communes. By existing cantonal constitution, the legislature or *Grossrath* is elected on a proportional basis by universal suffrage, while the executive is elected by a popular. vote.

The canton every three years elects nine members to the Conseil National and sends two members to the Conseil des Etats (federal council). Citizens have the right of "initiative" as to constitutional amendments or legislative projects.

The canton is composed of the vanous districts which the town acquired, the dates being those at which the particular region was finally secured—Weggis (1380), Rothenburg, Kriens, Horw, Sempach and Hochdorf (all in 1394), Wolhusen and the Entlebuch (1405), the so-called "Habsburger region" to the N.E. of the town of Luzern (1406), Willisau (1407), Sursee and Beromunster (1415), Malters (1477) and Littau (1481), while in 1803, in exchange for Hitzkirch, Merenschwand (held since 1397) was given up.

LUCERNE, LAKE OF, the name usually given by foreigners to the principal lake of central Switzerland. In French it is called the *Lac* des Quatre Cantons, and in German the *Vier*waldstattersee, the cantons being Lucerne, Unterwalden, Uri and Schwyz. It is named after Lucerne, at the west end, where the Reuss issues from the lake, after having entered it at Flüelen at the east end; the Muota enters the lake at Brunnen (north) and two mountain streams, the Engelberg and the Sarnen Aa, at Buochs and Alpnachstad respectively (south). The lake is most beautifully situated between steep limestone mountains, the best known being the Rigi (north) and Pilatus (southwest), and great promontories thrust themselves into its waters, such as Horw (south j, Bürgenstock (south), Meggenhorn (north) and Seelisberg (south), giving it a romantic irregularity. It occupies an old terminal basin of a glacier and along its shores are evidence of damming by moraines.

It is composed of four main basins (with two side basins), which represent four different valleys, orographically distinct, and connected only by narrow and tortuous channels. There is, first, the most easterly basin, the Bay of Uri, extending from Flüelen (south) to Brunnen (north). At Brunnen the delta of the Muota forces the lake west, so that it forms the Bay of Gersau or the Gulf of Buochs, from the promontory of Seelisberg (east) to that of Burgenstock (west). Another narrow strait between the two "Noses" (Nasen) leads west to the Basin of Weggis, between the Rigi (north) and the Biirgenstock promontory (south). This bay forms the eastern arm of the "Cross of Lucerne," the western arm being the Bay of Lucerne, the northern arm the Bay of Kussnacht and the southern arm that of Hergiswil, prolonged southwestward by the Bay of Alpnach, with which it is joined by a narrow channel, spanned by the Acher iron bridge. The Bay of Uri offers the sternest scenery, and at Brunnen the Everlasting league of 1315 was made, while the legendary place of meeting of the founders of Swiss freedom was the meadow of the Rütli (purchased by the Confederation in 1859), and the site of Tell's leap is marked by the Chapel of Tell (east).

In the Bay of Gersau is the village of Gersau (north), an independent republic (1390–1798), and now in Schwyz (1818 onward). In the next basin to the west is Weggis (north), and on the northern shore of the lake is Vitznau, whence a rack railway leads up to the top of the Rigi ($4\frac{1}{4}$ mi.), while on the southern shore of the lake is Kehrsiten, with electric railway to the Bürgenstock promontory. The town of Lucerne is connected with Flüelen by the St. Gotthard railway. On the promontory between Lucerne and Kussnacht stands the castle of New Habsburg, while from Kussnacht a motor road leads through the "Hollow Way" (Hohle *Gasse*), the scene of the legendary murder of Gessler by William Tell.

The western shore of the southern arm is traversed from Horw to Alpnachstad by the Brunig railway ($5\frac{1}{2}$ mi.), which continues toward Sarnen (Obwalden) and the Bernese Oberland, and southwest from Alpnachstad, whence a rack railway leads northwest up Pilatus ($2\frac{3}{4}$ mi.).

Lucerne is the only town of importance, but several spots serve as ports for neighbouring villages (Brunnen for Schwyz, Fliielen for Altdorf, Stanstad for Stans, Alpnachstad for Sarnen). Most of the villages are summer resorts (Gersau also in winter), especially Hertenstein, Weggis, Gersau, Brunnen, Beckenried and Hergiswil, while hotels have been built on heights above, as well as on the Rigi, Pilatus and the Stanserhorn. The area of the lake is 44 sq.mi., and it is about 24 mi. long. At its broadest point, the Lake of Lucerne is only 2 mi. wide; at its greatest depth it is 702 ft.; while the surface of the water is 1,424 ft. above sea level.

Parts of the lake are in the cantons of Lucerne ($15\frac{1}{2}$ sq.mi.), Nidwalden (13 sq.mi.), Uri ($7\frac{1}{2}$ sq.mi.), Schwyz ($7\frac{1}{2}$ sq.mi.) and 1 sq.mi. in Obwalden.

LUCERNE: see ALFALFA.

LUCHAIRE, ACHILLE (1846–1908), French historian, whose original work on the Capetians had great value, was born in Paris on Oct. 24, 1846, and died there on Nov. 4, 1908. In 1879 he became a professor at Bordeaux and in 1889 professor of medieval history at the Sorbonne; in 1895 he became a member of the Académie des Sciences Morales èt Politiques. The most important of Achille Luchaire's works are *Histoire des institutions monarchiques de la France sous les premiers Capétiens* (1883 and again 1891); *Manuel des institutions françaises: pkriode des Cape'tiens directs* (1892); *Louis VI le Gros, annales de sa vie et de son règne* (1890); *Etude sur les actes de Louis VII* (1885); *Innocent III* (6 vols., 1904–08); and contributions on the 13th century to E. Lavisse's great history of France.

LUCHOW (LU-CHOU, LU-HSIEN), a river port, road and regional trade centre on the Yangtze river in southwestern Szechwan province, China. Pop. (1953) 289,000. The city is located at the mouth of the T'o Chiang (sometimes Lu river), navigable in its lower course much of the year by native craft. Luchow is an old trade and transport centre, on the Yiinnan-North China route, and a distributing centre for salt and sugar, these products being produced at Tzu-liu-ching and Nei-chiang, to the north.

(J. E. SR.)

LUCHU ISLANDS: *see* RYŪKYŪ ARCHIPELAGO.

LUCIAN, SAINT (LUCIAN OF ANTIOCH, LUCIAN THE MARTYR) (d. 312), Christian theologian and martyr, was born at Samosata. His parents, who were Christians, died when he was 12. In his youth he studied under Macarius of Edessa, and after receiving baptism he adopted a strictly ascetic life. Settling at Antioch (*q.v.*) he became a presbyter, and is regarded as the founder of the theological school of Antioch. He is represented as the connecting link between Paul of Samosata and Arius (*qq.v.*), but his identification with the heretic of the same name referred to by Alexander of Alexandria (Theodoret, *Church History*, i, 3, 4) has been questioned. However, Arius seems to have been among his pupils. In any case he was in good standing at the outbreak of persecution, and the reputation won by his high character and learning was confirmed by his courageous martyrdom.

Lucian was carried to Nicomedia before Maximin Daza, and persisting in his faith perished on Jan. 7, 312 under torture and hunger, which he refused to satisfy with food offered to idols. His defense is preserved by Rufinus (ix, 6) and Eusebius (*Church History*, ix, 9). His remains were conveyed to Drepanum in Bithynia, and under Constantine the town was founded anew in his honour and exempted from taxes (A.D. 327). There in 387. on the anniversary of his death, Chrysostom delivered the panegyrical homily from which (with notices in Eusebius, Theodoret and the other ecclesiastical historians, the life by Jerome, but especially from the account by Metaphrastes) the facts given above are derived.

Jerome says that Lucian wrote *Libelli de fide* and several letters, but only a short fragment of one epistle remains. The authorship of a confession of faith ascribed to Lucian and put forth at the semi-Arian synod of Antioch (A.D. 341) is uncertain. Lucian's most important literary labour was his edition of the Greek Old Testament corrected by the Hebrew text, which, according to Jerome. was in current use from Constantinople to Antioch. From his work derives the text commonly used until modem times, probably for the New Testament as well. St. Lucian's feast day is Jan. 7. *See* BIBLE: *Old Testament*.

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(E. R. HY.)

LUCIAN (Λουκιανός) (*c.* A.D. 125–*c.* 190), Greek sophist and satirist, was born at Samosata (*Hist.* 24), the chief town of Cornmagene in Syria, on the west bank of the Euphrates (*Pisc.* 19). The precise dates of his birth and death are uncertain, and the little that is known of his life is derived from his own works, supplemented by the notice in Suidas: "Lucian of Samosata, surnamed 'the blasphemer,' because in his dialogues he alleges that the things told of the gods are absurd. . . . He was at first an advocate in Antioch, but, having ill success in that, he turned to the composition of discourses, and his writings are innumerable. He is said to have been killed by dogs, he having been rabid against the truth. For in his 'Life of Peregrinus' he attacks Christianity and, wicked man, blasphemes against Christ himself. Wherefore for his madness he suffered meet punishment in this life, and hereafter with Satan he will be inheritor of the everlasting fire." First apprenticed to his uncle, a sculptor (*Somn.* 2), he soon abandoned sculpture for the study of rhetoric, in particular forensic oratory. After practising as an advocate in Antioch he adopted the profession of a sophistic rhetorician, and in this capacity he travelled widely, visiting various parts of Asia Minor, Macedonia, Greece, Italy and Gaul (*Alex.* 57, *Bis accus.* 27, *Apol.* 15, *De electo* 2). In Rome he made the acquaintance of the Platonist Nigrinus, as he describes in the dialogue of that name. About A.D. 165 he settled in Athens, where he made his home for the next 20 years. Here he devoted himself to writing dialogues of a satiric character. Towards the end of his life he accepted an official post in Egypt, defending himself in the *Apologia* against the charge of inconsistency to which he thus exposed himself, he having in his earlier *De mercede conductis* denounced the practice of serving for hire. In this post he seems to have died, but nothing is known as to the date or circumstances.

Under the name of Lucian we have some 79 prose works, and, in addition, two mock tragedies (the theme being gout) and a collection of 53 epigrams. Neither of the tragedies, *Tragodopodagra* and *Ocypus*, is now considered genuine (the latter having apparently been written by the 4th century rhetorician, Acacius, the correspondent of Libanius), nor is much confidence to be placed in the authenticity of the epigrams, which in any case contain nothing notable, save perhaps No. 17 Ἓξ ὧραι μόχθοις ἱκανώταται, αἱ δὲ μετ' αὐτὰς γράμμασι δεικνύμεναι "ζῆθι" λέγουσι βροτοῖς, *i.e.*, Six hours are enough for work; the next four, expressed in letters (ζ', q', θ', ι'), say to men "Live" (in the emphatic sense of "enjoy life" as in Martial's *sera nimis vita est crastina: vive hodie*).

Several of the prose writings are considered spurious on grounds of varying certainty—*Lucius or the Ass*, *Nero Macrobii*, *Philopatris* (written in the 10th century), *Halcyon*, *De sacrificiis*, *De Syria dea*, *De astrologia*, *De parasito*, *De saltatione*, *Calumniae non temere credendum*, *Hippias*, *Charidemus*, *Demosthenis encomium*, *Amores*. The chronological order of his writings is uncertain, but in general the rhetorical works may be regarded as mainly belonging to his earlier period, the satirical dialogues as the work of his maturity, written for the most part during his residence in Athens.

1. Rhetorical Declamations — As typical of these may be named the *Tyrannicide* (a man goes to slay a tyrant but, finding not him but his son, slays the latter, leaving his sword in the wound. The tyrant finds his son slain, takes the sword, and kills himself. The man claims the reward of a tyrannicide); *Phalaris* I. and II. (in I., Phalaris, sending the brazen bull to Delphi, transmits therewith a defence of his own life and conduct; in II., a Delphian priest advises acceptance of the offering); *The Disinherited*, Ἀποκηρυττόμενος (a disinherited son learns medicine and, curing his father's madness, is received again into his family, but refusing to cure his step-mother is again disinherited. He pleads against this sentence); *Praise of the Fly*; *The Trial of the Vowels* (an action is brought by the letter sigma [s] against tau [τ] for the encroachments of the latter in the case of Attic ττ for σσ, etc., the vowels forming the jury).

2. Literary Criticism. — Representative of this type are the *Teacher of Orators*, ironical advice how to become a successful rhetorician by means of claptrap and impudence; *Pseudo-sophist*, a dialogue in which the interlocutors are Lucinus (*i.e.*, Lucian) and a Solecist, and the discussion is of certain solecisms and the distinction of similar words and phrases; *Lexiphanes*, in which the interlocutors are Lucinus and Lexiphanes. The latter recites a *Symposium* composed by himself and packed with far-fetched phraseology and recondite words. Meeting a doctor he receives

an emetic, which cures his distemper by causing him to disgorge a flood of abstruse vocables. There are interesting references to the Altar of Dosiades and the Alexandra of Lycophron. But the best specimen of his literary criticism is contained in the essay How History *Should* be Written, which belongs probably to an early period of his residence in Athens, and which contains sound, if not particularly profound, criticism. The description of the ideal orator (*Hist.* 41) may be quoted: "I would have the historian to be fearless and incorruptible, independent, a lover of frankness and truth, one who, as the comic poet says, will call a fig a fig and a spade a spade; indulging neither hate nor affection, unsparing and unpitying, not shy nor shamefast, an impartial judge, benevolent towards both sides but giving neither more than its due; knowing in his writing no land and no city, bowing to no authority and acknowledging no king, not considering what this man or that will think, but stating facts as they occurred." His remarks on the style appropriate to the historian are also admirable.

3. Biographical Works.—These include On the Dream, which is autobiographical; the Life of *Demonax,* an account of Demonax of Cyprus, a cynic philosopher whose society Lucian enjoyed at Athens (Vit. Demon. 1); Alexander, or the False Prophet, an indictment of the Paphlagonian religious impostor of that name—written after A.D. 180, since in sec. 48 θεὸς Μάρκος, i.e., divus Marcus, implies that M. Aurelius (died March 17, 180) was already dead; On the Death of Peregrinus, written about 166, an account of the death of Peregrinus (Proteus) of Parium, who, after professing Christianity, became a cynic and finally committed suicide by publicly burning himself at Harpina near Olympia in A.D. 165, Lucian being an eye-witness (Peregr. 2). The references to Christianity in this dialogue (11 seq.) and in the Alexander (25 and 38) are of interest, particularly the references to Christ, "that great man who was crucified in Palestine because he introduced this religion into life" (Peregr. 11), to the unsparing devotion of the Christians, and to their beliefs: "for these unhappy men have persuaded themselves that they will be immortal and live for ever; wherefore they despise death and willingly sacrifice themselves. Further, their first lawgiver has persuaded them that they are all brothers one of another, when once they renounce the gods of the Greeks and worship that crucified sophist and live in accordance with his laws" (Peregr. 13).

4. **Romances.**—*Lucius* or the Ass seems not to be genuine. The story is that of one Lucius who, visiting Thessaly, sees his hostess transform herself by a drug into a bird. Trying the same experiment, but using the wrong drug, he turns himself into an ass and goes through various adventures before he is able to procure roses (the antidote to the drug), which he eats and regains human form. The same theme seems to have been used by Lucius of Patrae in the 1st century A.D. (Phot. cod. 129) as it was again by Apuleius in his Metamorphoses in the 2nd century. The True History, in two books, is a novel of adventure, describing the marvellous experiences of certain voyagers who, setting sail from the Pillars of Hercules, are caught up into the air, fight for the men of the moon against the men of the sun over the colonization of the morning star, are swallowed, ship and all, by a huge sea-monster, from which they at last escape and voyage to the islands of the blest, etc. The writer warns the reader at the start: "I write of things which I have neither seen nor suffered nor learned from another, things which are not and never could have been, and therefore my readers should by no means believe them" (V.H. i. 4).

5. Satirical Dialogues.—The satirical dialogues may be taken as the most mature and characteristic work of Lucian. In the *Twice* Accused Lucian is arraigned by Rhetoric on a charge of desertion (κάκωσις). Rhetoric tells how she found him quite a youth, "still a barbarian in speech and all but dressed in the Assyrian fashion, wandering about Ionia and not knowing what to do with himself," and how she educated him in the art of speaking and made him famous, travelling with him not merely in Ionia and Greece but even so far afield as Italy and Gaul (Bis *accus.* 27). Lucian in his reply admits the benefits which he received from Rhetoric, but he pleads that it was only when he found her abandoning the Demosthenic style of oratory for a more meretricious fashion, "decking herself and wearing her hair in the manner of a courtesan, using paint and pencilling her eyes," that he resolved to desert her for Dialogue: "In any case it was well for me, a man of some 40 years of age, to be done with those tumults and lawsuits and to leave 'gentlemen of the jury' alone; to escape from tirades against tyrants and praise of princes, and to go to the Academy or the Lyceum and walk with this most excellent Dialogue, conversing quietly and requiring no praise or applause" (Bis accus. 32). On the other hand, Dialogue arraigns Lucian in an action for insult (ὕβρις), complaining that whereas he (Dialogue) had previously held high discourse of the gods and nature and the universe, soaring high above the clouds, where Zeus drives his winged car, Lucian had dragged him down to earth and broken his wings, robbing him of his mask of tragedy and wisdom and substituting for it a mask of another sort, comic and satyric and almost ridiculous, associating him with jest and lampoon and cynicism and Eupolis and Aristophanes, "scoffers at serious things and mockers of what is well ordered," and finally Menippus, "a terrible dog who bit while he laughed" (*Bis* accus. 33). Lucian in reply substantially admits the accusation, but pleads that by abandoning the subtleties of philosophy and introducing comic relief he had caused Dialogue to "walk upon the earth after the manner of men" and thus to become more generally attractive.

In the *Nigrinus* Lucian makes that philosopher describe himself as "sitting as it were aloft in a crowded theatre surveying the actions of men, some capable of affording amusement and laughter, others calculated to try the firmest heart" (*Nigrin.* 18). If the function of the chorus in Greek tragedy as the κηδευτὴς ἄπρακτος (an interested party who takes no part in the action) is comparable to that of the Wedding Guest, Lucian in his rôle of the laughing philosopher may be compared to the Casual Spectator, for whom in his detachment and unconcern all the world's a stage and all the men and women merely players. This is a notion to which Lucian again and again recurs, e.g., *Menippus* 16: "You have often seen, I imagine, on the stage those tragic actors who, according to the exigencies of the play, appear now as Creon and now as Priam or Agamemnon, and the same person, who a little before had with great dignity represented Cecrops or Erechtheus, comes forth at the bidding of the poet as a menial; and, when the drama is ended, each doffs his gold-bespangled dress and lays aside his mask and stepping down from his still-boots walks about, a poor and humble man, no longer Agamemnon the son of Atreus, or Creon the son of Menoeceus, but Polus son of Charicles of Sunium, or Satyrus son of Theogeiton of Marathon." This detached and external point of view is obtained in the *Menippus* by a descent to Hades; and so, too, in the Dialogues of the Dead (with which may be classed the *Cataplus*) the theme is the contemplation of the fugitive vanities of human life from the point of view of those for whom "what comes after life" (τὰ μετὰ τὸν βίον, Mort. Dialog i. 1) is no longer a matter of speculation but a present reality. In the *Icaromenippus,* on the other hand, the vantage-ground is got by an ascent to Heaven; in the *Charon* by piling upon Ossa Pelion, then Oeta, then Parnassus, whence Charon with his guide Hermes contemplates a series of celebrities, and, beholding the futility of human endeavour, is moved to cry "O foolish men! Wherefore are ye so busied about these things? Cease from your labours, for ye will not live for ever None of those earthly dignities is abiding, and a man can carry none of them with him when he dies, but must depart naked, while his house and lands and gold will own one master after another" (*Charon* 20). In the Anacharsis we have Greek institutions as they present themselves to the eye of a barbarian, and a justification of them against his criticisms.

Besides the dialogues already referred to may be mentioned the Hermotimus (written when Lucian was 40 years of age, Herm. 13), the upshot of which is that all philosophy is vanity; the Ship, emphasizing the vanity of human wishes; the Symposium, describing a riotous banquet at which the philosophers behave rather worse than others; the Sale of Lives, in which the lives of various philosophers are auctioned at market value; the Timon, in which the Athenian misanthrope (whose tower was seen by Pausanias, i. 30) is restored to wealth to find himself once more the centre of a crowd of flatterers.

The English writer whom Lucian most recalls is Swift, who, as he probably took the idea of *Gulliver's* Travels from the True History, may have found the inspiration for the Letter of Advice to a Young Poet in the Teacher of Orators. In ease and lucidity of style Lucian's Greek (founded on the best Attic models and only in some minute details aberrant from them) is not inferior; and if he suggests less of the saeva indignatio of the conventional satirist, that may well mean not any lack of personal conviction and moral earnestness but a stricter fidelity to what he conceived to be the function of the satirist — ridentem *dicere* verum.

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LUCIDOR, LASSE, pseudonym of LARS JOHANNSON (1638–1674), Swedish lyric poet, author of some of the most powerful poems of the baroque period in Swedish literature. was born in Stockholm in 1638. Lasse studied at Greifswald and Leipzig, and spent several years abroad as a wandering scholar and, perhaps. actor. On returning to Sweden, he lived first in Uppsala and, after 1669, in Stockholm. becoming known as the writer of funeral elegies and epithalamiums. His most personal poems are drinking songs and funeral hymns — a typically baroque combination. His models were the German baroque poets, among them Andreas Gryphius, but his best poems surpass theirs in intensity of feeling and power of expression. His most famous song "Skulle Jag sorja så vore Jag tokot" ("Were I to grieve, then I were a fool"), was written in prison, after an accusation of using disparaging words in a poem to a noble family. He was killed in a tavern brawl in Stockholm. Aug. 13, 1674.

Lucidor's poetry was posthumously published in Helicons Blomster (1689). His Samlade Dikter were edited by F. Sandwall in a commented edition (1914–30). (CL. FN.)

LUCIFER (d. 370/371), bishop of Cagliari in Sardinia, was a supporter of Athanasius (*q.v.*) and the founder of a small rigorist sect named after him. Nothing is known of his life until after the Arianizing council of Arles in 353, when he tried to obtain a new and impartial council. At the council of Milan (355) he refused to sign the condemnation of Athanasius, and was exiled to the east, where he wrote five polemical tracts remarkable more for their violent language against Constantius II than for correctness and wealth of doctrine. His quotations from scripture, however, are of value for the study of the Old Latin text. Of his letters, two survive.

Allowed by Julian's edict to return home, Lucifer declined an invitation to attend the synod of Alexandria (362), and passed through Antioch, where he refused to recognize Meletius as bishop, and consecrated Paulinus, leader of the Eustathian faction, in his stead, thus prolonging the Antiochene schism for many years. Lucifer refused ecclesiastical fellowship with all those who had signed, even under duress, the Arianizing formula of Rimini (359), as he considered them fallen from their clerical dignity through heresy. The short-lived sect which he founded comprised small groups in Spain, Gaul and even Rome. Its best-known members were Gregory, bishop of Elvira (Granada); Ephesius, Luciferian bishop of Rome; and the two Roman priests Faustinus and Marcellinus who presented a petition *Libellus* precum on behalf of the sect to Theodosius I in 384.

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LUCIFER, Latin "light-bringer," is a name given in classical mythology to the planet Venus when it appears above the eastern horizon before sunrise. It is used in Isa. xiv, 12 (Authorized version; "day star" in Revised Standard version) to translate the Hebrew epithet "shining one," applied to the king of Babylon, fallen from his high estate to Sheol. The Fathers interpreted the words of Jesus, Luke x, 18, "I saw Satan fall like lightning from heaven," as a reference to this passage in Isaiah, so that "Lucifer" came to be regarded as the name of Satan before his fall. It is so used by Milton in Paradise Lost, and the idea underlies the proverbial phrase "as proud as Lucifer."

LUCILIUS, GAIUS (c. 180–*c.* 102 or 101 B.C.), the earliest Latin satirist, of whose writings only fragments remain, was born at Suessa Aurunca, on the Campanian confines of Latium. He was of good family and education. and served under Scipio Aemilianus in the Numantine War in Spain, 134–133 B.C. He was a friend of learned Greeks and well acquainted with Greek manners and thought, was on intimate terms with Scipio and mixed with other great figures of his time. He spent the greater part of his life at Rome but was living at Naples when he died. His career as a writer extended from 131 B.C. to nearly the end of his life. His works were collected in a posthumous edition of 30 books, of which the last five were the earliest in date. In his four earliest books Lucilius composed in *septenarii* and senarii, as well as in hexameters. After his fourth book, he chose the hexameter except for some poems in elegiacs. Of his work about 1,300 complete or partial lines have survived.

Lucilius may be regarded as the inventor of poetical satire, as he was the first to give to the formless Latin satura that distinctive character of critical comment on manners, politics and literature which the word "satire" still denotes. Unlike other forms of Latin literature, it owes virtually nothing to Greek. In his style and his choice of subject Lucilius was equally original. He ridiculed the donventional language of epic and tragic poetry and used the style of familiar speech, even to the point of frequently employing Greek, which was then fashionable in educated circles. For his subjects he abandoned the hackneyed ground of Greek and Roman mythology and treated of the politics and wars, the business and pleasure, the scandals and vices of his own day. These he handled, not in Juvenal's spirit, but, like Horace, from the standpoint of a man of the world and the associate of men of affairs. But he differed from Horace in being a thoroughly gcod hater, and also in a savage outspokenness of attack characteristic of the public life of his age.

Lucilius' unpolished and vigorous poetry was something new. Its topics were various: politics, social life, luxury, marriage, aims in writing, history, literary and dramatic criticism, grammar, rules of spelling, a letter to a friend, a journey. But it was largely self-portraiture, and this is borne out by Horace, whose artistic development in his hexameter writings owed much to Lucilius' work. Lucilius is recorded as saying that he wrote neither for the most ignorant nor for the most learned. Quintilian says that some men of his day preferred Lucilius not only to all other satirists but to all other poets. Certainly the loss of his work, except for fragments, is one of the most grievous in Latin literature.

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LUCINA, "light bringing," an epithet applied to both Diana and Juno (*qq.v.*) but particularly to the latter as protectress of women, especially in childbirth. As a goddess especially of moonlight, and hence controller of the menses, Lucina's functions spread over the entire birth cycle: fertility, conception, pregnancy, nourishment of the fetus, labour and delivery, lactation, etc. On coins Juno Lucina is represented as a matron holding a child and a flower, symbols of fertility. A shrine of Juno Lucina on the Cispius dated from 375 B.C., and the introduction of the cult went back traditionally to Titus Tatius.

See G. Wissowa, Religion und *Kultus,* 2nd ed., p. 183 ff. (1912); S. B. Platner, *Topographical Dictionary of Ancient Rome,* completed and rev. by Thomas Ashby, s.v. "Juno Lucina" (1929). (R. B. LD.)

LUCIUS, the name of three popes.

LUCIUS I, SAINT (d. 254), pope from 253 to 254, succeeded Cornelius in the summer of 253. Exiled at first, he returned to Rome at the accession of Valerian and received a letter of congratulation from St. Cyprian. Cyprian, writing later to Pope Stephen I, referred to Cornelius and Lucius as being in agreement with Cyprian's policies. St. Lucius died in March 254. His feast day is March 4. (F. X. G.)

LUCIUS II (Gherardo Caccianemici) (d. 1145), pope from 1144 to 1145, was born at Bologna, was cardinal and papal chancellor and succeeded Celestine II on March 12, 1144, the year the Romans proclaimed a constitutional republic, rejecting papal civil rule. Lucius made a truce with King Roger II of Sicily and recognized Portugal as a papal fief. He died on Feb. 15, 1145, following an assault on the Campidoglio.

LUCIUS III (Ubaldo Allucingoli of Lucca) (d. 1185), pope from 1181 to 1185, Cistercian monk and cardinal since 1141, was elected on Sept. 1, 1181, as successor to Alexander III. He was unable to remain in Rome with its autonomy-minded republic. Unable also to agree, despite his willingness, over outstanding problems with Frederick I (Verona, 1184), except for action against the Catharist and other heresies, Lucius died on Nov. 25, 1185, at Verona, before an open break occurred, still hopeful of promoting the Crusade cause.

See H. K. Mann, *The Lives of the Popes in the Middle Ages*, vol. 9–10 (1925). (J. J. RN.)

LUCK (LUTSK), a town in the Volynsk oblast, Ukrainian S.S.R., U.S.S.R., on the Styr river, 85 mi. N.E. of Lvov. Formerly in Poland, the town was ceded to the U.S.S.R. in 1945. Pop. (1959) 49,000. In the 11th century it was known as Luchesk, and was the chief town of an independent principality. In the 15th century it was the seat of a bishop and became wealthy. but during the wars between Russia and Poland in the second half of the 16th century, and especially after the extermination of its 40,000 inhabitants, it lost its importance. In 1791 it was taken by Russia; it reverted to Poland in 1821. The town was occupied by the Russians in 1939 and fell to the Germans in 1941. It is an agricultural centre producing leather, lumber, flour and agricultural implements.

Among its buildings is a 16th-century castle. Luck was the seat of a Roman Catholic bishop.

ŁUCK or **LUTSK, BATTLES OF.** Under this heading are described the Russian attacks on their south-westem front, which extended from the Pinsk marshes to the northern frontier of Rumania, during the summer and autumn of 1916. These attacks are generally known as "the Brusilov offensive." The original break-through of the Austrian front occurred near the town of Łuck (Lutsk), in Volhynia, on the river Styr, which thus gives its name to the whole series of operations.

The general situation in May 1916 was such that despite the failure of the attacks in March which it had launched, the Russian supreme command had set to work to prepare a large scale offensive on the front west of Molodeczno as its contribution to the great general Allied offensive which was to open on all fronts on July 1. Since the great offensive of the Central Powers against Russia had come to an end in the autumn of 1915, their forces on the Eastern front had been considerably reduced. The Germans had taken troops for their Verdun offensive, and the Austrians during the spring had withdrawn formations for an offensive against Italy. The Russians, on the other hand, had recovered rapidly from their disasters of the previous year; the ranks were full and munitions more plentiful than they had been formerly.

Preparation of **Brusilov's Offensive.**—Gen. Brusilov succeeded Ivanov as Commander-in-Chief of the south-westem front in March. He was a cavalry soldier and had commanded the 8th Army since the commencement of the war with conspicuous success. He received instructions to prepare attacks on the south-western front to distract the enemy's attention from the main Russian effort at Molodeczno. The four armies under Brusilov were: the 8th (Kaledin) from the Kowel-Kiev railway near Rafalowka to about Kremenets, 11 divisions and four cavalry divisions; the 11th (Sakharov) from Kremenets to near Tarnupol, eight divisions and one cavalry division; the 7th (Shcherbachev) from near Tarnupol to Potok, seven divisions and 3½ cavalry divisions; and the 9th (Lechitski) from Potok to the Rumanian frontier, ten divisions and three cavalry divisions. There was one corps (two divisions) in reserve.

The Austrian 4th Army (Archduke Joseph Ferdinand), from near Rafalowka to Dubno, with 10½ divisions and one cavalry division, and the 2nd Army (Bohm-Ermolli), from Dubno to near Kremenets, with eight infantry and two cavalry divisions, were opposed to Kaledin; the German Southern Army (von Bothmer) with one German and nine Austrian divisions and two cavalry divisions, held a long front, corresponding approximately with those held by the Russian 11th and 7th Armies; while the Austrian 7th Army (Pflanzer-Baltin), with 8½ divisions and four cavalry divisions, opposed Lechitski. In the actual number of divisions there was little disparity between the total forces at the disposal of either side; the Russians had 38 divisions and 12 cavalry divisions to the Austro-German 37 divisions and nine cavalry divisions; but the Russian divisions were larger. The Austrian front had 'been strongly fortified and organized, and in spite of the removal of some of their most reliable divisions and much heavy artillery to the Italian front the Austrians were confident of being able to hold their ground.

About the middle of April, Brusilov had ordered each of his army commanders to select a sector of attack and to make preparations with the resources at his disposal within his own army to penetrate the enemy's front in that sector. Preparations were to be complete before the middle of May. These attacks were designed simply as aids to the main Russian offensive in the north, timed for July 1. On May 14, however, the Austrians began an offensive in the Trentino against Italy. The Italians appealed to the Russians to relieve the pressure by attacking the Austrians on their front. Brusilov accordingly launched his attacks on all four army fronts on June 4, without any expectation of a decisive break-through or arrangements for exploitation of success on a large scale.

The Break-through at **Łuck.**—The sector of attack chosen by Kaledin, commander of the 8th Army, centred on the village of Olika, east of Luck. The bombardment began on June 4 and the assault was made by the 40th and 8th Corps early on June 5. The 40th Corps carried three lines of enemy trenches and penetrated over two miles, and the 8th Corps, though less successful, made considerable progress. The advance continued on June 6 and on June 7 reached Luck. By this time a wide gap had been made between the Austrian 4th Army and the 2nd Army farther south, and a great opportunity for the numerous Russian cavalry seemed to have come. But of the four cavalry divisions allotted to Kaledin's army, two had been used to hold trenches so as to enable infantry to be concentrated for the assault and one was despatched by Brusilov in a fruitless raid along the railway towards Kowel through marshes entirely unsuited for cavalry action. The one remaining division could accomplish little. Meanwhile the left wing of the 8th Army occupied Dubno on June 9; on June 10 the front of the army lay along the line of the rivers Styr and Ikwa, from Rozyszcze through Łuck to Dubno.

Attacks of the **11th,** 7th and 9th Armies.—The attack of the 11th Army north-west of Tarnupol was a failure. Shcherbachev's 7th Army attacked in a sector on its extreme left near the village of Jaziowec. After two days' bombardment the infantry assaulted early on June 6 and carried the enemy positions; next day the Austrians were driven behind the Strypa. The Russians crossed the river on the 8th and gained further ground during the next two days. Counter-attacks then arrested their advance for the time being. Lechitski's 9th Army attacked some zom. north of Czernowitz, near the village of Okna, with complete success. By June 10 the front was broken and the Austrians retreated in disorder behind the Prut. Czernowitz was captured on June 17.

Consequences of **Brusilov's Success.**—Thus by the middle of June the Austro-German front south of the Pinsk marshes was completely broken on both flanks, and two armies, the 4th and 7th, were in full retreat. In the centre Bohm-Ermolli's and von Bothmer's armies still held, though their outer flanks had been driven in. On three-quarters of the whole Russian south-western front their armies were moving forward. These entirely unexpected results of an offensive undertaken purely as a demonstration reacted instantly on the whole strategy both of the Russians and of the Central Powers. On the Russian side the new situation demanded the immediate transfer of the principal reserves from the north, where they had been grouped for the Molodeczno offensive, if Brusilov's success in the south were to be exploited. The decision was taken promptly enough: the Molodeczno offensive was abandoned. Lesh's 3rd Army astride the Pripet was added to Brusilov's command and troops were hurried south as rapidly as the capacity of the railways would permit. Unfortunately for the Russians the poverty and the low efficiency of their communications gave the enemy time to concentrate sufficient reinforcements to restore their front before the full weight of the Russian reserves could give a fresh impetus to the advance.

For the Germans the sudden reverse came at a difficult time, for they were fully engaged at Verdun and were expecting a Franco-British offensive at an early date; obviously, too, events might have a decisive influence on the attitude of Rumania. Reinforcements were at once collected to restore the situation; to close the principal gap it was decided to stage a counter-attack on a large scale on both sides of the Kowel-Rowne railway. This attack was entrusted to von Linsingen, the German commander of the Austro-German army holding the area of the Pinsk marshes opposite the Russian 3rd Army. He was reinforced by three German divisions from the northern part of the Eastern front, four from France and two Austrian divisions from the Trentino. During the whole of the latter half of June, as these reinforcements arrived, he counter-attacked persistently towards Luck and to the north and south of it. These attacks, though they brought the Austro-German forces little gain of ground, had at least the effect of limiting Kaledin's break-through. On July 4 the left of Lesh's 3rd Army, in conjunction with Kaledin's right, launched an attack in the bend of the Styr east of Kowel and drove von Linsingen's army back to the Stochód river. This put an end to the Austro-German counter-attacks, and there were no further important operations on this part of the front till the end of July.

Meantime, Lechitski in the south with the Russian 9th Army was completing the conquest of the Bukovina. After the capture of Czernowitz, part of the Austrian 7th Army retreated precipitately south to the Carpathians, pursued by the left wing of Lechitski's army, which occupied Kimpolung on June 24. His right wing, advancing between the Dniester and the Prut, won a victory on June 28 and occupied Kolomyja on the following day. At the beginning of July the Austrians in the south received reinforcements and made a series of counter-attacks opposite Kimpolung and Delatyn. These were defeated, and Lechitski's right wing occupied Delatyn on July 10. His army was now, however, enormously extended and had to halt to await reinforcements.

Reorganization of Command by the Central Powers.—The German command, which had since the beginning of June sent 16 divisions to the front south of the Pinsk marshes, naturally claimed an increased influence on the direction of operations on this front. Very shortly after the first break-through at Luck they had insisted on the removal of the Archduke Joseph Ferdinand from his command of the 4th Army and on the extension of von Linsingen's sphere of command southwards to the northern frontier of Galicia. The greater portion of Pflanzer-Baltin's 7th Army had also been transferred to von Bothmer commanding the German Southern Army. It was now proposed to appoint Hindenburg to the supreme command of the Eastern front as far south as Lemberg; the remainder of the front, on both sides of the Dniester and in the Carpathians, was to be under the Austrian heir apparent, the Archduke Charles, with the German Gen. von Seeckt as his chief of staff.

This arrangement was eventually brought into force early in August. The Archduke Charles had originally come from the Italian front at the beginning of July to command a 12th Army, which was to be formed from troops on the spot and fresh reinforcements, and was to deliver a counter-attack on a large scale on both sides of the Dniester in a south-easterly direction But as the incoming reinforcements had always to be thrown into the battle as soon as they arrived, the formation of the 12th Army and the proposed counter-offensive never took place. Instead, the 3rd Army command from Tirol took over the troops between the Carpathians and the Dniester. The Archduke's command thus comprised the 7th, 3rd and Southern armies.

Concurrently during the latter half of July, while the Russian 8th and 9th Armies on the flanks paused to await reinforcements, Brusilov ordered Sakharov's 11th Army, which had extended its front northwards to beyond Dubno, to take the offensive. It attacked near Boromel, south-west of Luck, on July 16, and drove the enemy back across the Lipa. Sakharov then moved south on Brody, which he captured with 40,000 prisoners on July 28—a fine victory. Meanwhile Shcherbachev's 7th Army, in spite of repeated attacks north-west of Buczacz towards Monasterzyska, had failed to make much impression on von Bothmer's Southern Army. Lechitski, however, at the end of July gained some ground towards Stanislau.

Attack on **Kowel.**—Towards the end of July the Russian Guard Army (1st and 2nd Guard Corps, 1st Corps, 30th Corps, Guard Cav. Corps) detrained from the north and took up a front between the 3rd and 8th Armies. The Guard had not been in action since the previous September and had been carefully trained and kept in hand for a great occasion. It was now decided to use it to force the line of the Stochód river and capture Kowel. It is difficult to understand why this line of advance was chosen for a supreme effort. The terrain is mainly marsh and advance is usually possible only on narrow causeways. The attacks, which commenced on July 28 and were continued up to Aug. 10, resulted in a complete and costly failure. The Guard Army lost 55,000 men for a trifling gain of unimportant ground. Brusilov thereafter abandoned the direct advance on Kowel, but continued up till the middle of October attempts to enlarge the Luck salient in the direction of Wlodzimierz Wolynski. All these attempts ended in failure.

In the south the Russian Army commander, Lechitski, attacked again south of the Dniester on Aug. 7 and drove back Kovess' 3rd Army. He occupied Stanislau on Aug. 10 and Nadwórna on Aug. 12. On this latter date the 7th Army occupied Monasterzyska. Under the threat from this flank and pressure from Sakharov's army south of Brody, von Bothmer now at last gave up the original line which he had held throughout all the turmoil and withdrew towards Brzezany.

Austro-German counter-attacks in the Carpathians in the first half of August had little success. On Aug. 20 the Russians reorganized their front so as to allow Lechitski's 9th Army to have as its only task the forcing of the Carpathian passes between Delatyn and Kimpolung in order to protect the right flank of the Rumanians, who joined the Allies on Aug. 27. In spite of severe fighting throughout September little progress was made on this front. Nor was any appreciable advance made elsewhere on the south-western front in spite of repeated assaults. In October the defeat of the Rumanians necessitated the transfer of troops to that theatre and the abandonment of further offensive operations. The summer which had opened so brilliantly ended in disappointment and failure.

Results of the Offensive.—Although Brusilov had recaptured practically the whole of the Bukovina and large portions of Eastern Galicia and Volhynia and had taken some 350,000 prisoners and over 400 guns, the cost had been exceedingly heavy. The casualties on the south-western front were over 1,000,000. These losses and those suffered in the abortive attacks on the Northern and Western fronts in 1916, at Lake Naroch, Baranowicze and Riga, were in the end the principal cause of the rapid infection of the army with anti-war propaganda when the Revolution came. Hailed by her Allies as proof of the complete regeneration of the Russian army, Brusilov's offensive was really its death-knell.

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LUCKA, EMIL (1877–1941), Austrian author and philosopher, born in Vienna on May 11, 1877, came to the forefront of Austrian literature in 1912. His novels and shorter tales are as rich in thought as in invention, their plots being laid either in the middle ages, as in *Isolde Weisshand* (1909), *Heiligenrast* (1919), *Der Weltkreis* (1919), *Fredegund* (1924); or in Vienna society, as in *Das Brausen der Berge* (1918) ; or in the Austrian Alps, as in *Am Sternbrunnen* (1925). In *Die drei Stufen der Erotik* (1913) Lucka gives a representation of the development of love throughout the ages; in *Grenzen der Seele* (1916) he presents the psychology of genius; and in *Urgut der Menschheit* (1924) he discusses the problem of how the primaeval myths may be revived to meet the needs of modern civilization. Later works included a biography of Michelangelo (1930); a novel, *Der blutende Berg* (1931) ; *Die Verwandlung des Menschen* (1934); and *Die grosse Zeit der Niederlande* (1936).

LUCKE, FRIEDRICH (1791–1855), German theologian, was born on Aug. 24, 1791, near Magdeburg. He studied theology at Halle and Göttingen. After holding various academic posts he became in 1827 professor of theology at Göttingen, where he remained until his death on Feb. 4, 1855. Liicke, one of the most influential of the so-called "mediation" school of evangelical theologians (*Vermittelungstheologie*), is chiefly remembered for his *Kommentar über die Schriften d. Evangelisten Johannes*, 4 vol. (1820–32; 3rd ed. 1856).

LUCKENWALDE, a town in the Potsdam *Bezirk* (district), German Democratic Republic, on the Nuthe, 30 mi. S. of Berlin, on the line to Dresden and Leipzig. Pop. (1959 est.) 28,680. The site of Luckentvalde was occupied in the 12th century by a Cistercian monastery, but the place did not become important till the reign of Frederick the Great though it became a town in 1430. Its cloth and hat manufactories were among the most extensive in Prussia. Among its other industries are brewing, and the making of metal and bronze goods, paper and pianos.

LUCKNOW, the second largest city, and a district and division, of Uttar Pradesh, Republic of India. The city was the capital of Oudh from 1775 until the chief commissionership was merged into the United Provinces in 1901; thereafter it in effect shared with Allahabad the position of provincial capital, but in 1949 it became officially the capital of Uttar Pradesh (as the province was by then called). Pop. (1961) 662,196. It lies mainly on the right bank of the winding river Gumti. East of the city the civil lines stretch for a distance of more than 2 mi.; then comes a well laid-out cantonment with a substantial civil population and accommodation for troops of all arms.

Lucknow is a place of parks, gardens and imposing monuments, though most of the latter are of inferior architecture and material. It is the seat of the Uttar Pradesh state legislature; the high court is at Allahabad, but a bench sits in Lucknow throughout the year. Lucknow university is a federation of eight residential colleges, of which Canning is by far the largest; three of the other colleges are for women; another is a medical college, one of the finest in northern India; clinical teaching is provided in the well-equipped hospital adjoining. The Colvin school is intended for the education: on British public-school lines, of the sons of the talukdars, or large landlords of Oudh; and La Martinière school, housed in a picturesque building, takes most Anglo-Indian boys and is partly supported by an endowment left by Gen. Claude Martin in 1800. There are several important industrial establishments, chiefly paper mills, printing presses and metal works; but the city as a whole swarms with the decayed families of the hangers-on of the overgrown court of the old Oudh kingdom. The chief indigenous industries are the manufacture of gold and silver brocades, muslins, embroidery, brass, copper and ivory ware, beaten-silver vessels and ornaments, and pottery and moulding in clay. Lucknow is an important railway centre, and there are large workshops.

The Residency. — Among the events of the Mutiny of 1857 the defense of the Lucknow residency comes, in historic interest, second only to the tragedy of Cawnpore. The name "residency" is now applied not only to the residency itself, but to the whole of the outbuildings and entrenchments in which Sir Henry Lawrence concentrated his small force. These entrenchments covered almost 60 ac. of ground and consisted of a number of detached houses, public edifices, outhouses and casual buildings, netted together, and welded by ditches, parapets. stockades and batteries into one connected whole. On the summit of the plateau stands the shell of the residency proper. the official residence of the chief commissioner, a lofty building three stories high, with a fine portico. Near the residency comes the banqueting hall, and beyond the Baillie Guardgate lie the ruins of the surgeon's house, where Sir Henry Lawrence died of a shell wound, and where the ladies of the garrison were sheltered in underground rooms. Round the line of the entrenchments are pillars marked with the names of the various "posts" into which the garrison was distributed. The most dangerous of these was the Cawnpore battery post. where the stockade was directly exposed to the enemy's fire. Close to the residency is the Lawrence memorial, an artificial mound 30 ft. high crowned by a marble cross.

Other Monuments. — Among the other buildings of interest in Lucknow is the Imambara, which is one of the largest rooms in the world (162 by 54 it.). having an arched roof without supports. This room was built by the Nawab Asaf-ud-dowlah in 1784, to afford relief to the famine-stricken people. The many monuments of his reign include his country palace of Bibiapur, outside the city. Among later buildings are the two palaces of Chhattar Manzil, erected for the wives of Ghazi-ud-din Haidar (1814) and now used as a club; the remains of the Farhat Baksh, dating from the previous reign, and adjoining the greater Chhattar Manzil; the observatory (now a bank) of Nasir-ud-din Haidar (1827); the imambara or mausoleum and the unfinished great mosque (Jama Masjid) of Mohammed Xli Shah (1837), and the huge debased Kaisar Bagh. the palace of Wajid Ali Shah (1847–1856), now divided up into apartment houses. Modern buildings. such as the railway station and the council chamber, have been designed to fit in with the old.

The DISTRICT OF LUCKNOW lies on both sides of the river Gumti, and has an area of 977 sq.mi. Its general aspect is that of an open champaign. well studded with villages, finely wooded and in parts most fertile and highly cultivated. In the vicinity of rivers. however, stretch extensive barren sandy tracts (*bhúr*), and there are many wastes of saline efflorescence (*usár*). The country is an almost dead level, the average slope, which is from northwest to southeast, being less than a foot per mile. The principal rivers are the Gumti and the Sai with their tributaries. The population in 1961 was 1,345,494.

The DIVISION OF LUCKNOW contains the western half of the old province of Oudh. It comprises the six districts of Lucknow, Unao, Sitapur, Rae Bareli. Hardoi and Kheri. Its area is 12,099 sq.mi. and its population in 1951 was 7,152,237.

LUÇON, a town of western France, in the *département* of Vendée, 23 mi. S.E. of La Roche-sur-Yon. on the railway from Nantes to Bordeaux, and on the canal of Lucon (9 mi. long!. which affords communication with the sea in the Bay of Aiguillon. 'Pop. (1954) 6,927. Between Luçon and the sea stretch marshy plains, the bed of the former gulf, partly drained by numerous canals, and in the reclaimed parts yielding excellent pasturage, while in other parts are productive salt-marshes; and ponds for the rearing of mussels and other shellfish. Luçon is the seat of a bishopric, established in 1317, and held by Richelieu from 1607 to 1624. The cathedral, 12th-century and later, nas originally an abbey church. The cloisters are of the late 15th century. Near by is the bishop's palace, possessing a large theological library. There is an ecclesiastical seminary there.

LUCRE, money which is the object of greed (Lat. *lucrum*, gain). In the adjective "lucrative." profitable. there is, however, no sense of disparagement. In Scots lan the term "lucrative succession" (*lucrativa acquisitio*) denotes the taking by an heir, during the lifetime of his ancestor, of a free grant of any part of the heritable property.

LUCRETIA, a Roman lady, wife of Lucius Tarquinius Collatinus, distinguished for her beauty and domestic virtues. Having been outraged by Sextus Tarquinius, one of the sons of Tarquinius Superbus, she informed her father and her husband, and, having exacted an oath of vengeance from them, stabbed herself to death. Lucius Junius Brutus, her husband's cousin, put himself at the head of the people, drove out the Tarquins, and established a republic (traditional date, 509 B.C.). The accounts of this tradition present many points of divergence.

LUCRETILIS MONS, a mountain in Sabine Hills, mentioned by Horace as visible from his farm, generally (and rightly) identified with Gennaro, a limestone peak 4,170 ft. high. Excavations on the site of Horace's farm have led to the discovery of the building itself, with baths added at a later date.

LUCRETIUS (TITUS LUCRETIUS CARUS) (earlier half of last century B.C.), Latin poet and philosopher, whose one poem, *De rerum natura* ("On the Nature of Things") renders in hexameters the atomic theory of Epicurus (*q.v.*). Its declared purpose is to free mankind from religious fears by proving that the soul is material and is born and dies with the body, and that, though gods exist, they cannot intervene to help or harm men. Apart from his poem almost nothing is known about him. What little evidence there is, is quite inconclusive. Jerome in his chronicle, for 94 B.C. (so most manuscripts; others 96 or 93 B.C.), states that Titus Lucretius the poet was born in that year; afterward he became mad from a love potion, and having written in lucid intervals some books, which Cicero afterward emended, he killed himself in his 44th year (*i.e.,* 51 or 50 B.C.). Donatus in his "Life" of Virgil notices that Virgil put on the *toga virilis* in his 17th year, on his birthday (*i.e.,* Oct. 15, 54 or 53 B.C., according to whether Virgil was entering or completing his 17th year), and that Lucretius died that same day; but Donatus contradicts himself by stating that the consuls that year were the same as in the year of Virgil's birth (*i.e.,* Crassus and Pompey, consuls in 70 B.C. and again in 55 B.C.). This last date, 55 B.C., seems partly confirmed by a sentence in Cicero's reply to his brother in Feb. 54 B.C. (*Ad Quintum fratrem* 2, 9, 3). The sentence, though variously interpreted or emended, suggests that Lucretius was already dead and also that Cicero may have had something to do with the publication of his poem: "The poems (*poemata*) of Lucretius are as you write in your letter—they have many high lights of genius (*lumina ingeni*), yet also much artistry (*ars*). But more when you come." The coincidence noticed by Donatus, of Lucretius dying on the day that Virgil came of age, looks like the neat invention of literary history. Again, though Lucretius clearly died before finally revising his poem, it is surprising to find no other reference to the remarkable circumstances of his life and death alleged by Jerome. They may belong to a late story put about by Christian polemic developed perhaps from an ignorant or wishful misunderstanding of *docti furor arduus Lucreti* (Statius, *Silvae,* 2, 7, 76). Excepting the single mention in Cicero, the only contemporary who names Lucretius is Nepos (*Atticus* 12, 4) in the phrase "after the death of Lucretius and Catullus," and the only contemporary whom Lucretius names is the Memmius to whom he dedicates his poem, probably C. Memmius (son-in-law of Sulla, praetor of 58 B.C., patron of Catullus and Cinna) for whose friendship Lucretius "hopes" (i, 140).

Theme of "De Rerum Natura."—*De rerum natura* translates the title of the chief work of Epicurus, *Peri Physeos,* as also of the didactic epic of Empedocles (*q.v.*), of whom Lucretius speaks with admiration only less than that with which he praises his master Epicurus (*cf.* i, 731 ff. with iii, 14 ff.). The poem is the fullest statement extant of the physical theory of Epicurus, but it also alludes to his ethical and logical doctrines. The argument in outline is as follows.

1. No thing is created out of nothing and no thing can be reduced to nothing. The universe is infinite: an infinite extent of empty space (or void) and an infinite number of irreducible particles of matter (or atoms), there being a finite number of different kinds of atoms, but an infinite number of atoms of each kind. Atoms differ only in shape, size and weight. They are absolutely hard, changeless, everlasting, the limit of physical division. They are made up of inseparable "minimal parts" or units, which are the limit of mathematical division. Bigger atoms have more such parts; but there is a limit to the size of atoms, and even the biggest are minute. Atoms of all kinds move always at an equal and constant velocity many times greater than the velocity of light (ii, 161 ff.). All atoms would move everlastingly downward in infinite space, and never collide to form atomic systems unless they swerved at times a minimal degree from the vertical. To these indeterminate swerves is due the creation of an infinite plurality of worlds, and also free will. All things that exist or happen consist ultimately only of matter and void: they are systems of moving atoms, separated by greater or smaller intervals of void, which cohere more or less according to the shapes of the constituent atoms. All systems are divisible and therefore perishable (except the gods). Only systems of atoms have "secondary" properties: colour, taste, heat, smell, or sensation. All change is explainable in terms of addition, subtraction or rearrangement of changeless atoms.

2. The soul is made of atoms exceedingly fine, and has two connected parts: the *anima* distributed throughout the body, which is the cause of sensation, and the *animus* in the breast (not the head), the central consciousness where thinking, willing, and the emotions of joy and fear occur. The soul is born, grows, and dies with the body. At death it escapes, like "smoke," into the air and disintegrates more quickly than even the body.

3. The gods exist, but neither made nor manipulate the world. They themselves are creatures of the atomic process, systems of exceedingly fine atoms, human in shape, yet by some principle of existence everlasting. They live remote, in between worlds, unconcerned with human affairs, examples to men of the ideal life of perfect happiness (absence of mental fear and bodily pain). Their excellent being is perceived at times by some sort of intuition of the mind.

4. We know by sense perception; and argue by reason, correctly if according to certain rules (the *Canonica*). The senses are infallible. Reason however can make false inferences. We see objects because they discharge from their surface representative films which strike the eye. Similarly hearing, smelling, etc., are explained by atomic discharges striking the appropriate sense organ. Separate atoms are in principle imperceptible because they have no dischargeable parts. The senses perceive the existence of matter; reason infers that it exists in the form of atoms, and also that void, untouchable and so imperceptible, exists to explain the perceived movement of matter.

5. We know from feelings of pleasure or pain what we should do or not do. Our aim should be so to conduct our lives that we get, on balance, the maximum of pleasure and the minimum of pain.

Structure of the Poem.—Lucretius distributes his argument into six books, beginning each with a highly finished exordium. Books i and ii establish the main principles of the atomic universe, refuting rival theories of Heraclitus, Empedocles and Anaxagoras (*qq.v.*), and covertly attacking the Stoics. Book iii demonstrates the atomic structure and mortality of the soul, and ends with a triumphant sermon on the theme: "death is nothing to us" (iii, 830). Book iv describes the mechanics of sense perception and thought and certain bodily functions, ending with a violent condemnation of sexual love. Book v describes the creation and working of this world and the celestial bodies, the evolution of life and human society. Book vi explains remarkable phenomena of the earth and sky, in particular thunder and lightning. It ends with a description of the plague at Athens, a sombre picture of death contrasting with that of spring and birth in the invocation to Venus with which the poem opens.

Use and Adaptation of the Latin Language.—The problem of Lucretius was to render the bald and abstract prose of the Greek Epicurus into Latin, and into hexameters, at a time when Latin as yet had no philosophic vocabulary. He had to find scanning equivalents for Greek terms as well as synonyms for the sake of poetic variety. He succeeded admirably in spite of repeated complaints about "the poverty of our native speech" (i, 136 ff.). He applied common words to a technical use. So he used *concilium,* "assembly of people" for a "system of atoms," and *primordia,* "first-weavings" for the "atoms" which make up the texture of things. When necessary he invented words, *e.g., clina-*

men for the "swerve," usually on the pattern of the Greek originals. In poetic diction and style his debt to the older Latin poets, especially Ennius, is apparent (i, 117; iii, 1025). He freely used alliteration and assonance, solemn and often metrically convenient archaic forms, and old constructions. He formed with almost Greek facility expressive compound adjectives of a sort rejected by Augustan taste, *e.g.,* "the light-sleeping hearts of dogs" (v, 864), "forest-breaking winds" (i, 275). He imitated or echoed Homer, Aeschylus, Euripides, Callimachus, Thucydides and Hippocrates. His hexameters can be said to stand halfway between those of Ennius who introduced the metre into Latin, and Virgil who perfected it. An ear familiar with Virgil will notice some incoherence of rhythm due to words ending with the end of the second foot, to spondaic words occupying the fourth foot, or to words of one or more than three syllables concluding the verse, as well as harsh elisions and examples of unusual prosody. The influence of Lucretius on Virgil is pervasive and unmistakable, especially in the Georgics, the next masterpiece of didactic poetry in Latin and it is in evident allusion to the author of De *rerum* natura that Virgil wrote Felix qui potuit *rerum* cognoscere *causas* (Georgics ii, 490).

Poetical Power and Moral **Fervour.**—Lucretius wrote his poem with the conviction of a proselytizing convert. Epicurus to him nas a saviour "god" (v, 8 ff.), greater than the mythical benefactors of mankind, Ceres, Liber or the Stoic hero Hercules. But Epicureanism seemed bitter to the "gross" of men (i, 945). So Lucretius was offering the medicine cup of beneficial wormwood, edged with the deceptive honey of poetry. His poem opens with an invocation to Venus, mother of Aeneas, mistress of Mars, the only divinity in the Pantheon competent to grant his prayer for beauty for his words and peace for the Roman world, the natural symbol of pleasure and of the creative moment in the atomic process. The argumentative runs of the poem read less "pleasantly," but are relieved by finished passages of a higher strain, more impressive in their poetical power than almost any other ancient poetry. Even in his more cobbled verses interest is sustained by his evident will to convince, and by the energy, propriety and perspicuity of his language. The style ranges from classic economy (*e.g.,* v, 1188–1193) to the persuasive redundancies of the enthusiastic lecturer. His mind is visual. His eye notices the curious particularity of nature. The argument by analogy prescribed by the Canonica (that hypotheses of reason must agree with, or not contradict, sense perception) gives him his opportunity as a poet. He regularly follows an abstract exposition by a concrete picture. The constant motion of imperceptible atoms within an apparently still object he illustrates by the distant view of grazing sheep, which appear as a "white stationary gleam on a green hillside" (stare *videntur* et in *campis* consistere fulgor. ii, 332).

He speaks to mankind as well as to the "sons of Aeneas" in austere compassion for the ignorant, unhappy human race. His moral fervour expresses itself in gratitude to Epicurus and in hatred of the seers (vates i, 102) of the Graeco-Roman world who inculcate religious fears (religiones) by threats of eternal punishment after death, of the Etruscan soothsayers (*haruspices,* vi, 381) with their lore of thunder and lightning, of the false philosophers—Stoics with their belief in divine providence, or Platonists and Pythagoreans who teach the transmigration of immortal souls. The first appearance of *religio* in the poem is as a monster which thrusts its fearful head from the augural quarters of the sky (i, 62 ff.). Epicurus, not intimidated by theological myths or by thunder and lightning, had ranged beyond the "flaming ramparts of the world" through the infinite universe, broken into the citadel of nature, and brought back in triumph the knowledge of what can and what cannot be, of that "deep-set boundary stone" which divides the separate properties of things, the real from the not-real. "So religion is crushed beneath our feet and his victory lifts us to the skies" (i, 78 ff.).

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LUCRINUS LACUS [LUCRINO], in Campania, Italy, about ½ mi. N. of Lake Avernus, and only separated from the sea (Gulf of Pozzuoli) by a narrow strip of land, traversed by the coast road, Via Herculanea, which runs on an embankment traditionally attributed to Heracles in Strabo's time, and the modern railway. Its size was reduced by the rise of the Montenuovo crater in 1538. Its greatest depth is about 15 ft. In Roman days its fisheries were important and were let out by the state to contractors. Its oyster beds are renowned; their foundation is attributed to Sergius Orata, about 100 B.C. It was also a resort for excursions from Baiae. On the banks were many villas; the best known was Cicero's Cuman villa (also called the Academia), on the east bank. The remnants of this villa, with the village of Tripergola, disappeared in 1538. In 1922 almost all the fish in the lake were killed by exhalations of steam and sulphuretted hydrogen from vents on the east bank.

LUCULLUS, LUCIUS LICINIUS, surnamed Ponticus, (c. 110–56 B.C.), Roman general, was noted for his wealth and luxurious banquets. The son of Lucius Licinius Lucullus and a sister of Metellus Numidicus, he joined the party of Sulla early in life; after service in the Social War (90) he went with Sulla as quaestor to Greece and Asia in 88. While Sulla besieged Athens, Lucullus raised a fleet and drove Mithradates out of the Mediterranean, winning a great victory off Tenedos. Lucullus was praetor in 77, with the province of Africa to follow, and consul in 74. In the allotment of provinces he drew Cisalpine Gaul, but contrived to exchange it for Cilicia, while his colleague Cotta took Bithynia, the two provinces between them involving the joint command against Mithradates (*q.v.* for further information about this campaign). Lucullus' first season was mainly occupied in relieving Cyzicus, besieged by Mithradates, who had heavily beaten Cotta. Most of 73 and 72 were taken up in clearing the sea and the coast of Pontus, but an expedition up country to Cabeirus led to a major success. and Mithradates fled to Tigranes in Armenia. Lucullus left the final reduction of the Pontic kingdom to his lieutenants while he attended to the administration of Asia, which the combined exactions of Sulla and the publicani had left in a desperate condition. By drastically limiting interest rates he cleared the province of debt; but his reforms left a legacy of unpopularity for him at Rome, where the capitalist interests set themselves to destroy his reputation. Similarly his strict discipline and his moderation after victory made for trouble with the army.

In 70 B.C. Lucullus sent to Tigranes to demand the surrender of Mithradates. Tigranes refused, and Lucullus, with a small force, crossed the Euphrates and struck direct for Tigranocerta, the new capital (69). Tigranes fled, and returned with a vast army to raise the siege, but was defeated. Lucullus captured the city and dispersed its inhabitants, and wintered on the Tigris. The rest of his campaign is anticlimax. Mithradates and Lucullus were both negotiating with Parthia; Lucullus attempted to force Parthia's hand, but his troops refused to go on, so he turned north for Artaxata, won another victory, and again his troops mutinied. So he returned, took Nisibis and wintered there. The next year (67) things were worse; it was now known that he was to be superseded; he could exert no authority; he could only watch Mithradates regaining Pontus and Tigranes overrunning Cappadocia. It was left for Pompey to reap where Lucullus had sown.

On his return to Rome he was attacked by the popular party, which succeeded in delaying, though it could not prevent his triumph. He was very rich, and politics were not attractive. He retired into that elegant leisure, that luxury refined by good taste and tempered by philosophy.

Lucullus is one of the interlocutors in Cicero's *Academica;* he had a great library; and he wrote a history in Greek. His occasional interventions in public affairs were not very successful.

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His brother, MARCUS LICINIUS LUCULLUS, was adopted by

Marcus Terentius Varro, and was hence known as Marcus Terentius Varro Lucullus In 82 B C. he served under Sulla against Marius. In 79 he was curule aedile with his brother, in 77 praetor, and in 73 consul with Gaius Cassius Varus. While praetor he forbade the carrying of arms by slaves and. with his colleague in the consulship. passed the *lex Terentia Cassia,* which gave authority for purchasing corn with the public money and retailing it at a fixed price at Rome. As proconsul in Macedonia in 72 he made war with great cruelty against the Dardani and Bessi, and compelled them to acknowledge the supremacy of Rome. Having enjoyed a triumph, he was then sent out to the east to settle the affairs of the provinces conquered by his brother. Siding with Cicero during the Catilinarian conspiracy, he did his utmost to prevent Cicero's banishment, and subsequently supported his claim for the restoration of his house. He was one of the better representatives of the optimates and enjoyed some reputation as an orator.

LUCUS FERONIAE, an ancient shrine in Etruria. It was visited both by Latins and Sabines even in the time of Tullus Hostilius and was plundered by Hannibal in 211 B C. It was in the territory of Capena; but in imperial times became an independent community receiving a colony of Octavian's veterans (*Colonia Iulia felix Lucoferensis*) and possessing an amphitheatre. It is probably to be placed at Nazzano, which was reached by the Via Tiberina.

LUCY, SAINT, a martyr at Syracuse in Sicily, probably during Diocletian's persecutions. whose veneration is attested by a 4th/5th-century inscription found at Syracuse. Her legend, which is historically worthless. relates how she was martyred for refusing to marry because she had taken a vow of virginity. It closely resembles that of St Agnes and other virgin martyrs, and was widely diffused: the English St. Aldhelm (d. 709) used it in his *De laudibus virginitatis* and *De laudibus virginum.* St. Lucy is named in the canon of the Roman mass. and her feast day is Dec. 13. Probably because of her name *(lux,* "light") she is invoked by those with eye trouble, and is sometimes represented in art with a dish containing her eyes which were said to have been torn out by her persecutors. There was much popular devotion to St Lucy and she was well known in folklore; for example, the saying "Lucy-light, shortest day, longest night."

See H Thurston and D. Attwater (eds), *Butler's Lives of the Saints,* rev, and supplemented, vol. iv, pp. 548–549 (1956). (D. AR.)

LUCY, SIR HENRY (1845–1924), British journalist, was born at Crosby, near Liverpool, on Dec. 5, 1845. Educated in Liverpool, he began life in a Liverpool merchant's office, but soon became a reporter for a Shrewsbury periodical. In 1870 he joined the staff of *The Pall Mall Gazette,* London, and in 1873 became parliamentary reporter to *The Daily News,* with which paper he had a long connection in various capacities. In 1881 he also joined the staff of *Punch* and won a great reputation as the contributor of its parliamentary sketch signed "Toby M. P." He was knighted in 1909 and retired from parliamentary work in 1916. He published his autobiography, *Sixty Years in the Wilderness,* in 1909, and *The Diary of a Journalist* in 1920. He died on Feb. 20, 1924.

LUCY, RICHARD DE (d. 1179), called the "loyal," chief justiciar of England, appears in the latter part of Stephen's reign as sheriff and justiciar of the county of Essex. He became, on the accession of Henry II., chief justiciar conjointly with Robert de Beaumont, earl of Leicester; and after the death of the latter (1168) held the office alone for 12 years. The chief servant and intimate of the king, he was among the first of the royal party to incur excommunication in the Becket controversy. In 1173 he played an important part in suppressing the rebellion of the English barons, and commanded the royalists at the battle of Fornham. He resigned the justiciarship in 1179, though pressed by the king to continue in office, and retired to Lesnes abbey in Kent, which he had founded and where he died. Lucy's son, Godfrey de Lucy (d. 1204), was bishop of Winchester from 1189 to his death in Sept. 1204; he took a prominent part in public affairs during the reigns of Henry II., Richard I. and John.

See J. H. Round, *Geoffrey de Mandeville* (1892); Sir J. H. Ramsay, *Angevin Empire* (1903); and W. Stubbs, *Constitutional History,* vol. i.

LUCY, SIR THOMAS (1532–1600), the English Warwickshire squire who is traditionally associated with the youth of William Shakespeare, was born on April 24, 1532, the son of William Lucy, and was descended, according to Dugdale, from Thurstane de Charlecote, whose son Walter received the village of Charlecote from Henry de Montfort about 1190. Walter is said to have married into the Anglo-Norman family of Lucy, and his son adopted the mother's surname. Three of Sir Thomas Lucy's ancestors had been sheriffs of Warwickshire and Leicestershire, and on his father's death in 1552 he inherited Sherborne and Hampton Lucy in addition to Charlecote, which was rebuilt for him by John of Padua, known as John Thorpe, about 1558. By his marriage with Joyce Acton he inherited Sutton Park in Worcestershire, and became in 1j86 high sheriff of the county. He was knighted in 1565. He is said to have been under the tutorship of John Foxe, who is supposed to have imbued his pupil with the Puritan principles which he displayed as knight of the shire for Warwick in the parliament of 1571 and as sheriff of the county, but, as Mrs. Carmichael Stopes points out, Foxe only left Oxford in 1545, and in 1547 went up to London, so that the connection must have been short.

Lucy often appeared at Stratford-on-Avon as justice of the peace and as commissioner of musters for the county. As justice of the peace he showed great zeal against the Catholics, and took his share in the arrest of Edward Arden in 1583. In 158j he introduced into parliament a bill for the better preservation of game and grain, and his reputation as a preserver of game gives some colour to the Shakespearian tradition connected with his name. Nicholas Rowe, writing in 1710, told a story that Lucy prosecuted Shakespeare for deer-stealing from Charlecote Park in 1585, and that Shakespeare aggravated the offence by writing a ballad on his prosecutor. The trouble arising from this incident is said to have driven Shakespeare from Stratford to London. The tale was corroborated by Archdeacon Davies of Sapperton, Gloucestershire, who died in 1708. The story is not necessarily falsified by the fact that there was no deer park at Charlecote at the time, since there was a warren, and the term warren legally covers a preserve for other animals than hares or rabbits, roedeer among others.

Shakespeare is generally supposed to have caricatured the local magnate of Stratford in his portrait of Justice Shallow, who made his first appearance in the second part of *Henry IV.,* and a second in the *Merry Wives of Windsor.* There are many considerations which make it unlikely that Shallow represents Lucy, the chief being the noteworthy difference in their circumstances. Lucy died at Charlecote on July 7, 1600.

For a detailed account of Sir Thomas Lucy, with his son and grandSon of the same name, *see* Mrs. C. Carmichael Stopes, *Shakespeare's Warwickshire Contemporaries* (and ed., 1907). *Cf.* also an article by Mrs. Stopes in the *Fortnightly Review* (Feb. 1903), entitled "Sir Thomas Lucy not the Original of Justice Shallow," and J. O. Halliwell-Phillipps, *Observations on the Charlecote Traditions* (Brighton, 1887).

LUDDITES, the name given to organized bands of English rioters for the destruction of machinery, who made their first appearance in Nottingham and the neighbouring districts towards the end of 1811. The "Ludds" or Luddites were generally masked, and operated at night. Their leader, real or imaginary, was known as "General Ludd" from a probably mythical "Xed Ludd" of whom various stories were current. Great distress had been caused by the dismissal of handicraftsmen in the areas in which textile machinery was introduced; and even those handicraftsmen who did not lose their employment suffered considerable worsening of conditions owing to competition. The riots began with the destruction of stocking and lace framee, and, continuing through the winter and the following spring, spread into Yorkshire, Lancashire, Derbyshire and Leicestershire The riots were directed not merely against reductions of wages but also against the poor quality goods (especially stockings) produced by the new machines The rioters were supported by local public opinion, and they abstained from bloodshed or violence against living beings, until in 1812 a band of them was shot down by soldiers on the request of a threatened employer, Horsfall, who was afterwards murdered. They were met by severe repressive legislation, introduced by Lord Liverpool's government, a notable feature in the opposition to which was Lord Byron's speech in the House of Lords. The organization was temporarily broken up by a mass-trial at York in 1813, which resulted in many hangings and transportations: somewhere among the victims was probably the real "King Ludd," for the elaborate organization suddenly collapsed. In 1816 similar rioting was resumed, caused by the depression which followed the peace of 181j and aggravated by one of the worst of recorded harvests. In that year, although the centre of the rioting was again in Nottingham, it extended over almost the whole kingdom. The rioters were also thoroughly organized. While part of the band destroyed the machinery, sentinels were posted to give warning of the approach of the military. Vigorous repressive measures, and, especially, reviving prosperity, brought the movement to an end.

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LUDENDORFF, ERICH (1865–1937), German soldier, was born at Kruszevnia, in the province of Posen, April g, 1865. When 18 years old, he entered the Prussian army. In 1894 he joined the general staff, and, except for an interval of two years as company commander, remained on it from 1894 to 1913, under Count Schlieffen and the younger General von Moltke. As chief of the *Aufmarschabteilung* since 1908 he played a prominent part in the mobilization preparations. The last great increase in the strength of the army in 1913 was largely due to his initiative and energy. During the year preceding the outbreak of the World War he commanded first the 39th Fusilier Regiment at Dusseldorf, and afterwards an infantry brigade at Strasbourg.

At the outbreak of the World War Ludendorff was quartermaster general of the II. Army. His voluntary assumption in the beginning of August of a decisive *rôle* at the capture of the fortress of Liége gave him his first great opportunity. He took over the command of the 14th brigade of infantry, in the place of General von Wussow who was killed, and, breaking through the ring of fortifications at its head, seized the interior of the town. He was rewarded on Aug. 22 by being made chief of staff to Hindenburg in the VIII. Army which was fighting in East Prussia.

Campaigns in East **Prussia.**—The battle of Tannenberg revealed his powers of generalship, for he there demonstrated the justice of the theory of annihilation. The victory of Tannenberg over the Russian army of the Narew was more than another Cannae. For in this case there was not, as in former days, merely one enemy to be dealt with. On the contrary, the attempt was made to envelop the greatly superior main body of Russians in the presence of a second enemy force threatening the rear. And the attempt proved successful. In the subsequent operations which led to the first battle on the Masurian lakes and to the heavy defeat of the Russian army of the Niemen, the enemy's right wing was supported on the lake, and so only an envelopment of the southern wing was possible. The operations, therefore, took the form of an attack on the enemy's front and on his exposed flank.

The strategic success lay in the liberation of East Prussia from the enemy. The German Army of the East became available for the immediate support of the Austro-Hungarian ally, by this time in dire straits. This support was rendered in the brilliant October campaign of the newly-formed IX. German army directed through Southern Poland upon the Vistula. Its purpose—to facilitate the Austrian efforts in Galicia by drawing off upon the IX. Army the strongest possible body of Russian troops—was attained in a degree entailing grave danger to the outnumbered Germans themselves. The menace of envelopment by a vastly superior enemy, pouring up from the direction of Warsaw, was parried and beaten off by Ludendorff by means of an exceedingly gallant defensive action, carried out during withdrawal. In November after a rapid regrouping of the main German forces, an advance was made from the Wreschen-Thorn line against the right flank of the main body of the Russians, lying in West Poland. In the absence of sufficient strength a simultaneous frontal attack was impossible. But even so, the success achieved in the battle of Lódź was great. The Russians were definitely relegated to the defensive—and, in the pursuit which followed, were flung back behind the Bzura and the Rawka.

During the fighting in Masuria in Feb. 1915 Ludendorff achieved the destruction of another Russian army in the region of the Upper Bobr. This was followed by a period of relative inactivity on the German eastern front lasting for several months. Not before the middle of July 1915 did the army group of Hindenburg resume the war of movement. By an attack directed upon and beyond the Lower Narew it relieved, by means of a converging offensive, the army group of Mackensen which had advanced from Galicia into Southern Poland between the Vistula and the Bug. In the ensuing operations the Russian army was driven out of the Vistula positions and out of the whole of Poland towards the East. After a brief resistance the fortresses of Warsaw, Nowogeorgiewsk (Modlin) and Kovno fell. But no decisive issue was reached, because General von Falkenhayn, chief of the German general staff, rejected the proposal of Hindenburg and Ludendorff, which was to advance with the German left wing in a northerly direction through Kovno and Vilna upon Minsk, thereby cutting the Russian railway communications, to the north of Polesia. Had the operations been conducted in accordance with the views of Hindenburg and Ludendorff, the Russian army might have been dealt a mortal blow in the summer of 1915. Later, in September, the attempt was made on the German left wing, but with inadequate forces, to embarrass the retreat of the section of the Russian army withdrawing northwards from Polesia past Vilna; but the moment for success on a grand scale had gone.

After the victorious conclusion of the Balkan campaign in the winter of 191j–16 Ludendorff contemplated a great offensive into the heart of the Ukraine, with the object of breaking the back of the economic resistance of Greater Russia, which was already cut off from the sea. The offensive necessitated the occupation of Rumania; but General von Falkenhayn rejected this scheme, and chose Verdun instead of Kiev as the objective for operations. Accordingly in the year 1916 the eastern front of the allied Central Powers was assigned the duty of protecting the rear of the offensive movement in France. This task was amply fulfilled on the northern wing but on the southern wing, held by the Austrians, the front completely collapsed in June and July at Luck and in Galicia. The balance in the East was restored with difficulty by the intervention of the German command.

On Aug. 29 Field-Marshal von Hindenburg assumed the office of chief of the general staff of the armies in the field, in the place of Falkenhayn, and Ludendorff became first quartermaster general. In contrast with their predecessor's point of view, the two men still promised themselves triumph, but a triumph which could only result from a more vigorous conduct of the war by drawing upon the whole available strength of the country in wealth and population. The methods adopted for the utilization of these resources were expressed in the so-called "Hindenburg programme" of war industries and in the so-called law of auxiliary services; and here Ludendorff could only co-operate by means of suggestions and demands. In his own sphere too, he found that, owing to the almost desperate military situation inherited from his predecessor, he was not at first able to put into practice Schlieffen's doctrine of annihilation. The result of the offensive against Rumania was that this new enemy was overthrown in the winter of 1916. This victory was of inestimable value to the Central Powers, for new sources of economic power were thereby opened up.

Submarine Warfare.—After the defeat of the Rumanian army there remained but one further task. This was the frustration of the attacks of the enemy in the west, greatly superior in numbers and material. The restoration of the balance of strength thus aimed at was to enable the Central Powers later to deliver an offensive with decisive effect. A favourable diversion of this kind, however, could only be counted upon, if, during the strategical defence on land, England could be reduced to desperate straits. An intensified U-boat warfare in the blockade area round England was therefore adopted, a weapon, recourse to which had hitherto always been postponed on the score of political considerations. The disadvantage of this course was that it would give the United States a pretext for war on the side of the Entente; but regarding this as inevitable, Ludendorff hoped to render England disposed for peace before the Americans should be in a position to throw considerable forces into Europe.

Unrestricted U-boat warfare did not altogether fulfil expectations. The technical perfection of the enemy's defensive weapons and the ample scale upon which they had been completed contributed to this in a very material degree. On the other hand, without the adoption of unrestricted U-boat warfare the strategy of the Central Powers would have been altogether unable to hold the balance on land in suspense until, aiter Russia's collapse in the spring of 1918, there dawned a well-founded prospect of forcing a decision in France before the American forces on land became effective.

In the spring of 1917 in the western theatre of war Ludendorff was enabled, by a timely withdrawal to the Siegfried position and by the elasticity of his defensive tactics. to impose a check upon the Allied attack carried out with a gigantic expenditure: of men and material. Subsequently he had another opportunity of vindicating his theory of annihilation in the warfare on land. Under the blows dealt by the German hammer at Tarnopol, Riga, Dagö and Ösel, Russia fell. The reckoning with Italy followed in the autumn of 1917, but the situation in the west, particularly in Flanders where the fighting raged with undiminished fury, rendered it impossible for Ludendorff to secure a decisive victory.

The Offensive of **1918.**—The German resolution to take the offensive in the spring of 1918 was rendered imperative by the general position. The psychological condition of the army peremptorily demanded that the *rôle* of anvil should be exchanged for that of hammer. Conditions at home called for a potent remedy against the threefold poison instilled by the hunger blockade. enemy propaganda and revolutionary agitation. Germany's hard pressed allies had for long rested their sole hopes of delivery on the efforts of Germany. Ludendorff saw only one road by which a tolerable peace, in harmony with the honour of the German people, could be reached, the road of military victory. This again could be attained solely by means of an offensive which should be decisive, and in taking this course he hazarded everything. A series of small attacks with limited objectives or a powerfully conducted defence would in favourable circumstances only have secured a temporary advantage, but could not prevent the enemy from finally giving full effect to his superior strength in a battle of annihilation. It is questionable whether the choice of direction for the offensive on French territory can be defended. Many critics would have preferred an offensive in Italy, but apart from the natural difficulties, even the destruction of the Italian arrny could at best only have preceded the main decisive operations on French soil.

It has been questioned whether Ludendorff assembled adequate forces for the spring offensive of 1918. In March, at the beginning of this offensive, the Germans disposed of 193 divisions and three brigades in the Franco-Belgian theatre of war. The estimates of the forces commanded by the Entente in France and Belgium at the beginning of the spring offensive vary between 167 and 180 divisions. The Germans, therefore, enjoyed a slight superiority in the number of divisions. The original intention that a section of the Austro-Hungarian forces should take part. in the decisive encounter in France was finally thwarted by the opposition of the Habsburg emperor. Ludendorff accordingly chose the expedient of indirect assistance to he rendered by a relieving offensive carried out hy the Austro-Hungarian army in Upper Italy. This offensive. however, was undertaken much too late for the objective in view, in the middle of June, and, moreover, ended with a severe reverse. The occupation of Rumania called imperatively for four divisions and a greater number of Landsturm formations. The invasion of the Ukraine, carried out in February and March, demanded about 20 weak divisions, including eight divisions of Landwehr and three of cavalry. It is disputable whether it would have been wiser to abandon the enterprise in the Ckraine. The secretary of State of the *Kriegser*-nahrungsamt urged with the utmost emphasis that the economic resources of the Ukraine should be thrown open to Germany. Failing this, the Austrians' system of food supplies would collapse. The delivery of meat was important for Germany, too, and the delivery of horses was, above all, a matter of the greatest urgency.

On political and military grounds Ludendorff had resolved to deal the first decisive blow in the west against the English. For this purpose he chose the southern flank, on both sides of St. Quentin, as tactically the least defensible, with the intention of forcing his way through at this point and by advancing north of the Somme towards the northwest, to roll up the whole front gradually and press the English towards the sea. The southern wing of the German offensive was to guard his flank against a relieving attack on the part of the French. This strategy became subject to certain changes in consequence of the unexpected magnitude of the initial success of the German southern wing, which continued the offensive across the Somme and the Crozat canal against the French, in order to effect a cleavage between the English and French at and beyond Amiens. This end was not completely attained. and the result of the first offensive, though great from the tactical standpoint was strategically nugatory. A second attack on the Lys front, against the English and Portuguese, was made in the middle of April and was designed to gain possession of the commanding heights north of Bailleul and to cut off the Ypres salient; its result, however, was indecisive.

During the following months, in spite of successive brilliant diversive attacks carried out against the French front, no further headway was made in forcing a decisive engagement in Flanders; and the heavy toll of the spring offensives could not be made good rapidly enough. And yet, prior to the last great attempt to break through on both sides of Reims in July 1918, there still remained a prospect of final victory for the German arms. The goal had nearly been reached—which was a proof that the strategy adopted might have succeeded and was, therefore, the right strategy. But the fortune of war was against Ludendorff. His plans were revealed by treachery to the enemy, at a time when everything depended on secrecy and surprise. The great successes hitherto achieved had led to a wide extension of the German front, calling for the employment of disproportionately large forces and offering in its many angles and salients dangerous surfaces to the enemy's attacks. These factors now made their disastrous influence felt.

But the final cause of Ludendorff's inability to resume the initiative lay in the absence of a free command of reserves, due to the drying up of the sources of supply at home. When the German command fell back on the defensive before hostile attacks, Ludendorff realised that there was nothing to be done except to hold out until diplomacy succeeded in securing a tolerable peace, or to perish with honour. On Oct. 26, however, he was overthrown by the cabinet of Prince Max of Baden. The collapse of Germany's allies, combined with difficulties at home, rendered hopeless any further resistance by the army in the field now thrown upon its own resources.

General Ludendorff was above all a man of action, and one who rated formation of character and the attributes of leadership more highly than the acquisition of comprehensive learning. His resolution, his almost super-human and invincible powers of work and action, his understanding of the moral factors in warfare, inspired the German army with boundless confidence in his leadership and qualified it for mighty exploits If like Hannibal and Lee he failed in the final issue, it was through no fault in generalship, but was partly due to slowness in realising that his weapon had grown blunt and that the population at home was no longer capable of the effort of endurance and the indispensable will to victory. His powers of leadership reflected his character; brain, heart and will were all unsparingly enlisted in the service of one aim, the honour of his country. Along this path he was impelled to travel, whether it led to victory or defeat. (W. Fo.)

Ludendorff's complete collapse at the end of the war was one of the tragic sensations of the time. After demanding an unconditional armistice. when the armistice was actually concluded, he abandoned his country and fled to Sweden. In the spring of 1919 he returned to become, with his former chief of staff. Col. Max Bauer, the focus of all extreme reactionary conspiracies. With Bauer he was the initiator and organizer of the Kapp *Putsch* of March 1920; although he remained in the background and avoided responsibility, nevertheless his role was known, and he retired to the more conservative atmosphere of Munich to engage in fresh intrigues which showed a complete lack of any sense of political reality.

In 1923 he emerged into the open in connection with the attempted coup of Adolf Hitler, the National Socialist leader. After wavering between the rival conspiracies of Hitler and Gustav von Kahr. Ludendorfi joined the former in an attempt to establish an anti-Marxist dictatorship in Germany. The coup (Nov. 8, 1923) proved an ignominious fiasco. but Ludendorff's past reputation saved him from its consequences. In May 1924 he entered the Reichstag as a National Socialist and in 192j stood for president of the reich, securing slightly over 1% of the votes cast. In the same year he retired from the presidency of his small party and began to take a less prominent part in politics. He died in Munich, Dec. 20, 1937.

Ludendorff published several books on World War I, the most important of which are: *Meine Kriegserinnerungen 1914–18* (Eng. trans.. *My War Memories*) (1919); *Urkunden der obersten Heeresleitung über ihre Tatigkeit 1916–18* (1919); *Kriegführung und Politik* (1921); *Das Friedens- und Waffenstillstandsangebot* (1919). Among his polemical writings may be mentioned *Vernichtung der Freimaurerei durch Enthüllung ihrer Geheimnisse* (1927).

See H. Delbreck, *Ludendorffs Selbstportrat.* 10th ed. (1922). (C. A. M.)

LÜDENSCHEID, a town in the *Land* of North Rhine-Westphalia. German Federal Republic. lies in the wooded Sauerland at the watershed of the Lenne and Volme rivers. 19 mi. S.E. of Hagen at an altitude of 495 m. (1,625 ft.). Pop. (1950) 51,705; (1959 est.) 57,582. The main business street, the Wilhelmstrasse, joins several other streets at the city centre, while at the centre of the old town is the Church of the Saviour with a tower dating from 1072. There is a modern hospital, a park and recreational facilities. Liidenscheid is an industrial centre and manufactures aluminum. plastics and synthetics, light metal products and rolled and semi-finished goods.

A Frankish settlement in the 9th century and chartered in the mid-13th century. Liidenscheid became during the middle ages a centre of the iron industry, and was a member of the Hanseatic league. In the 17th century it passed with Cleves-Mark to Brandenburg; during the French occupation of 1806–15 it belonged to the grand duchy of Berg. In 1723 the town was destroyed by fire. (R. A. Kr.)

LÜDERITZ, a town in South-West Africa on the bay of same name (26° 40′ S., 15° 5′ E.). Pop. (1961 census) 3,604. Liideritz grew out of a trading station, which was established in 1883. It is the chief centre of the diamond diggings.

The hinterland is desert: the mean annual rainfall is 0.64 in. A railway leads inland: and links up with the south African system at De Aar. The town has to bring its water from Garub, 65 mi. away by train.

The local fishing grounds are extraordinarily rich, and. since the British occupation fish canning factories have been opened. Calling ships have to anchor in the bay, and cargo must be transshipped to or from lighters. Neighbouring islands yield about 8.000 tons a year of guano.

LUDFORD, NICHOLAS (*c.* 1480–*c.* 1542). English composer of masses, motets and a magnificat, is believed to have been a member of the Chapel Royal. but his name does not appear on its records. He married in 1535, and on June 1, 1542, his widow was given a lease to lands and a watermill in Warwickshire.

In the British museum is a collection of seven of his masses, probably one for each day of the week. Six of the masses (Roy. App 45–48) are in good condition, but the seventh (Add. RISS. 30.520) is a mutilated fragment. The fragment is known as the "Le Roy" mass because it is based on a melody by that name written by John Taverner. All seven masses are written for a solo voice and three-part chorus (treble, tenor, countertenor) with a sequence betneen the gloria and credo. The seven masses are believed to have been written before 1536 since the binding bears the arms of Catherine of Aragon, who died in that year.

LUDHIANA, a town and district of Punjab state. India. 'The town is 8 mi. from the present left bank of the Sutlej, 228 mi. by rail northwest of Delhi. Pop. (1961) 244,238. It is an important centre of trade in grain and has manufactures of shawls, etc., by Kashmiri weavers; and of scarves, turbans, furniture and carriages. There is a U.S. Presbyterian mission, and there are four colleges affiliated to the Panjab university (including an agricultural college and one for women).

The District of Ludhiana lies south of the Sutlej river, and north of the northern districts of the former state of Pepsu (the Patiala and East Punjab states union). Area 1.323 sq.mi. The district consists for the most part of a broad plain. without hills or rivers, stretching northward from the state borders to the ancient bed of the Sutlej. A branch of the Sirhind canal irrigates a large part of the southwestern area. The population in 1961 was 1,021,-190. The principal crops are wheat, millets, pulse, maize and sugar cane. The district is crossed by the main line of the Northern railway from Delhi to Lahore, with two branches.

During the Moslem epoch, the history of the district is bound up with that of the Rais of Rajkot, a family of converted Rajputs, who received the country from the Sayyid dynasty about 1445. The town of Ludhiana was founded, in 1480 by two of the Lodi race (then ruling at Delhi). from whom it derives its name.

The Lodis continued in possession until 1620, when it again fell into the hands of the Rais of Rajkot. Throughout the palmy days of the Mogul empire the Rajkot family held sway. but the Sikhs took advantage of the troubled period which accompanied the Mogul decadence to establish their supremacy south of the Sutlej. In 1806 Ranjit Singh crossed the Sutlej and reduced the obstinate Mohammedan family, and distributed their territory among his coreligionists.

After the British occupation of the Punjab, Ludhiana grew in wealth and population.

LUDLOW, EDMUND (*c.* 1617–1692), English parliamentarian. son of Sir Henrv Ludlow of Maiden Bradlev. Wiltshire. He went to Trinity college. Oxford. and was admitted to the Inner Temple in 1638. When the Great Rebellion broke out, he engaged as a volunteer in the life guard of Lord Essex and served through successive campaigns until 1646, when he was elected M.P. for Wiltshire in the room of his father and attached himself to the republican party. He was one of the chief promoters of Pride's purge in 1648 was one of the king's judges and signed the warrant for his execution. In February he joined the council of state.

In Ian. 1611 Ludlow was sent into Ireland as lieutenant general of horse, holding also a civil commission. Ireton, the deputy of Ireland, died on Nov. 26. 1651; Ludlow then held the chief command and had practically completed the conquest of the island when he resigned his authority to Fleetwood in Oct. 1652. On returning to England in Oct. 16jj he was arrested, as he refused to acknowledge Cromwell's authority as protector, but he was allowed to retire to Essex.

Ludlow sat in Richard's parliament of 1659, but opposed the continuance of the protectorate. He was a member of the restored Rump. and of its council of state and of the committee of safety after its second expulsion. and a commissioner for the nomination of officers in the army. In July he was sent to Ireland as a commander in chief. He came back to England in Oct. 1659 and, after a brief visit to Ireland at the end of the year, was impeached in the restored parliament.

Ludlow, having vainly sought to oppose the restoration of the monarchy, surrendered to the speaker on June 20, but, finding that his life was not assured, although he was not named for capital punishment, he escaped to Switzerland, where he lived at Vevey. In 1689 he came back to England but was forced to return to Vevey, where he died in 1692.

BIBLIOGRAPHY.—Ludlow's Memoirs, up to 1672, were published in 3 vol. at Vevey in 1698–99 and have often been reprinted; see the edition with introductory memoir by Sir Charles Harding Firth, 2 vol. (Oxford, 1894); also Firth's article in *Dictionary of National* Biography, vol. xxxiv (London, 1893).

LUDLOW, a market town and municipal borough in the Ludlow parliamentary division of Shropshire, Eng., on the left bank of the Teme below its confluence with the Corve, near the Herefordshire border. It is 28 mi. S. of Shrewsbury by road and 2 mi. N. of Hereford. Pop. (1951) 6,456. Area 1.7 sq.mi. On the peninsula the castle, now ruined, founded about 1085 by Roger de Lacy, occupies a commanding position. Interesting features are the late Norman circular chapel, the Decorated Gothic state rooms and Perpendicular and Tudor details. John Milton's masque *Comus* was first performed in the castle.

Ludlow is supposed to have existed under the name of Dinan in pre-Saxon days. Robert William Eyton identified it with one of the "Ludes" mentioned in Domesday Book. The name is said to mean "hill by the rapid." Its position on the Welsh border, particularly in relation to routes north and south and into Wales past Bishop's Castle (*q.v.*), ensured it an important place in the military and commercial life of the middle ages. Ludlow was a borough by prescription in the 13th century, but the burgesses owed most of their privileges to their allegiance to the house of York. Of the confirmation of early charters the last, dated 1665, continued in force until the Municipal Corporations act of 1835. The Council of the Marches held its court at Ludlow from the reign of Henry VII until 1689.

The greater portion of the old town wall, together with one of the original seven gates, still remains. Thanks to its strong position, Ludlow was the last Shropshire fortress to yield to the parliamentary forces in 1646.

The town has many beautiful half-timbered buildings and several Georgian houses. The parish church of St. Lawrence is of great size with a lofty central tower and a fine east window with 15th-century glass. Notable is the Butter Cross, an 18th-century building. The medieval Ludford bridge on the Teme has been declared an ancient monument. Ludlow is now a thriving market town, a noted centre for sales of Hereford cattle and, by virtue of its situation halfway between Shrewsbury and Hereford, a business and social centre for the surrounding rural area. It is also a tourist resort.

Besides the several industries connected with agriculture, there are light engineering works.

LUDMILA, SAINT (d. 921), wife of Borivoj, the first of the Czech princes to adopt Christianity in 874, and grandmother of St. Wenceslas, was born at Psovka, near Melnik. Her relationship with her daughter-in-law Drahomira, mother of Wenceslas, turned into a feud that ended with Ludmila's murder on Drahomira's instigation at Tetin near Beroun in 921. Ludmila was known as a pious woman, who had brought up Wenceslas in the faith, and oral tradition soon surrounded her with a martyr's halo. Only a short time elapsed before the first legends arose: a "prologue on St. Ludmila" in Church Slavonic, one of the oldest works to have arisen independently on Bohemian territory, and a Latin life based on it. The best-known legend is the Latin life of both Wenceslas and Ludmila written by the monk Christian in the 10th century. Ludmila's feast day is Sept. 16.

See J. Pekar, Die *Wenzels-* und Ludmilalegenden (1906).

LUDWIG, EMIL (1881–1948), German-born author and playwright, was born in Breslau, Jan. 25, 1881, of a Jewish family named Cohn. As a young man he practised law, and had some practical commercial experience; but from a very early age was engaged in literary productions, mainly dramatic, in prose and verse.

A number of these works were staged; they include *Ein* Friedloser, *Ein Untergang,* Napoleon, Die *Borgia,* Tristan *und* Isolde, *Atalanta* and *Ariadne* (ballet). Ludwig spent some time in England shortly before World War I studying modern tendencies, and during the war was employed as the foreign correspondent of a Berlin paper in the chief political centres of German-speaking Europe. During this period he wrote novels (Manfred und Helena; *Diana*) and sketches (An die *Laterne*), besides more dramatic pieces (*e.g.,* Friedrich *Kronprinz von Preussen*).

He now began to indulge his real bent for "humanizing" historical biography in a series of biographies, in which the main emphasis was laid on the psychological motive, represented in a vivid and flamboyant style. His subjects were Goethe (1920 and 1923), Wagner, Bismarck (a trilogy: *Volk und Krone* and Die *Entlassung,* 1922, *Genie und Charakter,* 1923), *Napoleon* (1924); *Wilhelm II* (1925) and Christ (*Menschensohn*) (1928). Of these the works on the emperor William and Bismarck were written with considerable inside political knowledge and in a stimulating and controversial fashion, which aroused great interest, especially in England, where a series of his works were translated (Wilhelm *II* and Bismarck, 1926; Napoleon and Goethe [the latter containing only half of the original German edition], 1927; The Son of Man, 1928).

The works on Napoleon, and still more that on Christ, revealed, on the other hand, an unhistorical manner, not redeemed by their psychological insight. From 1906–40 Ludwig lived almost continuously in Switzerland, becoming a citizen of that country. In 1940 he went to the United States. His later works included The Nile (1936), Roosevelt: a Study in Fortune and Power (1938), Bolivar (1942) and The Mediterranean (1942). He died Sept. 17, 1948, in Ascona, Switz.

LUDWIG, KARL FRIEDRICH WILHELM (1816–1895), German physiologist, one of the founders of 19th-century German physiology and teacher of many notable physiologists, was born at Witzenhausen, near Cassel, on Dec. 29, 1816. He studied at Erlangen and at Marburg, where he taught anatomy and physiology until 1849. He then became professor at Zürich, Switz. Subsequently he went to Vienna and later organized the newly created chair of physiology at Leipzig, 1865–95. He died on April 23, 1895.

Ludwig was ingenious in devising instrumentation for the study of physiological processes. To be especially mentioned are his adaptation of the Thomas Young kymograph for recording arterial blood pressure and respiration and the floating writing point on the mercury manometer introduced by J. L. M. Poiseuille.

His researches comprised a variety of fields. All modern theories of urine and lymph formation stemmed from his original communication on urine secretion (1844). He devised the first blood gas pump and the first instrument for determining the velocity of blood flow in the larger arteries (Stromuhr). With Élie de Cyon he discovered the depressor nerve (1866) and with Baxt the accelerator nerves to the heart. He studied the effect of certain drugs on the heart with Oswald Schmiedeberg and Sir Thomas Lauder Brunton, localized the vasomotor centre in the medulla and studied capillary blood pressure. With Wooldridge he studied certain phases of the coagulation of the blood and with H. P. Bowditch discovered the all-or-none law (*q.v.*), of cardiac muscle and the indefatigability of nerve.

Ludwig was the first to demonstrate that human digestive glands might be under the influence of secretory nerves, when he demonstrated that the chorda tympani nerve had such an effect on the submaxillary and sublingual glands. He also demonstrated that stimulation of the nervi erigentes caused a vasodilation.

See the biography by Walter J. Meek in the Gamma Alpha Record, vol. xxiii, no. 2, pp. 31–43 (May 1933). (F. L. A.)

LUDWIG, OTTO (1813–1865), German writer remembered for his realistic stories, which contributed to the development of the Novelle, was born at Eisfeld, Thuringia. on Feb. 12, 1813. Showing an early aptitude for both literature and music, he was sent to Leipzig in 1839 to study music under Mendelssohn. Later he changed to literary studies, in particular dramatic theory, his principal interest from 1844 to 1849, when he lived in Meissen. His last years were spent in Dresden, where he died on Feb. 25, 1865. His work is Heimatkunst (regional art) at its best; he coined the expression "*Poetischer Realismus,*" later used to describe the writing of several of his contemporaries. An admirer of Shakespeare but a sharp critic of Schiller, Ludwig strove to create dramas embodying his theories. *Der Erbforster* (1850), an attempt to depict the psychology and environment of the middle class, owes much to the Schillerian tragedy, despite Ludwig's efforts to avoid this effect. His other plays are forgotten, but his graphic stories of Thuringian life are still read, *e.g., Die Heiterethei* (1854), the humorous tale of a village love-affair, and the psychological masterpiece *Zwischen Himmel und Erde* (1855; Eng. trans., *Between Heaven and Earth,* 1928), in which a tragic conflict between two brothers is played out against the background of the slaters' trade. Ludwig's collected works were published by A. Stern and E. Schmidt (6 vol., 1891); unfinished critical edition by P. bferker (6 vol., 1912–22).

For biographies, studies and other editions *see* W. Kosch, *Literatur-Lexikon,* vol. ii (1953), pp. 1587–88. (L. H. C. T.)

LUDWIGSBURG, a town in the *Land* of Baden-Württemberg, Ger., 9 mi. N. of Stuttgart and 1½ mi. from the Neckar river. Pop. (1950) 58,489. It was founded at the beginning of the 18th century by the duke of Wiirttemberg, and was enlarged and improved by Duke Charles Eugene. Constructed as the adjunct of a palace, the town has straight streets and spacious squares. The former royal palace which stands in a park and contains a portrait gallery and the burial vault of the rulers of Wiirttemberg is now a museum. The industries include the manufacture of organs and pianos, of celluloid, watchcases, cotton, woolen and linen goods, chemicals, iron and wire goods, and brewing and brick-making. From 1758 to 1824 the town was famous for the production of a special kind of porcelain.

LUDWIGSHAFEN, a town of Germany, in the *Land* of Rhineland Palatinate, on the Rhine, immediately opposite Mannheim. Pop. (1885) 21,042, (1950) 123.869. Founded in 1843 by Louis I, king of Bavaria, Ludwigshafen was not made a town until 1859. It has trade in iron, timber, coal and agricultural products. fostered by a harbour opened in 1897 which is also a free port; and also large factories for making aniline dyes, soda, cellulose, tobacco, carriages, artificial manure, flour and malt; there are sawmills, iron foundries and breweries. During World War II it was severely bombed by the British Royal Air Force.

LUEGER, KARL (1844–1910), Austrian administrator, burgomaster of Vienna, was born on Oct. 24, 1844, the son of an usher, and, studying under the greatest material difficulties, succeeded in qualifying as an advocate (1874). He was at first a partisan of the Democratic party, then a leader of the Christian Socialists, an anti-Semite and advocate in the courts for artisans and "small men." He was a deputy to the Austrian parliament in 188j and 1891. He overthrew the German-Liberal municipal government of Vienna: and was elected burgomaster in 1895, but the emperor did not confirm the appointment, and Vienna was placed under the governorship of a state commission. In the new elections Lueger allowed another member of his party to be set up as dummy burgomaster, while he himself in form became vice-burgomaster. In 1897, however, when the people's candidate, Lueger, was again elected burgomaster, the emperor confirmed his election and repeatedly honoured him. He held the post for ten years. He was a zealous Catholic, and wished to "capture the university" for the church; he would have neither Social Democrats nor Pan-Germans nor Jews in the municipal administration. He secured good treatment for Czech immigrants and established Viennese municipal electrical stations, gasworks and streetcars, independent of the English gas and streetcar companies. He planned to make Vienna one of the most beautiful of garden cities. He died on March 10, 1910, in Vienna.

See Tomola, *Unser Biirgermeister, Dr. Karl Lueger* (1904); and Stauracz, *Dr. Karl Lueger, zehn Jahre Biirgermeister* (1907).

LUFFA or LOOFAH, the name given to the fruit of *Luffa cylindric~a* herbaceous plant of the family Cucurbitaceae (*q.v.*).

LUGANO, the most populous and thriving town in the Swiss canton of Ticino on the lake of Lugano at an altitude of 906 ft. Pop. (1950) 18,122, almost all Italian speaking. To the south is San Salvatore (2,992 ft.), on the southeast (across the lake) Monte Generoso (5,584 ft.) and to the east Monte Bré (3,061 ft.). All three are accessible by railways. By rail Lugano is 124 mi. from Lucerne and 51½ mi. from Milan. Situated on the main St. Gotthard railway line, Lugano is much frequented by visitors (largely German) in spring and in autumn. Though politically Swiss since 1512, Lugano is Italian in appearance and character. The railway station is connected with the quays by a funicular railway. The principal church, San Lorenzo, in part dates back earlier than the 15th century. This church is now the cathedral church of the bishop of Lugano, a see with jurisdiction over the Italian parts of Switzerland. The church of Santa Maria degli Angioli, built about 1499, and until 1848 occupied by Franciscans, contains several frescoes painted 1529–30 by Bernardino Luini. During the struggle of 1848–66 to expel the Austrians from Lombardy, Lugano served as headquarters for Mazzini. Books and tracts intended for distribution in Italy were produced there and at Capolago and the Austrian police were powerless to prevent their circulation.

LUGANO, LAKE OF, lying between Lago Maggiore and the Lake of Como, north Italy (anc. Lacus Ceresius). The great promontory of San Salvatore (2,992 ft.) nearly cuts off the western arm from the main lake. The area is 19 sq.mi., greatest length about 22 mi., greatest width 2 mi. and greatest depth 945 ft., surface 889 ft. above sea level. Between Melide (south of the town of Lugano) and Bissone (on the east shore) the lake is so shallow that a great stone dam has been built across for the St. Gotthard railway line and the road. The chief town is Lugano (at its north end), which by the St. Gotthard line is 19 mi. from Bellinzona and 9 mi. from Capolago, the station at the southeastern extremity of the lake, which is but 8 mi. by rail from Como. At the southwestern extremity a railway leads southwest from Porto Ceresio to Varese (9 mi.). Porlezza, at the east end of the lake. is 8 mi. by rail from Menaggio on the Lake of Como. while Ponte Tresa, at the west end of the lake, is about the same distance by electric railway from Luino on Lago Maggiore. Of the total area of the lake, about 12 sq.mi. are in the Swiss canton of Ticino (Tessin), formed in 1803 out of the conquests made by the Swiss from the Milanese in 1512. The remainder of the area is in Italy to which also belongs the small enclave of Campione, almost opposite the town of Lugano. The lake lies among the outer spurs of the Alps that divide the Ticino (Tessin) basin from that of the Adda, where the calcareous strata have been disturbed by the intrusion of porphyry and other igneous rocks. It is fed by numerous torrents issuing from short glens in the surrounding mountains, while it is drained by the Tresa, an unimportant stream flowing into Lago Maggiore. The first steamer was placed on the lake in 1856. (W. A. B. C.)

LUGANSK: *see* VOROSHILOVGRAD.

LUGARD, FREDERICK JOHN DEALTRY LUGARD, 1ST BARON (1858–1945), British administrator, son of the Rev. F. G. Lugard. was born on Jan. 22, 1858. He entered the army in 1878 and served in the Afghan War (1879–80), in the Sudan campaign (1884–85) and in Burma (1886–87). In May 1888 he took command of an expedition organized by the British settlers in Nyasaland against the Arab slave traders on Lake Nyasa, and was severely wounded. In April 1889 he was engaged by the Imperial British East Africa company. In their service he explored the Sabaki river region, and elaborated a scheme for the emancipation of the slaves in the Zanzibar mainland. In 1890 he was sent by the company to Uganda, where he secured British predominance and put an end to the civil disturbances, though not without severe fighting, chiefly notable for an unprovoked attack by the "French" on the "British" faction. While administering Uganda he journeyed round Ruwenzori to Lake Edward, mapping a large area of the country. He also visited Albert Nyanza, and brought away thousands of Sudanese who had been left there by Emin Pasha and H. M. Stanley.

In 1892 Lugard returned to England, where he opposed the abandonment of Uganda by Great Britain, contemplated by the fourth Gladstone administration. In 1894 Lugard was dispatched by the Royal Niger company to Bornu, where. distancing his French and German rivals, he secured treaties with the kings and chiefs acknowledging the sovereignty of the British company. In 1896–97 he took charge of an expedition to Lake Ngami on behalf of the British West Charterland company. He was recalled by the British government and sent to west Africa, to raise a native force to protect British interests in the hinterland of Lagos and Nigeria against French aggression. In Aug. 1897 he raised the West African Frontier force, and commanded it until the end of Dec. 1899. The differences with France were then composed, and, the Royal Niger company having surrendered its charter, Lugard was chosen as high commissioner of northern Nigeria. The part of northern Nigeria under effective control was small, and Lugard's task in organizing this territory was impeded by the refusal of the sultan of Sokoto and many other Fula princes to fulfill their treaty obligations. In 1903 a successful campaign against the emir of Kano and the sultan of Sokoto facilitated the extension of British control over the whole protectorate, and when in Sept. 1906 he resigned his commissionership, the whole country was being peacefully administered under the supervision of British residents. *(See* NIGERIA.) In April 1907 he was appointed governor of Hong Kong. He was appointed in March 1912 governor of both northern and southern Nigeria, with instructions to amalgamate the two administrations. The amalgamation became effective on Jan. 1, 1914, Sir Frederick being given the personal title of governor general. He guided the affairs of Nigeria throughout World War I, retiring in 1919, and was made a privy councilor in 1920. In 1922 he published *The Dual Mandate,* a book dealing with the duties of European powers in tropical Africa. From November of that year until 1936 he was a member of the permanent mandates commission of the League of Nations. *(See* MANDATE; NIGERIA.)

Lugard was created knight commander of the Order of St. Michael and St. George in 1901 and knight of the grand cross of the Order of St. Michael and St. George in 1911. He became a colonel in 1905, and held the local rank of brigadier general. He married in 1902 Flora Louise Shaw (daughter of Maj. Gen. George Shaw, companion of the Bath, Royal Academy), who had been a distinguished writer on colonial subjects for the *Times* (London). Lord Lugard, then Captain Lugard, published in 1893 *The Rise of Our East African Empire* (partly autobiographical), and was the author of various valuable reports on Northern Nigeria issued by the colonial office. Throughout his African administrations Lugard sought to ameliorate the condition of the native races, especially by the exclusion of alcoholic liquors, and by the suppression of slave raiding and slavery. He was created a baron in 1928. He died April 11, 1945, at Surrey.

LUGEON, MAURICE (1870–1953), French geologist, a brilliant pioneer in the development of modem Alpine geology, was born at Poissy near Paris on July 10. 1870. He moved with his parents to Lausanne, Switz., in 1876 and graduated at the university in 1893 where he later became extraordinary professor of geology and physical geography in 1898 and ordinary professor eight years later. Lugeon was closely connected with Hans Schardt's tectonic discovery of the far-traveled nature of the rocks of the Prealps that extend from Lake Geneva to Lake Thun and subsequently played the leading part in developing the tectonic ideas thus liberated and in providing a comprehensive interpretation of the Alps as a whole. In *Les grandes nappes de recouvrement des Alpes du Chablais et de la Suisse* (1901) he developed his great synthesis showing that from the Arve to Salzburg the north front of the Alpine chain is composed of large superimposed nappes. His tectonic interpretations were extended by him to regions outside the main Alpine province, notably to the Carpathians, Sicily and Morocco. Lugeon won international renown as a consultant on dam sites and published authoritative memoirs in this field: *Etude gkologique sur le projet de barrage du Haut-Rhône français à Génissiat* (1912) and *Barrages et gkologie* (1933). He died in Lausanne on Oct. 23, 1953. (C. E. T.)

LUGO, a maritime province of northwestern Spain, formed in 1833 of districts taken from the old province of Galicia, and bounded north by the Atlantic, east by Oviedo and León, south by Orense, and west by Pontevedra and Corunna. Pop. (1950) 521,213; area, 3,815 sq.mi. The coast, which extends for about 40 mi. from the estuary of Rivadeo to Cape de Vares, is extremely rugged and inaccessible, and few of the inlets, except those of Rivadeo and Vivero, admit large vessels. The province, especially in the north and east, is mountainous, being traversed by the Cantabrian chain and its offshoots; the sierra which separates it from Leon attains in places a height of 6,000 ft. A large part of the area is drained by the Miiio. This river. formed by the meeting of many smaller streams in the northern half of the province, follows a southerly direction until joined by the Sil, which for a considerable distance forms the southern boundary. Of the rivers flowing north into the Atlantic, the most important are the Navia, which has its lower course through Oviedo; the Eo, for some distance the boundary between the two provinces; the Masma, the Oro and the Landrove.

The principal agricultural wealth is on the Miiio and Sil, where rye, maize, wheat, flax, hemp and a little silk are produced. Agriculture is in a backward condition, mainly owing to the extreme division of land that prevails throughout Galicia. Iron is found at Caurel and Incio, arsenic at Castroverde and Cervantes, argentiferous lead at Riotorto. There are also quarries of granite, marble and various kinds of slate and building stone. There are manufactures of leather, preserves, coarse woolen and linen stuffs, timber and osier work.

LUGO, capital of the province of Lugo, Spain, on the river Miiio and on the railway from Corunna to Madrid. Pop. (1950) 52,093 mun. Lugo (Lucus Augusti) was a flourishing city under Roman rule *(c.* 19 B.C.–A.D. 409) and was made by Augustus the seat of a *conventus iuridicus* ("assize"). Its sulfur baths were then well known. It was sacked by barbarians in the 5th century, and suffered greatly in the Moorish wars of the 8th century. Franco's forces captured it in the civil war of 1936–39.

Lugo is an episcopal see, and was formerly the capital of Galicia. Suburbs have grown up round the original town, the form of which, nearly quadrangular, is defined by a massive Roman wall 30 to 40 ft. high and 20 ft. thick, with projecting semicircular towers which numbered 85 as late as 1809, when parts of the fortifications were destroyed by the French. The wall now serves as a promenade. The Gothic cathedral, on the south side of the town, dates from the 12th century, but was modernized in the 18th. The principal industries are tanning and the manufacture of linen and woolen cloth. About 1 mi. S., on the left bank of the Miño, are the famous hot sulfur baths of Lugo.

LUGSAIL: *see* RIGGING.

LUGUDUNUM, an old Celtic place name (fort or hill of the god Lugos or Lug) used by the Romans for several towns in ancient Gaul. The most important was the town at the confluence of the Saône and Rhône, now called Lyons *(q.v.).* This place had in Roman times two elements. One was a Roman *colonia* (municipality of Roman citizens, self governing) on the hill near the present Fourviéres (Forum vetus). The other was the temple of Roma and Augustus, to which the inhabitants of the 64 Gallic cantons in the three Roman provinces of Aquitania, Lugdunensis and Belgica—the so-called Tres Galliae—sent delegates every summer to hold games and otherwise celebrate the worship of the emperor which was supposed to knit the provincials to Rome. The two elements composed the most important town of western Europe in Roman times. Lugudunum controlled the trade of its two rivers, and that which passed from northern Gaul to the Mediterranean or vice versa; it had a mint; it was the capital of all northern Gaul, despite its position in the south, and its wealth was such that, when Rome was burned in Nero's reign, its inhabitants subscribed largely to the relief of the Eternal City.

LU HSUN (LUSIN; pseudonym of CHOU SHU-JEN) (1881–1936), Chinese writer, scholar, teacher and translator, was born of gentry stock at Shao-hsing, Chekiang. The imprisonment of his grandfather and the death of his father reduced the family circumstances when he was still a child and embittered his outlook. He matriculated at the School of Railways and Mines, Kiangnan Military academy, Nanking, and later studied western medicine, philosophy and literature in Japan on a government scholarship, returning home an ardent anti-Manchu revolutionary and a moderate cultural protectionist. In 1912 he joined the republican ministry of education, moved to Peking and devoted his leisure time to antiquarian pursuits. At the urging of friends associated nith the nascent literary movement, he wrote the short story "A Madman's Diary" (1918), a pungent satire on the dark, animal forces of traditional, Confucian-oriented society. *The True* Story of *Ah* Q (1921) is his representative work. A mixture of humour and pathos, it is a repudiation of the old order and a classic portrayal of the national psychology. Other stories in Call to Arms (1923), the work that brought him national prominence, the volume Hesitation (1926) and the various symbolic prose-poems, reminiscences and retold classical tales all reveal a modern sensibility informed by a sardonic humour and biting satire. Although Lu Hsun is better known abroad for his works of fiction, the prose essay is more characteristic of his genius. Forced by political circumstances to flee Peking in 1926. he eventually found sanctuary in the Shanghai International settlement, where, alienated from the right and courted by the left, he turned increasingly to direct prose expression. His Outline *History* of *Chinese* Fiction and companion compilations of classical fiction remain standard works. Translations, largely from the Russian, also occupy a large place in his complete works. Independent, antimaterialistic and antiauthoritarian, and imbued with a profound sense of moral justice, Lu Hsun nevertheless was adopted posthumously as the exemplar of socialist realism by the Chinese Communist movement.

CHOU TSO-JEN (1885–), eminent literary figure known for the casual, sophisticated essay, and CHOU CHIEN-JEN (1889–), scientist, teacher, politician and Communist governor of Chekiang province, are brothers of Lu Hsun. (W. R Sz.)

LUINI (LUVINI), **BERNARDINO** (fl. 1512–1532), Lombard painter, is best known for his religious frescoes. Although his fame has long been considerable, exceedingly little is known of his life. even Giorgio Vasari giving the minimum information. The earliest surviving painting certainly his work is a fresco of the "Madonna and Child" at the Cistercian monastery of Chiaravalle, near Milan. A contemporary record states that this was painted in 1512 by "B. Luino." This is also the earliest certain evidence of the painter's existence, statements concerning his birth and apprenticeship which are sometimes given as fact being derived from sources too late to be reliable. An altarpiece of the "Madonna and Child With Saints," now in the Musée Jacquemart-André, Paris, bears the inscription "Bernardin (us) Mediolanensis faciebat MDVII" and may be an early work of Luini, but the omission of the surname in the signature precludes certainty. An altarpiece of the "'Lamentation Over the Dead Christ" in the church of Sta. Maria della Passione at Milan is likewise frequently, but not universally, considered an early work of Luini, but it has no signature or documentation to support it.

Between 1512 and his death in 1532 a number of paintings are signed or otherwise reliably attributed, and still others can be ascribed to Luini with confidence on the strength of resemblance to the first group. Of these numerous works. the most important among those with religious subjects are the series of paintings in the churches of S. Giorgio al Palazzo and S. Maurizio at Milan. the frescoes in the church of Sta. Maria dei Miracoli at Saronno, the two Adorations "of the Magi" and "of the Shepherds" in Como cathedral, the huge fresco of the "Crucifixion" in the church of Sta. Maria degli Angeli it Lugano and the altarpieces at San Magno, Legnano. and in the Di Rovasenda collection at Turin (from Mendrisio). Of Luini's fewer paintings of secular subjects, the most important are two series of frescoes, subsequently detached and dispersed. One of these came from the Villa Pelucca, near Monza. It consists of various mythological subjects and also some from the Old Testament. Most of the pieces are now in the Brera, Milan. The second, from Casa Rabia, Milan, is divided between the state museums, Berlin and the National Gallery of Art at Washington, D.C. The subjects are the stories of Europa and of Cephalus and Procris. Luini's work is represented in other galleries in Europe and the United States and in Canada.

The art of Luini in its entirety fits naturally into the Lombard tradition of the second half of the 15th century and the opening years of the 16th, as exemplified by Vincenzo Foppa, Bernardino Butinone, Bernardino Zenale, Borgognone, Bramantino and Andrea Solari. To many scholars. honever, one of the main points of interest is its relation to that of Leonardo da Vinci. The periods of the latter's second residence in Milan were 1506–07 and 1508–13 and while it is certain that his work was known to Luini, no evidence of personal contact is forthcoming. Although Luini, on at least one occasion. incorporated a design of Leonardo's into a painting ("Holy Family" in the Ambrosiana, Milan, from Leonardo's cartoon now at the Royal Academy, London), he showed in general greater independence with regard to the great Florentine than did most of his Milanese contemporaries, The excellence of his craftsmanship and the unstudied sweetness of his pictures were the qualities which endeared him to John Ruskin and to the later 19th century.

See Angela Ottino della Chiesa, Bernardino Luini (1956).

(C. H. M. G.)

LUKE, SAINT, "the beloved physician," a companion of St. Paul (*q.v.*), the traditional author of the third Gospel and the Acts of the Apostles, the most literary of New Testament writers (*see* ACTS OF THE APOSTLES; LUKE, GOSPEL ACCORDING TO SAINT). His gentile origin is indicated by the name Loukas, a short form for the Latin Lucius or Lucanus (like Silas, Acts xv, 40. for Silvanus. I Thess 1, 1). Possibly he was the son of a freedman of some Roman family. The Anti-Marcionite Prologue, Eusebius of Caesarea and Jerome refer to him as a Syrian from Antioch. This probably means that he lived there and first met Paul there. Luke's connection with the early Antiochene church is abundantly illustrated by the detailed information he supplies in Acts (xi, 19 ff.; xiii. 1 ff.; xiv, 26–xv, 35) concerning the origin and growth of that community. Nothing is known of the time or circumstances of his conversion; if the reading of the Bezan codex in Acts xi. 28 is correct, "When we were assembled," this personal reference would indicate that Luke was an early member of the Antiochene community.

Paul calls Luke "the beloved physician" (Col. iv, 14), who undoubtedly attended the physically afflicted Apostle (II Cor. xii, 7; Gal. iv, 13–15). It can no longer be held, as it once was, that Lucan vocabulary proves that the author was a physician; however, later studies, showing that many of Luke's words formerly regarded as distinctively medical are to be found not only in medical writers but also in Josephus, Plutarch, Lucian and the Septuagint, have not done away with all the evidence. Some passages of the Marcan source that mention diseases when modified by Luke reveal the terminology and interest of a professional physician (Luke iv, 38; v. 12; viii, 44). While not proving that their author was a physician, these passages nevertheless support the tradition.

Luke accompanied Paul on his second missionary journey. The "we-sections" of Acts (*see* ACTS OF THE APOSTLES) recount how Luke joined Paul at Troas (*c.* A.D. 50) and passed over to Macedonia with him (Acts xvi, 11–12). Luke most likely remained at Philippi until the end of Paul's third mission (Passover, A.D. 58), when he joined him again as the latter set out for Troas on his return to Jerusalem (Acts xx, 5–xxi, 18). Finally, Luke accompanied Paul from Caesarea to Rome (Acts xxvii, 1–xxviii, 16). Writing from his Roman captivity, Paul refers to Luke as a "fellow worker" (Philem. 24; see Col. iv, 14) and faithful companion to the end (II Tim. iv. 11). Origen was the first to identify Luke nith the "brother who is famous among all the churches for his preaching of the gospel" (II Cor viii, 18) He seems to be the only non-Macedonian (as demanded by II Cor. ix, 2–4) of Paul's entourage eligible at the time for such identification (see Acts xx. 4).

A tradition that can be traced back to Irenaeus (c. 185) regards Luke as the author of the third Gospel. This attribution was probably also known to Justin in the middle of the 2nd century. The Muratorian canon (c. 190; see BIBLE) ascribes both the third Gospel and Acts to Luke. The Lucan authorship of both books is generally (though not universally) accepted by modern scholars.

Luke belonged to cultivated Hellenistic circles, uhere he learned to write with ease good, idiomatic Greek. His writings betray an acquaintance with the historical method of his day, and the

"Semitisms" that shine through his Greek style reveal a deep contact with the Greek Old Testament. In fact, his imitation of the style of the latter is at times surprising. He was a perceptive, sensitive writer with a knack for telling a story and depicting a scene, and his Gospel has been described as "the most beautiful book" ever written. His two books constitute the earliest history of the Christian church.

The Anti-Marcionite Prologue records that Luke wrote his Gospel in Greece, was not married and died in Boeotia (or Bithynia?) at the age of 84. But further details about his life come from either later traditions or legends; *e.g.,* that he was martyred, that he was one of the Seventy (Luke x, 1), that he was the unnamed disciple of Emmaus (Luke xxiv, 13–35), that he was a painter.

Luke is the patron of physicians and artists; in the Roman martyrology his feast day is Oct. 18. His symbol is an ox, the sacrificial animal, because his Gospel begins with the story of Zechariah, the priest, the father of John the Baptist.

Bibliography. — *See* Introductions to commentaries, as J. M. Creed, *The Gospel According to St. Luke* (1953), and C. S. C. Williams, *A Commentary on the Acts of the Apostles* (1958); A. H. McNeile, *An Introduction to the Study of the New Testament,* 2nd ed., by C. S. C. Williams (1953); J. Dupont, *Les Problemes du Livre des Actes d'apres les travaux recents* (1950); M. J. Lagrange, *Evangile selon S. Luc* (1927); A Harnack, *Luke the Physician* (1911); F. J. Foakes Jackson and Kirsopp Lake, *The Beginnings of Christianity,* vol. 11, pp. 207–359 (1922). (J. A Fi.)

LUKE, GOSPEL ACCORDING TO SAINT, the third Gospel of the New Testament. It is the first volume of a longer work which the author addressed to the same patron, Theophilus; another New Testament book, the Acts of the Apostles (*q.v.*), is the additional volume.

Sources. — As the third of the three synoptic Gospels the Gospel of Luke is closely related to Matthew and Mark; like Matthew it is based on the Markan narrative and it also uses Matthew's Saying-Source Q (see Mark, Gospel According to Saint; Gospel). In addition to these, Luke employs at least one other source which contained traditions unknown to Matthew and Mark, thereby preserving in his Gospel the following unique materials:

Luke i, 1–80:	promise of the Baptist's birth, annunciation, visitation, "Magnificat," birth of the Baptist, "Benedictus"
ii, 1–52:	nativity of Jesus, circumcision and presentation in the Temple, Jesus at 12 years
iii, 10–14:	John's sociological teaching
iv, 16–30:	first preaching in Nazareth
v, 1–11:	Peter's draught of fishes
vi, 24–26:	woes to the wealthy
vii, 11–17:	the widow's son at Nain
vii, 36–50:	the woman who was a sinner (41–43: parable of the two debtors)
viii, 1–3:	the ministering women
ix, 51–56:	the unhospitable Samaritans
x, 1, 17–20:	sending and return of the Seventy
x, 29–37:	parable of the good Samaritan
x, 38–42:	Martha and Mary
xi, 5–13:	parable of the friend at midnight
xi, 27–28:	the blessedness of Christ's mother
xii, 13–21:	parable of the rich fool
xii, 47–48:	parable of punishment and responsibility
xiii, 1–9:	call to repentance and parable of the fig tree
xiii, 10–17:	Sabbath healing of the bent woman
xiii, 31–33:	Jesus and Herod (leaving Galilee)
xiv, 1–6:	Sabbath healing of the man with dropsy
xiv, 7–14:	discourse at the banquet
xiv, 28–32:	parables of the architect and the king
xv, 8–32:	parables of the lost coin, and the prodigal son
xvi, 1–31:	parables of the unjust steward, and Dives and Lazarus
xvii, 7–10:	parable of the servant's wages
xvii, 11–19:	healing of the ten lepers
xvii, 20–21:	on the coming of the Kingdom
xviii, 1–14:	parables of the unjust judge, and the Pharisee and the publican
xix, 1–10:	Zacchaeus
xxii, 15–38:	special account of the Lord's Supper, and last words to the disciples
xxiii, 27–32:	words on the road to Calvary
xxiii, 39–43:	the two crucified criminals
xxiv, 13–35:	the road to Emmaus
xxiv, 36–49:	the appearance in Jerusalem
xxiv, 50–53:	the Ascension

The character of the source for this special Lucan material is debated. But whether there was actually a Proto-Lucan Gospel, or only a number of written "collections" (of parables, infancy narratives, resurrection accounts), the peculiarities of arrangement and outline of the present Gospel certainly are the work of its author, who impressed his own literary skill and theological insight upon the various sources used by him.

Style and Technique of Composition. — Luke is a writer of distinctive qualities of mind and style. Though he shares with other New Testament writings the vernacular flavour of 1st-century Greek, his language is more literary than that of his sources. He repeatedly improves Mark's wording, and also avoids foreign words, whether Latin or Aramaic, used by his sources.

Luke connects single narratives much more smoothly than does either Mark or Matthew; he sometimes localizes two scenes in the same setting (*e.g.,* v, 29–32 and 33–38), often establishes a temporal sequence and frequently employs connecting participle constructions. But Luke also realizes that a monotonous sequence of single stories would result in a rather unconvincing picture of Jesus' life. He therefore makes single incidents appear as illustrations of the whole of a continuous history; this purpose is served by the frequent introductory phrase "(and) it came to pass (when). . ." (Authorized Version), often connected with a date.

For purposes of division or connection he formulates summary statements (i, 80, etc.), a specifically Lucan device also employed in Acts (*e.g.,* ii, 42–47). Significant for Luke as a historian is his attempt to relate the history of Jesus to world history (i, 5; ii, 1–3; iii, 1–2; xxiii, 6–7).

A characteristic of the Gospel is Luke's intermittent use of sources in the following way (Q = synoptic Saying-Source; S = special Lucan sources; minor deviations are not mentioned):

Luke i, 5–ii, 52:	S
iii, 1–iv, 30:	synthesized from Mark, Q, and S
iv, 31–vi, 19:	Mark (insertions from S)
vi, 20–viii, 3:	Q (insertions from S)
viii, 4–ix, 50:	Mark
ix, 51–xiii, 30:	Q (insertions from S)
xiii, 31 – xv14:	S (insertions from Q)
xviii, 15–xxiv, 11:	Mark (insertions from Q and S)
xxiv, 13–53:	S

Thus, introduction (birth narrative) and conclusion (Resurrection appearances) are taken from special sources, whereas the body of the Gospel (iii, 1–xxiv, 11) retains the Marcan structure. But a large central section, the "travel narrative" (ix, 51–xviii, 14), is composed almost entirely on the basis of Q and S, without any use of Mark. Luke, however, adds and omits, rearranges and reinterprets the source material whenever necessary to express his own theological evaluation of Jesus' history.

Luke's View of History. — Luke, who in the manner of a Greek historian introduces his Gospel with a preface (i, 1–4), is the first to conceive of the life of Jesus as a revelation pertaining to a former period of an ongoing history. Thereby the early Christian twofold eschatological scheme of "this age and the age to come," within which Mark had understood the Jesus event as the eschatological turning point of the two ages, is replaced in Luke by a tripartite view of history in which the time of Jesus is the centre rather than the end. Luke's Gospel presents Jesus' life as this centre of history in its relation to the preceding period, the time of the Law and the Prophets, and to the following period, the time of the church, in the following way:

Luke i, 5–iv, 13:	the end of the prophetic era as preparation for the revelation
iv, 14–xxii, 2:	the revelation in Jesus' ministry as the centre of time
xxii, 3–xxiv, 53:	the beginning of the time of the church in Jesus' Passion and Resurrection

The beginning of the central period is marked by the departure of Satan after the temptation (iv, 13). The Baptist still belongs to the former period of the Prophets (xvi, 16), preaching only the "baptism of repentance" (iii, 3), but not the coming of the Kingdom (as in Matt. iii, 2). His imprisonment is told before Jesus' appearance, and he is not mentioned at Jesus' baptism (compare Luke iii, 21 with Mark i, 9).

The end of Jesus' ministry does not look forward to the end of the world and time (as in Mark xiii), but to the next period of history, the time of the church, which actually begins with the return of Satan at the beginning of the Passion of Jesus (Luke xxii, 3). It will be a time of temptation and suffering, as it is prefigured in Jesus' Passion, but it remains part of the ongoing history, and Luke repeatedly warns against mistaking events of this history as signs of the end—neither Jesus' Passion (xvii, 20–25), nor his Resurrection (Acts i, 4–11), nor the fall of Jerusalem (compare Luke xxi, 20–24 with Mark xiii, 14–20).

As a result the Gospel of Luke rightly can be understood as containing the proper conclusion of the Old Testament in its first chapters, whereas the last chapters have their direct continuation in the Acts of the Apostles (compare Luke xxiv, 49–53 with Acts i, 4–11 and ii, 1–31). The life of Jesus itself, as the time without Satan and without temptation, is the period of revelation and the sacred centre of history.

Geographical Scheme.—Corresponding to this historical structure of the Gospel is a certain geographical scheme used as a meaningful device of theological characterization.

1. The end of the prophetic period is closely connected with the sacred places of the Jewish people: Jerusalem (ii, 22, 41), Bethlehem (ii, 4, 11), the Jordan (iii, 3; iv, 1). the wilderness (iii, 2; iv, 2).

2. Jesus' ministry as the central period of history is limited to Jewish districts, Galilee and Judea (see especially xxiii, 5), which Jesus never leaves during His ministry, neither for Samaria (xx, 51–56), nor for the surrounding gentile country (compare Luke ix, 18 with Mark viii, 27). He also avoids the sacred places of the prophetic period. except in the Temple ministry and even on this occasion Luke does not say that Jesus entered the city of Jerusalem itself (compare Luke xix, 45 with Mark xi, 11, 12).

3. The beginning of the church era, however, is closely connected with Jerusalem, the place of Jesus' Passion and death (see xiii, 33). In contradiction to Mark and Matthew. Luke presents no Resurrection appearance in Galilee, but only in and around Jerusalem (xxiv, 13 ff., 33, 36 ff.; compare Luke xxiv. 6 with Mark xvi, 7). There also the disciples witness the Ascension (xxiv, 50–53) and there they are to wait for the sending of the Spirit (xxiv. 49; Acts i, 4). Thus Jerusalem, the Holy City and centre of prophecy, also becomes the birthplace of the church

Similarly, Luke's geographical details have special significance. He bypasses the Sea of Galilee as the centre of Jesus' early ministry and preaching (Luke viii, 4 omits the "sea" when reproducing Mark iv, 1), for example, and refers to it as a "lake" (of Gennesaret) where messianic epiphanies occur (Luke v, 1–11; viii, 22–25). In a similar way, "the mountain" is omitted in the temptation (iv, 5; compare Matt. iv, 8) and in the Lucan parallel to the Sermon on the Rfount (Luke vi, 12–17; compare Matt. v, 1), and exclusively designates the place of revelations and prayer (vi, 12, etc.).

Obviously such a reconstruction of the locality often is in contradiction to traditional information, and sometimes is geographically quite improbable. But Luke looks upon Palestine as the "Holy Country" of Jesus' sacred history, and, therefore, the primary significance of the locality is theological.

Jesus' Ministry as the Centre of Time.—This is portrayed by Luke in three phases:

Luke iv, 14–ix, 50:	wandering in Galilee and Judea
ix, 51–xix, 27:	traveling through Galilee and Judea to Jerusalem
xix, 28–xxii, 2:	the Temple ministry

In the first phase Jesus is wandering about like an itinerant Christian missionary, driven by the Holy Spirit (iv, 14; compare Acts xiii, 2 and passim). Jesus' works—no longer understood as the manifestation of the eschatological battle with Satan (see MARK, GOSPEL ACCORDING TO SAINT)—are attestations of his divine authorization (see Acts ii, 22). They always precede the discourses, in which Jesus sets forth the novelty of the "Christian way" as distinguished from that of the Pharisees and the Baptist (v, 30–39, etc.). The main purpose of this section is to assemble the witnesses. To the rejection at home (iv, 16–30) corresponds the call of foreigners (v, 1–11, 27–28; vi, 12–16), and the substitution for Jesus' family of all those who "hear the word of God and do it" (viii, 19–21). But the disciples who recognize Jesus as the "Christ of God" (ix, 20) witness the messianic epiphanies (viii, 22–25; ix, 28–36), receive the authority of healing and preaching (ix, 1–2) and are introduced to the necessity of suffering (ix, 22–27).

In the second phase the location (Galilee and Judea) and the general structure of Jesus' ministry ("acting and preaching") are retained; this section also begins with a "rejection" (ix, 51–56; compare iv, 16–30). But there are several new elements. Jesus is now traveling to a certain goal—Jerusalem (ix, 51, etc.). He repeatedly turns to His disciples with special instruction, especially discourses about the time of the church, whereas to "those outside" Jesus speaks only in parables (*e.g.,* xii, 13–21; compare xii, 1–12 and 22 ff.). Halfhearted followers are rebuked, especially by Jesus' demand to give up wealth, and any missionary emphasis is completely absent. Jesus is now the Messiah who decidedly travels toward His destination; who consciously faces the necessity of His suffering as the fulfillment of prophecy (xviii, 31 as compared with Mark x, 33); who is already watched by those who will kill Him, the Pharisees and lawyers, who are always nearby, offended by His behaviour and discussing His authority (xi, 25–37, etc.).

In the last phase the centre of Jesus' activity is the Temple, into which He enters upon arrival from Jericho, and the Mount of Olives. Preaching in the Temple, He is surrounded by three groups: (1) the people with their meaningless appreciation; (2) the leaders of Jerusalem who try to find an opportunity to destroy him; (3) the disciples who learn to distinguish between the historical event of the fall of Jerusalem and the eschatological events that bring time and history to a definite end (xxi, 5–36; compare Mark xiii, 1–37).

The Temple ministry as an exemplary description of the situation of a Christian missionary concludes the time of revelation. The Passion and Crucifixion of Jesus portray the typical death of a martyr, but according to Luke they do not have a special meaning for salvation. It is the opening chapter of the history of the church—a period without the presence of Jesus, but under the guidance of the Holy Spirit.

Literary History.—The author of the third Gospel (and of Acts) was, according to the tradition, Luke the physician and associate of Paul (Philem. 24; Col. iv, 14). This tradition encounters major difficulties in Acts, since the contradictions between Acts' narratives about Paul and Paul's own letters should not have arisen if the author had actually been Paul's assistant (see ACTS OF THE APOSTLES). In any case, the Gospel was written by a man who knew about Jesus only through traditions of the church and written sources. Whether he was a Jewish Hellenist or a gentile by birth, his Greek style and vocabulary were as educated as that of Greek writers like Xenophon, and he lived in a time for which not only the life of Jesus but also the "apostolic age" belonged to past history. Since the Gospel of Mark is also used, and the prophecy in Luke xxi apparently reflects the actual fulfillment in the year A.D. 70, the last two decades of the 1st century A.D. are probably the best date; some scholars even prefer the beginning of the 2nd century A.D., since neither the Gospel nor Acts was used before II Clement, Justin and the heretic Marcion.

About the place of writing, nothing can be said with certainty. If Luke's geographical picture of Palestine is really incorrect, it is more likely that he wrote in Asia Minor or Greece than in Syria. Nor is anything known about Theophilus, to whom both Gospel and Acts are addressed. See also BIBLE.

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LULEA, a seaport of Sweden, capital of the district (*län*) of Norrbotten, on the Sando peninsula at the mouth of the Lule river. Pop. (1950) 22,638. Lulea as founded by Gustavus Adolphus was 7 mi. higher up the river, but was moved to the present site in 1649. It was connected at Boden (22 mi. N.) by rail from Stockholm to Gellivara and Narvik on Ofoten fjord in Norway. It ships iron ore mined at Gellivara, 127 mi. N.W., and there are smelting works at Karlsvik. Timber is exported, being floated down the Lule river. As a rule the port is closed by ice from November to the end of May. The town was almost entirely burned in 1887.

LULEAN, an independent linguistic stock of South American Indians, so called from the Lules, the most important tribe. They lived on the western border of the Argentine Chaco, on the Salado river in the provinces of Santiago del Estero and Tucuman. They were a semiagricultural folk of simple culture, and known only from brief references by the 18th-century writers. There is considerable uncertainty as to just what tribes are to be included in the stock, the data available being very meagre and conflicting. The Vilela, on the Vermejo, who were near neighbours of the Lule, are, however, certainly members of the stock.

LULE BURGAS, BATTLE OF: *see* BALKAN WARS, 1912–1913.

LULL (or LULLY), **RAIMON** (or RAYMOND) (*c.* 1235–131*j*), Catalan author, mystic and missionary, was born in Palma, Majorca. Married at an early age to Blanca Picany, he led a dissipated life till his conversion (1266). when he resolved to devote himself to evangelical work among the heathen. to write an exposure of infidel errors and to promote the teaching of foreign tongues in seminaries. He dedicated nine years to the study of Arabic, and in 1275 showed such signs of mental exaltation that, at the request of his wife and family, an official was appointed to administer his estate. He withdrew to Randa, there wrote his *Ars major* and *Ars generalis,* visited Montpellier. and persuaded the king of Majorca to build a Franciscan monastery at Miramar. There for ten years he acted as professor of Arabic and philosophy, and composed many controversial treatises. After a fruitless visit to Rome in 1285–86, he journeyed to Paris. residing in that city from 1287 to 1289 and expounding his bewildering theories to auditors who regarded him as half insane. In 1289 he went to Montpellier, wrote his *Ars veritatis inventiva*, and removed to Genoa where he translated this treatise into Arabic. In 1291, after many timorous doubts and hesitations for which he bitterly blamed himself. Lull sailed for Tunis where he publicly preached Christianity for a year; he was finally imprisoned and expelled. In Jan. 1293 he reached Naples, where his efforts to interest Clement V and Boniface VIII in his favourite project of establishing missionary colleges mere unavailing. In 1300 he sailed to Cyprus to seek support for his plan of teaching oriental languages in universities and monasteries. He was rebuffed once more, but continued his campaign with undiminished energy. Between 1302 and 1305 he wrote treatises at Genoa, lectured at Paris, visited Lyons in the vain hope of enlisting the sympathies of Pope Clement V, crossed over to Bougie in Africa, preached the gospel and was imprisoned there for six months. On being released he lectured with increasing effect at Paris, attended the general council at Vienne in 1311 and there witnessed the nominal adoption of his cherished proposals. Though nearly 80 years of age, Lull's ardour was unabated. He carried on his propaganda at Majorca, Paris, Montpellier and Messina, and in 1314 he crossed over once more to Bougie. There he again resumed his crusade against Mohammedanism and raised the fanatical spirit of the inhabitants. was stoned outside the city walls and died of his wounds. The circumstances of Lull's death caused him to be regarded as a martyr, local patriotism helped to magnify his merits and his fantastic doctrines found many enthusiastic partisans. The *doctor illuminatus* was venerated throughout Catalonia and afterward throughout Spain as a saint: a thinker and a poet; but his doctrines were disapproved by the powerful Dominican order, and in 1376 they were formally condemned in a papal bull issued at the instance of the inquisitor, Nicolas Emeric The authenticity of this document was narmly disputed by Lull's followers, and the bull was annulled by Martin V in 1417. The controversy was renened in 1503 and again in 1578; but the general support of the Jesuits and the staunch fidelity of the Majorcans saved Lull from condemnation.

The speculations of Lull became obsolete outside Majorca where his philosophy still flourished in modern times, but his more purely literary writings are extremely curious and interesting. In *Blanquerna* (1283), a novel which describes a new Utopia, Lull renews the Platonic tradition and anticipates the methods of Sir Thomas More, Campanella and Harrington, and in the *Libre de Maravelles* (1286) he adopts the oriental apologue from *Kalilah and Dimnah.* And as a poet Lull takes a prominent position in the history of Catalan literature; such pieces as El *Desconort* (1295) and *Lo Cant de Ramon* (1299) combine in a rare degree simple beauty of expression with sublimity of thought and impassioned sincerity. (J. F.–K.)

LULLY or LULLI, **JEAN BAPTISTE** (1632–1687), French composer, of Italian birth, was born in Florence on Nov. 28, 1632. Through the duc de Guise he entered the service of Madame de Montpensier as scullery boy. He then studied the theory of music under Métra and entered the court orchestra, being appointed director in 1652 and court composer in 1653. The influence of his music produced a radical revolution in the style of the dances of the court itself. Instead of the slow and stately movements which had prevailed until then, he introduced lively ballets of rapid rhythm. The music for his ballets was arranged as orchestral suites, a new form which was cultivated in Germany as well as in France. In Dec. 1661 he was naturalized as a Frenchman, his original name being Giovanni Battista Lulli. For 15 years (1672–87) Lully was the director of the Paris opera. While directing a *Te Deum* on Jan. 8, 1687, with a rather long baton he injured his foot seriously and a growth resulted which led to his death on March 22. Lully was the founder of French opera, forsaking the Italian method of separate recitative and aria for a dramatic consolidation of the two and a quickened action of the story. Moreover, he laid more stress on rhythm and less on melody. He improved the composition of the orchestra, into which he introduced several new instruments. Lully was a friend of Molière, for some of whose best plays he composed illustrative music. Of his church music his *Miserere,* written for the funeral of the minister Séguier, is a work of genius: and on his deathbed he wrote *Bisogna morire, peccatore.*

LUMBAGO, a term in medicine applied to a painful ailment affecting the muscles of the lower part of the back. often regarded as of rheumatic origin. An attack of lumbago may occur alone or be associated with rheumatism in other parts of the body. It usually comes on suddenly as severe pain in the small of the back, greatly aggravated on movement, especially in attempting to rise from the recumbent posture and in drawing a deep breath, coughing or sneezing. The absence of any great constitutional disturbance beyond the pain renders the diagnosis a matter of no great difficulty. Lumbago seems to be brought on by exposure to cold and damp. Sometimes it follows a strain of the muscles of the loins. The attack is in general of short duration, but occasionally it continues for a long time as a feeling of soreness and stiffness on movement. The treatment includes remedies to allay the pain and the recognition of the cause which is often strain or other disorder of the sacroiliac, lumbosacral joints or intervertebral discs. (F. L. A.)

LUMBERING is a term applied to the growing and harvesting of the timber products of the forest and their conversion into various sizes and shapes for commercial use. The oldest industry in the United States, lumbering comprises a complex and highly competitive number of timber growers, contract loggers, lumber manufacturers, wholesalers, retailers and commission salesmen, all operating more or less independently of one another within the structure of the private enterprise system.

The forest was one of the first major obstacles that beset the early American settlers, and, other than supplying them with logs for shelter and wood for fuel, was of little economic value. Trees had to be removed in vast numbers to clear the ground for agricultural pursuits, and to these felled logs the settlers applied the term "lumber." Later, small quantities of "lumber" were shipped to England, sometimes serving merely as ballast for ships crossing the Atlantic. British sailors referred to the bothersome material as "just so much lumber."

In its modern concept, the term lumber is restricted to include only those products of the saw not further manufactured other than by sawing, resawing, passing lengthwise through a standard planing machine and crosscut to specific lengths and matched. Lumber includes boards, planks, structural timbers, scantlings, sawed crossties, flooring and dimension and pattern stocks, all of which are usually measured on the board foot basis.[1] Lumber is manufactured from both softwood (conifers) and hardwood (broad-leaved) species. For purposes of convenience lumber is divided into four broad categories as dictated by size and usage, viz.,(1) yard lumber,(2) factory and shop lumber, (3) structural lumber and (4) special lumber.

Yard lumber is practically restricted to softwood species, and embraces many sizes of materials usually destined for general construction. Four classes of yard lumber are recognized: (1) strips, pieces less than 2 in. thick and less than 6 in. in width; (2) boards, pieces likewise less than 2 in. in thickness but 8 in. or more in width; (3) dimensions, pieces from 2 in. to (but not including) 5 in. in thickness and 2 or more inches in width; and (4) timbers, pieces 5 in. or more in their least dimension. Yard lumber seldom exceeds a length of 20 ft. or a width of 12 in., and is usually cut to lengths in multiples of 2 ft. and in widths in multiples of 2 in.

Factory and shop lumber is lumber to be used for further manufacture into such products as sash and doors, millwork, box shook, furniture and similar products. It is usually produced in standard thicknesses expressed as multiples of 1/4 in.; *i.e.*, 3/4, 4/4, 5/4, 6/4, 8/8, etc. Shipments are usually made in random widths and lengths.

Structural lumber comprises pieces 2 or more inches in thickness and 4 or more inches in width. Pieces from 2 to (but not including) 5 in. in thickness and 4 or more inches in width are classed as joists, rafters and planks; those 5 in. or more in their least dimension are termed beams, stringers, girders, columns and posts. Structural lumber is an engineering material, and a number of stress grades have been developed for both softwood and hardwood species in order that they may safely sustain loads imposed upon them.

Sometimes it is necessary to develop a type of lumber for specific use. This is special lumber, of which aircraft-grade spruce lumber is an example. It is manufactured to rigid specifications which place limitations upon specific gravity, growth rings per inch, grain alignment and permissible defects.

A large volume of hardwood lumber is consumed annually in the production of furniture, flooring and a host of other commodities. Hardwood lumber is commonly produced in 6/4 and 8/4 stock and resawed into hardwood dimension. Hardwood flooring and dimension mills are commonly operated in connection with sawmills, or they may be run as entirely separate enterprises. In fact, flooring and dimension plants in some areas prefabricate their products to any required stage of completion.

The manufacture of hardwood lumber represents one of the most complex segments of the U.S. lumber industry, not only because of the diverse tree species involved but also because of the many uses developed for it.

Many other wood-using industries in the United States; such as pulp and paper, veneers and plywood, naval stores, wood distillation and cooperage, are dependent to various degrees upon the lumber industry, and in numerous instances lumbering becomes an integral part of their operations.

Development of **U.S.** Lumbering.—The forests, principal source of materials for shelter in early American times: provided lumber for houses and stockades and for fuel in bountiful measure. To provide safety from Indians and to develop arable lands for agricultural pursuits, great tracts of timber had to be cleared. and in these clearings developed the early American communities. Spars and ship timbers were delivered to England even before tobacco and other agricultural products were exported (a shipload of southern yellow pine hand-rived clapboards was sent from Jamestown, Va., to England in 1608). The first boards made in the new world were hand rived—split out of logs and hewn into shape with axes. A crude two-man saw soon replaced the axe, and boards were made by placing a log over a pit with one man working above the log and the other below it. The first power-driven sawmills were erected at York, Me., in 1623, Jamestown, Va., in 1625 and Berwick, Me., in 1631. These early mills were operated by water power but were capable of producing only a few hundred board feet of lumber daily. Water-driven mills were operating in the American colonies many years before any were erected in Great Britain. By the early 1700s water-powered "up and down" mills had become popular, many of them operated in conjunction with gristmills. About 1830 circular ripsaws were in common use, and at about this same period steam power was introduced. Then followed the introduction of the gang saw, consisting of a series of 24 to 42 parallel sash saws mounted on a heavy metal frame. Band saws came into use about 1880.

The development of the American lumber industry can be traced concurrently with the expansion of agriculture. Likewise. the shifting of lumber centres from New England to the north, south and west closely parallels the industrial development of the United States For years Maine led in lumber production, supplying home and foreign markets with white pine spars. staves and shipbuilding lumber. Virginia and the Carolinas produced large quantities of oak. and the Carolinas and other southern states supplied yellow pine lumber and rosin, an essential material in the shipbuilding industry of the times.

By 1840 lumber production in the United States approximated 8,000,000,000 bd ft. The centre of the industry was now in the state of New York. which was producing 20% of all lumber manufactured. In 1859 Pennsylvania took the lead. but ten years later surrendered it to Michigan, which in turn gave way to Wisconsin by 1899. Minnesota also came into prominence as a lumber-producing state at about that time, but the peak of lumber production in the lake states was reached in 1892. Beginning about 1895, southern yellow pine supplied from 20% to 40% of the total annual cuts, and more lumber was produced in the south and southeast than in any other forest region in the United States. The Pacific coast states, notably Washington and Oregon, came into prominence about 1900. From 1905 to 1922 (except 1920) Washington and Louisiana were the leading lumber-producing states. In 1920, and from 1923 to 1937, Washington and Oregon led in the order named. From 1938 Oregon led annually in the total production of lumber.

U.S. Production and Consumption.—The average annual production of lumber in the United States for the five-year period 1923–28 was approximately 37,000,000,000 bd.ft., of which 31,000,000,000 were softwood and 6,000,000,000 hardwood. In the five-year period 1933–38 annual production averaged 21,200,000,000 bd.ft., of which 17,700,000,000 were softwood. By 1953 annual production of lumber had reached a total of 36,742,000,000 bd.ft. Approximately 30.8% of the 1953 cut was produced in the south and 49.8% in the Pacific northwest and California. Nearly 80% of the 1953 production was in softwoods, with Douglas-fir and the southern yellow pines the leading species. Oak, yellow-poplar, sweetgum and maples were the principal hardwood species.

The United States is the world's largest consumer of lumber and uses between 65% and 70% of its annual production for building and construction. About 8% of the total cut is used by railroads for ties, timbered structures and car construction, and 24% is used by other manufacturers. In addition to the lumber and lumber products mentioned. approximately 3,620,000,000 cu.ft. of wood are consumed annually as fuel wood. The paper industry converted approximately 10,400,000 cords (1 cord = 128 cu.ft.) of pulpwood in 1937; by 1953 consumption had risen to 26,435,000 cords.

[1]The board foot is the standard unit of measurement for most lumber. It is a piece of lumbrr 12 in. wide, 12 in. long and 1 in. thick, or its equivalent volume in other dimensions.

There were about 53,000 mills producing lumber in the United States in 1953. These facilities employed approximately 719,900 persons earning wages and salaries totalling $2,086,000,000 and produced goods valued at $3,500,524,000. Approximately 37% of the lumber was produced by 5.000 mills; 75% by 5,600 mills. Only about 10% of the mills were located west of the Rocky mountain region. No one mill or company operating two or more mills produced as much as 5% of the total cut.

The largest mills are located in the Pacific northwest, where at least two have daily production capacities in excess of 1,800,000 bd.ft. Small mills, that is, those producing less than 5,000,000 bd.ft. annually, comprise about 80% of the western mills, but account for less than 20% of the lumber produced in that region. In the northern Rocky mountain region 93% of the mills are of the small type and produce 30% of the region's lumber output. In the east and south 99% of the mills each produce less than 5,000,000 bd.ft. annually, but they account for nearly 80% of the production in these two areas. In 1950 the Southern Pine Industry committee reported that of the 11,153 softwood and hardwood mills in the 11 southern states, 8,233 were of the mobile or portable type and only 2.920 mere regarded as perinanent installations. Only j38 of these mills were capable of producing more than 5,000,000 bd.ft. annually, and about 4,000 of them each had an annual production of less than 1,000,000 bd.ft.

In the 1950s the United States produced about a third of the world's lumber supply. Prior to World War I, about 3,000,000,000 bd.ft. of lumber were exported annually. In 1928 U.S. exports reached a high of 3,200,000,000 bd.ft., but by 1942 had dropped to a low of 300,000,000 bd.ft. An estimated 1,000,000,000 bd.ft. were exported in 1951. Lumber imports exceeded exports after 1940, and in 1950, 3,400,000,000 bd.ft. of lumber were imported, 85% of which came from Canada.

Some interesting statistics on lumber consumption were compiled by the National Lumber Rlanufacturers association in the publication. *Lumber Front Forest to You*. "Since the birth of this nation in 1,776, its lumber industry has produced an estimated 2,800 billion board feet of lumber. This is enough lumber to build 57 million urban homes, 13 million farm homes, 2.3 million schools and libraries, 720,000 churches, and 500,000 factories. If piled in one stack it would cover a large city block and stand 400 miles high; it would build a six-foot walk from the earth to the sun!"

TABLE I.—*Distribution of U.S. Saw-Timber Stands*
(in 000,000 bd.ft.)

Region	On virgin areas	On second growth areas	On other than saw-timber areas	Total	Total softwoods	Total hard-woods
Northeast . . .	1,304	88,543	21,612	111,459	46,357	65,102
Lake states . .	17,390	23,280	10,040	50,710	15,670	35,040
Central . . .	1,868	52,549	6,991	61,408	6,214	55,194
South. . . .	11,617	292,721	19,623	323,961	190,926	133,035
Plains . . .	1,080	8,126	1,672	10,878	459	10,419
Douglas-fir . .	408,271	93,811	2,849	504,931	501,065	3,866
Western pine and redwood . .	398,810	101,689	37,126	537,625	535,686	1,939
Total	840,340	660,719	99,913	1,600,972	1,296,377	304,595

Source: National Lumber Manufacturers Association, *Lumber Industry Facts* (Washington, D.C., 1953).

Timber Available in the U.S. for Lumbering Operation.—In connection with the quantity of timber available in the United States for lumbering operations, there are several factors of varying character such as changes in the standards of lumber-mill utilization, growth of small trees to saw-log size and conditions of markets for other nood products which may at any time divert saw timber into other uses such as pulp, poles. pilings, shakes and ties because of the higher prices offered for such uses.

The tendency in some parts of the country is to increase the minimum size of trees cut in lumber manufacture by the practice of selective logging. Although the portion of available timber to be used for lumbering cannot be forecasted. an estimate of the quantities that probably will be so used if conditions continue to follow current trends can be made.

In Tables I and II classifications have been made by regions based on the character of forest growth. The northeast region embraces all of New England, Delaware, New York, Pennsylvania, Maryland and New Jersey. Michigan, Minnesota and Wisconsin comprise the region of the lake states. The central region includes the states of Ohio, Indiana. Illinois. Kentucky, Missouri, West Virginia and Tennessee. The south includes the 11 states along the southern Atlantic coast and the Gulf of Mexico, from Virginia to Texas and Oklahoma. Iowa, Kansas. Nebraska, North Dakota and eastern South Dakota make up the plains region. The Douglas-fir region consists only of western Washington and western Oregon, uhile the western pine region (redwood region included) is a vast area embracing the South Dakota Black hills area, eastern Washington, eastern Oregon and all western states not otherwise noted above.

TABLE 11.—*Current Annual Growth on Commercial Forest Areas*
(in 000,000 bd.ft.)

Region	All timber growth			Saw-timber growth		
	Total	Softwood	Hardwood	Total	Softwood	Hardwood
Northeast . . .	24,636	7,992	16,644	4,062	1,463	2,599
Lake states . .	9,744	2,136	7,608	1,403	346	1,057
Central . . .	21,684	2,100	19,584	3,249	396	2,853
South	73,800	41,604	32,196	19,102	12,697	6,405
Plains . . .	2,820	120	2,700	477	17	460
Douglas-fir . .	12,288	11,904	384	3,741	3,669	72
Western Pine and redwood . .	15,468	15,216	252	3,267	3,260	7
Total	160,440	81,072	79,368	35,301	21,848	13,453

Source: National Lumber Manufacturers Association, *Lumber Industry* **Facts** (Washington, D.C., 1953).

Technological developments made it possible to produce paper pulps from species formerly regarded as wholly unsuited for such use A large newsprint industry was established in the south using southern yellow pine and new processes were developed for pulping Ion-grade hardwoods within the region. It was estimated that more than 75% of rayon production was manufactured from wood pulp. Increasing demands for pulpwood in some areas made it feasible to utilize trees of saw-log size for pulpwood.

The estimated depletion of timber in the United States for 1944 stood at 13,661,000,000 cu.ft Of this total, the timber cut for commodities was 12,182,000,000 cu ft. Fire accounted for a loss of 460,000,000 cu.ft., while insects and disease destroyed another 1,019,000,000 cu.ft. The present stand, plus growth, less depletion and losses, may be said to give an indication of the life of the lumber industry. During the second quarter of the 20th century the application of good forest management practices more efficient fire suppression systems and the reforestation of much idle acreage together aith rising stumpage prices did much to increase the production of timber on both public and private lands. In 1920 the ratio of forest drain to forest growth was an alarming 4 34 to 1. Dire predictions of a timber famine in the United States were heard from all sides However, between 1920 and 1944 the ratio dropped to 1 02 to 1. Thus. if the 1944 ratio were maintained or even bettered, it would appear that there was no longer a threat of such a famine. While forest growth was keeping up with forest drain in the 1950s, such a statement without qualification could be misleading. since no recognition of the qualitative factors is included With the depletion of old-growth virgin timber stands, log quality was greatly reduced. and a critical shortage of high-grade logs of several species developed. While there was no shortage of wood per se, several species were in short supply in the late 1950s.

U.S. METHODS OF MANUFACTURE

In the American colonial period. the manufacture of lumber was a comparatively simple. crude and inexpensive process. Trees were felled as needed. and the logs rived or hand-sawed into rough boards, planks and timbers for local and immediate use. With the development and expansion of the new nation, demands for lumber rose sharply, and more efficient lumbering procedures were created to keep pace with ever-increasing demands for lumber and other forest products. As forests became depleted the lumber industry shifted its centres of activity, and each new region presented new problems in logging. manufacture and distribution because of climatic conditions. variation in species, topography of the land and available labour. All of these factors had a marked influence on the development of modern lumbering methods.

Logging.—Logging has been one of the most interesting features of the American lumber industry. In the early days, and until relatively recently in most areas, the lumberman depended slmost entirely upon natural forces in the logging operations. In the northeastern and northern states the fall and winter seasons were devoted to felling trees. The logs were hauled out on snow sleds, either to sawmills close by or to concentration points on the banks of streams; in the latter case, the logs were rolled into the floodwaters as soon as the ice had broken up and floated downstream to sawmills or market centres. In the south the lumbermen had to resort to other means of transportation because of the lack of swift-moving streams and winter snows. Oxen and high-wheel carts were the principal means of log transportation for many years and are still used today in some of the low-lying districts along the south Atlantic coast. In mountainous country in both the east and west chutes and flumes mere used. Later came the use of wire cables stretched across the valleys and canyons. The logs were hung from a pulley and then, by gravity, travelled to the lower end of a cable. Although these relatively primitive methods of transportation are still used in hauling logs from woods to log concentration yards or "log landings" in some areas, they have been largely supplanted by tractors. At the landing the logs are loaded on trucks or railroad cars for transportation to the mill. Many of the larger companies built their own railways or truck roads. There were approximately 30,000 mi. of private logging railroads in the United States in the late 1950s, and probably an even greater mileage of truck roads. The use of tractors and the development of truck hauling made large areas of timber available which previously were regarded as commercially inaccessible, and in turn extended the life of many sawmills for years after the expiration of the expected cutting period.

The early crude logging camps consisted of as few buildings as possible. The loggers or lumberjacks lived in rough shacks or bunkhouses. Conditions were often unsanitary and as late as the 20th century many logging camps were more primitive than the early communities in Massachusetts or Virginia. Recreation consisted of "swapping" stories, fighting and drinking. Only at the end of the logging season did the lumberjack come out of the woods and mingle with civilization. Such lumber camps, however, have been largely replaced by lumber towns, and the average lumberjack and his family have available schools, churches, stores, medical care, modern sanitation and various forms of modern amusement and recreation.

The methods of felling trees and converting them into logs are generally the same in all forested regions. First the tree is undercut with an axe or a power saw on the side of the fall. A two-man crosscut saw or a power saw is employed opposite the undercut. Where the ground is flat, the men cut from the ground; but where the ground is rough or sloping and irregular, and particularly on the west coast, the undercutting and sawing are done from a platform or springboard. After felling, branches are trimmed off and the tree is sawed or bucked into log lengths, usually 16 ft. except in the northwest, where much longer lengths are handled (24 to 40 ft. are common, and in the most modern operations 40 to 65 ft. are the most favoured units of length). Certain other districts also cut logs to lengths greater than 16 ft. After bucking, the logs are dragged or skidded to concentration points, for the most part with either power skidders or tractors. Where steel cables are employed over valleys and canyons, the method is called high-lead skidding. Other methods are overhead skidding (the logs are hoisted up over the brush and ground for some distance) and ground-line skidding, which is the dragging of the log over the ground by means of a cable.

In the northwest a spar tree frequently is employed in the skidding operations. This tree is selected for its height and favourable location with regard to the surrounding trees to be felled. A man known as a high climber ascends the tree, aided by climbing spurs affixed to his shoes and a rope around the tree. He is equipped with a saw and axe, and as he ascends he cuts off interfering branches until he reaches the desired height, which is usually about 175 to 200 ft. and about 30 to 50 ft. from the treetop. Then he saws off the top, waits until the swaying caused by the top's rebound has stopped and descends The rigger next ascends, carrying equipment for rigging. Finally the spar is rigged at the top with cable and pulleys and a loading boom is affixed about 20 ft. above the ground. A cable with grab hooks on the end is carried to the log to be skidded and then, by means of a steam or electric skidder, the log is dragged within distance of the loading boom which raises the log off the ground and loads it on a nearby car or truck or stacks it for future loading. When the logs reach the mill centres they are stored in log ponds uhich usually cover a number of acres They are kept there until ready for manufacture. The ponds facilitate sorting and cleaning and also prevent deterioration which would occur if the logs were left on the ground for any appreciable length of time.

Sawmill Practice.—The first sawmills in the United States, as noted previously, mere built at Jamestown. Va., and York and Berwick, Me. Production was small until steam power supplanted water power around 1850. About the same time the single sash sa gave way to the circular saw and the latter was uidely used until about 1890, at which time the band saw became popular in the larger mills. For the next 20 years lumber production increased rapidly. Many new inventions and more efficient methods of operation contributed to the development of the lumber industry aith almost astonishing rapidity.

Most modern sawmills employ the same general type of machinery and follow somewhat similar plant layouts. Band sans of varying types such as single-cutting, double-cutting, vertical and horizontal band resaws and gang saws are common in the larger mills. Many labour-saving devices are employed. Various types of conveyors and other machinery permit the log to enter the mill and pass out as manufactured lumber with little handling or moving by hand The modern methods of lumber manufacture are so intricate and so efficient as a rule that the term sawmill has been supplanted in some measure by that of lumber manufacturing plant.

The following method of lumber manufacturing is prevalent, with variations to fit certain local requirements. The logs enter the head mill from the pond over an inclined chute or log slip. They are transported by an endless spiked conveyor known as a jack ladder or jack chain. As logs ascend the slip they are sprayed with water to remove grit and dirt that might dull the saws. From the slip the jack ladder carries the log under a large circular saw known as the deck saw, which is used if the log is to be shortened; otherwise the log is "kicked" off onto the log deck by steam-driven steel arms. From the log deck the log rolls onto the log carriage. A steam or air "nigger" (mechanically operated steel arms) helps to place the log in the proper position. The carriage is a long, flat platform which is made to travel back and forth rapidly on a track, keeping the log against a band or head saw which squares it and reduces it into flitches or cants. The log is turned from time to time on the carriage by means of the "nigger." If the log is to be used as a timber, it is squared and edged and passed immediately to the rear of the mill, where the timber dock usually is located. If it is to be converted into lumber, the flitches or cants enter the remanufacturing plant directly behind the head mill, where they pass to the gang saws and edgers and then to the trimmers.

From the remanufacturing plant the lumber passes through sorters. To explain this step the following description is given of a large modern lumber manufacturing plant in the northwest. Joining immediately on the end of the remanufacturing mill are three sorters. The first is a two-inch yard sorter where nothing is handled except t o-inch common lumber, all lengths and widths, which will be segregated into various packages as to grades. widths and lengths. These packages are then delivered by a monorail hoist to cars which are drawn by storage battery locomotives to the greenyard. The second is a one-inch sorter on which nothing is handled except one-inch common lumber to the yard. The third is a drop sorter, which automatically drops different lengths of lumber into separate and individual pockets, which in turn deliver each length to what is known as the Whaley sorter. With the use of the latter, each length of lumber is segregated to five different stacking units. Thus, all lengths, widths and thicknesses are separately put on kiln cars for kiln drying. From the drop sorter the rough lumber is delivered to automatically controlled dry kilns in which superheated steam is the usual drying agent. After leaving the kilns the lumber is passed to cooling sheds. thence to the dry sorters nhere the lumber is graded and sorted, picked up by overhead cranes and delivered to an endless conveyor which runs through unstacker sheds into rough lumber storage sheds and on to the planing mill.

Not all lumber passes from the kilns to the planing mill. a very important and necessary part of a lumber manufacturing plant. Some of it is placed in stock. Other packages pass on to the planing mill where the lumber is surfaced as plain boards and dimension or worked into ceiling, flooring. siding, moulding, partition, casing, etc. From the planing mill the lumber is conveyed to the dressed lumber sheds to be stored or to the loading sheds, ready for shipment. Waste resulting from the various steps of manufacture is converted into short-length lumber wherever possible; some of it goes into the manufacture of paper and pulpboard, and some is ground up for fuel. Wood is the principal source of fuel for power in lumber operations. The larger slabs and edgings may be converted into a number of small wooden items or reduced to chips for pulping.

WORLD TIMBER PRODUCTION AND LUMBERING METHODS

It was estimated that more than 51,000,000,000 cu.ft. of round wood were produced in the forested regions of the world during 1953. The geographical origins of this vast harvest, together with summaries of the total fellings. by both species groupings and kinds of wood, are presented in Tables III and IV.

TABLE 111.—*Total Fellings by Regions. 1953*

Region	Total fellings (in 000,000 cu.ft.)	Per cent
Europe	8,072	17.5
U.S.S.R.	14,400	27.5
North America	13,428	26.0
Latin America	5,968	11.0
Africa	3,888	7.5
Asia	4,572	9.0
Pacific area	792	1.5
Total	51,120	100.0

Source: United Nations Food and Agriculture Organization *Yearbook of Forest Products Statistics, 1954* (Rome, 1954).

About 60% of the forested areas of the world are found in Africa, Asia, Latin America and the Pacific area, yet collectively these regions produce less than 30% of the world's output of round wood. On the other hand, round wood extraction from the temperate forests of the northern hemisphere. where methods of harvesting and transportation have had their greatest development, comprises somewhat more than 70% of the world's annual output.

The extent to which harvesting and transportation develops in an area, and especially the degree to which such operations are mechanized, is dependent upon a number of factors, not the least of which are the economic and industrial developments within the region itself. The pattern of any lumbering enterprise is also influenced by the kipds, sizes and distribution of commercially acceptable timber species, the nature of available transpprtation facilities, either natural or man-made, the acquired skills of local labour and markets.

Europe. — Lumbering methods in northern Europe are exemplified by those employed in both Scandinavia and in Germany. These areas are moderately to heavily industrialized. yet the use of powered mechanical equipment in forest operations is by no means nidespread.

Extensive stands of both softwoods and hardwoods proximate to a network of navigable waterways makes unnecessary the construction of a labyrinth of woods roads and logging railways over much of Sweden, Norway and Finland. The axe and crosscut san are in almost universal use; powered chain saws are seldom used. however. Animal and tractor skidding were found to be less costly than the more elaborate, highly mechanized systems.

Much of the logging in Sweden takes place during the winter months when agricultural activity is at low ebb and when there is usually an abundance of farm labour. Skidding to watercourses or log concentration centres is accomplished over ice roads using horses, tractors and, occasionally, trucks. Northern coniferous timber is usually floated downstream during spring and early summer to manufacturing centres. In the south, however, where waterways cannot be depended upon, logs are usually moved by rail or truck. The heavier hardwoods of the north, the "sinkers," are also usually transported in this manner.

Manual felling of trees is also common to the countries of southern Europe, but skidding practices, depending upon timber size and topography, may be either primitive or highly mechanized. In Yugoslavia, for example, practically all skidding was done with horses in the 1950s, while in Switzerland, particularly in rugged terrain, power cable skidding was commonly employed and power winches and mechanical loaders were used for loading.

U.S.S.R.—Until about the end of the first quarter of the 20th century, logging tools and techniques in the U.S.S.R. were both crude and primitive. Harvesting of timber was a winter enterprise dependent upon muscle power, while river driving constituted the primary means of transporting logs. After World War II, however, mechanization of forest operations was rapid, and by the 1950s more than 91% of the felling practices. 60% of the skidding operations and 88% of the transportation methods employed a variety of mechanical devices.

Chain saws are used extensively. A major portion of skidding and loading is done with electrically operated skidders similar in design to those used in the Pacific northwest region of the United States and in British Columbia. It is of interest to note that wood waste is used to make producer gas which in turn serves as the fuel to drive electrical generating equipment. Wood waste is also used to power steam-driven equipment.

Truck roads and narrow-gauge railroads are the chief transport arteries for logs, and new roads are quickly opened with the use of bulldozers. Pole: plank and ice roads, similar to those found in Sweden and Finland, continued to be used in some of the more remote areas in winter operations.

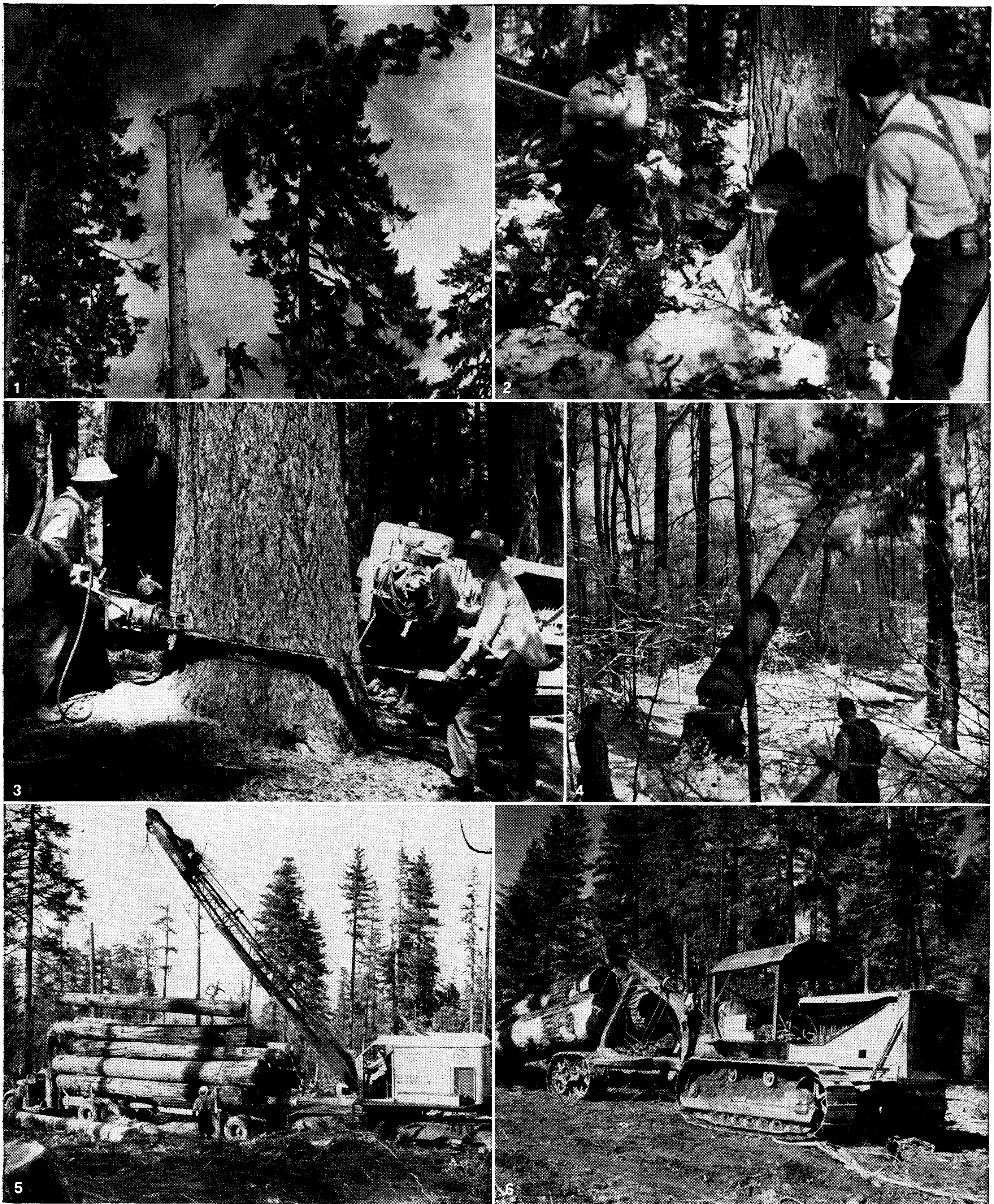
Various types of machinery are used in connection with river driving, rafting and towing; both portable and stationary cranes and conveyors are employed to place logs in or remove them from water. Bundling and rafting when required is commonly done with machinery patterned after types found in Sweden and Finland.

Latin America. — This vast area remains largely undeveloped both economically and industrially, and only relatively recently did

TABLE IV.—*Total Fellings by Kind of Product and Species Group, 1953*
(in 000,000 cu.ft.)

Area	Coniferous			Broadleaf			Undifferentiated*			Totals		
	Industrial wood	Fuel wood†	Total	Industrial wood	Fuel wood†	Total	Industrial wood	Fuel wood†	Total	Industrial wood	Fuel wood	Total fellings
Europe	3,362.4	709.2	4,071.6	597.6	1,454.4	2,052.0	1,216.8	964.8	2,181.6	5,176.8	3,128.4	8,305.2
U.S.S.R.	‡	‡	‡	‡	‡	‡	8,280.0§	6,120.0§	14,400.0§	8,280.0§	6,120.0§	14,400.0§
Sorth and central America	9,201.6	867.6	10,069.2	2,156.4	1,944.0	4,100.4	0	3.6	3.6	11,358.0	2,815.2	14,173.2
South America	144.0	‡	144.0	234.0	4,255.2	4,489.2	100.8	169.2	270.0	478.8	4,424.4	4,903.2
Africa	21.6	7.2	28.8	172.8	2,710.8	2,883.6	32.4	0	32.4	226.8	2,718.0	2,944.8
Pacific area	140.4	25.2	165.6	295.2	313.2	608.4	0	0	0	435.6	3	774.0
Asia	975.6	183.6	1,159.2	450.0	1.504.8	1,954.8	140.4	385 2	525.6	1,566.0	2.073.6	3,639.6
Total	13,845.6	1,792.8	15,638.4	3,906.0	12,182.4	16,088.4	9,770.4	7,642.8	17,413.2	27,522.0	21,618.0	49,140.0‖

Source: United Nations Fond and Agriculture Organization *Yearbook of Forest Products Statistics, 1954* (Rome, 1954). *Volumes reported not segregated as to coniicrous and broadleaf fellings. †Includes charcoal. ‡Not available. §Unofficial estimate. Estimates in this table do not agree with totals given in Table III because data cover only countries reporting within regions. Totals in Table III have been adjusted by FAO to include nonreporting countries.

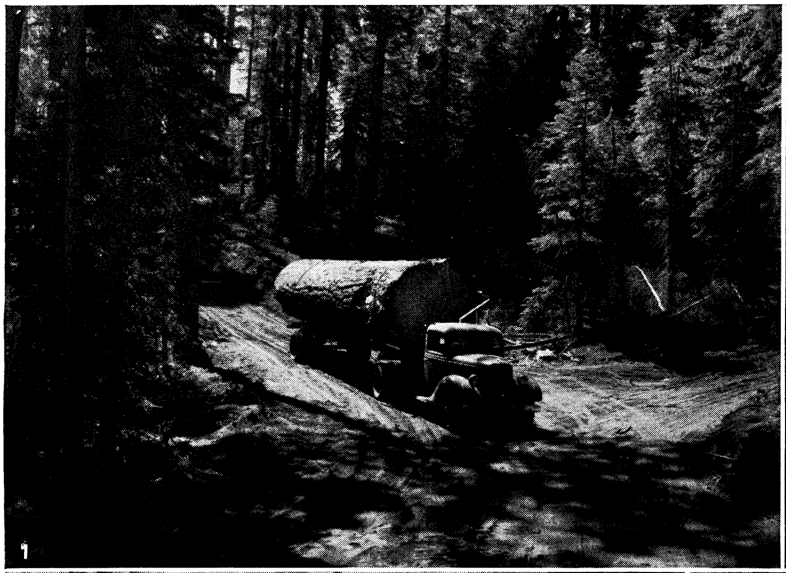


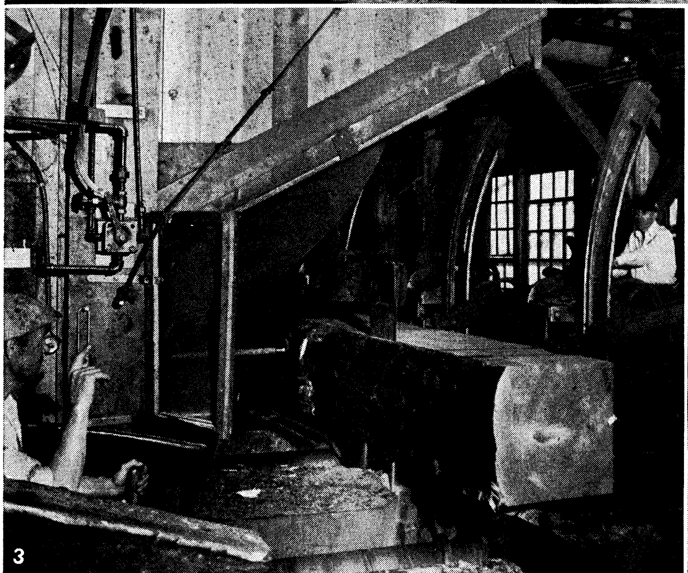
BY COURTESY OF (1, 3, 5, 6) AMERICAN FOREST PRODUCTS INDUSTRIES INC. AND (1, 6) WEYERHAEUSER TIMBER CO., (3, 5) RED RIVER LUMBER CO., PHOTOGRAPHS BY JACK ROGNON, WESTWOOD, CALIF.; PHOTOGRAPHS, (2, 4) PUBLIX

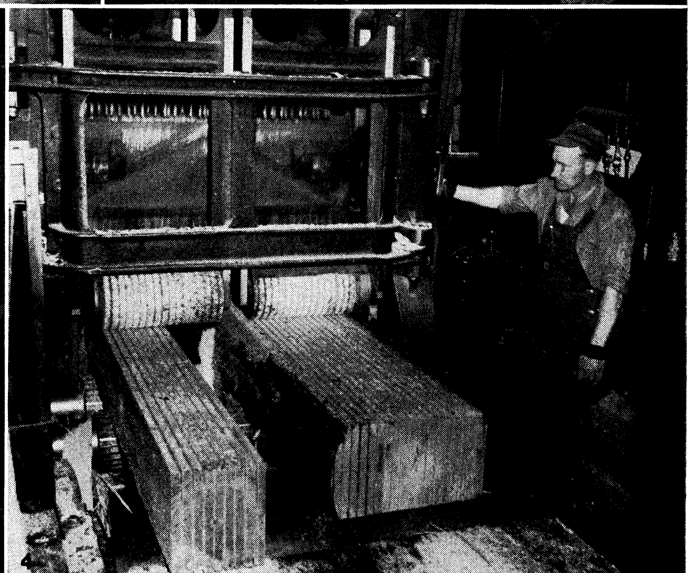
LOGGING OPERATIONS

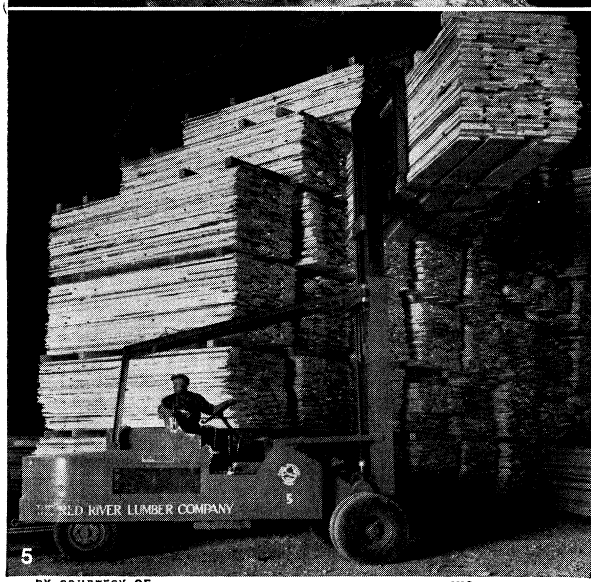
1. "Topping" a giant spar tree, to be equipped with a cable for skidding logs over the ground
2. Notching a tree with axes. The tree falls in the direction of the notch
3. Sawyers using an electric drag saw. They begin sawing on the opposite side from the notch
4. Large tree falling after being sawed through to the notch
5. Revolving crane loading logs on a truck
6. Logs being hauled from the forest by Diesel tractor

LUMBERING









BY COURTESY OF AMERICAN FOREST PRODUCTS INDUSTRIES INC. AND (1, 3, 5) RED RIVER LUMBER CO., PHOTOGRAPHS BY JACK ROGNON, WESTWOOD, CALIF., (2, 4, 6) WEYERHAEUSER TIMBER CO.

LOGGING AND THE MANUFACTURE OF LUMBER

1. Transporting a sugar-pine log by truck
2. Train of logs on the way to the mill
3. Band mill or "head rig" cutting a big log. The head sawyer at the left gives signals to the setter (right) for the cut
4. A gang saw in operation
5. Nose-lift lumber carrier which stacks and unstacks units of lumber
6. Lumber piles and overhead crane

domestic demand for lumber and other wood products become manifest in certain Latin-American countries. A very large proportion of the forests of Latin America lie in the tropical Amazon and Orinoco valleys, a vast, thinly populated region without either modern transportation or communication facilities. There the forest resources remain virtually untouched.

The valuable Paraná pine and hardwood forests of temperate Latin America are also separated from centres of consumption by distance and difficult topography. Transportation facilities are poorly developed, and lumbering in both temperate and tropical forests is limited to the most readily accessible areas. As a result, pine stands were clear-cut without provisions for forest regeneration, while in the tropical forests only a few of the most valuable hardwoods were harvested.

The rivers of Amazonia (including most of Brazil and parts of Bolivia, Peru, Colombia, Ecuador and Venezuela) are the highways, and sawmills are supplied with logs rafted from upstream areas. Manpower is the only source of power in the lumbering areas, and removal and movement of logs from stumps to waterways are uncertain and costly. Operations are restricted to water frontages and are scattered over vast areas. In practice, logs are rolled irom stump to water on primitive track made by parallel placement of logs. Felled timbers are slowly and tediously manoeuvred along these tracks, with or without the use of levers, to the nearest stream. There they are made up into rafts and floated to downstream mills. The harvest is largely restricted to manageable-sized mahogany and Spanish cedar trees.

In the Guianas, particularly British Guiana, some use is made of mechanical skidding, loading and truck transportation. Felling of the large tropical hardwoods is still done with single-bit axes. Because of strongly buttressed and fluted trunks, stumps are usually high; to facilitate dragging, log ends are generally tapered; and many logs for export are squared in the woods. All three such practices are very wasteful, and it was estimated that the current annual losses of usable wood left in the forest ran to 400,000 cu.ft., or about 11% of the total quantity produced in 1951. Loading and skidding equipment commonly consist of inefficient winches driven with underpowered automobile engines of various makes, while logs are hauled by truck over poorly constructed roads to the rivers.

The temperate forests of Chile, and to a considerable extent those of Argentina, because of location and a dearth of transportation facilities, also were ineffectively exploited. Sawmills in Chile are all of the portable type and located close to a supply of timber. Logging is a seasonal operation carried on with local rural labour during the slack agricultural season.

The inefficiency of lumbering practices in modern times stems from the lack of suitable equipment needed to transport timber of large size. Trees are not only felled with axes, but bucked into logs with the same tools. The use of crosscut saws is extremely rare. Carts or two-wheeled bummers, drawn by oxen, haul logs to nearby sawmills, but because of the capacity of vehicles of this sort, the largest and most valuable trees ordinarily cannot be harvested.

Africa.—Lumbering practices in the accessible forest areas of the African continent were until relatively recently very primitive and production was low. After World War II, however, improved methods were introduced on the west coast, in the Belgian Congo and in South Africa. Motor vehicles, tractors and trucks had the greatest influence in changing lumbering practices in the forested areas of the Airican tropics. These vehicles are used for both long and short hauls over a network oi good forest roads made possible by the introduction of the bulldozer.

In South Africa logging formerly was largely restricted to manual operations, supplemented with animals and trek chains. Tractors and other power devices were later used, however, including cranes, loaders and trucks.

Asia.—Logging in the wet Asiatic forest regions is based mainly on hand methods and the use of animal power for skidding. Hand squaring of timbers and pitsawing of boards are still common practices. In the teak iorests of Burma and India, buffalo and oxen are used on gentle terrain, but on steep, rocky slopes no power-driven contrivance had yet proved as economical as the elephant as of the late 1950s. The use of heavy-duty tractors, bulldozers and trucks was intensified in Thailand in later years. Much of the teak in Burma. and Thailand is floated to sawmills, while other hardwoods, generally too heavy to float, are transported by animal, truck and rail. Occasionally valuable, heavy hardwoods buoyed by bamboo floats are rafted out of otherwise inaccessible forests.

In eastern Pakistan the extraction of large timbers on private holdings is by elephant; on the larger government holdings tractors are in common use. Logs are usually delivered to mills by floating. By contrast, in western Pakistan, where timber tends to be of smaller size, felling and on-the-site hand-sawing of logs into cants is commonly practised. These cants are usually hauled from the forest to truck roads or riverbanks by manpower alone, or with the aid of donkeys, thence to mills by rail or water.

In Japan, which is much more highly industrialized than any other Asiatic nation, logging and the movement of logs to railheads or trucking points were almost entirely by hand labour in the late 1950s. Even the largest logs were loaded solely with manpower. Skidding in rough terrain was sometimes accomplished using cables, but more often the logs were moved by gravity using sleds or flatcars over crudely constructed narrow-gauge tracks. Only on national forestlands was modern mechanical lumbering and railroad or truck hauling practised.

Logging in the Philippines is more highly mechanized than in any other Asiatic area. The early methods of band-sawing logs into hoards still persisted in the late 1950s in isolated spots, but exploitation in the more important forested regions was based largely on surplus U.S. army equipment made available at low cost after World War II. Heavy tractors, modern loading machines and cable systems were used even in difficult terrain. Transportation of logs to mill was almost completely by truck.

Pacific Area.—Except for Australia, New Zealand and the Fiji Islands, there is little information on logging and lumbering methods in the forests of the Pacific area. Methods are generally primitive, however, except in the three countries noted above. Many of the larger operations in Australia and New Zealand are not too unlike those in the United States and Canada. In the Fiji Islands, log extraction is done by ground skidding using cable systems and steam-driven winches. Logs are moved to mills on small trucks mounted on wooden rails and hauled by tractors.

Canada.—The economic development of Canada has been intimately associated with the growth and expansion of its lumber industry. Lumbering leads all other Canadian enterprises in total employment, and came to be third in terms of both net value of derived products and in total wages and salaries paid.

The forests of Canada comprise 37% of the nation's land area, or 1,299,759 sq.mi.; more than 712,000 of these are in productive forests, of which 68%, or 484,000 sq.mi., are regarded as accessible for exploitation. While Canada's volume of commercial timber is estimated at approximately 308,279,000,000 cu.ft., only 56% of the more than 237,927,000,000 cu.ft. of softwood timber and 84% of the 70,352,000,000 cu.ft. of hardwood timber was accessible to arteries of transportation in the late 1950s. The residual, covering an area of nearly 228,000 sq.mi., represented a timber reserve for the future.

The demand ior Canadian lumber has been great; notwithstanding the losses caused by fire, insects and decay, productivity, as of the 1950s, had not been seriously impaired. In 1950 the logging industry employed about 150,000 workers to produce 3,322,000,000 cu.ft. of merchantable timber, while the lumber industry in the operation of approximately 7,500 sawmills had more than 60,000 people on its payrolls.

Generally speaking, logging and milling practices differ little if at all from those of the adjacent timbered areas of the United States, where forest composition, topography and climatic conditions are similar.

Logging operations in the forests east of the Rocky mountains are, for the most part, carried out as a part of the over-all operations of the lumber companies. The use of trucks for hauling logs from forest to mill materially reduced seasonal operations and dependence upon rivers for moving timber downstream to the mills. Power-driven loading devices and jammers mounted on trucks are examples of late developments in loading and unloading equipment. Tractors and snowmobiles are also used for hauling.

In the interior, notably that region between the Rocky mountains and the east slopes of the coastal ranges where species of secondary importance prevail, year-around logging increased after the adoption of mechanized equipment, tractors and power saws.

Unlike the industry in eastern Canada, logging on the west coast of British Columbia has been a strong, independent enterprise for many years. There are, however, a number of the larger lumber companies which operate their own logging units. In this region truck logging almost completely replaced railroads, which in turn made possible the removal of timber previously regarded to be commercially inaccessible.

In 1950, 16% of Canada's lumber was manufactured, in Quebec, 14% in Ontario and 53% in British Columbia. Mill output for the year was estimated at 6,500,000,000 bd.ft. of lumber, 4,400,000 crossties, 3,100,000 squares of shingles and 114,000,000 lath. These products, together with the box shooks and cooperage produced, had a gross value of $493,000,000.

Canadian exports of wood products steadily increased for a number of years. In 1946, 965,000,000 bd.ft. of lumber valued at $60,000,000 were exported to the United States. In 1950 these figures had risen to 3,024,000,000 bd.ft. and $2,500,000,000 respectively. The second largest importer of Canadian lumber is the United Kingdom, which with the United States accounted for about 92% of Canada's timber exports for 1950.

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LUMBINI, the grove, located near the village of Paderia in southern Nepal, in which, according to Buddhist legend, Gautama Buddha was born. There are two references to the name in the Pali scriptures, the first in the narrative poem prefixed to the *Nalaka-sutta* in the *Sutta-nipata,* where it is related how the gods rejoicing in the sky inform the sage Asita that "the Bodhisatta, the incomparable jewel, has been born for weal and happiness in the world of men, in a village of the Sakyas, in the Lumbini country." The other reference is in the *Kathavatthu,* one of the latest works in the canon. The detailed story of the birth as known to Pali Buddhism first occurs in the introduction to the commentary on the *Jataka.* This account says that Queen Mahamaya (of the Sakya people), when her time was come, desired to go to her parents' home at Devadaha. On the way she 'stopped in the Lumbini grove, her pains came upon her and there the future Buddha was born. The earliest canonical accounts of the birth are not in the Pali canon but in the Sanskrit scriptures of two other schools, the *Mahavastu* (ii, 18) and the *Lalitavistara* (ch. 7). Neither of these works can be put earlier than the 3rd or 4th century A.D., but the discovery of an inscription of Asoka makes it probable that the whole legend was established at least as early as the 3rd century B.C. The inscription, found in 1896, a few miles within the border of Nepal and several miles east of the site of Kapilavatthu (Kapilavastu), the city of Buddha's family, records that "Piyadasi [*i.e.,* Asoka], after he had been consecrated 20 years, came in person and worshipped, because here was born Buddha Sakyamuni. . . ." This makes the date 249 B.C., according to the accepted chronology of Asoka's reign. There is a shrine at the place, now increasingly a site of pilgrimage for modern Buddhists. The shrine contains a bas-relief repfesenting the birth of the Buddha. The legends with their fabulous details are not historical documents, but the archaeological evidence which has accumulated increases the probability that they originated in a historical event.

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LUMHOLTZ, CARL (1851–1922), Norwegian explorer and naturalist, was born in 1851 at Faberg in Gudbrandsalen. After graduating in theology at the University of Oslo (then Christiania) in 1876, he was sent by the university to Australia. where he spent four years (1880–84) in collecting zoological materials and anthropological data. In 1890 he went on behalf of the American Museum of Natural History to Mexico, accompanied by the Swede Hartmann, and there he succeeded in tracing and communicating with the Tarahumare Indians of Sierra Madre — descendants of the Aztecs. A unique collection, containing more than 1,700 photos, was the result of this expedition, which, with two later visits to Mexico, was described in his *Blandt Mexicos Indianere* (Christiania, 1902–03), later translated into English and Spanish; *New Trails in Mexico* (1912) deals more especially with the second of these expeditions. During World War I Lumholtz went to India, and in 1915–17 to Borneo. From Borneo he brought home a large zoological collection and valuable anthropometrical measurements, with new information on the language and customs of the Dyaks, recorded in *Through Central Borneo, Two Years' Travel in the Land of the Head Hunters* (2 vol., New York, 1920). He died at Saranac Lake, N.Y., on May 5, 1922.

LUMINESCENCE, the process by which certain materials are excited and emit light while the material is at low temperatures, such as ordinary room temperature. Familiar examples of luminescence emission are the light from (1) electronically excited gases, such as in neon lamps and lightning; (2) certain organic materials undergoing oxidation, for example luciferin in fireflies and glowworms; and (3) certain inorganic solid materials used as coatings in luminescent watch dials. television and radar kinescopes, fluorescent lamps and X-ray fluoroscope screens. In most of these examples, the temperature of the luminescing material is near room temperature. Luminescence emission, therefore, is sometimes loosely called cold light to contrast it with the incandescence emission from very hot materials.

Following are the main sections and divisions of this article:

I. INTRODUCTION

Excitation of the luminescent material is usually accomplished by injection of energy in the form of X-rays, ultraviolet radiation, electrons or alpha particles into the material. Another form of excitation is by application of electric fields to energize electrons or ions in the material. Energy liberated during some chemical reactions also may serve to excite suitable luminescent materials.

There are a few luminescent materials that are efficient enough for practical use. Useful luminescent materials are generally custom-made to be excited by a particular exciting agent, and to give a particular colour and intensity of luminescence emission. The colour of luminescence emission is determined chiefly by the chemical composition of the luminescent material. The intensity of luminescence emission depends not only on the composition of the material, but also on the intensity and nature of the excitation.

As mill be discussed later, the essential action in luminescence is electronic. A distinctive feature of the luminescence process is the localized absorption of energy that excites one or more electrons bound to a discrete atom, or group of atoms, without requiring agitation of the atoms as a whole. The excited atom, or group of atoms, then radiates (emits) at least part of its excitation energy as light.

1. Luminescence and Thermal Radiation. — Incandescence emission, or more generally thermal radiation, arises from a different process than luminescence and one that actually interferes with luminescence. Thermal radiation is produced by atomic motion and collision. Interatomic collisions or vibrations dissipate the localized electronic excitation energy needed for luminescence. Excitation of an incandescent material is accomplished simply by heating it; that is, raising its temperature until all of the atoms in the material are strongly agitated. Some of the thermally agitated atoms acquire enough energy, by collisions with neighbouring atoms, to become electronically excited and to radiate (emit light). Every material emits thermal radiation with a colour and intensity that is determined chiefly by the temperature of the material. All materials at room temperature have finite but imperceptible thermal radiation. Furthermore, most of the emission is located in the invisible far-infrared region of the spectrum. As the temperature of the material is increased, the intensity of thermal radiation increases, and the emission shifts to shorter wave lengths, moving toward and into the visible region of the spectrum When the material becomes hot enough to exhibit visible thermal radiation, the phenomenon is recognized as incandescence. Familiar examples of incandescence emission are the light from burning wood or candles, and from the very hot tungsten filaments in conventional incandescent lamp bulbs.

2. Luminescence and Pigment Action. — Luminescent materials have a distinctly different function from that of simple dyes and pigments. A suitable luminescent material, when irradiated with daylight, produces colour effects by absorbing some of the light and emitting visible radiation in excess of the normally imperceptible thermal radiation of the material. Dyes and pigments, however, produce colour effects by selectively reflecting incident radiation. without emitting appreciable radiation in excess of their thermal radiation. A red pigment, for example, reflects red light and absorbs the remainder of incident daylight. The energy of the absorbed light is converted into heat that increases the temperature and thermal radiation of the pigment by an inappreciable amount.

It is noteworthy that the colours of luminescing materials are additive. being provided by emitted light; whereas the colours of simple dyes and pigments are subtractive, being provided by selectively absorbed and reflected incident light. For example, when blue-emitting and yellow-emitting luminescent materials are mixed, as in monochrome television kinescope screens, the resultant blue-plus-yellow emitted light appears white. When, however, blue and yellow pigments are mixed and viewed under white light, each pigment selectively absorbs some of the incident light and the residual reflected light appears green.

Some luminescent materials may function simultaneously as dyes or pigments and as luminescent materials. These luminescent dyes can, for example, selectively reflect red light and, by luminescence, convert the energy of absorbed blue and green light into additional emitted red light. Such luminescent dyes are used to produce vivid colour effects in outdoor advertising displays. Other special dyes transmit white light and, by luminescence, convert the energy of absorbed ultraviolet into additional emitted blue or blue-white light. Such luminescent dyes are incorporated in detergents used in washing and coating white fabrics to enhance their lustre in sunlight.

II. EARLY HISTORY

Luminescence has been manifested for eons by lightning and the aurora borealis. Later in the earth's history there appeared luminous organisms, such as bacteria in the sea and in decaying organic matter, glowworms and fireflies. These apparently unrelated luminous apparitions in the air, sea and living things served mainly to appall and mystify man for thousands of years. According to available records, the first significant inquiry into luminescence was started in about 1603 by a cobbler-alchemist, Vincenzo Cascariolo of Bologna, Italy.

Contrary to what one would reasonably expect, Cascariolo did not begin with studies of the naturally available luminescences in gases, liquids and living matter. Nor did he start by discovering and studying luminescence in one of the various luminescent minerals that have existed on the earth since its genesis. He began, instead, by empirically synthesizing and testing a new, man-made, inorganic luminescent material.

1. The **Bolognian** Stone of **Cascariolo.**—Cascariolo found on Monte Paterno, near Bologna, some stones that were unusually heavy and had a silvery white colour. The stones were pieces of the mineral heavy spar (barite) which is now known to be chiefly barium sulfate. In typical alchemical fashion, Cascariolo pulverized the stones and heated the powder in contact with coal. The cooled product was a dull-coloured, friable, porous cake. Cascariolo, in common with other alchemists, sought to convert new-found minerals into precious metals and gems, or to synthesize the coveted philosopher's stone that was conceived of as having the power to transmute baser metals into gold. The attempt was unsuccessful, but Cascariolo noticed at night a continuous purple-blue glow from the cake of new material. The weak glow kindled hopes of magic properties, particularly when it was found that the material absorbed the "golden light of the sun," and the alchemical symbol for gold was the sun (Sol). The material was named *lapis solaris,* or "sun stone," and attempts were made to use it to transmute ignoble metals into gold. Despite the failure of *lapis solaris* to function as the illusory philosopher's stone, it gained fame for its property of absorbing light by day and glowing at night. News of the phenomenal *lapis solaris* was transmitted to several Italian scientists, including Galileo who gave samples to Gulio Cesare Lagalla of the Collegio Romano in Rome. Lagalla was the first to write of the *lapis solaris,* or Bolognian stone, in his book. *De phaenomenis in orbe lunae* (Venice, 1612).

2. Phosphorus and Phosphors. — Many names were proposed for Cascariolo's new material, including *lapis lunaris, lapis illuminabilis, lapis lucifer, luna terrestris* and *spongia solis*. The various Latin names lost favour, however, after the first monograph on the Bolognian stone was published. The monograph, by Fortunio Liceti, in 1640. bore the Greek title *Litheosphorus,* or "stony phosphorus" ("light bearer"). Thereafter, the word phosphorus increased in popularity as a designation not only for the Bolognian phosphorus, but for other luminescent materials. The term phosphorus was applied, also, to the chemical element, now bearing that name, after it was extracted from urine by Hennig Brand in 1669. It was natural to call the new element a phosphorus because it too glowed in the dark when it was in moist air. The element phosphorus did not require previous excitation by daylight, however, and we now know that its luminescence emission is the result of a chemical reaction (oxidation), that ceases when the source of oxygen is removed or the phosphorus is consumed. The original Bolognian phosphorus, on the other hand, luminesces as the result of an internal physical (electronic) action, that proceeds best in the absence of chemical change, and so the material may continue to luminesce indefinitely in a vacuum. Modern usage restricts the term phosphorus to the chemical element, as applied by Johann Sigismund Elsholz in 1677. while the shortened term phosphor is used to designate the original Bolognian phosphor and subsequent thousands of other solid luminescent materials.

3. Phosphorescence. — In the early experiments with phosphors, daylight was the sole known means for their excitation, and the light emission of the excited phosphor had to persist for a time long enough to permit removal to a dark place for observation. It was then that the term phosphorescence was introduced, and was associated with the long persistent emissions by phosphors. The apparent porous structure of early phosphors led to the postulate that phosphorescence was a simple spongelike absorption of light by the material, followed by gradual release of the selfsame light in the dark. This viewpoint had to be abandoned when, in 1652, Nicolai Zucchi showed that the colour of phosphorescence emission was the same whether the phosphor was excited by white light, or by light of several other colours, produced by passing white light through coloured glasses. In later years, Zucchi's experiments

were confirmed and refined by other experimenters who used prisms to provide purer coloured light for excitation. The implication of these results is that excited phosphors are generators of light; not storehouses of light. The foregoing correct interpretation was not obvious, however, in an age of mysticism when some persons associated light with the human soul, and other persons considered light to be a fifth element in addition to earth. air. fire and water.

4. Fluorescence and Luminescence.— As the news of the Bolognian phosphor spread, there was a quickening of interest in other lands and in other kinds of luminescence. A German Jesuit, Athanasius Kircher, busied himself with the Bolognian phosphor, light from the sea and light from living matter. In his book *Ars magna lucis et umbrae* (Rome, 1646), Kircher called attention to the peculiar appearance of an aqueous solution containing an extract from a wood called lignum nephriticum. This solution had first been described in 1565 as having an unusually intense blue colour by the Spanish physician Nicolás Monardes who recommended the liquid for treatment of kidney ailments. Kircher and, later, Francesco Maria Grimaldi of Italy, and Robert Boyle and Isaac Newton of England, reported that the tincture appeared blue by "reflected" white light, and yellow by the light that was transmitted through the liquid. All of these investigators referred to the blue light as being reflected; the concept of luminescence excitation and emission eluded them. It was not until 1852, after informative studies of the mineral fluorspar by the French mineralogist René Just Haüy, and of fluorspar and solutions of lignum nephriticum, quinine sulfate and chlorophyll, by the English astronomer John Herschel and the Scottish physicist David Brewster, that the blue light of lignum nephriticum was correctly identified as a luminescence emission by the English mathematician-physicist George Gabriel Stokes. The excitation, in this case. is by violet and ultraviolet radiation in sunlight. Stokes used prisms and optical filters, that were opaque to each others' light, to demonstrate that incident light of one narrow band of wave lengths, such as blue. was absorbed and instantaneously produced, in certain clear solids and solutions, emitted light of another colour, such as yellow, whose wave lengths were not contained in the incident light.

For this luminescence, which apparently ceased immediately when the incident light was shut off, Stokes proposed "to coin a term and call it fluorescence, from fluor-spar, as the analogous term opalescence is derived from the name of a mineral." The term fluorescence was thenceforth loosely applied to denote short-lived luminescence emission; also, luminescence emission during excitation, irrespective of duration after cessation of excitation. Through these, and other, indiscriminate usages, the term fluorescence has become ambiguous and misleading. It is now recommended that the generic term phosphorescence be used to denote persistent luminescence in general. Fluorescence should be used only to denote certain limiting cases of short-duration phosphorescence, such as from an isolated, simple excited atom. A typical value of fluorescence persistence is ten millimicroseconds (10^{-8} second) for emission of visible light. The general term luminescence, of Latin origin, including both fluorescence and phosphorescence, was first introduced by the German physicist Eilhard Wiedemann, in 1888, for "all those phenomena of light which are not caused solely by a rise in temperature."

In its original context, luminescence was associated with the production of visible light. When it became known that invisible radiations, such as ultraviolet and infrared, are also afforded by luminescence processes, the term was correspondingly broadened. Luminescence is used here in the broad sense, recognizing that there are other detectors of radiation than the human eye. If a more appropriate general term, such as radiescence, becomes established, usage of the term luminescence may revert to its original limited meaning.

III. LUMINESCENCE EXCITATION

From Cascariolo's time on, new materials were subjected to many different exposures and treatments, in order to discover new luminescent materials and new methods of excitation. Extensive studies disclosed that many materials were capable of exhibiting feeble luminescence, and that several means of excitation were capable of producing luminescence emission. Jacopo Bartolomeo Beccari, professor of physics. medicine and chemistry at Bologna, reported in 1744 and 1747 that some bodies. such as glowworms, certain marine life. rotten wood and the flesh of some birds and animals, throw out light spontaneously during putrefaction and chemical changes. whereas other materials. the phosphori, require excitation which may be accomplished by attrition, heat, exposure to air or exposure to light. Beccari's account gives a scrambled catalogue of some of the types of luminescence classified according to the means of excitation.

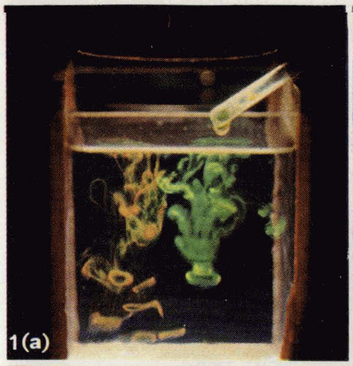
Modern terminology employs a distinctive prefix to indicate the means of excitation; for example, bioluminescence (as in glowworms), chemiluminescence (as in rotting mood), triboluminescence (as in grinding a phosphor) and photoluminescence (as in irradiating a phosphor with light).

1. Bioluminescence and **Chemiluminescence.**—One of the earliest references to naturally occurring luminescence, in glowworms and fireflies, is in the Chinese *Shih Ching,* or "Book of Odes," from the period 1200–1000 B.C. Aristotle (384–322 B.C.) wrote of seeing light come from decaying fish, and fostered the concept of cold light by mentioning in his De *coloribus* of the Opuscula: "some things though they are not in their nature fire nor any species of fire, yet seem to produce light." The experimental approach was first applied to natural luminescent matter by the pioneer Francis Bacon who described his experiments on decaying wood that luminesced (published posthumousiy in 1627). Alexander von Humboldt showed, in 1799, that rotting wood ceased luminescing when placed in nitrogen or carbon dioxide, and resumed its emission of light when placed in oxygen or air. Humboldt showed. also, that a living jellyfish, could be electrically stimulated into forced bioluminescence emission.

All of the cited luminescences of natural organic matter, both animate and inanimate. are now known to be essentially a chemiluminescence, wherein the excitation energy is supplied from excited molecules, molecular fragments or electron transfers that occur during a chemical reaction. The chemical reaction usually involves oxidation, and so these chemiluminescences utilize the same basic mechanism that provided light emission when the inorganic. chemical element phosphorus was first isolated and observed in moist air, in 1669. Bioluminescences are chemiluminescences that occur in living things.

Bioluminescences in the plant kingdom are occasioned by luminous bacteria and fungi that emit light continuously, whereas bioluminescences in the animal kingdom occur in higher-order organisms that can control their light emission. Some animals regulate the chemical reaction by valving the admission of air into their interiors where the oxygen of the air reacts with certain special organic fluids that are synthesized in the animal. Glowworms and fireflies so regulate their luminescences to exhibit periodic light emission for the purpose of attraction during courtship. According to Thomas Bartholin, Carolus Vintimillia in about 1647 first called attention to the intense periodic glow that female fireflies use as a signal to male fireflies at night. The railroad worm of South America has a sophisticated bioluminescence system. in that it emits red light from a spot on its head, and greenish-yellow light from rows of spots along each side. This rare worm, about two inches long, is actually the larva of a beetle. Its glow can be stimulated, as can the bioluminescences of other animals, by mechanical and electrical means. The greenish-yellow sidelights can be made to glow by shaking the worm, and the red headlight is made to glow by blowing air on it.

2. Triboluminescence.—The emission of light upon the scratching or breaking of cakes or large crystals of sugar was mentioned by Francis Bacon in his book *Advancement* of *Learning* in 1605. This type of luminescence came to be called triboluminescence. although the name is inappropriate because the prefix *tribo* comes from the Greek word meaning "to rub." The luminescence is genuine, being displayed by numerous organic and inorganic materials, and is allied to the blue glow that is observable when certain kinds of adhesive tapes are unrolled in the dark. The surfaces that are separated by breaking, scratching or pulling apart



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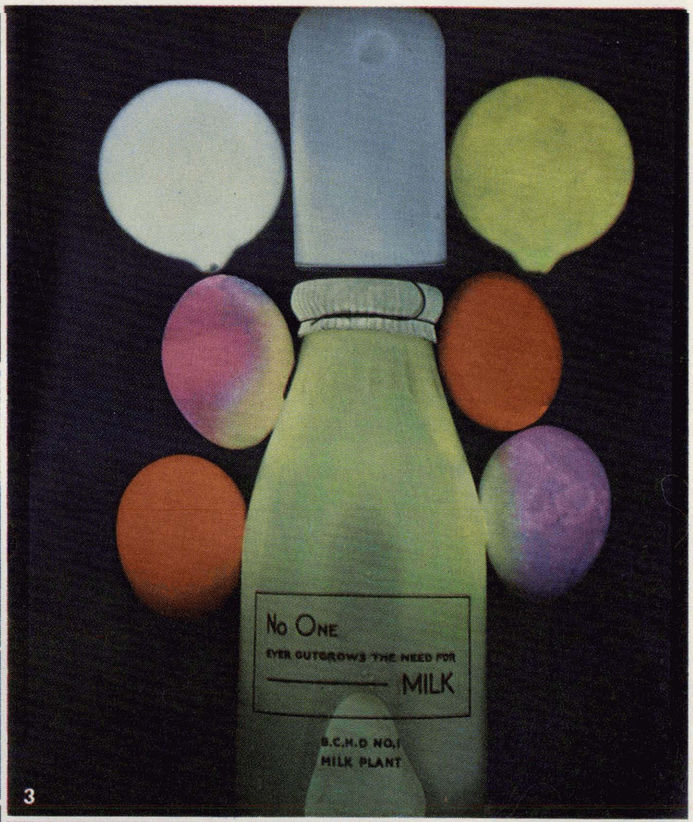

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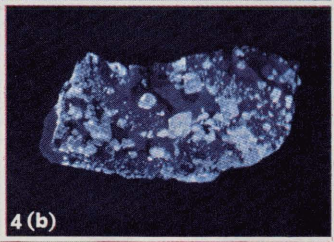

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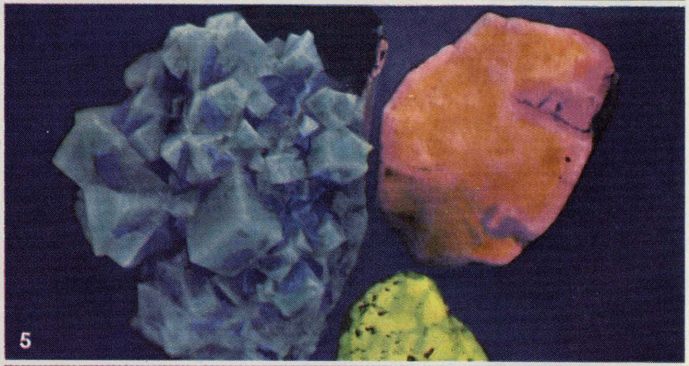

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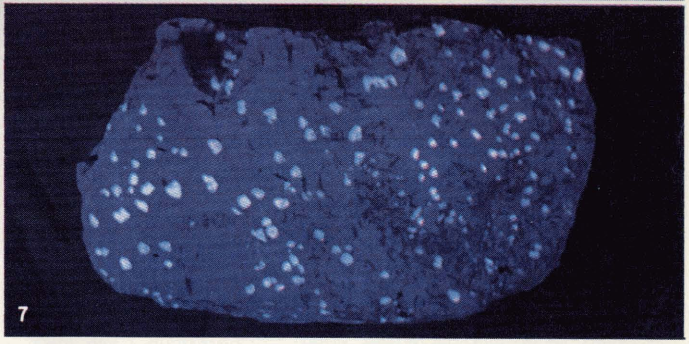

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BY COURTESY OF (1–3, 5) R. W. WOOD, (4, 6, 7) ULTRA-VIOLET PRODUCTS, INC.

1. Photoluminescence in a glass tank containing water. Very dilute solutions of the luminescent dyes fluorescein and rhodamine are dropped into the tank, forming graceful vortex rings and whorls as they descend. 1(a) shows the glass dropper above the tank, a second dropper at the left having been removed before a flashbulb was set off directly above the tank. Light from the flashbulb excited the luminescent dyes. 2. Red photoluminescence emission of a chemical substance in the Harderian gland of a rat under "black light" (ultraviolet radiation). At left is a normal rat with Harderian gland exposed by displacement of the eyeball. Rat at right received a diet deficient in pantothenic acid. In this rat the porphyrins excreted by the Harderian gland have migrated to the nose through the naso-lachrymal duct. These studies were made by H. J. Figge of the University of Maryland as part of a search for carcinogenic agents. 3. Photoluminescence, under ultraviolet radiation, of a bottle of milk surmounted by a smaller bottle of evaporated milk. On the right is a circular disk of butter and en the left one of margarine. The four ovals are hen's eggs whioh luminesce with a scarlet colour due to the presence of a luminescent material with whiah they became coated during their passage through the oviduct. 4. A specimen of the mineral scheelite, from Tulare county, Calif., photographed (a) in daylight and (b) under ultraviolet radiation in the dark. 5. Specimens of photoluminescent materials. The blue-emitting crystals on the left are fluorspar from which the name fluorescence was derived. 6. A specimen of the mineral willemite with a centre strip of calcite under ultraviolet radiation. The non-luminescent portions are chiefly franklinite. Specimen from Franklin, N.J. 7. Another specimen of scheelite from Lucin, Utah, photographed under ultraviolet radiation in the dark

LUMINESCENCE

PHOTOGRAPHS, ANDREAS FEININGER, "LIFE," © 1945 TIME INC.

EXCITATION OF LUMINESCENT MATERIALS

Top: Luminescent minerals and synthetic microcrystalline phosphors under (left) white light and (right) ultraviolet radiation in a dark room. Most useful phosphors simply reflect white light, but absorb ultraviolet rays and generate light with a colour that is determined by the composition of the phosphor. Phosphor crystals in the centre row of vials are zinc-cadmium sulfides with 0.01% silver activator. As the proportion of cadmium is changed from zero to 100%, the luminescent colour changes from blue to red. The phosphors in the trays below are zinc-beryllium silicates with manganese activator. As the proportions of beryllium and manganese am increased, the luminescent colour changes from green to red. Duratlon of phosphorescence (afterglow) also varier. with comporltion

Centre: Patches of synthetic microcrystalline phosphors on a plate in an evacuated cathode-ray tube under (left) white light and (right) under a beam of 12,000 volt electrons from an electron gun. The electron beam was deflected from patch to patch on the outer circle by manually rotating a bar magnet near the neck of the tube. When the magnet was removed, the beam struck the centre patch

Bottom: Left, separate pigments or dyes that selectively reflect blue and yellow light from incident white light provide a mixture that reflects green light. Right, separate phosphors that emit blue and yellow light under ultraviolet irradiation, in a dark room, provide a mixture that emits white light have unequal electrical charges that produce an electric discharge through the intervening air. The blue glow obtained on unrolling adhesive tape comes from atmospheric nitrogen that is excited by the discharge, and the glow obtained on breaking sugar, some candies and certain other triboluminescent materials is caused by excitation of the air and of the material itself by the electric discharge. These luminescences could more appropriately be called electroluminescences produced by mechanical means.

3. **Thermoluminescence.**—This name, another misnomer, was used to denote light emission from luminescent crystals that were warmed. Robert Boyle observed such emission from a diamond in 1663, and J. S. Elsholz observed similar effects in specimens of fluorspar in about 1676. The effects were real, but they served more to confuse than enlighten. The confusion arose because the phenomena seemed to indicate that heat alone could excite a luminescent material. More than two centuries of experimenting subsequently elapsed before it was realized that the heat simply accelerated the emission of light by a material that had been previously excited by some other means, such as exposure to ultraviolet radiation or electric discharges. The correct designation for this luminescence phenomenon is thermostimulated phosphorescence.

4. **Photoluminescence.**—Luminescence emission from a material excited by light was observed as early as 1565 when Monardes mentioned the intense blue colour of his wood extract, but the appreciation that a material could be photoexcited to produce light was delayed until Cascariolo's nocturnal discovery in 1603. Nearly two centuries then went by before the existence of invisible radiation, such as ultraviolet and infrared, became known. Johann Wolfgang von Goethe reported in his book *Zur* Farbenlehre, 1810, that he and Thomas Johann Seebeck in 1792 performed an experiment in which they exposed a specimen of the Bolognian phosphor to rays from a prism. They observed that particularly strong emission was obtained when the phosphor was held in the invisible region just beyond the visible violet rays. This instance of using a phosphor to disclose the existence of invisible rays was a forerunner of several other occasions when phosphors were vital detectors of important invisible radiations.

Positive identification of ultraviolet rays was made by Johann Wilhelm Ritter in 1801, and Ritter tested phosphors not only under ultraviolet rays, but also under the infrared rays that were discovered at about the same time. He found that ultraviolet rays excited phosphors very well, but he and Seebeck found that infrared rays decreased the phosphorescence emission of phosphors. The phosphorescence-quenching effect of infrared was later found to be specific for certain phosphors and certain wave lengths of infrared radiation. With some other phosphors, and selected wave lengths of infrared, it was found that a phosphorescence-stimulation effect occurred. The photostimulation of phosphorescence by infrared radiation, providing an accelerated emission of light by a previously excited phosphor, is similar to thermostimulation by heat. but the detailed mechanisms are not the same. In the photoquenching effect, infrared radiation facilitates dissipation of excitation energy in a phosphor, converting the potential emission energy into heat instead of light.

5. Stokes's Law.—G. G. Stokes made some dramatic experiments with luminescent liquids and solids exposed to ultraviolet radiations in about 1852, and showed that the wave length of the emitted light is always equal to or longer than the wave length of the exciting light. His discovery of a definite relationship between the wave lengths of the exciting and emitted light led to the labeling of this relationship as Stokes's law. The law was disputed for several decades, but its validity became firmly established for all except some rare instances in which thermal energy can contribute slightly to the excitation process of photoluminescence. In modern terms. Stokes's law is another way of stating the law of conservation of energy on a quantum basis.

6. **Electroluminescence.**—In 1672, Otto von Guericke, mayor of Magdeburg, Ger.. noticed that light was emitted when he rubbed a ball of sulfur in the dark, and he likened the light emission to that obtained when sugar is ground. We now know that rubbing electrified the sphere, and the light came from luminescent air molecules that were excited by an electric discharge from the sphere into the surrounding air. Guericke noticed, also, roaring and crackling sounds from his electrified sphere. He thus took a major step toward Benjamin Franklin's identification. in 1752, of the electric discharge as the exciting agent responsible for the natural luminescence phenomenon known as lightning. Natural lightning and Guericke's man-made luminescence are both caused by energetic electrons in electric discharges through a gas. and both phenomena are correctly called electroluminescence. Electroluminescence is luminescence in any material, gas, liquid or solid, that is excited by electrons. It is common to use electric fields to accelerate electrons and make them energetic enough to excite luminescent materials. The electric field may be constant or alternating, and the source of the electrons may be outside or inside the material.

The first reported electroluminescence in an evacuated vessel is attributed to Jean Picard, a French astronomer and priest, who in 1675 noticed a glow above the mercury in his barometer as he carried the barometer into a dark room. The glow ceased when the mercury was still, and the glow appeared when the mercury was moving downward, but not upward, in the glass tube. This "mercurial phosphor" was studied by Johann Bernoulli, a Swiss mathematician, who in 1700 reported that an evacuated clean glass phial containing some clean mercury glowed whenever the phial was shaken. The effect is due to electric discharges from the glass. Discharges occur when the mercury is moved rapidly away from an area on the glass. The newly exposed glass is left in a surface-charged condition previously induced by electrons acquired from the mercury. The electric charging effect was established by Christian Friedrich Ludolff, a physician of Berlin, in 1745, when he observed movements of silk threads suspended near the moving surface of the mercury next to the glass wall of the tube. Francis Hauksbee. a self-educated English scientist, had also studied the "mercurial phosphor," and during 1705–1711 performed experiments in which he obtained light by electric discharges from many materials. including glass. oyster shells, wool and flint, that were electrified by rubbing or fracturing in a partial vacuum.

Further studies of light emission associated with electrical phenomena led the English physicist John Canton, in 1768, to observe that phosphors could be readily excited by exposure to electric sparks. As the means for achieving higher voltages and stronger electric discharges in rarefied gases were improved, there was increasing interest in the possibility of using electroluminescence to provide a practical electric light. One of the earliest demonstrations of an electric discharge lamp was by J. P. Gassiot at a meeting of the Royal society, in London, in 1860. Gassiot's lamp utilized a high-voltage discharge through carbon dioxide at low pressure to give "a brilliant white light." Gaseous-discharge lamps were further developed by D. McFarlan Moore, of the U.S., and by Georges Claude, of France, in the period 1890–1900.

The practical combination of a gas-discharge lamp and a phosphor, the now common fluorescent lamp, did not appear. however, until the latter part of the 1930s. The modern fluorescent lamp utilizes a combination of electroluminescence and photoluminescence, in that electrons excite mercury-gas atoms that emit ultraviolet radiation which in turn excites a phosphor coating that emits visible light.

7. **Cathodoluminescence.**—This name is a partial misnomer, because it is luminescence excited by injection of high-velocity electrons into a luminescent material. Cathodoluminescence is a subclass of electroluminescence. The misnomer arose because the term cathode rays was introduced before the rays were identified and named electrons.

In 1858, J. Pliicker discovered that rays emitted from the cathode in an evacuated electron-discharge vessel could be magnetically deflected, as evidenced by the movement of a spot of light that was emitted from the glass wall of the vessel where the rays impinged. The luminescence emission of the glass served as a visible indication of the presence and motion of the invisible rays. Further experiments, especially by A. E. Becquerel. J. P. Gassiot, J. W. Hittorf, E. Goldstein, E. Wiedemann, F. Lecoq de Boisbaudran, William Crookes and P. Lenard, established that the rays could produce bright luminescence emission from many phosphors, including some natural minerals. Goldstein discovered, in 1876, that the rays from the cathode could be electrostatically deflected, and he named them cathode rays (German, *Kathodenstrahlen*). It was not until 1897 that the cathode rays were proven to be electrically charged particles by J. J. Thomson, who called them corpuscles. The name electron, which was first suggested in 1881 by G. Johnstone Stoney for the unit of electric charge, was not universally adopted until after 1900.

The relatively intense light emission obtained from cathode-ray bombardment of phosphors, spurred investigators to seek new luminescent materials to be excited by the invisible beams of electrons. Thousands of substances and minerals were subjected to cathode-ray beams, and striking displays of cathodoluminescence were obtained from platinocyanides, uranium salts, diamonds, rubies and many other solid materials.

The first useful combination of phosphors and a beam of cathode rays was in the cathode-ray oscilloscope tube invented by Karl Ferdinand Braun in 1897. This electron tube made it possible for scientists to observe electric and magnetic fluctuations that are too rapid to be followed by mechanical means.

Starting in the 1920s, the Braun tube was modified and improved. by providing more efficient cathodoluminescent phosphors and introducing means for modulating the intensity of the electron beam. The cathode-ray tube has since become the television and radar kinescope, or image-reproducer tube. Another prominent use of cathodoluminescence is in the viewing screens of electron microscopes, to transform invisible electron patterns into visible images with minute details.

8. Ionoluminescence, **Anodoluminescence.**—The discovery of cathode rays mas followed by E. Goldstein's discovery of rays from anodes, first called canal rays, in 1886. These rays, later identified as positive ions, also produced luminescence in certain gases and solids, but ions are less convenient and less effective exciting agents than electrons. Ionoluminescence is the most appropriate term for luminescence excited by ions, both negative and positive, but the terms anodoluminescence and radioluminescence have sometimes been used as synonyms.

9. **Radioluminescence.**—After cathode rays, anode rays and X-rays had been discovered in the period 1858–1886, Antoine Henri Becquerel of France sought to ascertain whether similar penetrating invisible radiations might be emitted from phosphorescing materials as an adjunct to their emission of visible light. In 1896, Becquerel excited a number of his father's luminescent materials by exposing them to light, and then placed them on a photographic plate that was wrapped with black paper. When the photographic plate was developed, Becquerel found that one of the luminescent materials, a uranyl potassium sulfate, had darkened. the plate. He then repeated the experiment, but without previous exposure of the material to sunlight, and obtained the same result.

Becquerel did not find the additional luminescence emissions that he sought. His experiments led, however, to the discovery of radioactivity; that is, to the finding of the penetrating rays that are spontaneously emitted from atomic nuclei in uranium, radium, thorium and other radioactive substances. These rays were then found to be capable of exciting phosphors, and the luminesccnces obtained under excitation by rays from radioactive substances were called radioluminescence. The term is ambiguous because rays from radioactive substances include electrons (beta rays). ions (alpha particles) and photons (gamma rays). Early use was made of the so-called radioluminescence by admixing a phosphor and a radioactive material in a paint vehicle to make self-luminous dial markings for watches and other instruments to be observed at night. The scintillations caused by individual alpha particles bombarding phosphor crystals are visible, to the dark-adapted eye, when the luminous markings on a timepiece are observed through a strong magnifying glass in the dark. The separate flashes of light are direct evidence that the excitation is by discrete particles.

The aurora borealis is a large-scale radioiuminescence. The primary exciting agents are elementary, charged particles that are sporadically ejected by the sun during violent fluctuations of its basic nuclear reactions. When the charged particles, especially protons, approach the earth, they are deflected by the earth's magnetic field and converge toward the magnetic poles. As the energetic particles enter the earth's atmosphere they bombard air molecules and produce heterogeneous showers of mesons, electrons, positrons, ions, photons and other secondary particles. The showers of primary and secondary particles vary in intensity. composition and penetration to produce varicoloured luminescence emission on deceleration as they excite gases in different strata of the atmosphere.

10. **Roentgenoluminescence.**—This luminescence, which is excited by X-rays, bears as a prefix the name of the discoverer of X-rays, Wilhelm Conrad Rontgen, a physicist of Wiirzburg, Ger. In 1895, when Rontgen was experimenting with a cathode-ray tube that he had enclosed in an opaque black-paper wrapper, he noticed that some barium platinocyanide crystals lying near the tube emitted light when the tube was operating. Subsequent work disclosed that there were new, invisible rays coming from the glass wall of the tube where it was struck by the cathode rays. The new rays. which were called roentgen rays or X-rays, were not deflected by electric or magnetic means, and they were much more penetrating than any radiations known theretofore. The rays were later identified as being the same as light, but of much shorter wave length.

Many phosphors were found to be luminescent under X-ray excitation, and phosphors were used to make the X-ray fluoroscope screens and intensifier screens that are employed in making visible details of bone structure and other internal structure of the human body. The production of X-rays is itself a fluorescence process, and so roentgenoluminescence is the second luminescence in a two-stage process.

IV. LUMINESCENT MATERIALS AND PHOSPHOR CHEMISTRY

During the search for new means for excitation, there was a parallel search for new luminescent materials that might be bright enough for some practical use. The Bolognian phosphor of 1603, a barium sulfide, was used to make novelty drawings and pictures that glowed feebly at night, after exposure to sunlight. In moist air, the material decomposed and evolved malodorous hydrogen sulfide. Despite these shortcomings, the recipe for making the phosphor was so highly prized that it was kept semisecret for nearly a century. When the formula eventually became widely known, efforts were made to improve the material by using different ingredients and preparative techniques. One of the first improvements was accomplished in 1700 when a calcium sulfide phosphor was made by Friedrich Hoffmann, a court physician in Prussia. Hoffmann used Cascariolo's technique, and calcined gypsum ($CaSO_4$) with coal to make a brighter phosphor. **A** better technique for making the same phosphor was devised by John Canton in 1768. He heated a mixture of ground oyster shells and sulfur to make a superior phosphor. Although Canton's phosphor glowed brighter than the Bolognian phosphor, both phosphors were difficult to reproduce, and both decomposed obnoxiously in humid air. The first stable sulfide phosphor, a zinc sulfide, was prepared in 1866 by the French mineralogist, Theodor Sidot, who heated zinc oxide in a stream of hydrogen sulfide.

1. Sulfide-Type Phosphors, Activators, Fluxes. — The difficulty of making uniform phosphors, even when using a standardized technique, led to the suspicion that the bulk material needed the absence or presence of certain trace ingredients. As the then infant art of chemistry progressed, purification and analysis were applied to phosphor ingredients and to completed phosphors, to ascertain and control their compositions.

In 1870, there appeared the first commercial phosphor, called Balmain's paint, and in 1879 a German patent on "Leuchtfarben" was issued. Balmain's paint was a calcium sulfide phosphor made with deliberate inclusion of about 0.01% of a compound of bismuth. It was not until 1886, however, that the French chemist **A.** Verneuil proved that a pure calcined calcium sulfide was nonluminescent, whereas the same pure substance after heating with a trace of a compound of bismuth gave the violet emission of Balmain's paint. Verneuil thus established the need for what is now called an activator (*e.g.*, bismuth) which must be incorporated in small proportions in the host crystal (*e.g.*, calcium sulfide) in order to convert the nonluminescent host crystal into a phosphor. In retrospect, it is apparent that Cascariolo's heavy spar ($BaSO_4$) and Canton's oyster shelis ($CaCO_3$) contained approximately the correct proportion of bismuth impurity to provide the necessary activator ingredient in their calcined products. It was found that Sidot's green-emitting zinc sulfide phosphor, on the other hand, had been prepared from ingredients that had a few thousandths of a per cent of copper impurity that functioned as the activator in his completed phosphor.

The best sulfide phosphors were made with about 2% of certain salts mixed with the other ingredients before they were heated at high temperatures. Sodium chloride (NaCl) was particularly effective as an additive in making efficient zinc sulfide: copper phosphors. but several other alkali halides gave nearly equivalent results. The seeming catalytic action of these salts led to their being called fluxes, a name derived from metallurgy wherein certain salts are used to facilitate the high-temperature welding of metals.

2. Oxide-Type Phosphors, Poisons. — After the discovery that a pure nonluminescent host crystal could be made luminescent by incorporating in it a trace of a certain impurity, called the activator, the search for new phosphors continued with more attention given to minor ingredients. Entire mineral collections were exposed to the new invisible radiations, and some specimens that were found to luminesce brightly were analyzed. As examples, bright red emission was obtained from specimens of ruby (aluminum oxide with chromium activator), green emission from some specimens of willemite (zinc silicate with manganese activator) and blue emission from specimens of scheelite (calcium tungstate, which requires no added impurity for an activator). These materials were then synthesized, and man-made phosphors were obtained with higher efficiencies than those of the best specimens of the corresponding natural minerals.

The higher efficiency of the synthetic phosphors was attributable to elimination of spurious ingredients, thorough purification of the essential ingredients and to intimate mixing, combining and crystallizing of the ingredients at an optimum high temperature (usually about 1,000° C.). Great care had to be taken to avoid the introduction of undesirable impurities, particularly iron and certain other elements, that decreased the efficiency of phosphors. Such efficiency-reducing impurities became known as poisons or killers, and individual phosphors were found to be hypersensitive to certain poisons, but relatively insensitive to others. Another selective feature that eventually emerged was that fluxes, which were essential in making efficient sulfide-type phosphors, were found to be unessential, and even poisonlike, in making most oxide-type phosphors.

3. Centres, Intensifier Activators, Originative Activators, **Coactivators.**—Speculations on the roles of activators in phosphors led to the concept of special and distinct atoms or groups of atoms, which P. Lenard in 1890 called centres, wherein the luminescence action takes place. In this concept, the host crystal functions as a medium in which to suspend foreign activator atoms which, with their neighbouring host-crystal atoms, provide discrete centres for localized absorption of excitation energy, followed by emission of part of the absorbed energy as light. As a corollary, poisons were conceived of as foreign atoms that incapacitate nearby centres.

It was found that there is an optimum proportion of activator, which is about 0.001% to 0.3% of the weight of the host crystal, and so it became evident that when centres are packed too densely in a host crystal they poison each other.

The centre concept is readily applicable for those phosphors that require deliberate inclusion of foreign activator atoms. Some phosphors, however, are luminescent even when made without any added activator.

Examples are pure calcium tungstate ($CaWO_4$), and pure zinc silicate (Zn_2SiO_4). In those phosphors the luminescent centres may be identified with certain distinct structural groups in the host crystal, such as the octahedral tungstate group (WO_6) in $CaWO_4$, and the tetrahedral silicate group (SiO_4) in Zn_2SiO_4.

When about 0.2% of titania (TiO_2) is incorporated in pure Zn_2SiO_4, or in some other pure silicates, the violet emission of the pure silicate is greatly increased. The titanium impurity beneficially perturbs the SiO_4 centres. making more of the SiO_4 groups capable of luminescing. For such instances. where an impurity intensifies a latent host-crystal luminescence, the impurity is called an intensifier activator.

When about 0.2% of manganese oxide (MnO) is incorporated in pure Zn_2SiO_4, honever, the violet emission of the SiO_4 centres in the host crystal disappears and is replaced by a strong green emission occasioned by the manganese centres. Manganese atoms replace some of the zinc atoms to form new, luminescent MnO_4 centres. For such instances. where an impurity produces a new luminescence emission, not ascribable to centres of the pure host crystal, the impurity is called an originative activator.

Another type of activator action was traced to the fluxes used in preparing sulfide-type phosphors. When pure ZnS is crystallized with 0 01% of a copper salt, and 2% of NaCl flux, the resultant solid is a phosphor with a strong green emission. It was found that trace amounts of chloride ions (Cl^-) from the flux were incorporated in the ZnS where they served to facilitate the incorporation of the copper activator ions (Cu^+), and to compensate their electrical charges. For such instances, where an additional impurity, such as Cl^-, facilitates the formation of luminescent centres associated with another activator impurity, such as Cu^+, the additional impurity is called a coactivator.

Identification of the centres, activators and poisons is a formidable challenge in some phosphors, because known purification and analytic techniques are often inadequate to cope with the minute proportions involved. In a very pure ZnS, for example, as little as 0.0000001% (10^{-7}%) of copper activator gives a readily discernible green emission. In the same phosphor. as little as 0.00001% of nickel or iron poison-impurity discernibly decreases the efficiency of the phosphor. Organic phosphors also exhibit sensitivity to impurities. The green emission that was for many years attributed to pure anthracene was eventually found to be due to traces of naphthacene impurity. Pure anthracene has a blue emission from its host-crystal centres, nhich consist of the planar anthracene molecule, $C_6H_4:(CH)_2:C_6H_4$. When a trace of naphthacene is incorporated in anthracene, the naphthacene molecule. $C_6H_4:(CH)_2:(CH)_2:C_6H_4$, functions as an originative activator and gives nearly the same green emission colour as that obtained from pure naphthacene.

There is a system of shorthand designation of phosphors which consists of denoting the crystal class of the host crystal, the chemical composition of the host crystal. the identity of the activator, the proportion of activator (usually in per cent by weight, of the host crystal), the identity of any auxiliary impurity. the crystallization temperature. the crystallization time and other essential data. On this basis one can denote some of the foregoing phosphors and their congeners as shown in Table **I.**

TABLE I.— Typical Onide-Type and Sulfide-Type Phosphors

Phosphor	Emission	
	Colour	Persistence
rhombohedral-Zn_2SiO_4:Mn(0.3%), 1,200° C., 60 min., slow cool	green	short
β-Zn_2SiO_4:Mn(0.3%), 1,600° C., 10 min., quench cool	yellow	short
cubic-ZnS:Cu(0.003%):[Cl], 950° C., 10 min., slow cool	green-blue	long
hexagonal-ZnS:Cu(0.003%):[Cl], 1,250° C., 10 min., slow cool	green	very long

The particular examples of phosphors were chosen to show that the structure of the host crystal can have considerable influence on the luminescences of some phosphors. Zn_2SiO_4:Mn, for example, can be converted from the yellow-emitting form to the structurally different green-emitting form, and vice versa, without altering the chemical composition of the material. In both phosphors, the manganese activator atom in the MnO_4 centre is the origin of the luminescence emission, and the manganese atom is significantly influenced when its four surrounding oxygen atoms have their positions altered by the transition of the host crystal from one structural arrangement to another.

For general use, phosphors may be symbolized with shorter designations, such as rhbdl.-Zn_2SiO_4:Mn, hex.-ZnS:Cu:[Cl] and tetr.-$CaWO_4$, without specifying the activator proportions and conditions of preparation. Each such general symbol. however. represents a family of phosphors, because phosphors prepared with different proportions of activator, or crystallized at different temperatures, behave differently. Hundreds of thousands of different phosphors have been synthesized and tested during luminescence research of the past few decades. Almost all of the known phosphors are original compositions, not found in the natural state. Of the many synthetic phosphors, about **36** are in practical use.

4. Gases, Liquids, Crystals, Photons. — Studies of the luminescences of condensed matter, both solid and liquid, were extended to studies of rarefied matter after the invention of the vacuum pump by Guericke in about 1650. A major virtue of studies of rarefied gases is the ability to determine the luminescence characteristics of isolated, simple atoms.

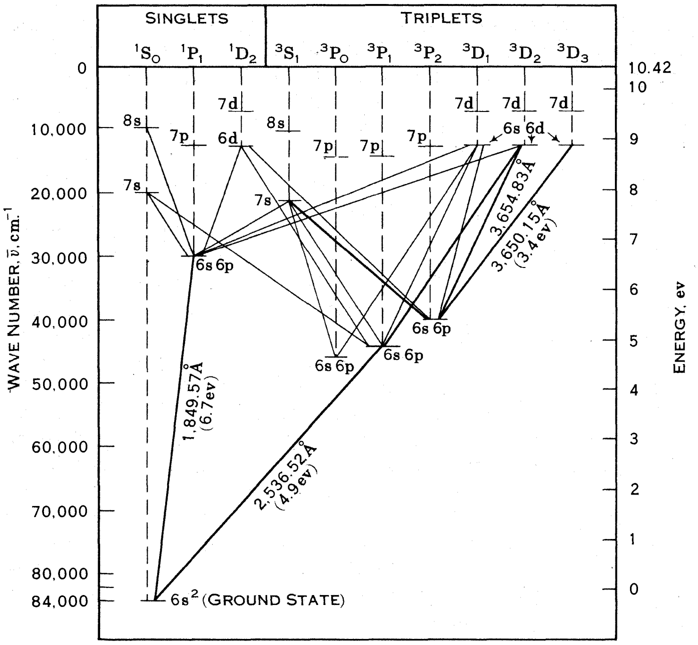

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FIG. 1.—PART OF THE ENERGY-LEVEL DIAGRAM FOR AN ISOLATED (FREE) ATOM OF MERCURY (Hg)

Extensive investigations disclosed that every kind of elemental atom, of which there are now over 100, can be excited and will emit light when it is alone in space. When the light emitted from excited isolated atoms, and ions. was passed through a prism or spectroscope, it was found that there were sharp lines of emission in some parts of the spectrum, but no emission in the wave length regions in between. The emission lines, which were different in location (wave length) and intensity for each different kind of atom and ion, were catalogued and eventually interpreted with the aid of the quantum theory of the atom (see QUANTUM MECHANICS; SPECTROSCOPY).

A pertinent feature of the quantum theory is that an isolated atom can exist indefinitely in an unexcited state (the ground state), or it can exist transitorily in numerous excited states which are discrete and are characteristic of the kind of atom or ion. In other words, a given kind of atom can be excited to exist briefly in one of several separate and distinct states of higher energy, but not in any intermediate state. Each state of the atom corresponds to a different configuration of its electrons. When the excited atom drops in energy from one of the sharply defined high-energy levels to a similarly sharp lower energy level, the difference in energy is emitted as a discrete quantum of radiation, or bit of light energy, that is called a photon.

Having established that all isolated atoms are luminescent, it is appropriate to inquire about the luminescences of isolated molecules, which are small groups of atoms that are tightly bound to each other. A lone excited atom can dispose of its excess energy only by radiation. in the absence of collisions with other atoms. An excited atom in a molecule, however, is bound to one or more neighbours that influence the energy levels of the excited atom and can dissipate the excitation energy by converting it into increased oscillation of the atoms relative to each other. Spectroscopic analysis of the light emitted by luminescing molecules shows that the energy levels of the constituent atoms are altered and proliferated into many additional closely spaced levels that are due to the vibrations and rotations of the atomic ensemble in the molecule. A multiatom ensemble, generally has a lower efficiency of luminescence than an isolated atom, because the assemblage of atoms can dissipate excitation energy by converting it into atomic motion, which in condensed matter is thermal agitation (heat).

The probability of dissipating potential luminescence emission energy, by conversion into heat energy, is enormously increased on going from an isolated atom to an atom bound to myriads of identical atoms in a pure, elemental liquid or solid. As would be expected, therefore, most pure, elemental liquids and solids are either nonluminescent, or are inefficiently luminescent. Mercury is an efficient luminescent gas, but it becomes nonluminescent when it is condensed to a liquid. Liquids are particularly inefficient, because their thermal agitation has nearly destroyed the structural regularity (crystallinity) of the assemblage, and every atom is buffeted by neighbouring atoms whose number and arrangement are changing rapidly. There are pure, nonelemental liquids, however, that have relatively high luminescence efficiencies. An example is benzene, C_6H_6, which is luminescent as a rarefied gas, as a liquid and as a solid. In this substance, the hexagonal benzene molecule functions as the ultraviolet-radiating luminescence centre in all three states of matter. In benzene, as in many other organic molecules, the strength of bonding between atoms in the molecule is much greater than that between molecules. The individual molecules, then, can function as discrete centres, even when they are associated with other molecules in liquids and crystals. Crystals are generally more advantageous than liquids and amorphous solids as hosts for luminescence centres. 4 crystal provides fixed kinds, numbers and arrangements of neighbouring atoms around its luminescence centres. In crystals, also, the ordered structures may be made favourable for the ingress of excitation energy, internal transfer of energy and egress of emitted photons.

V. LUMINESCENCE PHYSICS

1. Energy and Spectra, Excitation, Energy Levels, Black Light. — The basic mechanism in luminescence is conceptually simple. An isolated atom, for example, absorbs energy, becomes electronically excited and then returns to the unexcited state by emitting the absorbed energy as a photon of light. According to quantum mechanics, the energy (E) of the photon is related to the frequency and wave length of the light by the fundamental equations,

$$E = h\nu = hc/\lambda \text{ electron volt (ev)} \tag{1}$$

where $h = 4.141 \times 10^{-15}$ electron-volt second (Planck's elementary action constant, in ev sec.); ν is the frequency of the light, in cycles per second (= sec.$^{-1}$); $c = 2.998 \times 10^{18}$ angstroms per second (velocity of light in a vacuum, in Å sec.$^{-1}$); λ is the diffraction wave length of the light, in A. (Note: 1 electron volt = 1.6×10^{-12} erg = 3.8×10^{-20} calorie, and 1 angstrom = 10^{-8} centimetre = 10^{-4} micron.) The average human eye can see light that has photon energies ranging from about 1.8ev (deep red, near 6,900 A) to 3.1ev (deep violet, near 4,000 A).

In accordance with Stokes's law, excitation of luminescent materials may be accomplished by particles, such as photons or charged material particles (electrons, ions), with energies equal to or greater than the energies of the photons to be emitted. There is no known upper limit to the energies of primary particles ca-

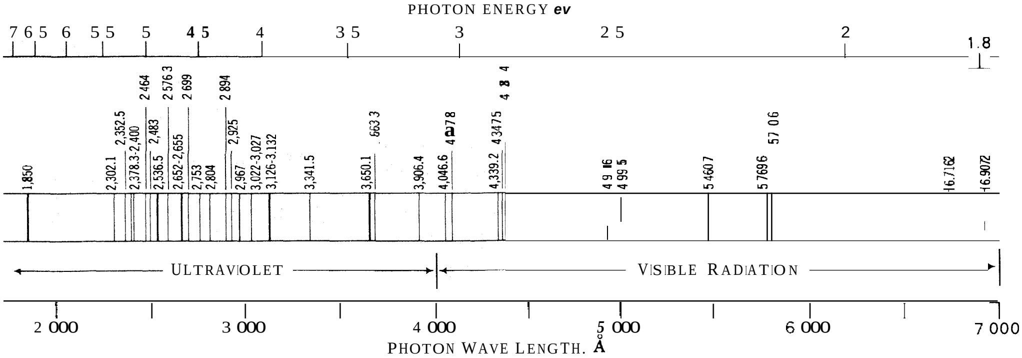

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FIG. 2.— SOME OF THE PRINCIPAL LINES IN THE ARC EMISSION SPECTRUM OF MERCURY (Hg). THE LINES ARE DISTINCT AT A PRESSURE OF 10^{-3} CM. (OF Hg) BUT GENERALLY BROADEN AND BECOME DIFFUSE BANDS AT 10^4 CM. ALSO, THE MEAN RADIATED-POWER DISTRIBUTION SHIFTS TOWARD LONGER WAVE LENGTHS WITH INCREASING PRESSURE

pable of exciting luminescent materials.

As a practical matter, the primary-particle energies used to excite luminescent materials generally range from about 3.4 ev, for photons in the near ultraviolet, to billions of electron volts, for energetic particles produced in accelerators, such as cyclotrons and synchrotrons. Under certain conditions, visible luminescence emission may be produced by applying quanta of much lower energy, as is described later in connection with solid-state electroluminescence.

Some phosphors, such as blue-emitting hex.-ZnS:Ag:[Cl], may be excited by electrons having energies ranging from about 6 ev to over 10,000,000 ev. The foregoing phosphor is used in television kinescopes, where it is excited by beams of electrons wherein each electron has an energy of about 20,000 ev. It is noteworthy that the colour of the light emitted by the phosphor is nearly independent of the energy of the particle used for excitation. The energies of the photons emitted by a luminescent material are determined chiefly by the composition and structure of the material.

The detailed mechanism in luminescence is complex, because an atom consists of a nucleus and 1 to 100-odd electrons. These subatomic particles have intricate interactions, and an atom can exist in only certain over-all energy states wherein its electrons exist in many different substates. As an example, a few of the energy levels of an isolated atom of mercury (Hg) are shown in fig. I.

Each energy level corresponds to a particular over-all state, or configuration, of the mercury nucleus and its surrounding 80 electrons. The excited-state energy levels, above the ground-state level, are those in which the two outermost electrons of the mercury atom have been put into abnormal configurations. By bombarding a mercury atom with an electron having somewhat more than 6.7 ev of energy, for example, the two outermost mercury electrons which were originally in the $6s^2$ singlet configuration may be excited into the 6s6p singlet configuration (see SPECTROSCOPY). When the excited atom returns to the ground state, the excess 6.7 ev is radiated as an ultraviolet photon with a wave length of 1,850 Å. If, however, more than 10.42 ev of energy were to be absorbed in the primary excitation, then one of the electrons would be ejected from the atom, whereupon the atom would become a singly charged positive ion (Hg^+).

Luminescence transitions in a mercury atom occur in the region between the ground state, at 0 ev, and the ionization threshold, at 10.42 ev. Within that energy span there are many excited-state energy levels that may be achieved by direct excitation from the ground-state level, by multiple-stage excitation from a lower-lying excited-state level, or by emission transitions from higher-lying excited-state levels. Not all interlevel transitions occur, however, and those that do occur have unequal probabilities of occurring.

Some of the permitted transitions are shown in fig. 1, with corresponding spectral locations shown in fig. 2.

The 2,537-Å emission is particularly strong when rarefied mercury gas, at about 10^{-5} atmosphere pressure, is bombarded by about 100-ev electrons. Under the stated conditions, at room temperature about 60% of the input electron energy is converted into the 2,537-Å electroluminescence radiation that is used to excite phosphors in fluorescent lamps (the phosphors, in turn, convert the invisible 2,537-Å radiation into visible light). As indicated in the caption of fig. 2, the spectral quality of luminescence emission from mercury gas alters as the pressure of the gas is increased.

At high pressures, the excited atoms have a high probability of colliding with other atoms which can alter the energy levels of the excited atoms, or de-excite, or further excite the already excited atoms. When mercury-vapour lamps are operated at about 8 atmospheres pressure, the 3,650-Å emission transition is prominent. Such lamps are used, with suitable optical filters that pass only ultraviolet radiation, to provide invisible near-ultraviolet radiation.

Ultraviolet radiation is commonly called black light. Ultraviolet, or black light, lamps are used to excite photoluminescent materials for decorative and theatrical effects. The lamps are used, also, in prospecting for luminescent minerals; in disclosing otherwise invisible luminescent markings for laundries, flaw detection and criminological investigations; in detecting diseased tissues in agriculture and surgery; and in disclosing flow and seepage paths of luminescent fluids in animate and inanimate matter. Incidentally, natural teeth luminesce with a pale blue glow under ultraviolet irradiation.

2. Time Aspects, Growth and Decay, Trapping, Stimulation, Quenching.— The first observations of the persistence of luminescence, after cessation of excitation, were made with the unaided human eye. A century and a half elapsed before it was found that the visual process itself is persistent, and was eventually found to persist for about 0.1 second. Luminescences that persisted longer than 0.1 second were the first to be observed, and were called phosphorescence. When Stokes, in 1852, identified a luminescence that had an imperceptibly short persistence, he called it fluorescence; and incorrectly contended that fluorescence was distinct from phosphorescence. A. E. Becquerel, in 1854, disputed Stokes's contention, and then devised a mechanical-optical device, called a phosphoroscope, to show that there are phosphorescences that are as short as 0.0001 second. Since 1897, cathode-ray oscilloscopes have been used to show intensity of phosphorescence emission as a function of time, down to times as short as 10^{-9} sec. At present, fluorescence is recognized as a limiting case of the general phenomenon of phosphorescence. Fluorescence is an uninhibited, spontaneous, luminescence emission, such as may be exhibited by a simple, isolated, excited atom.

The duration of fluorescence is a fundamental quantity that is related to the energy, or frequency, of the spontaneously emitted photon. For an allowed radiative transition of an excited, isolated atom, the natural fluorescence lifetime of the atom in the excited state is

$$\tau_f = \tfrac{1}{2}\pi\Delta\nu \text{ sec.} \qquad (2)$$

where $\Delta\nu$ is the frequency width, measured at half the peak intensity, of the emission line. Classically, for emitted photons of frequency ν_0,

$$A_P = 3.93 \times 10^{-23}\nu_0^2 \text{ sec.}^{-1} \qquad (3)$$

from which the energy width of the emission line is

$$\Delta E = h(\Delta\nu) = 1.66 \times 10^{-37}\nu_0^2 \text{ ev} \qquad (4)$$

and, according to the uncertainty principle for complementary energy and time, the minimum value of τ_f is

$$\tau_f \approx h/2\pi\Delta E \text{ sec.} \qquad (5)$$

From equations (1), (4) and (j) one obtains for emission of optical photons with a wave length of 6,000 Å, $\nu_0 = 5\times10^{14}$ sec.$^{-1}$, $\Delta E \approx 4\times10^{-8}$ ev and a fluorescence duration $\tau_f \approx 1.6\times10^{-8}$ sec. For emission of X-ray photons, with wave lengths less than 1 Å, line widths as large as 3 ev have been observed, and the corresponding fluorescence duration from equation (5) is $\tau_f \approx 2\times10^{-16}$ sec. (A more precise expression for $\Delta\nu$, which does not greatly change the indicated value of τ_f for optical photons, is given by quantum theory, as

$$\Delta\nu = 32\pi^3\nu_0^{\,3}|\mu|^2/3hc^3 \text{ sec.}^{-1}$$

where μ is the quantum-mechanical matrix element of the dipole moment. For photons of wave length 6,000 A, μ would have a value of about 6×10^{-18} electrostatic units [E.S.U.] to correspond to the classical expression given in equation [3].)

If there be a number N^* of excited, isolated atoms (centres) at time t, then the intensity of spontaneous luminescence emission from the N* atoms is

$$\mathrm{L} = -dN^*/dt = aN^* \tag{6}$$

which states that the number of photons emitted at time t is equal to a rate constant times the number of excited atoms existing at time t. Integration of equation (6) gives

$$-\log_\epsilon L = -\log_\epsilon N^* = \text{at} + [\text{constant}] \tag{7}$$

and, when $t=0$ (instant of cessation of excitation) and $N^* = N_0^*$, the [constant] $= -\log_\epsilon N_0^*$. The rate constant a is equal to the reciprocal of the lifetime r of the excited state,

$$\text{a} = \tau^{-1} \tag{8}$$

and r is the time taken by the assemblage of excited atoms to decrease (decay) in emission intensity to $L_0\epsilon^{-1}$ $(=0.368L_0)$ when L_0 is the intensity of emission at $t=0$. On this basis, equation (7) becomes

$$L = L_0\epsilon^{-at} = L_0\epsilon^{-t/\tau} \tag{9}$$

The foregoing equation represents a simple exponential decay of emission intensity with time, and is identical in form with the familiar equation for the decay of radioactivity.

When a luminescent material exhibits a simple exponential decay of emission intensity after excitation, it exhibits also an exponential growth of emission intensity during excitation. During excitation,

$$\mathrm{L} = dN^*/dt = I(N_0 - \mathrm{N}^*) - aN^* \tag{10}$$

where I is the intensity of excitation applied to the initial N_0 unexcited centres. On rearrangement, integration, solving for the integration constant at $t=0$, and substitution, one obtains from equation (10)

$$\mathrm{L} = aIN_0(1 - \epsilon^{-(a+I)t})/(a + \mathrm{I}) \tag{11}$$

At low excitation intensities, the time required for the emission intensity to increase and become substantially constant is approximately τ $(=a^{-1})$, and the emission intensity L is determined chiefly by the excitation intensity I. At excitation intensities higher than the value of I required to excite all of the N_0 centres in a time r, the time required for the emission intensity to become constant is shorter than r and is inversely proportional to I. In this saturated condition, the emission intensity is determined chiefly by N_0a $(=N_0/\tau)$.

If the excited atoms (centres) come in contact with other atoms during their excited-state lifetimes r, some of the N* atoms can become de-excited by radiationless transitions. Their potential photo-emission energy is then converted into heat by an alternative de-excitation process. Under such conditions, which obtain in dense gases, liquids and solids, the effective excited-state lifetime r, includes the foregoing temperature-insensitive radiative decay-rate a, and a temperature-sensitive nonradiative decay-rate a', such that

$$\tau_e = (\text{a} + a')^{-1} = (\text{a} + \nu_c\epsilon^{-\Delta E^*/kT})^{-1} \tag{12}$$

where ν_c is the number of collisions per second suffered by the excited centres, ΔE^* is the activation energy that must be imparted to the excited centre to cause it to transfer its excitation energy into heat energy, $k = 8.62\times10^{-5}$ ev degree^{-1} (Boltzmann's constant, in ev deg.$^{-1}$) and T is the temperature of the luminescent material, in degrees Kelvin (° K.). Substituting τ_e for r in equation (9), one obtains

$$L = L_0\epsilon^{-(a+\nu_c\epsilon^{-\Delta E^*/kT})t} \tag{13}$$

which is representative of the actual exponential decays of many dense luminescent materials.

In a crystal, the collision frequency ν_c is approximately the same as the highest vibration frequency of the atoms in the solid. A typical value of ν_c is about 10^{12} sec.$^{-1}$, and so an excited centre whose lifetime is as short as 10^{-8} sec. experiences about 10,000 thermal-agitation collisions during its excited-state lifetime. Under these conditions, the activation energy ΔE^* should exceed about $30kT$ in order to have a high probability that the excited centre will emit a luminescence photon. At room temperature, which is nearly 300° K., the value of kT is about 0.025 ev, and $30kT$ is about 0.75 ev. Lower values of ΔE^* require lower operating temperatures for efficient luminescence.

It is possible to decrease the observed decay time of luminescence emission to times shorter than r, or even τ_f $(\approx10^{-8}$ sec.), by either decreasing ΔE^* or by increasing T. Both expedients decrease the efficiency of the luminescent material. The value of ΔE^* in a phosphor may be decreased by increasing the proportion of activator beyond the optimum proportion, or by incorporating poison-type impurities in the phosphor.

Decay times longer than 10^{-8} sec. can be obtained by using semiallowed radiative transitions in isolated atoms, or by using suitable neighbouring atoms to alter the excited-state lifetimes of certain atoms or centres in a liquid or solid. Examples of the influence of the host crystal on the lifetime of the excited state of manganese centres in several phosphors are given in Table II. All of the listed phosphors have exponential decays of phosphorescence emission.

The data in Table II provide clear evidence of the potency of atomic interactions in altering the excited-state lifetimes and energy levels of luminescence centres in solids. Advantage is taken of atomic interactions to custom-make phosphors, and other electronically active solids, with specific characteristics for practical uses. For this purpose, inorganic solids are usually more versatile than organic solids. Inorganic solids: (1) permit broad use of combinations of all of the known species of atoms without requiring carbon to be a member of the combination; (2) provide the most degrees of freedom in using ionic, covalent and intermediate types of interatomic bonding; and (3) provide the greatest range of bonding energies, as attested by the high melting points of many inorganic solids.

Table 11.—Effective Excited-State Lifetimes τ_e of Some Phosphors With About 0.3%, by Weight, of Manganese Activator

Host crystal	Activator*	τ_e(sec.)	Emission colour
tetr.-ZnF_2	$Mn^{(2+)}$	0.1	orange
rhomb.-$CdSO_4$ . . .	"	0.05	orange
rhomb.-$MgSO_4$ . . .	"	0.03	red
rhomb.-$Zn_3(PO_4)_2$ . . .	"	0.02	red
? -$CdSiO_3$ . . .	"	0.019	orange
? -$Zn_2B_2O_5$ . . .	"	0.018	yellow
? -$Cd_2B_2O_5$ . . .	"	0.015	red-orange
rbhdl.-Zn_2SiO_4 . . .	"	0.013	green
rbhdl.-Zn_2GeO_4 . . .	"	0.0105	green-yellow
cub.-$ZnAl_2O_4$ . . .	"	0.0055	blue-green
cub.-$ZnGa_2O_4$ . . .	"	0.0043	green-blue
hex.-ZnS	"	0.0004	oranne

*The parentheses $^{(2+)}$ indicate that tl ere are variable proportions c f ionic and covalent nding of the manganese ion to its neighbouring atoms (F, O and S) in the different host crystals

There is another prominent mechanism for extending the duration of phosphorescence emission. In many solids this mechanism proceeds as follows: (1) excitation energy ejects an electron from a luminescence centre in a host crystal; (2) the excited electron is trapped in an imperfection elsewhere in the crystal; (3) additional energy, usually supplied by heat or infrared radiation, must then be imparted to release the electron from the trap; and finally (4) the electron returns to the ionized centre to be captured and

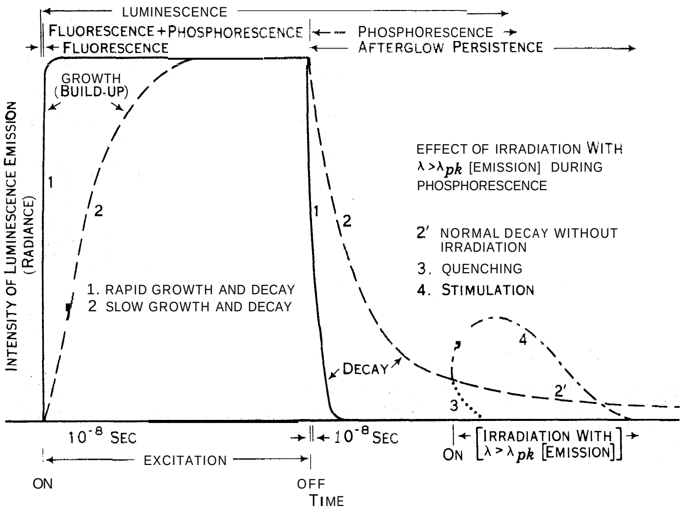

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FIG. 3—DIAGRAMMATIC REPRESENTATION OF THE DYNAMICS (GROWTH AND DECAY) AND TERMINOLOGY OF LUMINESCENCE EMISSION

make a radiative transition to the ground state in the usual manner. By inserting a trapping step between the excitation and emission steps, it is possible to prolong phosphorescence for days and even years. Trapping was responsible for the long afterglow of the Bolognian phosphor, and was responsible also for the phenomenon that was mistakenly called thermoluminescence.

The trapping mechanism in solids has its counterpart in the metastable excited states of isolated atoms in gases. A metastable state, such as the 6s6p, $^3P_0$ state of mercury shown in the centre of fig. 1, is a state from which a spontaneous, radiative transition is forbidden. The excited atom cannot contrive to go directly from its metastable-state electronic configuration to a configuration with lower energy. Instead, additional energy must be supplied to excite the atom into a higher energy level, such as the 7s, $^3S_1$ level, from which a radiative transition can occur. The additional energy can be supplied by collision with other atoms, or by photons. If collision energy be used, the release of stored energy in metastable states is strongly temperature-dependent and follows a relation of the type

$$N^* = -dN_m^*/dt = N_m^* \nu_c \epsilon^{-\Delta E^*/kT} \tag{14}$$

where N^* is the number of atoms elevated from the metastable state to a given excited state from which radiative transitions can be made, N_m^* is the number of atoms in the given metastable state, ν_c is the frequency of collisions (proportional to $T^{1/2}$ in a gas), and ΔE^* is the energy difference between the N^* radiative level and the N_m^* metastable level. Under these conditions, in the absence of retrapping in the metastable state, equation (14) leads to a phosphorescence emission that has a temperature and time dependence according to

$$L \doteq L_0 \epsilon^{-\nu_c t \epsilon^{-\Delta E^*/kT}} \tag{15}$$

Equation (15) represents the rate-determining process for the simplest case of transitions between one discrete trapping level and one discrete radiative level. In crystals, however, there are usually many trapping levels with different values of ΔE^*. The contributions of different numbers of traps with different depths requires that equation (15) be expanded into a series of terms, with different values of L_0 and ΔE^*. For a hypothetical uniform trap distribution, that is, an equal number N_t^* of traps of all depths

$$L = N_t^* kT(1 - \epsilon^{-\nu_c t})/t \tag{16}$$

which reduces to a hyperbolic relationship

$$L = N_t^* kT/t \tag{17}$$

when $\nu_c t$ is much larger than unity. Many sulfide-type phosphors at room temperature have phosphorescence emissions that decrease approximately as the reciprocal of the time after excitation is stopped. The exact reciprocal relationship cannot be exhibited, however. because then the total light output, called the light sum, would integrate to infinity.

A summary depiction of luminescence growth and decay, with corresponding terminology is given in fig. 3. The slow-decay curve, 2, is typical of phosphors, such as hex.-ZnS:Cu:[Cl], that have traps that are about 0.5 ev deep, that is, $\Delta E^* \approx 0.5$ ev. Heat, at room temperature, suffices to release trapped electrons and give phosphorescence emission that can be seen for many hours by the dark-adapted eye. Integration of the decay curve, and comparison with the volume of excited phosphor, gives light sums as high as 10^{18} photons (traps) per cubic centimetre.

The identity of the traps is obscure in most phosphors, but in cub.-Sr(S:Se):Sm:Eu:[$SrSO_4$:CaF_2] the samarium (Sm) has been identified as providing the traps, while the europium (Eu) provides the luminescence-emission centres and the ingredients indicated in brackets are fluxes. In this sulfoselenide phosphor, which is distantly related to the Bolognian phosphor: (1) 3 ev of excitation energy (*e.g.*, a photon of blue light) ejects an electron from a Eu^{2+} centre, which becomes Eu^{3+}; (2) the excited electron is captured by an Sm^{3+} trap, which becomes Sm^{2+}; (3) 1 ev of heat or infrared stimulation energy releases the electron from the Sm^{2+}, which reverts to Sm^{3+}; (4) the electron is recaptured by an Eu^{3+}, which becomes an excited Eu^{2+}; and (5) the excited Eu^{2+} centre makes a radiative transition to the ground state, emitting a photon with an energy of 2.2 ev (yellow light). The cub.-Sr(S:Se):Sm:Eu:[flux] phosphor is able to store trapped electrons for many months, even at room temperature, because its trap depth is very large relative to the heat energy (kT) of the solid. This phosphor has been used in devices for viewing scenes at night by reflected infrared radiation from an infrared lamp. Deep-trap phosphors can be used, also, for storage and later readout of information.

Some of the spectral and dynamic aspects of the luminescence of a cub.-Sr(S:Se):Sm:Eu:[flux] phosphor are given in fig. 4. The photostimulation curve (c), representing accelerated release of trapped electrons by infrared irradiation, has its counterpart in a thermostimulation curve, wherein the accelerated release is accomplished by heating the excited phosphor. When such a phosphor is excited at a low temperature and later heated, the curve of

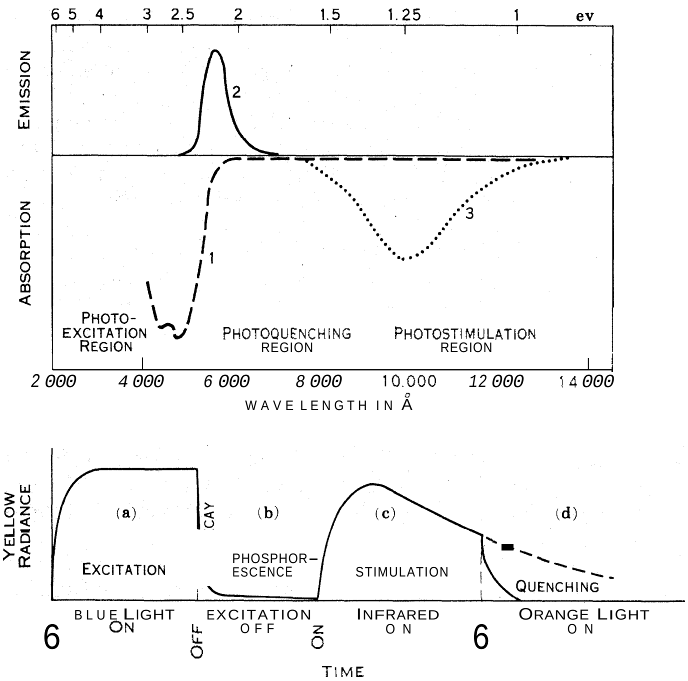

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FIG 4 — ABOVE SPECTRAL DISTRIBUTIONS OF EXCITATION. QUENCHING AND STIMULATION FOR A CUB -Sr(S Se) $SrSO_4$ CaF_2 Sm Eu PHOSPHOR BELOW DYNAMICS OF GROWTH AND DECAY OF THE ABOVE PHOSPHOR DURING AND AFTER (a) EXCITATION. (b) DECAY, (c) STIMULATION AND (d) QUENCHING

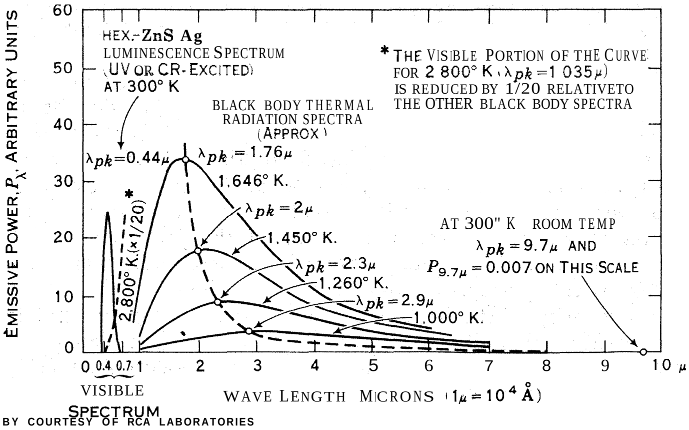

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FIG. 5.—THE ROOM-TEMPERATURE LUMINESCENCE EMISSION SPECTRUM OF A TYPICAL PHOSPHOR [HEX.-ZnS Ag(0 015), 1,250° C], AND THE THERMAL RADIATION SPECTRA OF A BLACK BODY AT VARIOUS TEMPERATURES

By varying the intensity of excitation, the relative height of the luminescence spectrum may be varied from zero to values much higher than the indicated black-body spectra. The black-body spectra are drawn to scale relative to each other

thermostimulated emission as a function of time of heating is called a glow curve.

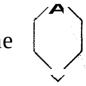
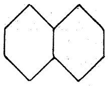
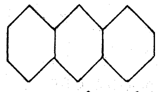
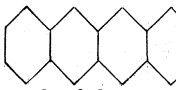
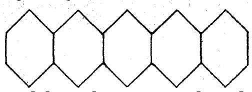
Light sums may be obtained by integration of photostimulation curves or thermostimulation curves. The conventional phosphorescence of a trap-type phosphor, at room temperature, is a thermostimulated phosphorescence.

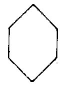
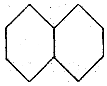
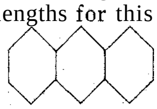
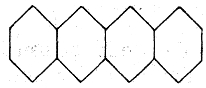
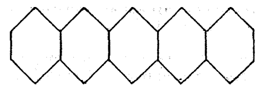
As shown in figs. 3 and 4, stimulation, which leads to luminescence emission, has its opposite in quenching, which converts stored excitation energy into heat. Quenching may be accomplished by having poison-type impurities in a phosphor, and then ejecting electrons so vigorously from traps that the electrons go far afield and encounter the poison sites. Incorporation of a trace of iron in hex.-ZnS:Cu:[Cl], for example. transforms the normal stimulation effect of broad-band infrared radiation into a rapid quenching of phosphorescence emission.

3. Emission Spectra of Phosphors, Cascading, **Sensitization.**—The sharp lines of emission from isolated atoms, as shown in fig. 2, become broadened when the excited atoms collide with other atoms. In a luminescent gas. the extent of the broadening increases with increasing temperature and density of the gas. In liquids and solids the alteration of energy levels is so pronounced that most, but not all, phosphor emission spectra are bands instead of lines at room temperature. The luminescence emission band of a hex.-ZnS:Ag:[Cl] phosphor is contrasted, in fig. 5, with the bands of thermal radiation obtained from matter at several different temperatures. Luminescence emission is a photon emission in excess of thermal radiation.

In contrast with thermal radiation: the intensity of luminescence emission generally decreases with increasing temperature, and the spectrum of luminescence emission is generally a narrow band of wave lengths whose shape and spectral location are relatively insensitive to changes in temperature. As shown in fig. 6, the emission spectrum of the luminescence centres in zinc sulfide crystals may be shifted gradually from the blue (curve 1) to the red (curve 8) by substituting increasing proportions of cadmium for zinc in the host crystal. This family of phosphors is typical of several other phosphor families in which the emission colour can be made to order by suitable choice of ingredients and conditions of preparation.

In kinescopes for black-and-white television for example, the luminescent screen is a mixture of microcrystals of a blue-emitting phosphor and a yellow-emitting phosphor. The blue-emitting phosphor is the one shown as curve 1 in fig. 6, while the yellow-emitting phosphor has a composition and emission spectrum between curves 6 and 7 in the same figure. Kinescopes for colour television have luminescent screens made of a blue-emitting hex.-ZnS:Ag:[Cl] phosphor, a green-emitting rbhdl.-Zn_2SiO_4:Mn phosphor and a red-emitting rhomb.-$Zn_3(PO_4)_2$:Mn phosphor. Inner coatings for white-emitting fluorescent lamps may be made of a blue-emitting monocl.-$MgWO_4$ phosphor mixed with a yellow-emitting rbhdl.-$(Zn{:}Be)_2SiO_4$:Mn phosphor, or of a single white-emitting phosphor, hex.-$3Ca_3(PO_4)_2\,CaF_2$:Sb:Mn. wherein the Sb centres emit blue light and the Mn centres emit yellow light.

Another example of a family of luminescent materials is the sequence of aromatic organic substances: benzene , naphthalene , anthracene , naphthacene  and pentacene 

Each of these ring-chain molecules is excited by photons in bands of wave lengths just below a certain demarcation wave length, and emits photons in bands of wave lengths just above the given wave length. The approximate demarcation wave lengths for this family are:  2,700 Å,  3,100 Å,  3,800 Å,  4,700 Å and  over 6,000 Å. Luminescence wave length increases progressively with increasing length of the molecule. just as the optimum wave length of a dipole antenna increases with increasing length of the antenna. Such an orderly unidimensional correlation is not observed in inorganic phosphors, whose centres generally involve a relatively small number of atoms bound in a multidimensional complex of host-crystal atoms.

It is possible to use luminescent materials in cascade, such that photons emitted by one material can be used to excite another material. In the preceding sequence of organic molecules, the emission from benzene. could excite naphthalene, whose emission could excite anthracene and so forth. Cascade luminescence is used in certain radar kinescopes that have composite luminescent screens made of a coating of a yellow-emitting hex.-(Zn:Cd)S:Cu:[Cl] phosphor covered with a coating of a blue-emitting her.-ZnS.Ag.[Cl] phosphor.

Electrons in the cathode-ray beam excite the blue-emitting phosphor whose photons excite the pello\?-emitting phosphor. The final phosphor has traps that provide long persistence of emission to retain the radar image for later observation. Direct excitation of the final phosphor by the cathode rays is unfavourable, because the highly energetic electrons in the beam heat the material and empty the traps too rapidly. Cascade luminescence may be accomplished, also. in a single phosphor by having two or more kinds of centres, such that the emission band of one centre overlaps the excitation band of another kind of centre.

There is another type of co-operative interaction, called sensi-

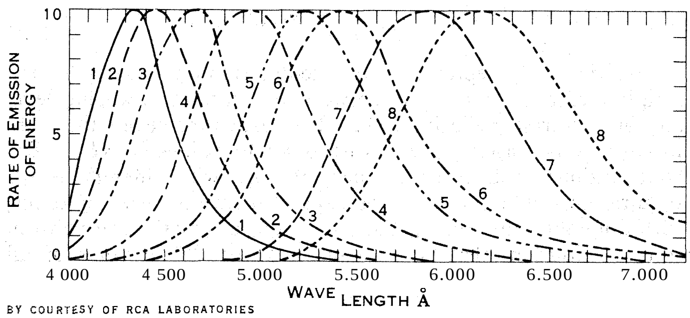


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FIG. 6.—SPECTRAL-DISTRIBUTION CURVES OF THE EMISSIONS OF SELECTED MEMBERS OF PHOSPHOR FAMILY (Zn:Cd)S:Ag(0.01), [NaCl(2)], 1.200° C

Curve		1	2	3	4	5	6	7	8
Mole proportions	ZnS	10	9·5	9	8	7	6	5	4
	CdS	0	0·5	1	2	3	4	5	6
Peak output excited by	6-kv. CR*	415	170	161	147	143	124	64	55
	3,650-Å UV*	217	148	114	109	110	99	60	47

*CR = cathode rays; UV = ultraviolet radiation tization, that can occur between different kinds of centres in a given host crystal. As an example, rbhdl.-$CaCO_3$:Mn emits orange light under excitation by cathode rays. but is not excited by 2,537-Å ultraviolet radiation, whereas the same orange light is emitted by rbhdl.-$CaCO_3$:Pb:Mn under the 2,537-Å ultraviolet irradiation. A mechanical mixture of the host crystals with the two activators incorporated separately gives no emission under ultraviolet irradiation, proving that cascade luminescence is not involved In the host crystal with both activators. the lead centres introduce a new excitation band into the host crystal and transfer absorbed energy to the manganese centres by an energy-exchange interaction that does not involve photon emission. A similar sensitization occurs in gases. For example, thallium gas alone is not excited by **2.537-A** photons, but when a little mercury gas is added. the mercury atoms are excited by the **2,537-A** photons and transfer their excitation energy to the thallium atoms on collision. In this indirect fashion. the thallium atoms are excited and they emit their characteristic spectral lines of radiation.

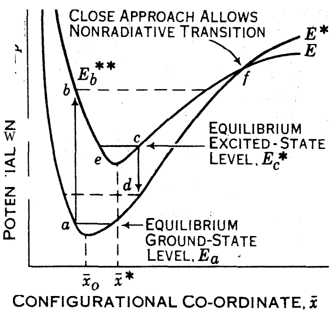
4. Solid-State Energy-Level Diagrams, Solid-State **Electroluminescence.**—The numerous emission lines of isolated atoms, as exemplified in fig. 2. contrast sharply with the single emission bands of centres in many crystalline phosphors, as exemplified in fig. 6. Luminescence in solids. therefore. requires description in terms of energy-level diagrams that differ considerably from the discrete-level diagram shown in fig. 1. Several kinds of diagrams have been evolved, and some have been found useful for general qualitative descriptions. The diagrams are not generally useful, however, for detailed, quantitative descriptions.

One type of solid-state energy-level diagram, shown in fig. 7, is adapted from the conventional diagram used to describe luminescence of an isolated diatomic molecule. As applied to a centre, the potential energy E_p of the centre is plotted as a function of the average distance $\bar{x}$ between the atoms. where $\bar{x}_0$ is the average interatomic spacing of the unexcited centre, and $\bar{x}^*$ is the average interatomic spacing of the centre in its lowest excited state. In a tetrahedral MnO_4 centre. for example. $\bar{x}$ would be the average distance between the central Mn atom and an oxygen atom at a corner of the tetrahedron. Higher allowed excited states are not shown.

At absolute zero of temperature, 0° K., the ground-state energy level would be nearly at the bottom of the lowest curve, corresponding to minimum amplitude of atomic vibration. At a higher temperature, such as room temperature. 300° K., the centre has considerable vibrational energy, and so the ground-state level lies higher, such as at a. If now, a bit of excitation energy approximating the energy represented by *b–a* is absorbed by the centre, the centre may be raised in energy into the excited-state level near E_b^{**}. The excited centre has a different electronic configuration than the unexcited centre, and the atoms of the excited centre readjust in about 10^{-12} sec. to a new equilibrium spacing $\bar{x}^*$ and excited-state level E_c^*. After the readjustment, the atoms may be arranged differently, with disproportionate changes in distances and angles from the central atom. The energy difference *b–c*, corresponding to the atomic readjustment,is given up as heat to the surrounding host crystal. With the centre in the excited-state level *c*, the length of time before there occurs a spontaneous radiative transition from *c* to *d* depends on the nature of the centre and its host-crystal environment, as indicated in Table II. After the centre has emitted the energy *c–d* as a photon of light, the electronic configuration has changed back to that of the unexcited centre, and the atoms again readjust in about 10^{-12} sec. to the original spacing $\bar{x}_o$, and ground-state level E_a, giving up the energy d–a as heat.

The radiative transition is practically independent of temperature, but the probability of a nonradiative transition to the ground state via $c \rightarrow f \rightarrow a$ increases exponentially with temperature, as discussed in connection with equation (13). The energy difference $f-c$ is equal to ΔE^* in equation (13). The observed decrease of luminescence efficiency with increasing temperature corresponds to a raising of the excited-state level *c* so that there is an increasing amplitude of interatomic vibration. When the highly agitated centre attains level f, the localized potential energy of the excited centre is converted into kinetic energy of atomic agitation that is dissipated away into the surrounding host crystal. If, at a given temperaturejthe energy $f-c$ is much less than $30kT$, then the centre quickly dissipates excitation energy by converting it into heat. When activator centres are located too near each other in a host crystal: they interact to reduce each others' energy f–c, thereby exerting a poisoning action on each other. A poison impurity atom exerts a similar debilitating action on a nearby activator centre. The diagram indicates, also, that a luniinescence centre that is efficiently radiative at low temperatures becomes increasingly nonradiative, and dissipative, as the temperature is raised. There are very few phosphors available for efficient operation at temperatures above about 400° C. An outstanding exception is a boron nitride phosphor that luminesces even when it is heated to a temperature above 1,100° C. In general. phosphors should be operated at as low temperatures as possible, with the exception of some trap-type phosphors that should be operated at temperatures high enough to eject excited electrons from the traps. Trapping, which is not indicated in fig. 7. corresponds to ionizing the centre and having the ejected electron caught in a remote potential well, of the type shown as the excited-state curve in fig. 7, except that radiative transitions do not occur in the trap.

Only one excited state is required to describe a single emission band. The apparent absence of higher excited states for radiative transitions is made plausible by assuming that such states correspond to ionization in the solid, or that only nonradiative transitions occur from other higher states below the ionization level. The width of the emission band, which can be of the order of an electron volt. is describable in terms of radiative transitions occurring from any point on the heavy excited-state curve below line c to any point directly below on the heavy ground-state curve. Additional band-broadening can be caused by differences of environment in the ensemble of centres in a given host crystal. Such differences may be caused by fluctuations in degree of thermal agitation, which alters level c, and by random distributions and perturbations of centres and other imperfections, including impurities. and displaced and omitted host-crystal atoms.



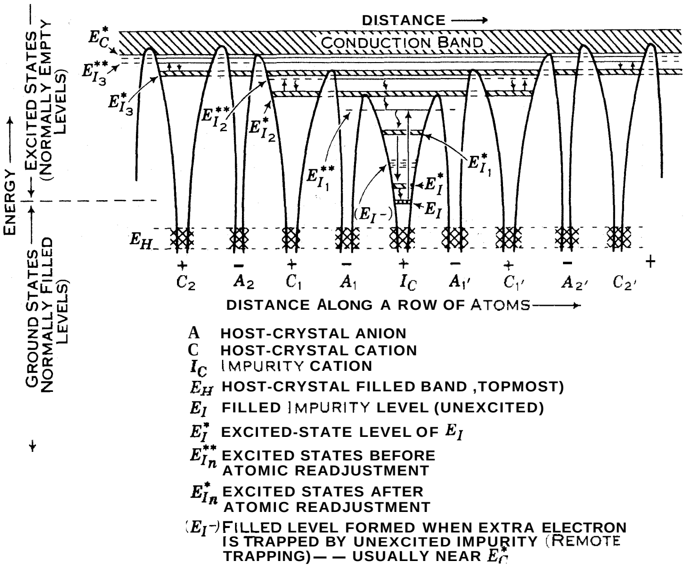
BY COURTESY OF RCA LABORATORIES

FIG. 7.— GENERALIZED ENERGY. LEVEL DIAGRAM OF A TYPICAL ACTIVATOR CENTRE AS A FUNCTION OF AVERAGED INTERATOMIC CONFIGURATION FOR THE GROUND STATE AND ONE (LOWEST) EXCITED STATE

Another type of energy-level diagram, shown in fig. 8. depicts the energy levels of a luminescence centre as a function of distance along a row of atoms in the crystal. This type of diagram indicates that the host-crystal energy levels are bands. The broadening of energy levels into bands is caused by interaction of electrons of all of the atoms in the crystal. There are about 10^{23} atoms per cubic centimetre in a crystal. and the Pauli exclusion principle permits only two electrons (of opposite spin) to occupy the same energy level in a given system (see QUANTUM MECHANICS). Each pair of electrons, therefore, must occupy a different energy level. Unlike the previous diagram, fig. 8 is drawn for a specific $\bar{x}$, and so one should imagine that the spacings and potential barriers between the atoms change with every energy change of the centre.

According to the given diagram, the activator atom I_C: (1) lowers the potential barriers between the neighbouring host-crystal atoms; **(2)** introduces an additional ground-state level E_I, occupied by an electron, into the forbidden zone of host-crystal energy; and **(3)** introduces one or more unoccupied excited-state levels E_I^* whose lateral extensions are short and thus localize excitation energy. The excitation transition $E_I \rightarrow E_{I_1}^{**}$ in fig. 8 corresponds to $a \rightarrow b$ in fig. 7, and the radiative transition $E_{I_1}^* \rightarrow E_I^*$ corresponds to $c \rightarrow d$. As drawn, this process is highly localized. and the spontaneous decay of luminescence emission is exponential with time, as represented by equation (9) in the absence of competing processes.

When the excitation energy is large, an electron can be raised into the ionization continuum. which is here called the conduction band E_C^*, where it moves away from the centre and out into the host crystal. The freed electron may be trapped, as previously discussed, by a remote imperfection from which it must be released by supplying additional energy. An electron so released can then return to an ionized centre, drop down to a radiative excited-state level, and make a radiative transition to the ground-state level. The foregoing ionization process may start with direct raising of a host-crystal electron in the normally filled band E_H up into the normally unoccupied conduction band E_C^*. The electron vacancy, called a positive hole, in the filled band can then wander through the host crystal, by an electron-exchange process until it encounters the unexcited activator centre I,. At that point, an electron from the filled level E_I of the activator can drop down to neutralize the positive hole. The activator atom is then in an ionized state and is ready to capture the excited electron in the conduction band. When trapping is involved in luminescence, phosphors may exhibit chiefly so-called power-law decays of emission intensity, such as are indicated in equations



BY COURTESY OF RCA LABORATORIES

FIG. 8.— GENERALIZED ENERGY-LEVEL DIAGRAM OF A PHOSPHOR LUMINESCENT CENTRE AS A FUNCTION OF DISTANCE ALONG A ROW OF ATOMS PASSING THROUGH THE CENTRE

(15) through (17), or they may exhibit initial exponential decays that trail off into power-law-decay tails. The spectral character of the emission is substantially constant during the decay time, even when there is a mixture of exponential and power-law decays. As is to be expected from fig. 8, electronic conduction occurs during the luminescences of trap-type phosphors, whereas little or no electronic conduction is observed when the luminescence decay of a phosphor is a simple exponential function of time, and is independent of temperature (equation [9] and fig. 7).

There are many mechanisms of luminescence excitation, because there are many ways of absorbing and transferring excitation energy. In photoluminescence, for example, the actions of excitation and emission may both occur in a given centre, or they may occur in separate sites with energy-transfer between the sites. Specifically, a single 3.4-ev ultraviolet photon may pass without loss of energy through a given phosphor host crystal until it is completely absorbed by a luminescence centre, which then emits one 2-ev photon of light. On the other hand, X-ray photons, and high-energy particles in general, excite atoms indiscriminately. The bulk of the energy of a high-energy particle is imparted in bit-wise fashion to the numerically preponderant host-crystal atoms. Energy transfer from the site of absorption to the luminescence centre can occur by several means, including mobile electrons, positive holes and excitons (paired electrons and positive holes). In cathodoluminescence, a single 20,000-ev cathode-ray electron gives up its energy stepwise and indirectly excites about 1,000 centres along its path in a phosphor crystal. Each excited centre then emits one photon of visible light (1.7- to 3.1-ev photons).

In another method of excitation, an alternating electric field is applied to special phosphor microcrystals embedded in a thin insulating layer of glass or organic material between two electrodes. A suitable phosphor for this purpose is hex.-ZnS:Cu:[I], which is made with a very high proportion of copper activator, and with careful incorporation of the iodine coactivator. In the completed phosphor, much of the copper is contained in the outer layers of the phosphor crystals. The copper-rich layers are apparently vital for absorption of energy from the applied electric field, and for conversion of the absorbed energy into a form suitable for transfer to the luminescence centres farther inside the crystals. Intense luminescence emission may be obtained by applying several hundred volts, at several thousand cycles per second, across a 0.01-centimetre-thick layer of hex.-ZnS:Cu:[I] microcrystals in castor oil. The phenomenon is a solid-state electroluminescence which has afforded sustained luminances higher than 1,000 millilamberts.

An analogous electroluminescence phenomenon occurs in gases on application of high-frequency, alternating, electric fields. Rarefied mercury gas, for example, luminesces visibly when it is subjected to millimetre-waves of electromagnetic radiation. At first glance, this phenomenon seems to violate the law of conservation of energy, because low-energy photons produce high-energy photons. Energy is conserved, however, because many low-energy photons must be absorbed to produce one high-energy photon. The process can start, when the electric field is applied, by accelerating some of the electrons and ions present in the gas, such as the charged particles produced by cosmic rays, or by electrification contact of gas atoms with the walls of the container, Some of the accelerated particles will have their directions reversed by elastic collisions with mercury atoms, so that on cyclic reversal of the electric field an accelerated-and-reversed particle is further accelerated. and so on until the energy of the particle becomes high enough to excite or ionize a mercury atom.

Solid-state electroluminescence may be produced also by injecting electrons and positive holes (extracting electrons) into a crystal from electrodes connected to a direct-current source. Referring to fig. 8, electrons may be injected into the conduction band E_C^*, and positive holes into the normally filled band E_H. The electrons and positive holes can recombine across the entire width of the forbidden band $E_C^*-E_H$ to produce recombination radiation characteristic of the host crystal, with $h\nu=E_C^*-E_H$, or they can recombine through a luminescence centre to produce radiation characteristic of the centre. Radiations resulting from recombination-transitions, across the forbidden band and in centres, have been observed in crystals of elemental germanium and silicon, and in crystals of compounds such as silicon carbide and cadmium sulfide. Another variation of electroluminescence occurs at the surfaces of oxidized electrodes, particularly aluminum electrodes, during electrolysis. This phenomenon, which is sometimes called galvanoluminescence, was observed by F. Braun in 1898.

5. Efficiency and Luminance. — Efficiency of luminescence, on both a quantum and energy basis, can approach 100% for resonance excitation and radiation of isolated atoms in a rarefied gas. Under these ideal conditions, each absorbed primary photon excites an atom that then emits a luminescence photon of the same energy as the primary photon. The input and output quanta are nearly identical in number and energy. When the energy of the primary particle is greater than that of the emitted photon, however, the energy efficiency is decreased. In the off-resonance condition, there is less effective coupling between the primary excitant and the system to be excited, and at least part of the energy difference is dissipated as heat. Heat losses are aggravated in condensed luminescent materials, such as liquids and crystals. When phosphors are excited by high-energy particles, as

in kinescopes, X-ray fluoroscope screens, and scintillation-counter crystals, the energy efficiency of the process is usually less than about 20%. The remaining 80% or more of the input energy is wasted as heat. Solid-state electroluminescence, and the electroluminescences of gases excited by radio-frequency waves, is also relatively inefficient, with over 90% of the absorbed energy usually dissipated as heat. In a gas excited by millimetre-wave radiation, much of the input, small-quantum energy is converted into atomic motion when the accelerated charged particles collide with atoms. There is a major technical challenge in the problem of attaining high efficiency of luminescence when the energy of the input excitation quanta differs greatly from the energy of the quanta of emitted radiation.

The emission intensities, or radiances, of luminescent materials are limited chiefly by the excitation intensity and by the numerical density and excited-state lifetime of the radiative centres that participate in luminescence. Intensities of visible emission greater than 10^7 millilamberts have been obtained from certain cathodoluminescent phosphors under short pulses of cathode rays. A luminance of 10^7 millilamberts corresponds to the emission of over 10^{20} photons per square centimetre per second. Under sustained excitation, however, the average luminance of cathodoluminescent materials may not exceed about 10^5 millilamberts without unduly heating the material and decreasing its efficiency and output. For comparison purposes, the luminance of fresh sno in full sunlight is about 10^4 millilamberts, an intensity that is painful to the eye. The radiances of luminescent materials after excitation are determined by their decay characteristics and light sums under the operating conditions.

It is likely that the intensity of phosphorescence emission first observed by Cascariolo, an hour or more after excitation, was less than 0.0001 millilambert. From that feeble beginning, research has achieved such commonplaces as television kinescopes, uith luminances of about 30 millilamberts. and fluorescent lamps, with luminances exceeding 3.000 millilamberts.

The practical uses of luminescence are many, and their number continues to increase. From the scientific standpoint, luminescence is uniquely useful as an instantaneous detector of invisible energetic particles, and as an ultrasensitive indicator of changes of composition, structure and atomic interactions in many different materials. See also BIOLUMINESCENCE; LIGHT.

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LUMPSUCKER or LUMPFISH (*Cyclopterus lumpus*), a marine fish, of the small family Cyclopteridae. The lumpsuckers have the ventral fins united into a circular concave sucker which enables them to attach themselves firmly to rocks or stones. The body is short and thick with a thick, scaleless skin covered with rough tubercles. The first dorsal fin is a mere lump on the back. The lumpsucker inhabits the coasts of both sides of the North Atlantic; it is not rare on the British coasts, but becomes more common farther north. In the spring the fish approaches the shores to spawn, clearing out a hollow on a stony bottom in which it deposits an immense quantity of pink-coloured ova. The male guards the spawn very assiduously until the young are hatched. A lumpsucker may weigh as much as zo lb. The male is only one-half or one-third the size of the female, and during the breeding season becomes bright blue, with red below. The bones are soft and contain little inorganic matter.

LUNA, ALVARO DE (d. 1453), constable of Castile, grand master of Santiago and favourite of King John II of Castile. was the natural son of Alvaro de Luna, a Castilian noble. Sent to court as a page by his uncle. Pedro de Luna, archbishop of Toledo, in 1410, he early acquired an ascendancy over the young prince. When Ferdinand, John's uncle. was elected king of Aragon, and the regency remained in the hands of the king's mother, Constance, daughter of John of Gaunt. Alvaro became a very important person. He was a master of all the accomplishments the king admired—a fine horseman, a skillful lance and a writer of court verse. Until he lost the king's protection he was the central figure of the Castilian history of the time. His story is in the main one of expulsion from the court by victorious factions and of his return when his conquerors fell out among themselves. Expelled in 1427, he was recalled to court in 1428; in 1431 he sought to employ the turbulent nobles in a war for the conquest of Granada. Some successes were gained, but a consistent policy was impossible with a rebellious aristocracy and a king of indolent character. In 1445 the Infantes de Aragon, Alvaro's main enemies, were beaten at Olmedo, and the favourite, who had been constable of Castile and count of Santesteban since 1423, became grand master of Santiago by election of the knights. His fall was caused by Isabella of Portugal, the king's second wife, who urged her husband to free himself from slavery to his favourite. In 1453 Alvaro was arrested and executed at Valladolid on June 2, 1453.

LUNACHARSKY, ANATOLY VASILIEVICH (1875–1933), Russian politician, author and dramatist. was born in Poltava of well-to-do parents. He joined the revolutionary movement when at college in Kiev, and afterward studied natural science and economics at Zurich. He began his revolutionary activities in Russia in 1892 and was deported to Vologda in 1898, where he remained for three years, achieving a reputation as a brilliant writer and lecturer on socialism. In 1903 Lunacharsky joined the Bolshevik wing of the Social Democratic party. He met Lenin in the following year. and joined the editorial staff of the Bolshevik *Vpered* ("Forward"). He was chiefly concerned with Social Democratic propaganda and with lectures and political meetings for Russian students and political refugees abroad. During the revolution of 190j Lunacharsky was imprisoned. and when the reaction set in he left Russia for Italy. Together with Gorky and Bogdanov, a well-known Social Democrat, he formed the so-called left wing of Bolshevism (opposed to Lenin on theoretical points), and was one of the promoters of the Social Democratic party schools at Capri and Bologna.

During World War I Lunacharsky maintained a determined internationalist attitude, and disseminated violent antiwar propaganda in Paris and Switzerland, renewing closer contact with the Lenin group after a temporary estrangement. In March 1917 he joined Lenin and Trotsky in Russia. He was arrested after the Bolshevik rising in July; but was subsequently liberated. In the initial stages of the November revolution and during the civil war, Lunacharsky was one of the ablest speakers of the party, and acted as emissary of the military revolutionary council to the various war fronts.

As people's commissar for public instruction, 1917–29, in the new government, Lunacharsky ensured the preservation of works of culture and art during the civil war. He promoted mass instruction, while his special concern for the welfare of the theatre furthered the development of the Russian stage.

Lunacharsky wrote 14 plays (published in 2 vol.), of which several were produced with conspicuous success in Russia and in Berlin. *Vasilisa* the Wise, Faust and the City and The Magi were translated into English by Leonard Magnus and published under the title of Three Plays (1923). He was appointed ambassador to Spain in 1933. He died Dec. 26, 1933.

LUNACY: see INSANITY.

LUNARDI, VINCENZO (1759–1806), pioneer balloonist who made the first aerial voyage in Great Britain. Born in Lucca, Tuscany, Jan. 11, 1759, he became secretary to the Neapolitan envoy in London and took a keen interest in balloons. On Sept. 15, 1784, he ascended in his hydrogen-filled balloon from the artillery ground at Moorfields, London, taking a cat, a pigeon, various equipment and provisions. He barely touched down at North Mimms (where the cat was left) and finally landed at Standon near Ware, in Hertfordshire; he covered 24 mi. in 2 hr. 15 min. He was the hero of the day, and went on to make other flights. The first Englishwoman to fly, Letitia Ann Sage, was to be his most distinguished passenger, with George Biggin; but on June 29, 1785, the balloon would not lift all three, and Lunardi sent his two passengers off together to make a successful journey to Harrow. Lunardi died in Lisbon, Port., July 31, 1806.

See J. E. Hodgson, *The History of Aeronautics in Great Britain* (1925), pp. 117–139. (*C.* H. G.-S.)

LUNATION, the period of return of the moon (luna) to the same position relative to the sun; for example, from full moon to full moon. Its duration is 29.5305884 days (see MOON).

LUND, a city of Sweden, in the district (*län*) of Malmohus, 10 mi. N.E. of Malmo by rail. Pop. (1950) 33.828. Lund (*Londinum* Gothorum), the "Lunda at Eyrarsund" of Egil's saga. was of importance in Egil's time (c. 920). In the middle of the 11th century it was made a bishopric, and in 1103 the seat of an archbishop who received primatial rank over all Scandinavia in 1163, but in 1536 Lund was reduced to a bishopric. Close to the town, at the hill of Sliparabacke, the Danish kings received the homage of the princes of Skane. A university was founded there in 1668 by Charles XI, with faculties of law, medicine, theology and philosophy. Its library is entitled to receive a copy of every work printed in Sweden. The folk museum near the university with its reconstructed old houses is important. The chief industries are sugar refining, iron- and brickworks and the manufacture of furniture and gloves.

LUNDY, BENJAMIN (1789–1839), U.S. philanthropist, prominent in the antislavery conflict, was born at Hardwick, N.J., on Jan. 4, 1789. From 1808 to 1812 he lived at Wheeling, Va. (now W.Va.), an important headquarters of the interstate slave trade. There he first became deeply impressed with the evils of the institution of slavery. In 1815 he organized an antislavery association, known as the Union Humane society. In 1821 he founded at Mount Pleasant, O., an antislavery paper, the Genius of Universal Emancipation, which he edited at irregular intervals and in diverse places until his death.

From Sept. 1829 until March 1830 Lundy was assisted in the editorship of the paper by William Lloyd Garrison (*q.v.*). Lundy traveled extensively on behalf of the cause, visiting Haiti twice, in 1825 and 1829, the Wilberforce colony of freedmen and refugee slaves in Canada in 1832 and Texas three times, 1830–31, 1833–34 and 1834–35. These visits were made, in part, to find a suitable place outside of the United States to which emancipated slaves might be sent. He was bitterly denounced for his antislavery agitation, and in Jan. 1827 was assaulted and seriously injured by a slave trader, Austin Woolfolk.

He was closely associated with John Quincy Adams in an effort to prevent the annexation of Texas. In 1836–38 Lundy edited in Philadelphia a new antislavery weekly, the National Enquirer, which under the editorship of Lundy's successor, John G. Whittier, became the Pennsylvania Freeman. The last year of his life Lundy spent in Illinois where he died Aug. 22, 1839. (R. F. N.)

LUNDY, an island, with two lighthouses, at the entrance to the Bristol channel, 12 mi. N.N.W. of Hartland point on the north coast of Devon, Eng. Pop. (1951) 43. Area 1.6 sq.mi. It is granite, except for some slate in the south, and an extreme elevation of about 450 ft. is found in the southern half. Most of the coast is cliffbound. The landing (southeast) is sheltered by small Rat Island, where the once common black rat survives.

Puffins and other sea birds breed on Lundy. The island, held at least from the reign of Henry II to about the 14th century by the turbulent and piratic Marisco family, has been captured by the Turks, Spaniards and by various pirates. In the 17th century it became a hiding place for French privateers.

LÜNEBURG, a town in the former Prussian province of Hanover and after 1945 in Lower Saxony, Ger., near a small hill named the Kalkberg, on the Ilmenau, 14 mi. above its confluence with the Elbe and 30 mi. S.E. of Hamburg. Pop. (1950) 58,139.

Luneberg existed in the days of Charlemagne, and gained importance after the erection of a convent and a castle on the Kalkberg in the 10th century. After the destruction of Bardowiek, then the chief commercial centre of north Germany, in 1189, Luneburg inherited much of its trade and subsequently became one of the principal towns of the Hanseatic league. Having belonged to the duchy of Saxony it was the capital of the duchy of Brunswick-Liineburg from 1235 to 1369; later it belonged to one or other of the branches of the family of Brunswick. The reformed doctrines were introduced into the town in 1530, and it suffered heavily during the Thirty Years' War. It reached the height of its prosperity in the 15th century, and in the 17th century it was the depot for much of the merchandise exported from Saxony and Bavaria to the mouth of the Elbe; after a period of decay the 19th century witnessed a revival of its prosperity. In 1813 the German war of liberation was begun by an engagement with the French near Luneburg.

The gypsum and lime quarries of the Kalkberg afford the materials for cement works. Other industries are the making of beer, spirits, chemicals, ironware, carpets and haircloth.

LÜNEBURGER HEIDE, a region of Germany, in Lower Saxony, lying between the Aller and the Elbe. Its main character is that of a broad saddleback, running for 55 mi. from southeast to northwest (greatest height, Wilseder Berg, 554 ft.). The soil is quartz sand and is chiefly covered with heather and brushwood. In the north and in the deep valleys there are extensive forests of oak, birch and beech, and in the south of fir and larch. Its main products are sheep, potatoes, bilberries, cranberries and honey. The region is also remarkable for numerous megaliths, popularly called Hun graves. It has an area of 2,852 sq.mi.

LUNETTE, a crescent-shaped or semicircular object. In architecture the term is applied to any semicircular shape or panel which is decorated, and especially to those which occur under semicircular arches or vaults. By extension, the term is used of small vaults intersecting a larger vault at right angles, especially if used for lighting the larger vault, as in the clerestories of St. Paul's cathedral in London and St. Peter's in Rome. Oval or circular openings through any vault are also sometimes known as lunettes.

LUNEVILLE, an industrial and garrison town of northeastern France, capital of an arrondissement in the *département* of Meurthe-et-Moselle, 21 mi. E.S.E. of Nancy. Pop. (1954) 20,-512. The name of Lunéville (Lunae villa) is perhaps derived from an ancient cult of Diana, the moon goddess, a sacred fountain and medals with the effigy of this goddess having been found at Léormont, about 2 mi. E. of the town. Lunéville belonged to Austrasia and, after various changes, fell in 1344 to the house of Lorraine. A walled town in the middle ages, it suffered in the Thirty Years' War and in the campaigns of Louis XIV from war, plague and famine. The town flourished again under Dukes Leopold and Stanislas, on the death of the latter of whom, at Lunéville, Lorraine was united to France (1766). The principal industries of Lunéville include cotton spinning and various manufacturing industries. Trade of the area is in grain, wine, tobacco, hops, cotton goods, etc.

LUNG, in anatomy, the name of each of the pair of organs of respiration in man and other air-breathing animals, the organs in fishes with the corresponding function being the gills. See RESPIRATORY SYSTEM, ANATOMY OF.

LUNG, DISEASES OF comprise all those disorders affecting the lungs. Other diseases of the chest are discussed in RESPIRATORY SYSTEM, DISEASES OF and PLEURA, DISEASES OF.

Lung Cancer.—Cells of the membrane lining the air passages in the lung undergo a change which leads to uncontrolled cell growth. The result is a malignant tumour which invades and destroys contiguous structures, blocks the air passages and spreads from its point of origin through the lymph channels and the blood stream to other parts of the body with results invariably fatal unless the growth is removed at an early stage. Bronchogenic cancer may be detected by the conventional chest X-ray examination, but the shadows cast by early symptomless cancers, often resembling harmless conditions, are difficult to identify. Thorough medical examination and sometimes exploratory surgery is necessary.

The remarkable increase in lung cancer during the 20th century has caused great concern throughout the world. It has become the most frequently encountered malignant tumour in men, occurring five to ten times more frequently in men than in women. Multiple causative factors may be involved, but the carcinogenic (cancer-causing) chemicals known to be present in the products of combustion are probably of greatest importance. Foremost among the fumes of combustion which enter the human lung in concentrated form is tobacco smoke, and statistical data are available to indicate that smokers are peculiarly susceptible to bronchogenic carcinoma. The gaseous wastes from combustion of motor fuels and other atmospheric pollution have been accused of causing the high incidence of lung cancer in large cities. (See also CANCER.)

Tuberculosis.—Although tuberculosis has diminished as a cause of death in most countries where hygienic conditions are optimal, it has diminished less rapidly than other preventable infectious diseases. In some countries it remains a principal cause of disability and death and is a serious social and economic drain upon human resources.

Diagnosis of tuberculosis requires routine chest X-ray examinations of well-appearing persons, especially if a positive reaction to the tuberculin skin test has occurred. Shadows on the X-ray film suggesting tuberculosis require general examination and study of sputum and blood for other indications of active infection. Some cases of inactive tuberculosis or those of uncertain activity must be examined repeatedly for many months or years to detect the earliest evidence of activity.

Treatment of active tuberculosis requires the administration of two or more of the several potent antituberculosis drugs. Isoniazid, streptomycin and PAS (para-aminosalicylic acid) are the most commonly used and most safe and effective drugs in treatment of tuberculosis. Treatment is ordinarily prolonged long after every indication of activity has disappeared, two years of specific drug therapy being frequently recommended. Surgical treatment of tuberculosis is necessary to remove areas of infected lung which cannot be treated successfully with drugs alone. Lung collapse, once a popular procedure in the opinion of many specialists, is necessary only in unusual cases.

The prevention of tuberculosis requires that contagious cases be diagnosed promptly and treated successfully, remaining segregated during the period of communicabilitv. Vaccination with bacilli of low virulence, such as the BCG strains, produces some degree of immunity, and such vaccination is desirable in those countries which lack adequate facilities for treatment and isolation of communicable tuberculosis. It is not generally recommended in countries where high standards of hygiene are maintained. (See also TUBERCULOSIS.)

Pneumonia and Pneumonitis.—Inflammation of the lungs, ordinarily acute and extensive, is called pneumonia. Less severe inflammation with less consolidation (filling of air spaces with exudate) is sometimes called pneumonitis. Many inflammatory agents can produce pneumonia, but bacteria and viruses are of greatest importance. Of the many bacteria which alone or in combination may cause pneumonia, the pneumococcus is best known and most often productive of very acute and dense consolidation of one or more lobes (lobar pneumonia).

Diagnosis frequently can be made by physical examination, but X-ray examination is necessary to follow the course of the disease and to detect complications. Distinction between lung cancer, tuberculosis, fungus infections and slowly resolving pneumonia may be very difficult. Treatment of the bacterial pneumonias with antibacterial drugs (antibiotics and other chemotherapeutic substances) is usually successful, and their use has resulted in a greatly diminished mortality rate, especially in cases of pneumococcus pneumonia. Treatment of the virus-caused pneumonias is less specific, but these infections are less likely to cause death and complications are rare. (See also PNEUMONIA.)

Fungus Infections.—Specific treatment (Amphotericin B) is available for serious cases of fungus infections. Coccidioidomycosis in certain dry areas (especially southwestern U.S.) and histoplasmosis of moist climates frequently cause no recognized symptoms but occasionally cause serious disease, sometimes confused with tuberculosis and cancer of the lung. Blastomycosis, cryptococcosis (torulosis) and actinomycosis are rare and often serious infections. (See also FUNGUS INFECTIONS.)

Emphysema.—Overinflation of the lung, an inability to exhale air from the abnormally dilated terminal air sacs (alveoli), is the essential feature of the usual type of pulmonary emphysema. It is attributed to loss of lung elasticity and to obstructive changes in the finer air passages. The obstruction is either of inflammatory origin or due to spasm of the involuntary muscles which encircle the smaller bronchi. Very prolonged and recurrent bronchial asthma and excessive tobacco smoking are among the recognized causes of pulmonary emphysema. The symptom of progressive shortness of breath on exertion, associated with an abnormally rounded chest (barrel chest), with or without wheezing respiratory sounds, most frequently prompts the patient to seek diagnosis and treatment. Unfortunately treatment is often ineffective when the condition is advanced, and prevention of further injury is all that the physician can hope to accomplish. (See also EMPHYSEMA.)

Bronchiectasis.—Bronchiectasis is a common disorder characterized by dilatation of the bronchi of one or more of the lung segments. Infection often becomes implanted in these bronchi where secretions stagnate. Symptoms of infection with cough, expectoration and recurrent episodes of lower respiratory tract infection are common. Bleeding from the lung is not uncommon. Medical treatment may yield temporary relief, but removal of the diseased segments is necessary for cure. (See also BRONCHIECTASIS.)

Pulmonary Embolism.—Blood may clot within the veins, especially leg veins, under abnormal conditions (thrombosis). If the clot (thrombus) becomes dislodged and is carried to the lungs it lodges in an artery of the lung and is called an embolus. A large embolus may interrupt blood flow and cause almost instantaneous death; small emboli cause less serious manifestations. Thrombosis and embolism occur most commonly after prolonged illness, certain surgical manipulations, fractures and prolonged immobilization. Obesity, varicose veins, advanced age and heart failure are additional predisposing factors. (See also THROMBOSIS AND EMBOLISM.)

Miscellaneous Disorders.—Prolonged inhalation of harmful dusts, especially silicon dioxide and asbestos, may cause permanent lung injury. Mild or severe temporary injury may result from inhalation of irritating fumes (pulmonary edema). (See also DANGEROUS OCCUPATIONS; PNEUMONOCONIOSIS.) Lung trauma in wartime and in such injuries as occur from automobile accidents may cause lung puncture and other impairments of function requiring emergency treatment to prevent early death. Lung abscess is usually attributed to inhalation of contaminated and irritating materials such as vomitus and to bronchial obstruction from cancer. foreign body. etc. Many malignant growths, some generalized infections and such disorders as the collagen diseases, sarcoidosis, allergic conditions and parasitic infestations may involve the lungs as well as other organs. See also HEART AND LUNG, SURGERY OF.

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(H. C. H.; H. C. Hw.)

LUNGCHOW (LUNGTSIN), a town in the province of Kwangsi, south China, near the frontier of Tonkin (Vietnam). It was opened to foreign trade in 1889 in the hope of building a railway from Tonkin to Kwangsi, but the Tonkin railway terminated at the frontier so trade remained insignificant. After the fall of Canton in 1938 and the strengthening of the Japanese sea blockade, efforts were made to complete the railway to Hengyang, and a brief trade increase resulted. In 1940 the Japanese attacked Lungchow and occupied it, but the Chinese recaptured it the same year.

LUNGFISH, a name given to the fishes of the order Dipneusti (double breathers), with gills and with the air bladder closely resembling the lung of higher vertebrates, and used for breathing air. Neoceratodus of Queensland only occasionally comes to the surface to breathe air. The Lepidosirenidae, including Protopterus of Africa and Lepidosiren of South America, inhabit swamps and marshes and rise to breathe air at frequent intervals; in the dry season, when the swamps dry up, the fishes curl up and sleep at the bottom of a burrow, the entrance to which is closed with a plug of mud, with one or more openings for the admission of air. It may be noted that fishes of other groups have the air bladder primitive and lunglike in structure and use it for breathing air, particularly the African Polypterus. See FISHES.

LUPERCAEIA, an ancient Roman festival. Its rites were under superintendence of a corporation of priests called Luperci, whose institution is attributed either to Evander (*q.v.*) or to Romulus (*q.v.*) and Remus. But the festival itself, which was held on Feb. 15, contains no reference to these late fictions. It began with the sacrifice by the Luperci of goats and a dog, after which two of the Luperci were led to the altar, their foreheads were touched with a bloody knife and the blood wiped off with wool dipped in milk; then the ritual required that the two young men laugh.

The sacrificial feast followed, after which the Luperci cut thongs from the skins of the victims and ran in two bands round the walls of the old Palatine city. A blow from the thong was supposed to cure sterility. The celebration of the festival went on until A.D. 494, when it was changed by Pope Gelasius I into the feast of the Purification.

The Luperci were divided into two colleges, called Quinctiliani (or Quinctiales) and Fabiani, from the gens Quinctilia (or Quinctia) and Fabia; at the head of each of these colleges was a magister. In 44 B.C. a third college, Luperci Iulii, was instituted in honour of Julius Caesar, the first magister of which was Mark Antony. In imperial times the members were usually of equestrian standing.

The ritual is apparently in honour of no god; Lupercus, whom authorities sometimes name, seems a mere invention, Faunus is a guess of the moderns.

LUPINE, any plant of the genus *Lupinus,* which comprises more than zoo species of annual and perennial herbaceous plants of the pea family (Leguminosae).

Native American species (*Lupinus perennis* and related species) with digitate leaves are found in moist fields and grassy hills along the cool Pacific coast from British Columbia to northern Chile. A few species occur in the Mediterranean regions. Others, with single leaflets, are found in Brazil and eastern North America. Many of these are good subjects in the wild garden.

The species of which earliest mention is made is probably L. *termis,* which was cultivated by the ancient Egyptians. It is wild in some parts of the Mediterranean area and is extensively cultivated in Egypt. Its seeds are eaten by the poor after being steeped in water to remove their bitterness. The lupine of the ancient Greeks and Romans was probably L. *albus,* which is extensively cultivated in Mediterranean countries for forage, for soil enrichment and for its round flat seeds, which form an article of food. Yellow lupine (L. *luteus*) and blue lupine (L. *angustifolius*) are also cultivated in Europe as farm crops for green manuring. L. subcarnosus, the state flower of Texas, is the bluebonnet.

The flowers, borne on long spikes above the dark-green foliage, are of the usual pealike form and range in colour from white, yellow and shades of pink to blue and purple. Grown chiefly for ornamental purposes in the U.S. and especially in England (where the climate is very favourable), the one- to five-foot plants are well adapted to borders and beds and are beautiful as cut flowers. Numerous garden hybrids of unknown parentage have been developed and are easily cultivated in any rich light sandy soil (neutral to acid) in full or partial sun. Perennials, including the fine Russell hybrids, should be seeded in summer and given adequate winter protection for flowering the following summer. The roots of young plants may be divided in very early spring. Annuals are best sown in place early in the spring. As with all leguminous plants, inoculation with nitrogen-fixing bacteria encourages root nodules and increased vigour.

LUPUS is a term applied to certain diseases which characteristically involve the skin. The important variety is lupus erythematosus, the cause of which is not known. The commonest type is discoid lupus, characterized by lesions on the nose and cheeks arranged in a butterfly pattern. The patches are reddish and may be covered with superficial scales, associated with follicular plugging and in the healing stages with atrophy and scarring. Occasionally, the patient with the chronic discoid form may suddenly develop acute systemic manifestations.

The systemic form of lupus erythematosus has varied manifestations associated with lesions of connective tissue in the vascular system, the dermis and the serous membranes. There is usually a prolonged course characterized by exacerbations and remissions over years, during which many systems of the body may be involved. The characteristic laboratory feature is the antinuclear antibodies found in the gamma globulin portion of the serum. Arthritis and kidney disease are commonly present. The active manifestations of the disease usually can be controlled by adrenocortical steroid therapy, but this is not curative. Certain antimalarial drugs such as chloroquine are reported to be helpful, particularly in the discoid type.

Lupus vulgaris, tuberculosis of the skin, occurs chiefly on the face, about the nose, cheeks or ears, but may affect the skin of the body or limbs. The lesions are small nodules covered with thin crusts which may ulcerate, leaving disfiguring scars. Treatment is with antituberculous chemotherapy and the prognosis is excellent. (A. M. HY.)

LUQMAN or **LOKMAN,** the name of two, if not of three, persons famous in Arabian tradition. The first was of the family of 'Ad, and is said to have built the great dike of Marib and to have received the gift of life as long as that of seven vultures, each of which lived 80 years. The name of the second Luqman, called "Luqmān the Sage," occurs in the Koran (31, 11). Two accounts of him are found. According to Masudi (i. 110) he was a Nubian freedman who lived in the time of David. According to some commentators on the Koran he was the son of Ba'ura, one of the sons of Job's sister or maternal aunt. Derenbourg in his Fables de *Loqmân le* sage (1850) identifies Ba'ura with Beoi, and believes the name *Luqmān* to be a translation of Balaam. The grave of Luqman was shown on the east coast of the lake of Tiberias, also in Yemen.

The so-called Fables of *Luqmān* are known to have existed in the 13th century, but are not mentioned by any Arabian writer. They were edited by Erpenius (1615) and have been reprinted many times. For the relation of these to similar literature in other lands, see J. Jacobs's edition of Caxton's Fables of Aesop, vol. i (1889).

LURAY CAVERN, a large limestone cave in Page county, Va., U.S., near the town of Luray. The largest cave in the state, it embraces a total of 64 ac., of which 27 are open to the public.

After 1878 when it was discovered, wide natural corridors and the installation of indirect lighting have revealed its beauties to millions of tourists.

Luray cavern was formed millions of years ago by underground rivers and seepage of acid-bearing water through layers of limestone and clay. In time the clay was washed away, leaving only the limestone shell. Long after the formation of the cavern and after many stalactites had developed from the dripping of water impregnated with lime, the excavation was completely filled with glacial mud. This mud was charged with acid which eroded the dripstone and altered its shape. When the mud was subsequently removed by flowing water the older eroded forms remained alongside the new growth. This turbulent history has made the striking display of many-hued stalactites, stalagmites, columns and cascades one of the most remarkable in the world, including massive columns wrenched from their perpendicular position and hurled on the floor. Clear water, apparently containing no forms of life, is found in basins up to 50 ft. in diameter and 15 ft. in depth. The temperature in the cave remains at 54° F. throughout the year. Of particular interest is the "stalacpipe" organ which substitutes carefully selected stalactites for organ pipes. (G. M. Be.)

LURGAN, a market town and municipal borough of County Armagh, N.Ire., 21 mi. S.W. of Belfast. Pop. (1951) 16,183. It is a modern town, taking its rise from a grant of land made by James I to William Brownlow, and in 1619 it consisted of 42 houses all inhabited by English settlers. Lurgan shared in the vicissitudes of subsequent Ulster history. It became a manufacturing town, carrying on all branches of the linen industry; and knitwear, handkerchiefs and optical goods also are made there. In 1839 the Brownlow family received the title of Baron Lurgan.

LURIA, ISAAC BEN SOLOMON (1534–1572), Jewish mystic, was born in Jerusalem. From his German descent he was surnamed *Ashkenazi* ("the German"). In 1559 Luria was living in Cairo and trading as a spice merchant with his headquarters in Alexandria. He had come to Egypt as a boy after his father's death, and was brought up by his wealthy maternal uncle Mordecai Francis.

When Luria was 17 a copy of the Kabbalistic "Bible"—the *Zohar* of Moses de Leon (*q.v.*)—came into his hands. In order to meditate on the mystic lore he withdrew to a hut by the Nile, returning home for the Sabbath. It is said that Elijah, who had been his godfather in his babyhood, now paid him frequent visits, initiating him into sublime truths. By night Luria's soul ascended to heaven and conversed with celestial teachers who had once been men of renown on earth.

In 1566 at the earliest Luria removed to Safed, where there was a large circle of Talmudists in existence. He died at Safed in 1572. But these six years were momentous for Judaism. Luria founded a school of mystics who powerfully affected Judaism after the master's death.

The Holy Spirit, we are told, rested on him, drawn to him by the usual means of the mystics—self-flogging, ablutions and penance. He had wonderful gifts of insight, and spoke to the birds. Miracles abounded. He went on long walks with enthusiastic disciples, whom he taught without books. Luria himself wrote no mystical works; what is known of his doctrines and habits comes chiefly from his Boswell, Hayim Vital.

There was little of originality in Luria's doctrines; the theory of emanations, the double belief in the Process of the Divine Essence as it were self-concentrating (*Zimzum*) and on the other hand as expanding throughout creation; the philosophical "scepticism" which regards God as unknowable but capable of direct intuition by feeling—these were all common elements of mystical thought.

Luria was an inspirer of saintly conduct rather than an innovator in theories. Not beliefs, he said, but believers need rebirth. He or his school introduced innumerable ritual customs.

LURISTAN, in the more restricted sense, a former province of Iran, from 1938 part of Iran's sixth province, or *ostan;* in the wider sense, the "land of the Lurs," namely that part of western Iran which was bounded by Iraq on the west and extended for about 400 mi. S.E. from Kermanshah with a breadth of 100 to 140 mi. The area is chiefly mountainous, being intersected by numerous ranges running northwest-southeast. The central range has many summits, rising to 13,000 ft. and more, and in it are the sources of Iran's most important rivers. Between the higher ranges are many fertile plains and low hilly districts.

The Lurs are thought to be aboriginal Persians with a mixture of Arab blood. Their language is a dialect of Persian. Outwardly Moslems of the Shia sect, most of them showed little veneration for either prophet or Koran. The northern part of Luristan is inhabited by the Feili Lurs, divided into the Pishkuh (cismontane) Lurs in the east and the Pushtkuh (ultramontane) Lurs in the west adjoining Iraq.

Little Luristan was governed by independent princes of the Khurshidi dynasty, called atabegs, from 1155 to the beginning of the 17th century when the last atabeg, Shah Verdi Khan, was removed by Shah Abbas I, and the government of the province given to Husain Khan, the chief of a rival tribe, with the title of vali. The descendants of Husain Khan retained the title. The southern part of Luristan, known as Luri-i-Buzurg (great Luristan), was composed of the Bakhtiari district of the province and the districts of the Manasani and Kuhgalu. Great Luristan was an independent state under the Fazlevieh atabegs from 1160 until 1424, and its capital was Idaj, now only mounds and ruins at Malamir, 60 mi. S.E. of Shushtar.

Luristan acquired fame in 1929 and immediate subsequent years when local diggers discovered powerfully designed, technically competent bronzes—vessels, implements, personal adornments and, particularly, horse trappings—covering a period from 2600 B.C. to A.D. 800, the majority of the finest pieces datable by cuneiform inscriptions between the 12th and the 19th century B.C.

The area of Luristan is 16,325 sq.mi., with a population (1956 census) of 629,776. The chief town is Khurramabad, linked by roads with Ahwaz, Kermanshah, Hamadan, Qum (Ghom) and Isfahan. Luristan is crossed by the trans-Iranian railway (Bandar Shahpur-Tehran-Bandar Shah).

LUSAKA, the capital of Northern Rhodesia and the seat of its government, lies in the centre of the Federation of Rhodesia and Nyasaland, on a limestone plateau 4,200 ft. above sea level. Its population at the 1956 census totaled 28.700 non-Africans and employed Africans. Cairo road, Lusaka's main thoroughfare, with its tree-lined boulevard and modern multistoried buildings, is regarded as one of the finest streets and shopping centres in the federation. In the town are the legislative assembly building and offices as well as the Northern Rhodesia high court building, the British South Africa company's offices and the largest and most modern secondary schools in the federation. Owing to its situation in an extensive limestone area, large quantities of cement are manufactured at Lusaka. It is also the centre of a major farming district which provides a large proportion of Northern Rhodesia's food. (C. L. Cs.)

LUSATIA (German Lausitz, Lusatian Lužica, from *luž,* "meadow"), the name of a territory inhabited by the Luzicane or Srbi, whom the Germans called Lausitzer Sorben or Wenden. Unconnected with the Serbs of Yugoslavia, they are the smallest of the Slavonic peoples who alone withstood Germanization north of Bohemia and west of the Oder-Neisse line.

Their country was conquered by the Germans in 938, incorporated with Poland in 1018, reconquered by the German empire, sold to the margraves of Brandenburg in 1303 and made part of Bohemia in 1368. It was a part of Saxony from 1635 to 1815 when it was partitioned. Saxony retained Bautzen (Budysin), or upper Lusatia, while lower Lusatia was divided between the Prussian provinces of Silesia with Hoyerswerda (Hojerky) as the main centre and that of Brandenburg with Kottbus (Chocebuz) as the chief town.

By 1815 the western part of Lusatia was germanized; but its eastern marshy and sandy part offered but a small prize and there the Lusatians retained their language, dress and customs. After 1871 intensive germanization started, through the schools, and considerably reduced the number of Lusatian-speaking people.

In 1935 the Lusatian National council or *Domowina* ("homeland") petitioned Chancellor Adolf Hitler for the creation of a

Reichsgau Lausitz of about 4,900 sq.mi. In *1938* the *Domowina* was dissolved by the Germans and its chairman, Pawel Nedo, arrested. The Lusatian daily newspaper, *Srbske Nowiny*, was closed down and its publisher, Fr. Jan Cyz, arrested. Both Nedo and Cyz survived, reformed the *Domowina* in 1945 and claimed territorial autonomy.

In 1949 article 11 of the constitution of the German Democratic Republic guaranteed to the Lusatian people equal development of their language and culture. A daily newspaper *Nowa Doba* and five periodicals were published, and a teachers' college was opened at Radibor.

In 1952 Wilhelm Pieck, president of the republic, officially visited the *Domowina* at Bautzen. (K. SM.)

LUSHAI HILLS (correctly MIZO), a mountainous district of Assam, south of Cachar, on the border between Assam and Burma. Area *8.134* sq.mi.; pop. (1951) *196,202*. The hills are for the most part covered with dense forest or bamboo jungle, in which there are clearings for cultivation. They are sparsely inhabited by the Lushais and cognate tribes. The earliest known inhabitants were Kukis: the Lushais were not heard of until *1840* when they invaded the district from the north. Their warlike spirit and predatory habits made them one of the most troublesome tribes on the northeast frontier of India, but military operations in 1890 resulted in the pacification of the northern Lushais, and in *1892* of the eastern Lushais. The final submission of the chiefs of the southern Lushai hills, who were under the control of the government of Bengal, was not secured till *1895*. The latter hills were transferred in 1898 to Assam and amalgamated with the northern hills in one district. The limits of the district were extended by the inclusion of 900 sq.mi. between the south of the Lushai hills and the Chin hills in Burma. The villages are, as a rule, perched on the tops of ridges or spurs. Each is ruled by a chief or headman.

LUSIGNAN, the name of a family, of Poitevin origin (10th century), which gave a line of kings to Cyprus (1192–1475). In the 13th century, moreover, the Lusignans were important in France during the struggle between Capetians and Plantagenets: they rebelled against John of England in 1201, when he deprived Hugh (afterward Hugh X; d. 1249), son of Hugh IX, count of La Marche, of his fiancée Isabella of Angoulême, and their appeal gave the French king a pretext for confiscating John's French fiefs. Hugh X. however, was defeated in 1242 after he had reverted to the English side.

The elder branch of the family became extinct in 1303. But from the time of Hugh VI the Devil, who took part in the crusade of 1100–01 and was killed at Ramleh, the Lusignans had been interested in the east.

The house of Lusignan d'Outre-Mer sprang from Guy and Amalric, the third and fourth sons of Hugh VIII the Brown, who went to the Holy Land in 1164 and was taken prisoner at Harenc (Harim, east of Antioch) in *1165*. Guy reached Palestine *c.* 1180 and quickly won the good will of the leper king Baldwin IV and the love of his sister and heiress Sibylla, whom he married, receiving the counties of Ascalon and Jaffa He was made regent *(1183)* on Baldwin's becoming blind, but soon fell from favour and was deprived of all right of succession. In *1186*, however, on the death of Baldwin V, he became king of Jerusalem in spite of the opposition of Raymund of Tripoli. Next year he suffered a crushing defeat at the battle of Hittin and was taken prisoner by Saladin. Released in *1188*, he at once broke his parole and began the siege of Acre. Difficulties, however, had arisen with Conrad of Montferrat; and after Sibylla's death, Conrad won fresh support and was generally recognized as king in *1192*.

Though Conrad was almost immediately assassinated, the crown did not return to Guy, but went to Henry II of Champagne, who married Isabella, Sibylla's sister. Guy bought from the Templars the island of Cyprus and reigned there for the last two years of his life (1192–94). He is judged harshly by contemporary writers, as *simplex* and *insufficiens*, perhaps largely because the kingdom of Jerusalem was lost in his reign.

Guy mas succeeded in Cyprus by his brother Amalric, who acquired the title of king of Cyprus from the emperor Henry VI and became king of Jerusalem in 1197 by his marriage to Isabella, after the death of Henry of Champagne. *(See* AMALRIC II.) Amalric was the founder of a dynasty of kings of Cyprus which lasted till 1475; while after *1269* his descendants regularly enjoyed the title of kings of Jerusalem. For the history of the Lusignan kings *see* CYPRUS.

The most famous were Hugh III the Great (1267–85) to whom, apparently, St. Thomas dedicated his *De Regimine Principum;* Hugh IV (1324–59), to whom Boccaccio dedicated one of his works and who set on foot an alliance with the pope, Venice and the Hospitallers, which resulted in the capture of Smyrna (1344); and Peter I (1359–69), who with his chancellor Philippe de Mézières represented the last flicker of the crusading spirit. *(See* CRUSADES.)

Five short-lived kings of a branch of the house of Lusignan ruled in Armenia after 1342, "Latin exiles," as W. Stubbs says, "in the midst of several strange populations all alike hostile." The kingdom of Armenia fell before the sultan of Egypt, who took prisoner its last king Leo V in 1375, though the kings of Cyprus afterward continued to bear the title; the kingdom of Cyprus itself continued to exist under the house of Lusignan for 100 years longer. The mother of the last king, James III (who died when he was two years old) was a Venetian lady, Catarina Cornaro. She had been made a daughter of the republic at the time of her marriage to the king of Cyprus; and on the death of her child the republic first acted as guardian for its daughter and then, in *1489*, obtained from her the cession of the island.

See J. M. J. L. de Mas-Latrie, *Histoire de l'île de Chypre sous les princes de la maison de Lusignan,* 3 vol. (Paris, 1852–61); W. Stubbs, *Lectures on Mediaeval and Modern History,* 3rd ed. (Oxford, 1900).

LUSTRATION, a term that includes all the methods of purification and expiation among the Greeks and Romans. Among the Greeks two ideas prevailed; that human nature must purify itself (κάθαρσις) from guilt before it is fit to enter into communion with God or even to associate with men, and that guilt must be expiated voluntarily (ἱλασμός) by certain processes which God has revealed.

The methods of purification consist in ceremonies performed with water, fire, air or earth, or with a branch of a sacred tree, especially of the laurel, and also in sacrifice and other ceremonial. The torch and sulphur (τὸ θεῖον) were also powerful purifying agents. Purification by air was most frequent in the Dionysiac mysteries; puppets suspended and swinging in the air *(oscilla)* formed one way of using the lustrative power of the air. Rubbing with sand and salt was another method. The sacrifice chiefly used for purification by the Greeks was a pig; among the Romans it was always, except in the Lupercalia, a pig, a sheep and a bull (*suovetaurilia*). On extraordinary occasions lustrations were performed for a whole city. So Athens was purified by Epimenides after the Cylonian massacre, and Delos in the Peloponnesian War *(426* B.C.) to stop the plague and appease the wrath of Apollo.

In Rome. besides such annual ceremonies as the *Ambarvalia, Lupercalia, Cerealia, Paganalia,* etc., there was a lustration of the fleet before it sailed, and of the army before it marched.

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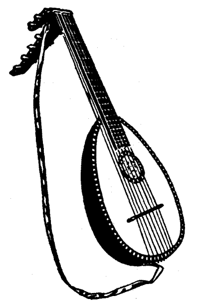
LUTE, an ancient stringed musical instrument, derived in form as well as name from the Arabs. The complete family consisted of the pandura, tanbur or mandolin as treble, the lute as alto or tenor, the barbiton or theorho as bass and the chitarrone as double bass. The Arabian instrument, with convex sound body, pointing to the resonance board or membrane having been originally placed upon a gourd, was strung with silk and played with a plectrum of shell or quill. It was adopted by the Arabs from Persia. Instruments with vaulted backs are all undoubtedly of Eastern origin; the distinct type, resembling the longitudinal section of a pear, is more specially traced in ancient India, Persia and the countries influenced by their civilization.

As long as the strings were plucked by fingers or plectrum the large pear-shaped instrument may be identified as a forbear of the lute. When the bow, obtained from Persia, was applied to the instruments by the Arabs, a fresh family was formed which was afterwards known in Europe as rebab and later rebec. The lute family is separated from the guitars, also of Eastern origin, by the formation of the soundbody which is in all lutes pear-shaped and joined directly to the sound board without the sides or ribs necessary to the structure of the flat-backed guitar and cither.



BY COURTESY DIRECTOR OF VICTORIA AND ALBERT MUSEUM
THE LUTE

Observing this distinction, the little Neapolitan mandolin of 2 ft. long is included in the lute family no less than the large double-necked Roman chitarrone, which was not infrequently 6 ft. long. Mandolins are partly strung with wire, and played with a plectrum, indispensable for metal or short stiff strings. Perhaps the earliest lyres were so played, but the large lutes and theorbos strung with catgut have been invariably touched by the fingers only.

The lute was in general use during the 16th and 17th centuries. In the 18th it declined though J. S. Bach wrote a partita for it. Peri, Caccini and Monteverde used theorbos to accompany their newly devised recitative, the invention or which in Florence, from the impulse of the Renaissance, is well known.

Handel wrote a part for a theorbo in Esther (1720); but after that date it appears no more in orchestral scores, but remained in private use until near the end of the century.

LUTETIUM (formerly lutecium, symbol Lu, atomic number 71, atomic weight 174.99) derives its name from Lutetia, the Roman name for the city of Paris. The element has a stable isotope, Lu^{175} (97.4%), and a naturally occurring radioactive isotope, Lu^{176} (2.6%).

Lutetium is one of the least abundant elements of the rare-earth group and was discovered by G. Urbain in 1907 and independently by Auer von Welsbach, who named the element cassiopeium. Lutetium occurs along with yttrium, ytterbium, etc.. in the minerals gadolinite, euxenite, xenotime, etc. It is usually separated from the other members of the group by fractional crystallization of the bromates. It forms a white oxide (Lu_2O_3); the salts are colourless, giving no absorption spectra, but give a characteristic spark spectrum. In general the salts are more soluble than those of ytterbium; the pure salts should be diamagnetic. Minute amounts of its salt have been reduced to the metal by thermoreduction with the alkali metals. It crystallizes in the hexagonal close pack system ($a=3.509$ A, $c=5.559$ A) with a calculated density of 9.740 g. per cubic centimeter. (See RARE EARTHS.) (F. H. SP.)

LUTHER, MARTIN (1483–1546), the great German religious reformer, was born on Nov. 10, 1483, at Eisleben, in the county of Mansfeld, whither his parents, Hans Luther and Margaret Ziegler, who belonged to the free peasant class, had migrated from Mohra in Thuringia. Six months later they removed to the town of Mansfeld, the centre of the iron ore mining and smelting industry, in which his father found employment as a miner. Within the next decade Hans Luther became the lessee of several smelting furnaces and one of the four elected members of the town council. For some years he had a hard struggle to maintain his growing family, and Luther in later years speaks of the poverty of his childhood. The atmosphere of the home was a pious one, and there is no ground for the tale that his father was a Hussite and was disaffected to the traditional Church. Luther was reared in the current religious beliefs and popular superstitions, which the parents taught their children. Both were strict disciplinarians, and Luther later complained of the harshness of his upbringing, whilst recognizing that his parents meant well by it and cherishing a deep affection and gratitude towards them. The harsh discipline prevailed in the local Latin school, to which he was sent in his seventh year and in which he passed through a graduated course in Latin grammar and syntax, as set forth in the text-books of Donatus and Alexander de Ville Dieu, in select passages from some of the classical authors, and in religious instruction and singing. According to Mathesius he was a diligent and apt pupil, and he evidently profited from this early training, in spite of his later drastic criticism of the schools and schoolmasters of the pre-Reformation period. In his 14th year (1497), he was sent to Magdeburg to continue his education, and in accordance with the practice of the time earned his bread by singing in the streets. His teachers at Magdeburg were members of the Brotherhood of the Common Life, which devoted itself specially to education and was distinguished by its practical reforming spirit. On the conclusion of the school year he removed to Eisenach, where he attracted the interest of an opulent burgher, Kuntz Cotta, and his wife, who received him into their home and relieved him from the necessity of singing for his bread in the streets. He was fortunate, too, in finding in the Rector Trebonius and his assistant Wigand efficient teachers of the higher courses in Latin grammar, composition, rhetoric, and poetry, in which he easily out-distanced his fellow pupils. At the close of this training, which extended over three years, he entered the University of Erfurt in the spring of 1501. At this period the fame of Erfurt exceeded that of all the German universities. The curriculum for the bachelor of arts degree, which he took in the autumn of 1502, included grammar, logic, rhetoric, physics, and philosophy. Two years further study were required for the master's degree, the course including, besides higher instruction in the subjects already studied, mathematics, metaphysics, and ethics. At the age of 22 his ability and proficiency secured him the second place in a list of 17 candidates who passed the master's examination in the winter of 1505.

As the result of these four years of intensive study he had acquired a firm grasp of the current scholastic philosophy, and had developed a marked dialectic skill. He was the ornament of a circle of fellow-students, who met to discuss philosophy, and to whose intercourse his musical gifts contributed an additional charm. Among his teachers were Trutvetter and Ulsingen who professed the Nominalist philosophy as expounded by William of Occam, the great English Franciscan of the 14th century. Under their influence Luther became an enthusiastic adherent of the Occamist or "modern" school of thought as against the various forms of Realism represented by Thomas Aquinas and Duns Scotus. He speaks of Occam as "my master," and refers to his school as "my sect," and he retained his predilection for the philosophic teaching of the great schoolman even after he came to differ from his distinctive theology. He owed allegiance, too, to the authority of Aristotle, whose logic and philosophy dominated all the schools, including that of Occam. Whilst thus absorbed in the conventional scholastic study, he does not seem to have been influenced at this period to any appreciable extent by the humanist movement, which only later took a firm hold of the university, though he found both pleasure and benefit in reading some of the Latin authors, including Cicero, Virgil, and Livy,

The Augustinian Friar.—At the desire of his father, rather than from personal inclination, he entered on the study of law in May 1505. Two months later (July 17) he suddenly renounced the world and entered the monastery of the Augustinian Eremites at Erfurt. There is a difference of opinion among his biographers whether his resolution to become a monk was the result of a sudden impulse, or the climax of a gradually maturing predilection for the monastic life, due in part to certain influences, religious and psychic, working on his high-strung temperament. On the whole the evidence tends to show that his decision was unpremeditated. He himself ascribes it to the fear of sudden death during a thunderstorm, which overtook him, on the road near Erfurt, whilst returning from his home at Mansfeld, when he was prostrated by a flash of lightning and vowed to become a monk. It was in pursuance of this vow that, to the distress and bitter chagrin of his father and the astonishment and regret of his friends, he immured himself in the Erfurt monastery. In any case he regarded his involuntary vow as a call from Heaven, and its fulfilment as an imperative act of obedience to God. It had thus a religious significance which he could not ignore, and he devoted himself to his new vocation with consuming thoroughness.

The Erfurt Augustinians belonged to the strict section of the order, in contrast to the Conventuals or laxer section. After a year's novitiate Luther took the vows of obedience, poverty and chastity, and submitted to the drudgery which was an essential part of his training. Under his preceptor, Nathin, he then went through a course of theological instruction in preparation for his ordination as priest, which took place in 1507. Thereafter he continued his theological studies for the degrees of biblical bachelor and master of the sentences *(Sententiarius)*, or dogmatic theology, as expounded in the Sentences of Lombardus, attending the lectures of the theological faculty of the university as well as the theological school of the monastery. In accordance with the prescribed course, he studied the Bible, the Sentences, and the works of Occam, and his disciples D'Ailly and Biel, and dipped into those of St. Bernard, Duns Scotus, and Augustine. He continued these studies at Wittenberg, where he spent a year from the autumn of 1508 to that of 1509 as lecturer on Aristotle's *Ethics,* and where he enjoyed the personal intercourse of John Staupitz, professor of theology and vicar-general of his order. On his return to Erfurt he obtained the degree of *sententiarius,* and began to lecture on the Sentences. The books which he read in his preparation of these lectures were discovered in the library at Zwickau in 1889, and contain on the margins a large number of notes (given in vol. ix. of the Weimar edition of his works) in his own handwriting, which throw light on his theological and philosophical thought and standpoint at this stage of his development. Whilst displaying a critical, enquiring mind, they show no material departure from the scholastic method and the scholastic theology in its Occamist form, though some modern theologians like Seeberg find evidence in them of a distinctive divergence from his theology. At most they reveal a growing predilection for the teaching of Augustine.

This lectureship he filled till the late autumn of 1511, when, at the instance of Staupitz, he was transferred to the monastery at Wittenberg, of which he was ere long appointed sub-prior at a meeting of his order at Cologne in the following year. In Oct. 1512 he took the degree of doctor of theology of the university and became the successor of Staupitz as professor of biblical literature. Towards the end of 1510 he had paid a short visit to Rome on business connected with his order, and though his visit was that of the devout pilgrim, he appears to have been painfully impressed by the secularized ecclesiasticism and the low moral standard of the Holy City. There is, however, no evidence for the oft-repeated statement that the discovery of his distinctive doctrine of justification by faith came to him as he climbed on his knees the steps of the Scala Sancta at the Lateran church.

Conversion.—It was only during the winter of 1512–13 that this decisive illumination dawned on his mind as he meditated in the Black Monastery at Wittenberg on Romans i. 16-17, and suddenly attained a new apprehension of this doctrine. Despite the most punctilious performance of the minutiae of the rule of his order, the most rigorous asceticism, he had hitherto failed to find peace of conscience, the assurance of acceptance in the sight of God, and he had been periodically harassed by doubts on the score of his personal salvation. Hence the long spiritual struggle in the quest for a gracious God, which had clouded his early years as a monk and which Denifle unwarrantably contests as a later fabrication invented by him to justify his apostasy from the Church. Luther's testimony as to the reality of this spiritual ordeal cannot be thus invalidated, even if we make due allowance for the later tendency to exaggerate it under the influence of his changed religious standpoint.

The root of this struggle to find a gracious God lay in his personal temperament, his lofty religious and moral ideal and in the religious the practical, and the theological teaching of the mediaeval Church. In temperament he was high-strung, emotional, impressionable, and liable to fits of depression which took at times an acute form. He had a sensitive conscience and a keen sense of sin, which the meticulous observance of the rule of his order only tended to intensify. To him sin and the sinful tendency (concupiscence) were terrible realities in keeping with his exalted conception of God as perfect righteousness and the retributive character of this righteousness *(justitia Dei)*, which impels Him to judge and condemn the sinner, and which was emphasized in the teaching and practice of the mediaeval Church. How to attain to the ideal divine righteousness and thus enter into a proper relation of acceptance and fellowship with God, and thereby also ensure salvation from the Divine retribution for sin, was the problem that obsessed him and led to this recurring spiritual conflict (*Anfechtungen*). In the sacrament of penance the Church sought to ensure the penitent sinner against this retribution by imposing penitential works in satisfaction for sins. Luther, however, could not be sure of the sufficiency either of his contrition or of his penitential satisfaction in spite of official absolution. The Church further sought to ensure the sinner against the Divine judgment by its doctrine of merits, based on the relative freedom of the will to do the good whereby, with the aid of God's grace, he could conciliate the Divine favour on the day of judgment. Here again Luther, conscious of the weakness of the will to attain the absolute good which alone could avail in the sight of a perfectly righteous God, failed to find the assurance of salvation in this teaching. In addition he was distressed over the doctrine of predestination, which had for him not only a speculative, but a religious significance. How could he be sure that he was among the number of the elect whom God had predestined and chosen, according to the Occamist teaching, by an act of his absolute, arbitrary will.

The vicar-general, Staupitz, during his sojourn at Wittenberg in 1508–09, as well as his preceptor and his confessor in the Erfurt monastery, did their best to help him, and to them he owed at least a relative appeasement of his spiritual distress. He owed something, too, to the sermons of St. Bernard, to which an old monk directed him, and to the writings of Gerson. But his full deliverance came to him only in the winter of 1512–13, when, as the result of long and intense meditation on Romans i. 16-17 he grasped the truth that the righteousness of God in this passage is not to be understood of his retributive justice (*justitia activa)*, by which he judges the sinner according to his merits, but in the sense of the righteousness which he mercifully gives or imputes to the sinner *(justitia passiva)*, and which the sinner receives by faith, and is thereby justified in His sight and made capable of entering into a filial relation to Him, living the divine life in active obedience to the will of a merciful God. Justification is thus due solely to the mercy or grace of God and the merit of Christ appropriated by faith, not to human works or merits which, being vitiated by sin, can in no way avail to avert the retributive justice of God, or bring the soul into a feasible and assured relation to Him.

This conception is already reflected in his lectures on the Psalms (1513-15), and is elaborated in those on the Epistle to the Romans (1515–16) in which the influence of Augustine and also the mystic teaching of Tauler and the "German Theology" (*Theologia Deutsch)* on the one hand, and the reaction from the scholastic theology are alike apparent, though he still makes use of the scholastic method and terminology. As the result of this elaboration of his new religious conception on the basis of this fundamental doctrine, he could justly claim to be the exponent of a "new theology," though he was still unconscious of any material divergence from the received teaching of the Church, whilst boldly attacking the philosophy of Aristotle and the scholastic theology which was based on it (98 Theses against the scholastic theology, Sept. 1517, which one of his students defended in a public disputation for the degree of biblical bachelor).

The 95 Theses.—In the lectures on Romans he already appears as the practical reformer, and in the year 1517 he emerged in this capacity from the academic sphere with his epoch-making challenge to the work of reformation in his 95 Theses against the abuse of indulgence, which he posted up on Oct. 31, in the door of the Castle church at Wittenberg. The practice of indulgence had grown out of the penitential system of the ancient Church, which punished grave sins by temporary exclusion from the fellowship of the Christian community. In course of time it became customary to mitigate this discipline by permitting the delinquent to make satisfaction, in part at least, in the form of a money contribution. In the later middle age it was extended by the popes as a means of inciting the faithful to participate in the crusades against the infidel (the Cross Indulgence). Those taking part in the holy war or contributing for this purpose were thereby guaranteed the relaxation of penance due for their sins, or even the plenary remission of sin. The practice brought large sums into the papal treasury. With the decline of the crusading spirit, it was extended by Pope Boniface VIII. in connection with the celebrations of the jubilee year 1300. The revenue brought in by this jubilee indulgence was increased by the subsequent expedient of reducing the jubilee years from 100 to 50, or even 25 years and thereby establishing more frequent jubilee celebrations. Indulgences were also issued in connection with other projects such as the rebuilding of St. Peter's at Rome, and by the beginning of the 16th century, the practice had become a regular financial expedient for increasing the papal revenue. In 1447 the efficacy of indulgence was extended by Pope Calixtus III. to souls in purgatory.

The practice was based on the doctrine of the "Treasure of the Church," consisting of the infinite merits of Christ and the superfluous merits of the saints, which was elaborated by Thomas Aquinas and officially sanctioned by Pope Clement VI. in 1343. According to this doctrine, the pope could draw on this inexhaustible source for the benefit of the faithful, whose own merits were insufficient. Theoretically confession and contrition were incumbent on those desiring the benefit of an indulgence. It was further assumed that it could not take away the guilt and eternal punishment of sin, which was only obtainable in the sacrament of penance through the absolution of the priest. It could only ensure the remission of the temporal punishment of actual sins to which the sinner was still liable in this life and in purgatory, and the attainment of this benefit pre-supposed contrition and confession for these sins on the part of the applicant. In the case of the buying of an indulgence in behalf of souls in purgatory, however, contrition and confession on the part of the purchaser were not deemed essential. The practice was liable to great abuse, inasmuch as the indulgence preachers, in their striving to raise as much money as possible for the specific object of any given indulgence, did not always make the conditions and limitations underlying it clear to their hearers. There was besides difference of opinion among the doctors of the Church on both the doctrine and the practice, especially on the question of the application of indulgence to souls in purgatory, as well as widespread dissatisfaction over its abuse.

On both doctrinal and practical grounds Luther felt impelled to attack the system in connection with the Indulgence of 1515–17, which was issued by Pope Leo X. professedly for the rebuilding of St. Peter's. In reality its object was to enable Albrecht of Brandenburg, Archbishop of Mainz, who also held the sees of Magdeburg and Halberstadt, to pay the large debt which he had incurred to the banking house of the Fuggers of Augsburg in payment of the papal dispensation, plus the usual fees, to enable him to acquire the additional office. John Tetzel and other preachers, to whom the archbishop entrusted the business of selling the indulgence, were doing a brisk trade in these pardons when Luther, who discovered in the confessional their misleading teaching on the subject and its nefarious moral and spiritual effects, intervened by posting up his 95 Theses and sending a copy, with a strongly worded letter of protest, to the archbishop. In these theses he distinguished between true repentance and mere penance for sin, maintained that the pope could only remit penalties imposed by his own authority or that of canon law, that God alone can remit the guilt of sin, which is obtained only in the sacrament of penance, not by papal indulgence, and that in the sacrament, pope and priest have only a declaratory power of remission, which is due to the grace of God in Christ as proclaimed in the Gospel—the true "Treasure of the Church." He further denied that the remission of canonical penalties through the papal indulgence applies to souls in purgatory, and, whilst recognizing the principle of indulgence in a strictly limited sense, vigorously denounced the false teaching and the pernicious activity of the indulgence preachers, and asserted the right of every penitent Christian to remission apart from this mercenary traffic in pardons.

The proposed disputation did not actually take place. But the theses were widely circulated, both in the original Latin and in a German translation, and before the end of the year were being eagerly read and discussed throughout the empire, and even beyond its bounds. The attack provoked a counter attack on the part of Tetzel and the Dominican Order, of which he was a member, in the form of a series of anti-theses in defence of the traditional doctrine, which, though ascribed to Tetzel, were drawn up by Wimpina, professor of theology in the University of Frankfurt-on-the-Oder. In a couple of effusions under his own name, Tetzel roundly accused Luther of heresy and schism; and a more formidable opponent, John Maier of Eck, otherwise known as Dr. Eck, professor of theology at Ingolstadt, repeated the charge in a communication to the bishop of Eichstadt, entitled "Obelisks," which, though not printed, was circulated in manuscript. Both Tetzel and Eck maintained that the 95 Theses were an attack on the papal power as well as on a received institution of the Church. Luther replied to Wimpina and Tetzel in a "Sermon on Indulgence and Grace"; to Eck in a series of "Asterisks," in which he stoutly rebutted the charge of heresy. At a congregation of his Order at Heidelberg (April 1518) he expounded and defended his distinctive theology, and amplified his theses in a work entitled *Resolutiones,* which shows a distinct advance in their standpoint, and explicitly emphasizes his fundamental doctrine of justification by faith as the criterion of faith and practice. This work he sent to the pope as a vindication of his action and a confutation of the charges of his opponents, coupled with a respectful and submissive, but outspoken letter (May 1518).

Citation to Rome.—By this time the pope, to whom the archbishop had sent the theses, and who was at first disposed to regard the controversy as a mere monks' quarrel, had decided to take action. As the result of an official examination of Luther's Theses by Prierias, the master of the palace, Leo cited him to appear at Rome within 60 days as a heretic and a rebel against ecclesiastical authority. The citation was forwarded to the learned Dominican, Thomas di Vio, otherwise known as Cardinal Cajetan, the papal legate in Germany. Through the intervention of the elector Frederick of Saxony and for political reasons connected with the prospective election of a successor to the emperor Maximilian I., the pope ultimately consented to forego the citation and to refer the case to the legate, who was empowered to receive Luther's submission. In accordance with this decision he appeared before Cajetan at Augsburg in Oct. 1518. During the interview the legate insisted on unconditional retractation, and Luther stoutly refused to retract unless he was proved from Scripture to be in error, and, appealing from the cardinal to the pope, he secretly left Augsburg. He published an account of the proceedings (*Acta Augustam),* and in November appealed from the pope to a general council.

The issue of a papal decretal on the subject of indulgences left no doubt that Luther's standpoint was irreconcilable with the official doctrine and practice. The attempt of Miltitz, whom the pope sent as his nuncio to Germany to confer the Golden Rose on the Saxon elector, to bring about an accommodation proved fruitless. At a conference at Altenburg in Jan. 1519 Luther went the length of agreeing to refrain from further discussion and to refer the case to the arbitration of a German bishop, on condition that his opponents also observed silence. Miltitz also, in his eagerness to play a rôle in the case which was not warranted by his commission, sent a misleading report to the pope, representing that Luther was not only prepared to refrain from further agitation, but to retract his errors. In reply the pope invited him in a friendly spirit to Rome for this purpose (March 29, 1519). This missive, which never came into Luther's hands, was based on a complete misunderstanding of his real position. What he had refused to Cajetan he was not prepared, at the instance of a busybody like Miltitz, to concede to the pope himself, though at the instigation of the elector he wrote an *Instruction to the People,* in which, whilst emphasizing the abuses in the institutions of the Church, he still recognized the papal supremacy and the duty of obedience to the Roman Church.

Controversy with Eck.—The death of the emperor Maximilian on Jan. 11, 1519, and the long negotiations relative to the election of his successor, brought a lengthy pause in the further consideration of his case as far as the Roman Curia was concerned. Meanwhile the condition of the truce between him and his opponents was broken by the intervention of Eck, who challenged him to a debate at Leipzig on the subject of the papal power. Luther accepted the challenge and in preparation for the disputation made an intensive study of the constitution of the ancient Church and the later claims of the bishop of Rome to its headship, as expressed in the papal decretals. Thus carefully prepared, he encountered his formidable antagonist in the famous disputation which took place in July 1519 and forms another landmark in the development of his reforming teaching. In the course of it he controverted the divine right of the papacy, asserted the supreme authority of Scripture, maintained that John Hus had been unjustly condemned by the council of Constance, and questioned the infallibility of a general council. Eck, who was a practised debater, had skilfully led him into these compromising admissions and claimed the victory. He had at all events shown that he was at variance with the received teaching of the Church, not merely in the comparatively minor subject of indulgences, but on fundamental doctrines. Though both parties had at the outset agreed to refer the contest to the judgment of the universities of Paris and Erfurt, both continued it in a number of controversial writings, to which new adversaries—Alveld. Emser, Dungersheim. Hoogstraten—contributed on the side of Eck, and Melanchthon, Occolampadius, Bucer, Hutten and others on the side of Luther. Luther himself, as well as Eck, added an important quota in the *Resolutiones Lutherianae,* a sermon on the sacrament of the altar, and a treatise on good works, which only widened the breach between him and his opponents.

Bull of Condemnation.—Ultimately Eck betook himself to Rome to prosecute the suit against Luther which the Curia had determined to resume and bring to a final issue. As the result of the re-examination of his case by a series of commissions appointed by the pope in the spring of 1520, the bull *Exsurge Domine,* condemning 41 errors in his teaching. was formulated, and after discussion in the consistory, was issued in June. It granted to the heretic an interval of 60 days after its publication in Germany for the purpose of retracting and returning to the Church. Failing compliance, he and his adherents were to be excommunicated, arrested and punished as notorious and pertinacious heretics. Excommunication was also denounced against all, of whatever rank, who should refuse to comply with the provisions of the bull, which Eck and Aleander were commissioned, as papal nuncios, to publish throughout the empire.

The Bull of Condemnation only fanned the pugnacious spirit of the reformer. At first he professed to see in it a fabrication of Eck, and denounced it in two defiant philippics, *Eck's New Bulls and Lies,* and *Against the Execrable Bull of Antichrist.* Then, recognizing its authenticity, he renewed his appeal to a general council, and finally, on Dec. 10, 1520, publicly consigned it, with a copy of the canon law and other documents, to the flames. During the previous summer and early autumn he had sent forth his three great reform treatises—the *Address to the German Nobility, The Babylonic Captivity of the Church* and *The Freedom of a Chrirtian Man.* In the first he arraigned in passionate language the abuses rampant in the Church, and appealed to the secular power to undertake the work of reformation on the ground of its divine institution, its Christian character, and its ethical functions which entitle it to summon a general council to rectify what is amiss in the Church, and even to undertake this clamant duty in case the Church refuses to reform itself. In the second he attacked the mediaeval sacramental system, reduced the number of the sacraments from seven to three, and asserted the right of the individual Christian to emancipate himself from priestly bondage. In the third he expounded anew in simple, non-controversial terms his fundamental doctrine of justification, which involves alike the freedom of the individual from the work-righteousness of mediaeval religion and the obligation of self-discipline and service for others as the indispensable fruit of justifying faith.

The Diet of Worms.—In Jan. 1521, the pope, in consequence of Luther's refusal to retract and submit to the authority of the Church, launched a Bull of Excommunication against him *(Decet Romanum),* and called on the emperor Charles V., the successor of Maximilian, to execute it forthwith. Instead of complying, the emperor, in deference to the intervention of the Saxon elector and the will of the majority of the diet, which met at Worms at the end of January and continued its sittings till May, decided to summon him to appear for examination before the diet under the imperial safe conduct, whilst promulgating an edict against his writings at the instigation of the papal nuncio Aleander. On April 16, Luther entered Worms. On his appearance before the assembly on the following day he acknowledged the authorship of the books on the table, the titles of which were recited by a secretary. But, in answer to the question whether he was prepared to recant any part of them, he asked for time for consideration on the ground of the importance of the issue involved. He was granted an interval of 24 hours. Late on the morrow, the 18th, he was asked by the official of the archbishop of Treves, Dr. John von der Ecken, who acted as interrogator, whether he was now prepared to defend all the books which he had recognized as his. In reply he proceeded to show why he should not be asked straight away to recant, and requested to be convinced of his errors from Scripture. If thus convinced he would forthwith revoke and be the first to throw his books into the fire. In a long harangue the official rebuked his audacity in arrogating a knowledge of the Scriptures against all the doctors of the Church, and concluded by demanding a definite and straightforward answer to the question whether he would retract his errors or not. Then came the fateful words uttered in firm and clear tones: "Unless I am convinced by the testimony of Scripture or by an evident reason *(ratione evidente)*—for I confide neither in the pope nor in a council alone, since it is certain that they have often erred and contradicted themselves—I am held fast by the Scriptures adduced by me, and my conscience is taken captive by God's Word, and I neither can nor will revoke anything, seeing that it is not safe or right to act against conscience. God help me. Amen." On retiring from the excited assembly he was greeted by the emperor's Spanish guards with the cry "To the fire with him!" whilst he and his adherents passed on with uplifted hands after the old German fashion of celebrating a victory. "I am through," he cried joyfully on reaching his lodging and receiving the congratulation of his friends. He persisted in his refusal before a committee appointed by the diet to bring about a feasible accommodation, and was commanded by the emperor to leave Worms on April 26. On May 4 he was intercepted by a party of horsemen in the Thuringian forest, in accordance with a previous arrangement of the elector of Saxony and two of his trusty councillors, and was furtively lodged in the electoral castle of the Wartburg, overlooking Eisenach. On May 26, after the close of the diet on the previous day, the emperor, having received the assurance of the papal support in his war against Francis I. of France, formally signed the Edict of Worms placing him and his adherents under the ban of the empire and instituting a rigorous censorship of the press. It professed to be issued "with the unanimous consent and will" of the estates of the empire. In reality it had been submitted on the previous evening to only a fraction of the members after the formal closing of the diet, and did not represent the mind of the German people. As the result of these four years of strenuous conflict, the breach between Rome and Luther was complete and irretrievable, and the indomitable, heroic monk had won the sympathy and support of a large proportion of his countrymen on material and economic as well as religious grounds.

The Wartburg.—Luther remained at the Wartburg under the pseudonyrn of "Knight George" till the spring of 1522. He continued and extended the attack on Rome in a series of controversial writings, including those on auricular confession, on the abrogation of private Mass, and on monastic vows, and kept in touch with his colleagues and friends by a voluminous correspondence. He began and completed the translation of the Greek New Testament which, after revision with the co-operation of Melanchthon, was published in Sept. 1522. It is a monument of his linguistic ability in moulding the vernacular into a fitting medium of the language and thought of the Greek original. He challenged the resumption of the indulgence traffic under the auspices of the archbishop of Mainz at Halle, and so potent had his influence become that the archbishop was fain humbly to apologize and put a stop to the business. He wrote a series of sermons (Postille) for the instruction of the people in the new evangelism, which afford an insight into his distinctive power and style as a preacher. Early in Dec. 1521 he paid an incognito visit to Wittenberg and enjoyed for a few days the renewed personal intercourse with his colleagues. He expressed his satisfaction with all that he had seen and heard in spite of the popular demonstrations against the old religion which had resulted in student riots, but which he did not take very seriously. On the other hand, the spirit of religious and social unrest among the people, which he had observed by the way, impelled him to issue a *Warning Against Tumult and Revolt,* in which he inculcated his characteristic doctrine of submission to constituted secular authority in the matter of religious innovations, the necessity of leaving the Word of God to work gradually the transformation of traditional beliefs and institutions, and the inadmissibility of irresponsible violence in the work of reformation.

This passive attitude did not commend itself to the more militant reformers at Wittenberg like Carlstadt and Zwilling, who in the winter of 1521–22 introduced communion in both kinds, demanded the removal of images from the churches and championed the marriage of the clergy. In this forward policy they had the support of the university theological faculty and the town council, and the town council embodied it in an ordinance regulating on evangelical lines the religious and social life of the community. But it encountered the opposition of the elector on political grounds, and the *impasse* which supervened led Luther to leave the Wartburg at the beginning of March 1522 and resume his public activity at Wittenberg.

The Reformed Worship.—Though he approved on principle of communion in both kinds and the marriage of the clergy, he was a striking combination of the conservative and the revolutionary, and was disposed to consider the expediency of actual changes before making them, and of avoiding precipitate measures which the weaker brethren were not prepared to approve. In a series of eight consecutive sermons during the first week after his arrival, he won over his hearers to his own policy of the gradual institution of an evangelical order in place of the old usages, and modified the ordinance in this direction. It was not till the following year that he deemed the time ripe for a more incisive reform of worship and usages and the reorganization of the church at Wittenberg and elsewhere in accordance therewith, though these changes were to be made without constraint of conscience. Hence the *Formula Missae,* or reformed communion service, which he drew up for Wittenberg, and the order of worship for the church at Leisnig which served as a model for other reformed churches.

At the same time he carried on a brisk campaign against his Romanist opponents, whose antagonism these innovations tended to intensify. These controversial writings included an onslaught on the hierarchy, *Against the Falsely called Ecclesiastical Estate of the Pope and the Bishops,* and a reply to King Henry VIII., who had written an anti-Lutheran *Defence of the Seven Sacraments (Assertio Septem Sacramentorum adversus Martinum Lutherum).* He added a *Vindication of Married Life* as a divine and natural institution on behalf of the marriage of the clergy. In 1525 he himself followed the example of the increasing number of married ex-priests, monks, and nuns by contracting a union with Catherine von Bora, who had renounced the conventual life, and bore him a family of three sons and two daughters, and proved a worthy helpmate throughout the remaining 20 years of his wedded life.

As the result of this propagandist activity and the co-operation of a growing band of preachers, drawn largely from the ranks of the secular and regular clergy, the evangelical movement ere long attained such formidable dimensions that it was practically impossible to enforce the edict of Worms throughout a large part of the empire. The diet which met at Nuremberg during the winter of 1522–23 refused to support the demand of pope Adrian VI., the successor of Leo X., for its execution, declined to suppress the evangelical preachers, and, whilst authorizing the punishment of married priests and apostate monks, insisted on the convocation within a year in some German city of a free Christian council in which the laity should have a voice. "Luther's doctrine," reported the archduke Ferdinand to his brother, Charles V., "has taken such deep root that among a thousand persons there is not one who is not to some extent touched by it." A second diet, which assembled in the same city during the winter of 1524, proved less recalcitrant under the manipulation of Campeggio, the legate of Adrian's successor, Clement VII. But it would only undertake to enforce the edict against Luther "as far as possible," and renewed the demand for the convocation of a free council in Germany. In reply Luther launched a strongly-worded philippic *(Two Contradictory Mandates concerning Luther)* in which he unsparingly aspersed the emperor as well as the majority of the diet.

The Peasant Revolt.—Towards the close of 1524 the influence of the evangelical movement on the mass of the people received a startling exemplification in the rising of the peasants which followed the miscarried attempt of Franz von Sickingen and Ulrich von Hutten to vindicate by force the rights of the lesser nobility against the princes in the previous year. In his tract *On the Civil Power* (1523), Luther, in contrast to his attitude to the State on the *Address to the German Nobility* three years previously, sharply distinguished bet een the political and spiritual spheres, and, whilst denouncing the misgovernment of the princes, inculcated anew the duty of the subject to submit to the civil power and the established order in the State and to suffer, not actively repel, injustice. Some of the evangelical preachers were, however, less restrained, and actively sympathized with the demand of the peasants for social emancipation and the radical modification of the feudal system to this end. Moreover, Thomas Münzer, the leader of the extreme wing of the evangelical party, advocated a social and religious revolution by forcible methods, and Carlstadt, who had by this time been estranged from Luther, though less violent, also actively espoused the cause of the peasants. On theological grounds Luther was repelled by these extremists, who professed a more subjective type of religious thought, based not exclusively on the Word of God, but on the illumination of the individual believer in direct communion with God (the "inner light"). Their association with the social movement contributed to prejudice him against it, though he had pleaded for a more equitable treatment of the common man in the spirit of the Gospel. At the same time his own revolt against the traditional Church, his resounding appeals for its drastic reformation, and on behalf of the rights of the individual mind and conscience enlightened by the Word of God, his doctrine of justification by faith alone, and especially of the spiritual priesthood of all believers, contained democratic implications which the mass of the people were not slow to apply in the service of a social as well as a religious reformation, and of a far-reaching transformation of the prevailing order in the State and society as well a, the Church. This popular movement found expression in the *Twelve Articles* of the Swabian peasants which were evidently drawn up under the influence of evangelical preachers like Schappeler and Hubmaier, if not actually composed by them, demanded the abolition of serfdom and the preaching of the pure Gospel, and were widely adopted. The leaders of the peasants submitted these articles, which were couched in a moderate spirit, for Luther's judgment, and whilst deprecating the resort to force, he expressed sympathy with the reasonable grievances of the common man, and counselled both sides to seek an accommodation *(An Exhortation to Peace in Response to the*

Twelve Articles of the Swabian Peasants, April, 1525). When, however, the peasant bands in southern, western, and central Germany discarded his advice and took arms to enforce this programme of social reforms, he took the side of the princes and lords and issued a sanguinary and ill-judged appeal to a war of extermination against the rebels *(Against the Murderous and Thieving Peasant Bands,* May, 1525). Not only was the rising ruthlessly suppressed; the princes and lords sullied their victory by a savage retribution, of which many thousands of their subjects became the victims, and which both dashed the hope of achieving the legitimate social aspirations of the masses in connection with the religious reformation, and embittered the common man against the reformer, whom they denounced as the accomplice of their oppressors.

Organization of Reform.—In this year Luther was deprived by death of his potent protector, the elector Frederick. His successor, the elector John, was, however, a confirmed adherent, and his cause had won the ardent support of the landgrave Philip of Hesse, Albert of Brandenburg, grand master of the Teutonic order, and other princes, as well as a large number of cities, and its princely supporters were beginning to league themselves in its defence. On the other hand, the archduke Ferdinand of Austria. the two dukes of Bavaria, the elector of Brandenburg, and Duke George of Saxony had combined to stem the progress of the movement, and the persecution of his adherents had already begun in Romanist territories. In the diet which met at Spires in 1526 the Lutheran princes, in conjunction with the moderate Roman Catholics, were strong enough to carry a resolution to suspend the edict of Worms pending the meeting of a general, or at least a national, council; and meanwhile so to act in the matter of the edict as its members should answer to God and the emperor.

The evangelical princes interpreted the decision as entitling them to organize the evangelical Church within their territories, and for this purpose Melanchthon, by direction of the elector John, drew up, and Luther revised, a church ordinance (*Kirchenordnung*) which formed alike a confession of faith, a directory of public worship, a scheme of educational reform, and contained the germ of the later consistorial form of Church government, which consigned the ecclesiastical administration to a body of State officials or consistory, composed of theologians and jurists, under the supremacy of the territorial prince. At the second diet of Spires in 1529 the emperor Charles, through his commissioners, succeeded in reversing the decision of the previous diet. On this occasion the extreme Catholics were in the majority and carried a resolution enforcing the diet of Worms in Catholic territories and disallowing further religious innovations in the Lutheran States, whilst prohibiting the profession of the Zwinglian and Anabaptist forms of the reformed faith. Against these decisions the Lutheran minority appealed and protested and this Appellation and Protestation was signed by 14 cities as well as by the elector of Saxony, the landgrave of Hesse and four other princes. Hence the name Protestant as a designation of the evangelical party.

The Zwinglian Controversy.—This reverse to the Lutheran reformation was aggravated by the dissension between Luther and the Swiss theologians on the doctrine of the Lord's Supper. Whilst rejecting the mediaeval doctrine of transsubstantiation, Luther firmly believed in the bodily presence of Christ in the bread and wine (consubstantiation). Zwingli, the reformer of Zurich, and the south German theologians, on the other hand, accepted only a spiritual presence in the elements, and a bitter controversy had been proceeding for some years over this question before the landgrave Philip, in the hope of uniting the warring parties, summoned the leaders to a conference at Marburg in October 1529. During the three days' debate Luther doggedly argued in support of the literal interpretation of the words, "This is my body" *(Hoc est meum Corpus)* against Zwingli and his Swiss and South German colleagues Occolampadius, Bucer and Capito, who contended in favour of the figurative sense of the words They further adduced the impossibility of the presence in the elements of Christ's body, which had ascended into Heaven, against Luther's contention on behalf of its ubiquity in virtue of Christ's divine nature which was not subject to any human limitations. Neither party would give way on these two fundamental points, and the debate ended in a complete deadlock Luther refused to extend the right hand of fellowship to Zwingli. who was prepared to agree to differ for the sake of unity. Despite this *impasse* the landgrave, after the formal close of the debate in the afternoon of Oct. 3, made a final effort to secure unanimity. He besought both parties to consider in private the possibility of finding a formula uhich they could subscribe. In response Luther drew up a formula which, while asserting that "the body of Christ is truly *i.e.,* essentially and substantially" present in the sacrament, waived further discussion on the question as to the mode of its presence This was undoubtedly a considerable concession on Luther's part, and Bucer was at first disposed to accept it as a satisfactory solution. Zwingli and Occolampadius, on the other hand, could not bring themselves to subscribe this Lutheran formula in the course of the private discussion of the following day, and held to their view that Christ is present only in a spiritual sense. The next best thing in the interest of the landgrave's policy of a comprehensive evangelical union was to give expression to their agreement on the other doctrines of the reformed faith, and Luther joined with his opponents in subscribing the Marburg Articles which he drew up for this purpose. The Marburg conference was thus not a total failure. The inability to see eye to eye on the sacramental question resulted, however, in an unfortunate estrangement between the Lutheran and the Swiss and south German Churches for the time being at least, and frustrated the project of a great evangelical alliance in defence of the Reformation to meet the menace of the impending imperial attempt to suppress it.

The movement had by this time lost the support of Erasmus and the older humanists, whilst retaining the adhesion of the younger votaries of the new learning like Melanchthon and Bucer. Up to the diet of Worms Erasmus had exerted his influence to shield Luther from the hostility of his scholastic opponents of Cologne, Louvain and other centres of the scholastic theology, who were also his own enemies. He used his influence with the German princes to secure him a fair hearing, and denounced the obscurantism and intolerance of the heresy hunters Luther who had a deep sense of the value of the new learning for the evangelical movement had cultivated his friendship, whilst disapproving of his theological standpoint. After the diet of Worms and the actual initiation of the Reformed Church, Erasmus, in his fear of revolution, became more critical, and at length yielding to the solicitations of powerful patrons, entered the lists against his theological teaching in a controversial work on Free Will (*De Libero Arbitrio,* 1524). Luther replied with a counter attack in the Unfree Will *(De Servo drbitrzo, 152j),* and though both observed a relative moderation of style in these writings, the breach between them in the theological sphere was henceforth irretrievable.

The Augsburg **Confession.**—As an outlaw Luther was not present at the diet of Augsburg in 1530, at which the emperor appeared in person, and to which Melanchthon presented a confession of the Lutheran faith (the Confession of Augsburg). But he energetically intervened by his letters to the elector John and to his pliant colleague who, in the course of the long negotiations, was in danger of conceding more than he was prepared to approve He thus stiffened their opposition to the final ultimatum of the emperor to agree to a matenal modification of its teaching in a Romanist sense. Thus strengthened, the elector left the diet in the face of the imperial demand for surrender to his Romanist policy; and Luther at last overcame his scruples on the score of active resistance to the imperial authority in defence of the evangelical cause. He not only consented to the defensive Protestant League of Schmalkald, which the elector and the landgrave cemented, but published a manifesto asserting the right of such rrsistance to authority oppressively exercised over conscience and the Gospel. (*Warning to the Germans,* October 1530, and *Declaration* of November 1530.) In consequence oi this combination and the menace of a Turkish invasion by the sultan Solyman, Charles was fain to agree to an accommodation in the religious peace of Nuremberg (1532).

In further negotiations with Bucer and the South German theologians on the sacramental question, Luther relaxed somewhat in his exclusive dogmatism on the subject, and agreed to the Wittenberg Concord (1536). Though the agreement did not include the Zwinglians, he meantime maintained friendly relations with Bullinger, Zwingli's successor at Zurich, and was impressed by the mediating view of Calvin, though he never came into direct contact with the Genevan reformer. Towards the anabaptist movement, on the other hand, he adopted an attitude of uncompromising antagonism. These sectaries, who took their rise at Zurich in 1525, and rapidly spread their views from Switzerland over the Empire, continued the more radical tendency of Miinzer, whose revolutionary teaching was adopted by the more extreme section and eventuated in the fantastic and fanatic attempt to establish the reign of the saints at Münster in Westphalia. The more moderate section led by Hubmaier, Hetzer, and Denck, all of them men of scholarly attainments, eschewed revolutionary violence, and advocated adult baptism as the exclusive scriptural practice, and a more literal revival of primitive Christianity as they understood it. To Luther both sections were alike obnoxious as subverters of religious and social order, and he ultimately belied his own principle of freedom of conscience by supporting the persecution to which both sections were alike subjected in Protestant as well as Roman Catholic territories, and in joining Melanchthon in pronouncing for the infliction of the death penalty for persistent profession of Anabaptist error (1536).

Last Years.—In spite of the increasing ill-health from which he suffered during the last ten years of his life, he continued to toil at the task of maintaining and vindicating the Reformation. Whilst compromising it by his secret, though reluctant sanction of the bigamous marriage of the landgrave, Philip (1540), which ere long leaked out and was not rendered less scandalous by his honest, but warped attempt to justify it, Luther continued the warfare against the papacy as anti-Christian in a closing series of controversial works. He staunchly opposed the policy of Paul III. to effect a reunion with Rome through a general council, which the pope at last agreed to convene. Such a reunion could only be achieved at the price of sacrificing the essential principles of the Reformation as a revival of the teaching and the institutions of the New Testament and the early Church, which he claimed to have vindicated against the corrupt and secularized Roman distortion of them. He maintained a sceptical, though less uncompromising attitude towards the attempt of the emperor, for political reasons, to bring about a feasible accommodation *(The Wittenberg Reformation,* Jan. 154*j).* His more constructive contribution to the movement during these declining years is the revision, with the assistance of his colleagues, of his translation of the Old Testament, which he had completed between 1523 and 1532, as well as that of the New Testament. By the year of his death the number of editions of this Luther Bible, or parts of it, had risen to 377, exclusive of the Low German versions of it. Had he contributed nothing else besides this literary and religious treasure to the Reformation, he would amply deserve the title of the greatest religious benefactor of his people in modern times. He added to the value of this service by his commentaries on the books of the Bible, which entitle him to a high place among biblical exegetes, and which were the fruit of his expositions of Holy Writ in the classroom. Next to the influence of his translation of the Bible, may be placed that of the hymns with which he enriched the reformed worship, and the two catechisms which he composed in 1529 for instruction in the distinctive doctrines of the Christian faith.

He did not live to experience the force of the blow to his cause which the emperor was at last preparing to deliver. He died on Feb. 18, 1546, at Eisleben, where he had been born 63 years before. He had paid a visit to his birthplace to arbitrate in a dispute between Counts Albrecht and Gebhard of Mansfeld. He successfully accomplished his mission, and preached several times to crowded congregations. But the exposure to the inclement weather during the journey thither, and the protracted negotiations, proved too great a strain for his infirm body, and in the early morning of the 18th he passed quietly away. His last word was an emphatic "yes" to the question of Jonas whether he remained steadfast in the doctrine which he had taught. Count Albrecht would fain have laid him to rest in his native Eisleben. But the elector, John Frederick, insisted on the transference of his body to Wittenberg, where his life work had been done, and there, on Feb. 22, it was interred in the Castle church, in the presence of his stricken widow and children and a great concourse of notables, disciples and burghers.

The impression produced by his personality and his work on his closest associates is reflected at first hand in the funeral sermon preached by Bugenhagen and the funeral oration delivered by Melanchthon to this great assembly. A man, said Bugenhagen, who never feared anyone, however great and mighty, in much the same words as the regent, Morton, used at the grave of John Rnox. Though to some he appeared too sharp and bitter in reproof and denunciation, this was his due prerogative as a prophet, as it was of Christ himself in his conflict with the scribes and the Pharisees. In his rôle as a prophet sent by God, he rediscovered and vindicated the Gospel and delivered the Church from the corruption and tyranny of Rome. The preacher could only liken him to the angel of the Apocalypse who flew in mid-heaven with the everlasting Gospel to proclaim to the dwellers on earth, and the effects of his prophetic mission could only be described in the words of the second angel, "Fallen, fallen is Babylon the great!" Dead in the body, Luther would live in his work in accordance with his own prophecy, *Pestis eram vivus, moriens tua mors ero Papa* ("In life *I* was thy pestilence; dying, I will be thy death, O Pope").

For Melanchthon, Luther was the unique praeceptor. He belonged to the long line of God-inspired teachers and leaders who from the days of the patriarchs onwards had successively preserved and renewed the Church. In this succession he was worthy to stand beside Isaiah, John the Baptist, Paul, Augustine. He was the great renovator, not the innovator of the Church, which he had striven to purify from error and abuse. Strife and division had ever been an inevitable concomitant of the working of the Divine Spirit at such crises in its history, and the responsibility for this division lay with those who refused to hear the truth. Melanchthon assumes that what Luther taught in his long struggle with his opponents was the true doctrine, of which he gave a rapid summary. He combined in the highest degree the gifts of the great Christian teacher and the active reformer. As in the days of Nehemiah the builders of Jerusalem rebuilt the walls with the one hand and held the sword in the other; so Luther had maintained the struggle with the enemies of the true doctrine, and had at the same time, by his writings and his translations of the Scriptures, brought enlightenment and comfort to a multitude of burdened consciences. For this double work pious Christian hearts would be eternally grateful to him and thank God for him. Melanchthon, who had sometimes to suffer under his masterfulness and his vehemence, indicated, indeed, that there might be truth in the complaint of some—and these good-hearted people—that Luther was too hard and rough in his controversial writings. In the face of such a charge he reminded his hearers of the reputed saying of Erasmus, "God in these last times, in which great and terrible diseases have prevailed, has given the world also a sharp physician." As God placed His Word in the mouth of Jeremiah to tear up and break down, to plant and to build, so in the case of Luther. Certain it was that, in defending his teaching, he was acting solely in obedience to his conscience, not merely from quarrelsome and malevolent motives. All who knew him must bear him this testimony. They would, too, readily testify to his amiability, his kindliness, his goodness in private intercourse. "His heart was true and without falseness, his utterance friendly and kindly, and his striving ever to observe the Apostles' command, 'Whatsoever things are true, etc.'" Undeniable, too, his deep piety, his striving to exercise himself in the Christian virtues and in all good and useful studies and arts, his continence and freedom from vice, his readiness to conciliate and arrange the quarrels of others, his hatred of intrigue and trimming, his singleness of purpose, his constant recourse to prayer in the midst of the trial and stress of affairs, his unfailing courage in reliance on God's help as his immovable rock, his rare intellectual acumen and quickness in dealing with difficult situations and problems, his power of observation and ability to read character, his devotion to study, his wide knowledge, his aptness to apply it in his writings and lectures, and his wonderful gift of language.

The picture is, in the circumstances, naturally drawn from the angle of a poignant sense of loss. Nevertheless, the words addressed by one who had been Luther's close associate as disciple, co-worker and friend for nearly 30 years to an audience which had known him in daily intercourse for a longer period, leave on the reader the impression of having been uttered in complete sincerity and truth. *(See* also REFORMATION.)

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(J. M.)

LUTHERANS, the general title given to those Christians who have adopted the principles of Martin Luther as opposed to those of the Roman Church, the followers of Calvin, and the sectaries of the times of the Reformation. Lutheran churches often term themselves Evangelical as distinct from Reformed, but these uses are not strictly applied in all cases. Lutheran dogmatic symbols are usually said to include nine separate creeds which together form the *Book of Concord (see* CONCORD, BOOK OF). Three belong to the early Christian church—the *Apostles' Creed,* the *Nicene Creed* (in its western form; *i.e.,* with the *filioque*), and the so-called *Athanasian Creed;* six come from the 16th century—the *Augsburg Confession,* the *Apology for the Augsburg Confession,* the *Schmalkald Articles,* Luther's two *Catechisms* and the *Formula of Concord.* But only the three early creeds and the *Augsburg Confession* are recognized by all Lutherans. Luther's *Catechisms,* especially the shorter of the two, have been almost universally accepted, but the *Formula of Concord* was rejected by many Lutheran churches who did not like its strict and detailed doctrinal statements. The *Augsburg Confession* and Luther's *Short Catechism* may therefore be said to contain the distinctive principles which all Lutherans are bound to maintain, but, as the principal controversies of the Lutheran church all arose after the publication of the *Augsburg Confession* and among those who had accepted it, it does not contain all that is distinctively Lutheran. Its universal acceptance is perhaps due to the fact that it exists in two forms (the *variata* and the *invariata*) which vary slightly in the way in which they state the doctrine of the sacrament of the Supper. The *variata* edition was signed by Calvin, in the meaning, he said, of its author Philipp Melanchthon.

Development in Germany.—After Luther's death the more rigid Lutherans declared it to be their duty to preserve the *status religionis in Germania per Lutherum instauratus,* and to watch over the *depositum Jesu Christi* which he had committed to their charge. As Luther was a much greater preacher than a systematic thinker, it was not easy to say exactly what this deposit was, and controversies resulted among the Lutheran theologians of the 16th century. (1) The Antinomian controversy was the earliest (1537–60). It arose from differences about the precise meaning of the word "law" in Luther's distinction between law and gospel. Luther limited the meaning of the word to mean a definite command accompanied by threats, which counts on terror to produce obedience. He declared that Christ was not under the dominion of the law in this sense of the word, and that believers enter the Christian life only when they transcend a rule of life which counts on selfish motives for obedience. But law may mean ethical rule, and the Antinomians so understood it, and interpreted Luther's declaration to mean that believers are not under the dominion of the moral law. (2) The Arminian controversy in the Reformed church, the Jansenist controversy in the Roman Catholic church, had their parallel in disputes among the Lutherans lasting from 1550 to 1580. In the end it was generally agreed that sin had not totally destroyed man's ethical nature: and that grace changed what was morally insensitive into what was morally sensitive, so that there could be a co-operation between God's grace and man's will ("synergism"). (3) The controversy raised by Andreas Osiander was more important. He felt that Luther had omitted to make adequate answer to an important practical question, how Christ's death on the cross could be brought into such actual connection with every individual believer as to be the ground of his actual justification. It was answered that the principal effect of Christ's work on the cross was to change the attitude of God toward the whole human race, and that, in consequence, when men come into being and have faith, they can take advantage of the change of attitude effected by the past historical work of Christ. The Reformed church, on the other hand, had its own distinctive doctrine of the atonement, with a strong emphasis on predestination. (4) The other controversies concerned mainly the doctrine of the sacrament of the Supper, and Luther's theory of consubstantiation. This required a doctrine of *ubiquity,* or the omnipresence of the body of Christ extended in space, and therefore of its presence in the Communion elements. Calvin had taught that the true way to regard substance was to think of its power *(vis),* and that the presence of a substance was the immediate application of its power. The presence of the body of Christ in the sacramental elements did not need a presence extended in space. Melanchthon and many Lutherans accepted the theory of Calvin, and alleged that Luther before his death had approved of it. Whereupon the more rigid Lutherans accused their brethren of crypto-Calvinism, and began controversies which dealt with that charge and with a defense of the idea of ubiquity. The University of Jena, led by Matthias Flacius, was the headquarters of the stricter Lutherans, while Wittenberg and Leipzig were the centres of the Philippists or followers of Melanchthon.

Conferences only increased the differences. The Lutheran Church seemed in danger of falling to pieces. In the end, the greater proportion adopted the *Book of Concord* (1580). Its recognition was mainly due to the efforts of Augustus, elector of Saxony. The churches within Germany which refused the Book of Conrord became for the most part Calvinistic or Reformed. They published as was the fashion among the Reformed churches, separate creeds for themselves, but almost all accepted the Heidelberg Catechism (*q.v.*). These differences in the German Protestant churches of the second half of the 16th century are reflected in the American Lutheran church. This church exists in three separate organizations. The General Synod of the Evangelical Church of the United States, organized in 1820, has no other creed than the Augsburg Confession, so liberally interpreted as not to exclude Calvinists. The Synodical Conference of North America, organized in 1872, compels its pastors to subscribe to the whole of the nine creeds contained in the Book of Concord. The General Council, a secession from the General Synod, was organized in 1867, and accepts the "unaltered" (*invariata*) Augsburg Confession in its original sense, and the other Lutheran symbols as explanatory of the Augsburg Confession.

The divided state of German Protestantism, resulting from these theological differences, contributed in no small degree to the disasters of the Thirty Years' War, and various attempts were made to unite the two confessions. Conferences were held at Leipzig (1631), Thorn (1645), Cassel (1661); but without success. At length the union of the two churches was effected by the force of the civil authorities in Prussia (1817), in Nassau (1817), in Hesse (1823), in Anhalt-Dessau (1827) and elsewhere. These unions for the most part aimed, not at incorporating the two churches in doctrine and in worship, but at bringing churches or congregations professing different confessions under one government and discipline. They permitted each congregation to use at pleasure the *Augsburg* Confession or the Heidelberg Catechzsm. The enforced union in Prussia was combined with the publication of a new liturgy intended for common use. This led to secessions from the state church. These seceders were at first treated with great harshness, but have aon their way to toleration, and form the Lutheran Free or Old Lutheran churches of Germany.

The liturgies of the Lutheran churches exhibit the same diversities in details as appear in their constitutions. It may be said in general that while Luther insisted that public worship ought to be conducted in a language understood by the people, and that all ideas and actions which were superstitious and obscured the primary truth of the priesthood of all believers should be expurged, he wished to retain as much as possible of the public service of the mediaeval church. The external features of the mediaeval churches were retained; but the minor altars, the tabernacula to contain the Host, and the light permanently burning before the altar, were done away with. The ecclesiastical year with its fasts and festivals was retained in large measure. In 1526 Luther published the German Mass and Order of Divine Service, which, without being slavishly copied, served as a model for Lutheran communities. It retained the altar, vestments and lights, but explained that they were not essential and might be dispensed with. The peril attending the misuse of pictures in churches was recognized, but it was believed to be more than counterbalanced by the instruction given through them when their presence was not abused. In short Luther contented himself with setting forth general principles of divine service, leaving them to be applied as his followers thought best. The consequence was that there is no uniform Lutheran liturgy. Divergences are the wider, since the Reformed tradition commonly rejected all the liturgical practices of the mediaeval church, substituting for them bare and severe forms of divine service.

The divergences in ritual and organization, the principal underlying all the various ecclesiastical unions; viz.. to combine two different confessions under one common government, and, resulting from it, the possibility of changing from one confession to another, have all combined to free the state churches from any rigid interpretation of their theological formulas. A liberal and a conservative theology (rationalist and orthodox) exist side by side within the churches, and while the latter clings to the theology of the 16th century, the former ventures to raise doubts about the truth of such a common and simple standard as the Apostles' Creed. Up to the end of World War I, the relation of the Lutheran Church to the state was essentially as follows. In each state the sovereign was held to be the *summus episcopus*. He appointed a minister of public worship, and through him nominated the members of the governing body. the Oberkirchenrath or consistcrium or *directorium*. This council dealt with property, patronage and all other ecclesiastical matters. But each parish elected its own council for parochial affairs, which had a legal status and dealt with such matters as the ecclesiastical assessments. Delegates from these parish councils formed the Landessynode. In cases that called for consultation together, the consistorium and the synod appointed committees to confer. The income of the state churches was derived from four sources. The state made an annual provision for the stipends of the clergy, for the maintenance of fabrics and for other ecclesiastical needs. The endowments for church purposes, of which there were many, and which were destined to the support of foreign missions, clerical pensions, supply of books to the clergy, etc., were administered by the *consistorium*. The voluntary contributions of the people were all absorbed in the common income of the national churches and were administered by the supreme council. Each parish was legally entitled to levy ecclesiastical assessments for defined purposes.

Reorganization after World War I aimed at the separation of church and state in Germany. The churches were guaranteed diminishing state support, with the ultimate purpose of divorcing them entirely from the state, or Lander, governments. The acute economic depression of 1922–24 affected most disastrously those elements of the laity from which the greatest measure of church support was to be expected, and it subjected the clergy to severe privations.

During the nazi rule (1933–45) leading Lutherans took a prominent part in the "Confessing Church" movement which resisted nazi efforts to use Christianity for its own ends. After the defeat of Germany in 1945 the Protestant churches were particularly affected by the partition of Germany into western and Soviet zones. The area of Germany controlled by the U.S.S.R. was the most Protestant part of the country, and of the 11,000,000 or so refugees from the east in the Federal Republic in 1954 the great bulk were Protestant, for the most part Lutherans.

Outside Germany. — From the first days of the Reformation Lutheranism spread quickly from Germany to other countries but its course of development elsewhere was different. The most important converts to Lutheranism were the peoples of the Scandinavian countries.

Sweden and Finland, Denmark and Norway adopted Lutheranism as the religion of their countries in the 16th century, and their Lutheran churches are all established by law and count the overwhelming majority of the people as their members. In 1953 the membership was reckoned as: Sweden 6,580,000; Denmark 4,156,500; Norway 3,036,844; and Finland 3.996.442. All four of these churches have retained the traditional episcopal system of the mediaeval church, but only Sweden has kept the line of episcopal consecration unbroken, though Finland has restored it. The Scandinavian churches have made notable contributions to the intellectual life of Lutheranism in theology. Iceland is also mainly Lutheran (140,000) as a result of its Danish connection.

After World War I the winning of independence by the Baltic states resulted in independent Lutheran churches there (Latvia, Estonia and Lithuania). Their organization was disrupted by successive Russian and German occupations during World War II and after, and many of their members became refugees from Communist rule at the end of that war. The numbers of Lutherans in these countries in 1953 was calculated to be 1,615,000.

The only Lutheran churches of any size in Slavonic lands are those in the U.S.S.R. and Slovakia. The former was permitted to organize itself in 1924: the latter (430,000 in number) has had a vigorous life in a predominantly Roman Catholic environment. Smaller Lutheran churches are to be found in Hungary. France. Austria and the Balkan countries, and some Lutherans are found in almost every land in the world. Outside Europe and North America, Brazil. Indonesia and South Africa have the largest Lutheran churches.

Particularly after 1945 American Lutheranism played a big part among Lutherans everywhere. Huge sums of money were collected by Lutherans in the United States to help Lutherans in distress, particularly in Germany. The main organ of this activity was the Lutheran World federation, organized and financed by Americans: it claimed about 70% of the world's Lutherans as its members. The Missouri synod was also active and the policy of both these organizations was to encourage the formation of Lutheran churches where they did not exist, and their expansion where they did. In Great Britain, for example, their policy after 1945 was to bring together all the Lutheran refugees in Britain in order to form one British Lutheran church. The Lutheran World federation represents the liberal Lutheran tradition and the Missouri synod the extremely conservative outlook, but their policies coincide in some points. Lutheran leaders play an important part in the World Council of Churches, and American Lutherans from 1945 onward were generous in helping needy Christians of other churches as well as their own Lutheran brethren.

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(T. M. Li.; C. M. J.; H. M. W.)

UNITED STATES AND CANADA

In 1953 the Lutheran Church in the United States and Canada had 6,869,066 baptized members, of whom 202,885 were in Canada. They were divided into three major groups of almost equal size: the United Lutheran Church; the Lutheran Synodical Conference, a consultative federation of five bodies of which the Lutheran Church — Missouri Synod was by far the largest; and a group of five bodies, loosely associated in the American Lutheran Conference until 1954, when negotiations for a closer union were under way. The remainder, slightly more than 1% of the total membership, was divided among five small, independent bodies.

History. — There were Lutherans among the earliest American colonists who settled in New Netherland and New Sweden, and these were followed by German colonists who settled especially in the present Middle Atlantic states, in the Shenandoah valley, in Georgia and in Nova Scotia.

The geographical spread of Lutherans was extended by migrations to the western frontier and by the large immigrations during the 19th and early 20th centuries of Germans, Norwegians, Swedes, Danes, Finns, Slovaks, Hungarians, Icelanders and others. Many of these immigrants settled in the middle west, and from there Lutherans later pushed on to the far west. Consequently Lutherans came to be distributed among all the states of the United States and the provinces of Canada. Since they brought with them from Europe a variety of languages and customs, they organized congregations, and later synods, according to their national origins, and originally the names of synods usually reflected their European provenance. In the American environment Lutherans in time adopted the English language, more quickly in the east than in the west where the effects of immigration were felt longer, and this was accompanied not only by the discarding of national references in synodical titles but also by closer associations on the part of people who had before been separated by linguistic differences.

Organization. — Although there are some differences in polity, as a rule a strong sense of the independence of local congregations marks Lutheranism in America. This is modified, however, by the delegation of authority to synods and to the conventions of larger bodies. Hence a mingling of congregational and presbyteral elements is observable, and the authority exercised by synodical and other presidents also suggests the presence of an episcopal element.

The first permanent synod was organized in 1748, to which about 100 others were added later. These were gradually reduced by mergers to 17 bodies, the largest of which by the mid-20th century were the United Lutheran Church with 2,143,372 members (1953), the Lutheran Church — Missouri Synod with 1,916,510 members, the Evangelical Lutheran Church with 919,840 members, the American Lutheran Church with 824.535 members, the Augustana Lutheran Church with 499,640 members, and the Joint Synod of Wisconsin with 322,947 members. Two-thirds of the Lutherans in North America (often exclusive of the Synodical Conference) act co-operatively in many areas — including publicity, social action, education, missions and welfare — through the National Lutheran council, an agency of the churches formed in 1918. The lines betneen Lutheran bodies are also crossed by federations and associations of Lutheran men, women, young people, educators, publishers, editors, statisticians, etc. A majority of the churches in North America are associated with Lutherans in other parts of the world in the Lutheran World federation and with other Christians in the World Council of Churches.

Doctrines. — The distinguishing mark of Lutherans is neither their form of organization nor their form of worship (which is moderately liturgical) but their confession of faith. All Lutherans in North America adhere to the *Augsburg Confession* and Luther's *Small Catechism*, most of them also embracing the other confessions in the *Book of Concord* (1580). The unity thus demonstrated has sometimes been disturbed by doctrinal controversies, but these have usually been carried on within the framework of the confessions and have accordingly involved interpretations of these standards. The conservatism in doctrine characteristic of Lutherans spared them the sharp divisions which other Protestants in North America sometimes suffered.

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LUTHULI, ALBERT JOHN (1898–), South African political leader, the winner of the Nobel peace prize for 1960, was born in Southern Rhodesia, the son of an African Christian missionary of Zulu stock, to whose family home at Groutville. Natal. he was taken while still a boy. Having completed his education at Adams college, near Durban, he taught there for 15 years till 1935, when he was elected tribal chief of Groutville. He then did much to improve the economic position of African sugar farmers in Groutville and elsewhere. Just before World War II he was a delegate to an international missionary conference at Madras, India, and in 1948 he went to the United States to lecture about Christian missions in South Africa. Long interested in the political advancement of Africans, he had finally joined the African National congress (A.N.C.) at the end of World War II. An advocate of nonviolent resistance to the South African government's policy of *apartheid*, he helped to organize a campaign of civil disobedience in 1952. For refusing to resign from the A.N.C., of which he was elected president (also in 1952), he was deprived of his chieftainship by the Native Affairs department. Arrested on a charge of high treason in 1956 but later released, he was in 1959 banished for five years to his home district; in 1960 the A.N.C. was banned. The award of the Nobel peace prize to him was made in 1961.

LUTON, market town and municipal and parliamentary borough in the South Bedfordshire parliamentary division of Bedfordshire. Eng., 20 mi. S. of Bedford. Pop. (1961) 131.505. It lies where the river Lea passes through the Chiltern hills (Luton = "Lea town"). Long famous for its manufacture of straw hats, it has achieved a new reputation for hats of felt and other materials and an even greater reputation as an engineering centre.

Luton has large motor-vehicle works and other manufactures include electrical equipment and precision instruments. In the museum in Wardown park can be seen the history of the straw-hat industry which originated with the colony of straw-plaiters transplanted by James I from Scotland. The most striking modern building is the town hall (1936). The municipal airport is of the same date. Two miles south-southeast is the mansion of Luton Hoo, with the priceless Wernher collection of art treasures (see BEDFORDSHIRE).

LUTSK: see LUCK.

LUTTRELL, HENRY (*c.* 1765–1851), English wit and writer of society verse, was the illegitimate son of Henry Lawes Luttrell, 2nd earl of Carhampton. In 1820 he published his *Advice to Julia,* of which a second edition, altered and amplified, appeared in 1823 as Letters to Julia in Rhyme. This poem, suggested by the ode to Lydia in the first book of Horace's Odes, was his most important work. His more serious literary contemporaries nicknamed it "Letters of a Dandy to a Dolly." In 1827 in *Crockford* House he wrote a satire on the high play then in vogue. Byron characterized him as "the best sayer of good things, and the most epigrammatic conversationist I ever met"; Sir Walter Scott wrote of him as "the great London wit," and Lady Blessington described him as the one talker "who always makes me think." Luttrell died in London on Dec. 19, 1851.

LÜTZEN, a town in the district of Halle, Ger., in former Prussian Saxony (pop. [1950] 5,375), chiefly famous as the scene of a great battle fought on Nov. 6–16, 1632, between the Swedes, under King Gustavus Adolphus, and the imperialists, under Wallenstein. After being foiled in his prolonged effort to bring Wallenstein to battle at Nürnberg (see THIRTY YEARS' WAR), Gustavus moved south to the Danube. But instead of being drawn by this threat to Bavaria, Wallenstein advanced into Saxony. The menace led Gustavus to march rapidly north, pausing at Nürnberg, 60 mi. south of his rival at Leipzig, to await reinforcements. As Gustavus had thrown up entrenchments Wallenstein, assuming that no immediate attack was likely, allowed Pappenheim to take a large detachment in order to lay siege to a small castle near Halle. When Gustavus heard of Pappenheim's departure he determined to strike while his enemy was thus weakened.

About noon Gustavus gave the signal to advance. The king himself commanded the right wing. The Swedes charged and routed the first line of the imperial cavalry but were stopped by the second line, and at that moment Gustavus galloped away to the centre where a gap had opened and was killed leading a countercharge. The news of Gustavus' death spread and the fire of the assault died out. Wallenstein recaptured his guns and drove the Swedes back.

But the fiery Duke Bernhard of Saxe-Weimar took up the command and ordered a fresh advance. Again the imperialists were driven in and their guns recaptured, this time all along the line. About three in the afternoon the Swedes were slowly bearing back Wallenstein's stubborn infantry when Pappenheim appeared and charged at once in direction of the enemy's right. Wallenstein thus gained time to re-establish his order, and once more the now exhausted brigades of the Swedish first line were driven over the road. But Pappenheim fell in the moment of victory, and his death disheartened the imperialists. For the last time Bernhard forced the Swedes to the attack and thus carried the day.

Lutzen is famous also as the scene of a victory of Napoleon over the Russians and Prussians on May 2, 1813. (*See* NAPOLEONIC CAMPAIGNS.) This battle is often called Gross Gorschen.

LÜTZOW, ADOLF, FREIHERR VON (1782–1834), Prussian lieutenant general, was born in Berlin on May 18, 1782, and entered the army in 1795. At the outbreak of the "war of liberation," he received permission from Scharnhorst to organize a "free corps" consisting of infantry, cavalry and Tirolese marksmen, for operating in the French rear and rallying the smaller governments into the ranks of the allies. At Kitzen (near Leipzig) the whole corps, warned too late of the armistice of Poischwitz, was caught on the French side of the line of demarcation and, as a fighting force, annihilated. Lützow cut his way out with the survivors, and recruited and reorganized the corps, which fought at Gadebusch (where Korner fell), Gohrde (where Lützow was wounded) and at the siege of Jülich. At Ligny Lützow led the 6th Uhlans to the charge, but they were broken by the French cavalry, and he was captured, escaping, however, on the day of Waterloo. He died at Berlin on Dec. 6, 1834. One of the last acts of his life for which Lützow is remembered is his challenge (which was ignored) to Bliicher, who had been ridden down in the rout of the 6th Uhlans at Ligny, and had made, in his official report, comments thereon, which their colonel considered disparaging.

See K. von Lutzow, *Adolf Lützows Freikorps* (1884); Fr. von Jagwitz, *Geschichte des Lützow'schen Freikorps* (1892).

LUWIANS, an extinct people of ancient Asia Minor, also known as Luites. Their language, Luwian (Luvian, Luish) is known from cuneiform texts of the 14th and 13th centuries B.C. found at Boğazköy, the capital of the Hittites (*q.v.*), where it is referred to by the adverb *luwili* (lu-u-i-li), "in Luwian." This language is related to, but distinct from: Hittite; with Hittite and Palaic it belongs to the Anatolian group of Indo-European languages (see ANATOLIAN LANGUAGES). The language written with the so-called Hittite hieroglyphs, which were used for inscriptions from the 14th to the 7th century B.C., is very close to Luwian, probably nothing but a dialect of it; and the Lycian language, written in a variety of the Greek alphabet in the 5th and 4th centuries B.C., is equally related and may go back to still another dialect of Luwian. Personal names that have been claimed as Luwian are attested in Asia Minor from the 19th century B.C. to the Roman period.

Language.—Luwian shares with Hittite and Palaic the following characteristics: (1) it has only two genders, masculine-feminine (genus *commune*) and neuter; (2) the verb has a present and a preterit tense in the indicative mood and an imperative but no other moods; (3) it has an active and a middle form. The main differences between Luwian and Hittite are: (1) replacement of the genitive by a possessive adjective in *-assi-;* (2) a case in -ti serving as ablative and instrumental; (3) plural of the genus commune in *-nt:* nominative in *-nzi,* accusative in *-nza* (in cuneiform Luwian only, not in hieroglyphic). (4) The verb has 1st singular present in *-wi* (against Hittite -mi), 3rd singular in -ti, plural in *-nti* (against Hittite *-zi, -nzi*), preterit *-ta, -nta* (against Hittite *-t,* plural *-er*). (5) In the vocabulary, Luwian has a set of connective particles different from the Hittite. Some words are identical with or very close to their Hittite counterparts (often replacing Hittite *e/i* by a); others are different, such as tati, "father," against atta; and *massana,* "god," against *siuni,* etc.

Distribution and History.—The Hittite laws, datable to about 1500 B.C., mention Luwia as a foreign country. One copy of the laws replaces "Luwia" by "Arzawa." The term Luwia is not used thereafter, whereas Arzawa (Arzava) is frequent as the name of a large region comprising several principalities, probably in southwestern Asia Minor. If the variant means that "Luwia" and "Arzawa" were roughly synonymous (the older term standing for or at least including Arzawa), then Luwians would have lived in the southwest. The language is, however, also attested in Kizzuwatna, a country including the Cilician plain in the south, so that the old term Luwia may include that region also. Both Arzawa and Kizzuwatna were independent kingdoms during the Old Hittite period (c. 1700–1370 B.C.) but later became vassals of the Hittite empire, Kizzuwatna under the ruler Suppiluliuma (*c.* 1370 B.C.) and Arzawa under his son, Mursili II. Apparently Luwians both shared in and contributed to Hittite civilization. The Luwian texts found in the Hittite capital (mostly magic spells) as well as the use of hieroglyphs throughout the empire and the appearance of Luwian loanwords in Hittite texts testify to the penetration of the Hittite empire by Luwians, a process that increased toward the end of the empire, in the 13th century.

Since Luwians lived in southwestern and southern Anatolia, attempts have been made to ascribe to them certain types of pottery found in those regions, but these attributions remain hypothetical. Similarly, place names formed with the suffixes *-nd-* and *-ss-*, which are found in parts of Asia Minor and in Greece, have been claimed as Luwian. Closer examination of the place names occurring in Hittite texts has shown, however, that many of them are not Luwian and that they also occur outside the Luwian area. Personal names of Luwian type first occur in limited numbers toward the end of the Assyrian merchant colony period (c. 1800 B.C.). They were common in the Hittite period and survived until Roman times.

After the downfall of the Hittite empire (c. 1200 B.C.) hieroglyphic inscriptions in Luwian are common in southeastern Anatolia and northern Syria. Their appearance in Syria indicates an expansion of Luwians into regions not previously held by them. The history of the Luwians in the 1st millennium B.C. thus is the history of the so-called Late Hittite principalities—Tabal (biblical Tubal) around Kayseri, Tuwanuwa (classical Tyana), Gurgum with capital Marqasi (Maraş), Milit (Melitene, Malatya). Carchemish on the Euphrates, Hattina (the plain of Antioch) and Amatu (Hamath). The hieroglyphic inscriptions are of votive character, containing little more than the names of rulers. sometimes with genealogies. Most historical information about these states comes from the annals of Assyrian kings, who repeatedly raided them and imposed tributes, until Sargon II (722–705 B.C.) incorporated them as provinces into his empire. Most Syrian states were conquered by Aramaeans prior to the Assyrian conquest; but in the Anatolian principalities (Tabal, Tuwanuwa, Milit) and above all in Carchemish, the most important kingdom of the group, Luwian proper names and hieroglyphic script remained in use until the end. From roughly 700 B.C. also is dated the bilingual inscription in Phoenician and hieroglyphic Luwian discovered at Karatepe in eastern Cilicia. What little is known about Lycia (*q.v.*), finally, comes from classical sources.

Religion and **Civilization.**—Luwian gods were incorporated into the pantheon of the Hittites. On the whole, the beliefs of the two peoples were very similar so that their gods could easily be identified with one another. The chief god in both systems was a god of thunderstorm and rain, called Tarhunt in Luwian. The Luwian sun god was called Tiwat; the moon god had the same name, Arma, in both languages. Other gods worshiped in Luwian belong to different ethnic groups; *e.g.*, Kupapa, the main goddess of Carchemish. A Luwian dialect was used in the cult of the gods of the town of Istanuwa (location unknown). The presence of Luwian magical rituals in the Hittite capital indicates that Luwians had a certain reputation as magicians. In the late hieroglyphic inscriptions some of the gods known from earlier cuneiform texts recur. In these inscriptions the gods are asked to punish anyone who might damage the object or the text.

As stated earlier, the Luwians partook in the general Hittite civilization. Whatever institutions or cultural traits may have been typically Luwian remains to be determined. The small Luwian states of the 1st millennium carried on the Hittite tradition, as witnessed by the traditional Hittite names of some of their rulers, such as Lubarna, Sapalulme, Katuzili or Muwatalli, and by the name "Hittite" given them by both the Assyrians and the Israelites of the period of the monarchy. The art of these states combines Hittite motifs with others of more generally near-eastern origin; its style, which differs markedly from that of the Hittite empire, was influenced by that of the Aramaeans and, later, of the Assyrians, so that it is hard to identify specifically Luwian characteristics. On the whole it appears that the main importance of the Luwians lies in the continuation of Hittite tradition after the downfall of the empire.

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LUXEMBOURG, FRANÇOIS HENRI DE MONTMORENCY-BOUTEVILLE, DUKE OF (1628–1695), marshal of France, the comrade and successor of the great Condé, was born at Paris on Jan. 8, 1628. He was the son of the comte de Montmorency-Bouteville, and was brought up by his aunt, Charlotte de Montmorency, princess of Condé, with her son, the duc d'Enghien. The young Montmorency (or Bouteville as he was then called) shared his cousin's successes and reverses throughout the troubles of the Fronde. He returned to France in 1659 and was pardoned, and Condé arranged his marriage to the greatest heiress in France, Madeleine de Luxembourg-Piney, princesse de Tingry and heiress of the Luxembourg dukedom (1661), after which he was created duc de Luxembourg and peer of France. At the opening of the War of Devolution (1667–68), Condé, and consequently Luxembourg, had no command, but during the second campaign he served as Condé's lieutenant-general in the conquest of Franche Comté. In 1672 he held a high command against the Dutch. He defeated the prince of Orange at Woerden and ravaged Holland, and in 1673 made his famous retreat from Utrecht to Maestricht with only 20,000 men in face of 70,000, an exploit which placed him in the first rank of generals. In 1674 he was made captain of the gardes du corps, and in 1675 marshal of France. In 1676 he commanded the army of the Rhine, but failed to keep the duke of Lorraine out of Philipsburg; in 1677 he stormed Valenciennes; and in 1678 he defeated the prince of Orange, who attacked him at St. Denis after the signature of the peace of 'Nijmwegen. Luxembourg spent some months of 1680 in the Bastille, but on his release took up his post at court as *capitaine* des gardes.

When the war of 1690 broke out, the king and Louvois gave Luxembourg command of the army of Flanders. On July 1, 1690, he won a victory over the prince of Waldeck at Fleurus. In 1691 he commanded the army which covered the king's siege of Mons and defeated William III. of England at Leuze on Sept. 18, 1691. Again in the next campaign he covered the king's siege of Namur, and defeated William at Steenkirk (*q.v.*) on June 5, 1692; and on July 29, 1693, he won his greatest victory over his old adversary at Neerwinden, after which he was called *le tapissier de Nôtre* Dame from the number of captured colours that he sent to the cathedral. He was received with enthusiasm at Paris by all but the king, who looked coldly on a relative and adherent of the Condés. In the campaign of 1694, Luxembourg did little in Flanders, except that he conducted a famous march from Vignamont to Tournay in face of the enemy. He died on January 4, 1695. As a general he was Condé's grandest pupil. Though slothful like Condé in the management of a campaign, at the moment of battle he seemed seized with happy inspirations, against which no ardour of William's and no steadiness of Dutch or English soldiers could stand. He left four sons, the youngest of whom was a marshal of France as Maréchal de Montmorency.

See, besides the various memoirs and histories of the time, Beaurain's *Histoire militaire du duc de Luxembourg* (Hague and Paris, 1756); *Mémoires pour servir à Phistoire du maréchal duc de Luxembourg* (Hague and Paris, 1758); Courcelles, *Dictionnuire des généraux français*, vol. viii. (Paris, 1823). *See* Ségur *La jeunesse du mare'chal de Luxembourg, 1628–68* (1900); *Le mare'chal de Luxembourg-et le prince d'Orange, 1668–98* (1902) and *Les dernières années du mare'chal de Luxembourg* (1904), also Canonge, *Le mare'chal duc de Luxembourg* (1924).

LUXEMBOURG. A sovereign grand duchy of Europe, Luxembourg comprises part of the southern Ardenne uplands and part of the adjoining plateau of Lorraine. It is bounded on the north and west by Belgium, on the east and southeast by Germany and on the south by France. It has an area of 2,586 sq.km. (999 sq.mi.), with maximum distances of 82 km. (51 mi.) from north to south and of 57 km. (35 mi.) from east to west.

The Ardenne region (or Oesling) in the north constitutes nearly one-third of the grand duchy and has an altitude of 1,300 to 1.850 ft.; the southern half of the country (Gutland or the Bon Pays) has an average elevation of 900 ft. The whole of Luxembourg is dissected by deep valleys, whose rivers drain mostly eastward into the Sûre, which in turn runs into the Moselle on the eastern frontier.

History.—At the time of the Roman conquest between 57 and 50 B.C. the area of what is now Luxembourg was inhabited by a Belgic tribe, the Treveri. The population received a fair Roman infusion during the occupation. After A.D. 400 Germanic invaders began to penetrate into the region, and it became part of the Frankish kingdom of Austrasia and later of Charlemagne's empire. By the treaty of Verdun (843) the area was included in the central division of the three into which that empire was split, but it became an independent entity in 963 under Siegfried, count of Ardenne. Conrad (d. 1086), a descendant of Siegfried, took the title of count of Luxembourg *c.* 1060, and his successors enlarged their possessions, chiefly by marriage. Conrad's great-granddaughter the countess Ermesinde (1196–1247) granted charters of franchise to most of the important towns of the county. Her great-grandson Hen IV became German king in 1308 and Holy Roman emperor as Henry VII, and the Luxembourg dynasty was continued on the imperial throne in the persons of Charles IV, Wenceslaus and Sigismund (d. 1437). In 1354 the emperor Charles IV made the county a duchy. The French branch of the house of Luxembourg descended from Waleran of Ligny, younger son of Ermesinde's son Count Henry II.

The country was bought (1442) by Philip the Good of Burgundy from Sigismund's Habsburg successors but reverted to the Habsburgs on the partition of Burgundy in 1506. Spanish domination began in 1555–56, with the abdication of the emperor Charles V. In the revolt of the Low Countries against Philip II, Luxembourg took no part; it was to remain united with what is now Belgium as the Spanish Netherlands. During the 17th century the French under Louis XIV annexed several towns of the area, and Luxembourg itself was captured in 1684 but was returned 13 years later to Spain by the treaty of Ryswick. In 1713 Luxembourg with Belgium passed from the Spanish to the Austrian Habsburgs. It was occupied by the French republic in 1795 and became a department of France under Napoleon.

The congress of Vienna in 181j gave Luxembourg as a grand duchy to William I, king of the Netherlands. Districts lying to the east of the Moselle, Sûre and Our were handed over to the king of Prussia. Luxembourg had the legal position of an independent state, in personal union only with the Netherlands, and was included within the German confederation. However, William I succeeded in uniting the grand duchy de *facto* and *de jure* with his kingdom, as its 18th province. But when the Belgian provinces revolted against William the greater part of the country, with the notable exception of the town of Luxembourg itself (then garrisoned by Prussians), sided with them. In Nov. 1831 the powers divided the country into two parts, of which the larger (now the Belgian province of Luxembourg) went to Belgium and the smaller, in the east, was retained by William I, who, however, refused to accept the decision until 1839. From that year until 1867 the grand duchy was administered separately from the Netherlands. It received from William II a restricted constitution in 1841 and a more liberal one in 1848. After the dissolution of the German confederation in 1866 the link which bound Luxembourg to Germany was broken. but the Prussian garrison still remained in the capital. In 1867. by the treaty of London, this garrison was withdrawn; the neutrality of the grand duchy was guaranteed by the powers, and its sovereignty was vested in the house of Nassau. On the death of William III of the Netherlands in 1890 aithout male heir, the grand duchy passed. in accordance with the Nassau Succession agreement (1783). to Adolphus, duke of Nassau-R'eilburg (d. 1905), who was succeeded by his son William (d. 1912). In 1914 the neutrality of Luxembourg was violated by Germany. On Jan. 1j. 1919, after its liberation, William's daughter, the gracd duchess Marie-Adélaïde, who had shown pro-German sympathies. abdicated in favour of her sister Charlotte. Charlotte, born at the Berg castle, Lux., on Jan. 23, 1896. was married on Nov 6 1919 to Prince Felix of Bourbon-Parma. Prince Jean, their eldest son (b. Jan. 5, 1921). the heir apparent. was married on April 9, 1953, to Princess Josephine Charlotte (b. Oct. 11, 1927), daughter of former king Leopold III of Belgium. On April 16, 1955, she gave birth to a son, Henri.

Luxembourg was occupied again by the Germans from 1940 to 1944, during World War II. Civil government was finally re-established in Sept. 1944. Though it suffered some damage in the fighting of 1944, the industrial capacity of Luxembourg was not seriously impaired, and the country soon regained its prosperity.

Population. — The population of Luxembourg was 290,992 in the census of 1947 and 314,889 in 1960. The chief tonns (1960 census) are Luxembourg (71,653), Esch-sur-Alzette (27,954) and Differdange (17,637).

TABLE I.—Population Statistics, 1910–58

Year	1910	1922	1930	1935	1947	1958
Male	134,101	132,023	154,405	149,429	145,096	163,346
Female	125,790	128,744	145,588	147,484	145,896	158,697
Total*	259,891	260.767	299,993	296,913	290,992	322,043
Foreigners	39,723	33,436	55,831	38,369	29,142	

*Foreigners included

The people are essentially a peasant stock, hard-working and thrifty, individual and conservative and inspired by a strong sense of nationality. They form a bilingual nation and possess, in addition to French and German, a widely spoken dialect. Both French and German became official languages in 1830 and this was confirmed by the constitution of 1848. There are no special areas in which one or the other is exclusively spoken, and education is given in both tongues. The native dialect. *Letzeburgesch,* is a Moselle Franconian (one of the West Middle German group) and is used by all classes. In Oct. 1939 it was made the third official language of the country. About 98% of the population are Roman Catholic. An episcopal see was created at Luxembourg in 1870.

Government and Administration. — The grand duchy is a constitutional monarchy, ruled by a hereditary grand duke or grand duchess. Should the sovereign die without legal issue, the chamber of deputies elects a successor. The sovereign power is vested in the nation and is exercised by the monarch according to the constitution and laws of the country.

The constitution, modelled on that of Belgium, was proclaimed in Oct. 1868. Modifications introduced in 1918 vested sovereignty in the nation (article 32) and instituted election to the chamber of deputies on the basis of universal suffrage of all citizens over 21 years of age exercised according to a system of proportional representation. Every citizen has equality before the law, freedom of religious belief, of expression and of association. etc. The constitution had defined the international status of Luxembourg by guaranteeing the perpetual neutrality of the state in accordance with the treaties of 1839 and 1867, but this was abolished by a revision of 1948, and the country became a signatory to the Brussels and North Atlantic treaties.

Legislative poaer is shared by the sovereign and the chamber of deputies. The sovereign exercises the executive power and has the right to initiate legislation. A council of government appointed by the monarch and consisting of a minister of state (prime minister) and five other ministers (*directeurs-généraux*), uho may each be responsible for several departments. constitutes the administration which in practice, though not in theory, is based upon the support of the chamber.

All laws must be passed by the chamber. This body is elected on the basis of one member to constituencies (grouped in four electoral districts) of 5,500 inhabitants, with one extra representative for a residue of 3,000. Deputies hold office for six years, and one-half their number retires every three years. Decisions are by a majority vote. and debates are in French.

There is also a council of state, of not more than 1j members, appointed for life by the sovereign. This body considers any proposed legislation or any administrative problems submitted to it by the sovereign or government From its members is elected every six years a committee of seven (*comité du contentieux*), which acts as a final judicial court in cases relating to the powers of the administration

Five professional chambers (*chambres professionelles*) were set up by a law of April 4, 1924, to share in legislation. These bodies are composed of representatives from agriculture, handicrafts, commerce, private employees and labour. No law affecting a particular occupation can be passed by the chamber of deputies until the opinion of the interested professional chamber(s) has been given.

The basic unit of local government is the commune. Each commune is administered by an elected council and has a burgomaster and two aldermen (*échevins*). The council is both a local administrative body and an instrument of the central authority. Its term of office is six years, one-half its members retiring every three. The burgomaster and the kchevins (except for the city of Luxembourg) are appointed by the government; those for Luxembourg are nominated by the sovereign. These officials are the executive heads of the communes. As in Belgium, the commune has a great measure of independence. and within the competence of its council fall such matters as public undertakings, elementary education, public health, etc.

The communes themselves are grouped into cantons and these in turn into arrondissements administratifs, each of which is administered by a *commissaire* du district, who represents the government in general matters of policy and administration and is appointed by the sovereign.

The Legal System.—Judicial power is exercised by courts and tribunals, whose decisions are executed in the name of the sovereign. The system and conception of law has been influenced by the Napoleonic code. Constitutional rights are similar to those of Belgium, and the penal code is based on the Belgian one of 1867. There is a close parallel with German economic and social legislation, a result of the country's inclusion within the Zollverein from 1842 to 1918.

Administration is centralized in a minister of justice. and the law is codified. Judges are appointed for life. The lowest court is that of jusfice de paix within each canton. Here the *juge* dc la paix has summary jurisdiction in the case of a breach of police regulations and in certain minor civil and commercial cases. Next, within the, two *arrondissements* judicinires of Luxembourg and Diekirch, come the tribunaux d'arrondissement, composed of a president and a number of judges. They serve as courts of appeal against the verdicts of the lower courts; their correctional jurisdiction embraces all offenses except serious crimes. with civil and commercial matters in the first instance. At the head of the judicial hierarchy is a cour *supérieure* de jusfice, which acts as a court of appeal and a court of cassation (*i.e.*, for the revision of legal procedure). Every three months the cour *supérieure* appoints a cour d'assises, which acts as a central criminal court, its six judges being also jurors and giving their verdict by majority vote, with acquittal in the case of an equal division.

In 1930 a central state police force (police sociale *étatisée*) was established. Gnder a chef de corps are three commissioners, each responsible for one of the police districts of Luxembourg (city), Diekirch and Grevenmacher. Local police commissioners within the communes are nominally under the authority of the burgomaster but are in practice supervised by the district commissioners. The police are supplemented by a small force of gendarmes.

Trade and Finance.—The economic union concluded between Luxembourg and Belgium in 1921 was dissolved in 1940 but was re-established in May 1945. A partial customs union was concluded between these two countries and the Netherlands in March 1947, and thencefor ard the possibility of a more complete economic integration between the two former countries and the latter was repeatedly explored. Luxembourg also became a member of the European Coal and Steel community, which began to function on Aug. 10, 1952, and was designed to integrate the industries within five west European countries (France, German Federal Republic, Belgium. Luxembourg. Italy).

TABLE 11.—*Budget*[a]

(In millions of francs)

Year	1938	1946	1948	1950	1953	1954†	1956†
Receipts	365	2,313	5,115	3,511	4,604	3,867	3,606
Expenditure	355	2,655	4,640	3,341	4,625	4,379	4,141
Balance	+10	−342	+475	+170	−21	−512	−535

*In 1913 receipts amounted to 21,743,000 fr., expenditure to 21,724,000 fr., leaving a balance of +19,000 fr. †Estimated.

TABLE 111.—*Public Debt*

(In millions of francs)

Year	Consolidated at each year end			Floating debt (year end)			Grand total
	Internal	External	Total	Internal	External	Total	
1913	...	10	10	...	...	17.1	27.1
1938	404.0	220.7	624.7	102.8	...	102.8	727.5
1945	456.5	329.8	786.3	360.0	1,026.6	1,386.6	2.172.9
1954	2,649.3	660.0	3,309.3	1,826.3	2,185.0	4,011.3	7,320.6

The monetary unit is the Luxembourg franc, which by decree of Oct. 14, 1944, was made equal to the Belgian franc. Tables II and III show the state budget and the public debt.

Communications.—The roads of the grand duchy are classified as follows: *routes* de l'ktat, which connect the principal centres; roads belonging to the communes but maintained by the state; and the two grades of local roads, which belong to the communes. The length of roads is 4,503 km. (2,796 mi.).

The railway system forms a link in communications between Belgium, the Netherlands, France, Germany and Switzerland and thus carries a considerable amount of international transit traffic. The standard-gauge lines belong to two companies, the Guillaume-Luxembourg and the Prince Henri. and have a length of 244 mi. Narrow-gauge (one metre) light railways are run by the state and have a length of 52 mi. The Moselle will carry 200-ton barges.

Agriculture and Industry.—Agriculture is the occupation of approximately a quarter of Luxembourg's working population (33,470 in 1938; 33,536 in 1950); since, however, the crop yields are low in comparison with those of neighbouring countries and there is no adequate system of tariffs, it has to be protected by subsidies and credits at low rates of interest. Gutland or the Bon Pays is an area of light and fertile soil, with a good climate. Farmhouses are concentrated into villages, and the fields of individual farmers are often scattered. Crops are distributed evenly between grain, roots and green fodder. Wheat, rye and potatoes are mostly raised for human consumption, oats, barley, roots and clover for animal. Considerable areas of the Ardenne are forested or covered with too poor a soil for cultivation. Arable land is found on the plateaus rather than in the steep-sloped narrow valleys, and the main crops are oats and potatoes. Vineyards extend along the slopes of the Moselle and the lower Siire.

TABLE IV.—*Number of Workers in Mining and Steel Industry*

Year	1929	1938	1947	1950	1955	1956
Native	17,390	16,138	15,016	16,993	18,850	19,110
Foreign	11,548	4,279	2,795	3,464	3,170	3,210
Total	28,938	20,417	17,811	20,457	22,020	22,320

TABLE V.—*Mining and Metallurgical Production*

(In thousand metric tons)

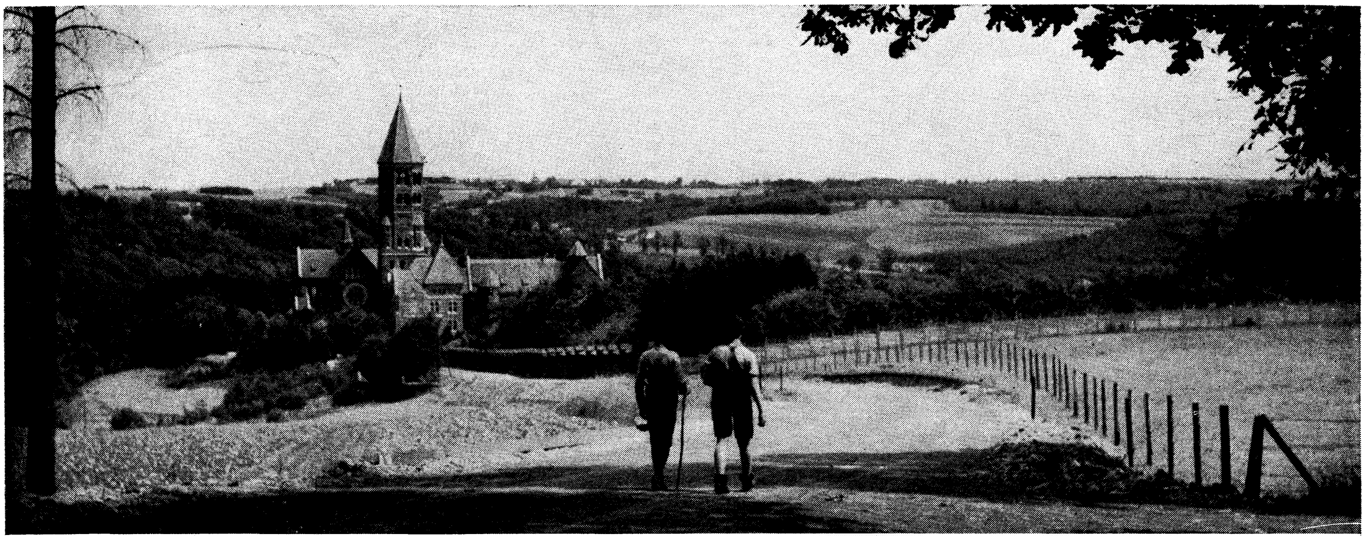
Year	1929	1938	1946	1952	1954	1955
Iron ore	7,571	5,141	2,247	7,246	5,892	7,205
Pig iron	2,927	1,551	1,365	3,076	2,796	3,085
Steel	2,703	1,437	1,295	3,002	2,832	3,225

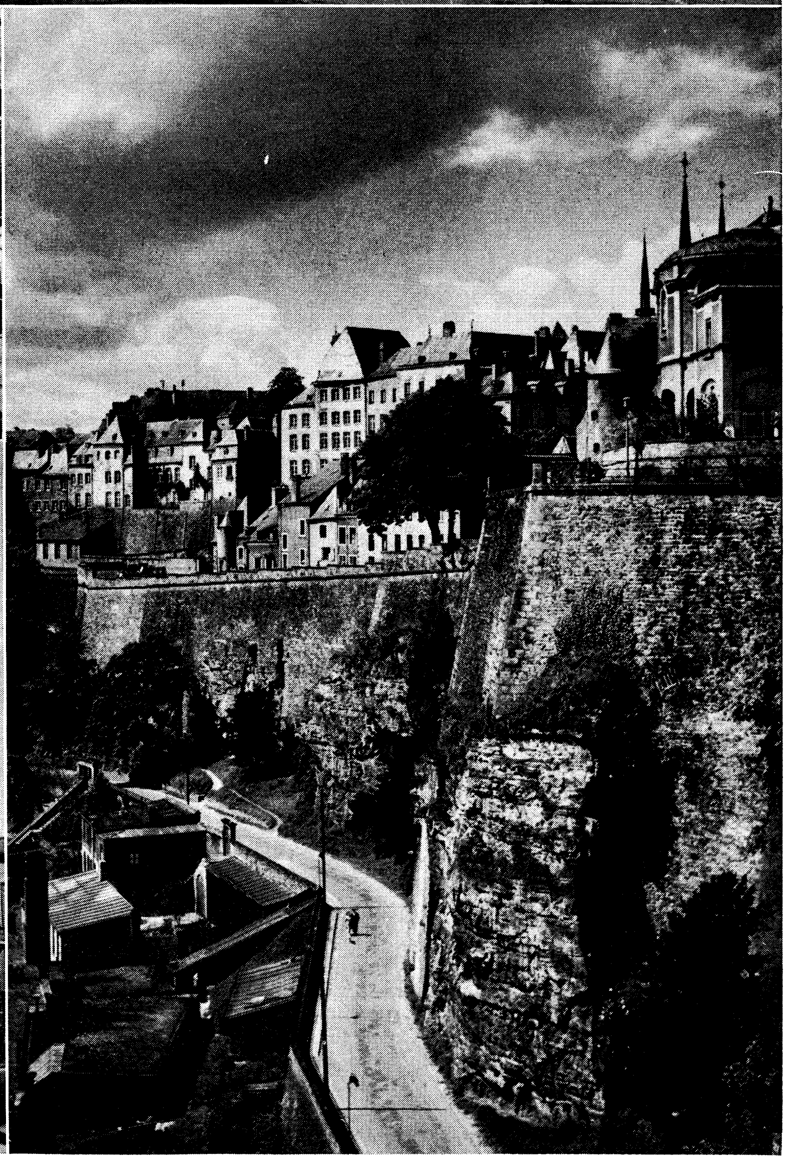
The raising of livestock, especially cattle, forms the major part of agriculture, and the majority of holdings each support a few head of cattle throughout the country. Sheep raising has been long declining, and pig breeding, particularly in the Bon Pays, was tending to supplant it at mid-20th century. Almost all farm produce is absorbed by the home market, and throughout the country there are many co-operative societies for its marketing.

The two major industries of the grand duchy are mining and metallurgy (see Tables IV and V). The large-scale exploitation of ore (termed minette) began with its working in central and southern Luxembourg as early as the 17th century. The most important deposits, which are an extension of the Lorraine field, are found in the extreme southwestern corner of the grand duchy and cover an area of 9,000 ac. in the basins of Esch, Rumelange-Dudelange and Pktange-Differdange. The iron ore content varies considerably, averaging 31%. It is relatively easy to extract, but requires 1,250 kg. of coke to produce a ton of pig iron.

Other industries include a small amount of engineering, textiles, tanning and leather, chemicals and cement.

Education.—Education, compulsory between the ages of 6 and 13, is administered by two government departments. Primary,

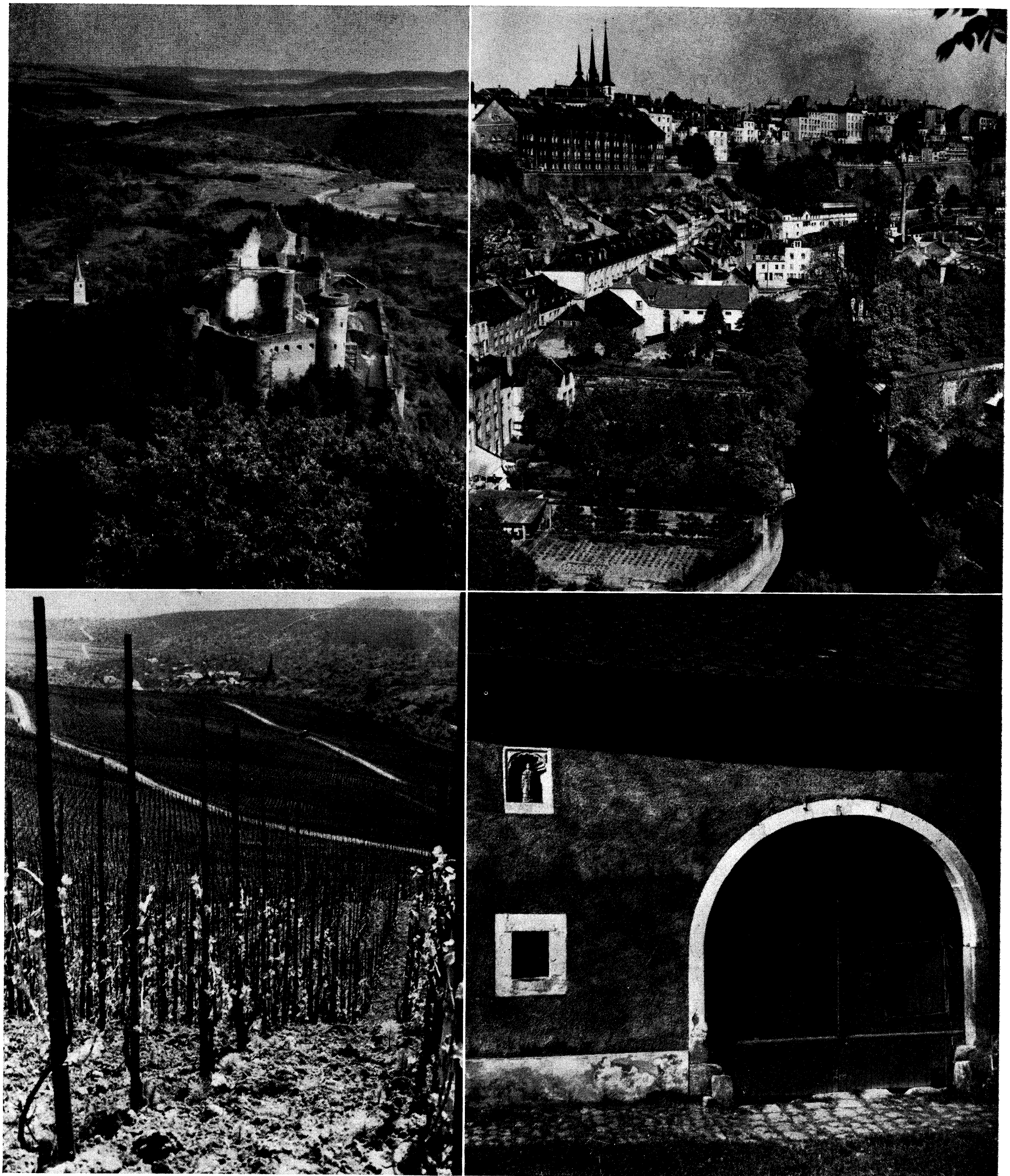




BY COURTESY OF (CENTRE LEFT) STANDARD OIL OF NEW JERSEY, (BOTTOM RIGHT) LUXEMBOURG NATIONAL TOURIST OFFICE; PHOTOGRAPHS, (TOP) AUTHENTICATED NEWS, (BOTTOM LEFT) PIX

VIEWS OF LUXEMBOURG

Top: The Benedictine abbey of Ciervaux
Centre left: Avenue de la Liberté, city of Luxembourg
Bottom left: Exterior of the Luxembourg royal palace
Bottom right: The ancient walls of the city of Luxembourg



BY COURTESY OF (TOP LEFT) LUXEMBOURG NATIONAL TOURIST OFFICE, (BOTTOM RIGHT) STANDARD OIL OF NEW JERSEY; PHOTOGRAPHS, (TOP RIGHT, BOTTOM LEFT) PIX

RURAL AND SUBURBAN LUXEMBOURG

Top *left:* The Château de Vianden overlooking the Luxembourg countryside
Top right: Grund, suburb of the city of Luxembourg, with the Alzette river in the foreground

Bottom *left:* Vineyards in the Moselle river valley. The town of Wellenstein is in the background
Bottom right: A picturesque barn in the country near Osweiler

secondary and higher education is under a permanent director general. Responsibility for technical education is that of the department of public works. In each commune is a school committee under the burgomaster, and expenditure is shared jointly by it and the state. Primary education is free and entirely under state control. Schools are divided into kindergarten, primary, higher-grade primary and continuation (*cours post-scolaires*). Secondary schools are also supported by the state and communes, and pupils enter them at about 12 years of age. There is no university in Luxembourg, but students are permitted to continue their education in foreign ones.

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LUXEMBOURG, province of southeast Belgium, formed of the high wooded Ardennes. Area 1,706 sq.mi.; pop. (1955 est.) 216,394. The upper Ourthe and lower Semoise valleys are much visited. The extreme south, often called Belgian Lorraine, has mines of minette (iron ore) and there, to the south of the high Ardennes, cultivation also prospers. On the higher ground are forest industries and slate quarrying at Vielsalm, Herbeumont, Bertrix, Martelange, etc. The chief towns are Arlon (the capital), Virton, Marche, and Bastogne. There are 5 administrative *arrondissements,* 20 cantons and 233 communes.

LUXEMBOURG or Lutzelburg (the little fortress or town), capital of the grand duchy of the same name (*see* above), situated on the Alzette, a tributary of the Sûre. Pop. (1960 census) 71,653. It is situated on cliffs which overhang the river, and the principal portion of the town with the palace and public buildings covers a central plateau. The more densely populated parishes of Clausen, Pfaffenthal and Grund lie in the valley. The fortress, considered the strongest in Europe after Gibraltar, was dismantled in 1867. Two viaducts carry the railway and the approach from the railway station to the town. The Alzette is lined with tanneries, breweries and distilleries. The Hôtel de Ville contains a collection of antiquities. The church of Notre Dame was built in 1613, and that of St. Michael dates in part from 1320. There are two annual fete days, one in honour of Our Lady of Luxembourg, patroness of the city, held on the Sunday before Ascension Day, and the other the annual fair or *Schobermesse* (tent fair), instituted in 1340 by Count John of Luxembourg, king of Bohemia, and held on Aug. 24.

LUXEMBURG, ROSA (1870–1919), German revolutionary, known as "rote Rosa," was born at Zamość, Russian Poland, on Dec. 25, 1870. An active worker among Polish socialists, she migrated about 1895 to Germany, where she married a German workman in order to acquire German nationality. In 1898 she edited the Saxon *Arbeiterzeitung,* but shortly afterwards joined the staff of the *Leipziger Volkszeitung.* She took part in the Russian revolution of 1905, and on her return to Germany founded with Karl Liebknecht the Spartacus league. In 1914 she was sentenced to a year's imprisonment for inciting to insubordination and throughout World War I remained in preventive custody. After the revolution she edited, with Liebknecht, the communist paper, *Rote Fahne.* They were arrested on Jan. 15, 1919, on the charge of instigating the street fighting in Berlin which had taken place a few days earlier. While being conveyed to the Moabit prison they were brutally attacked by army officers. Liebknecht was murdered and Rosa Luxemburg died a few hours later from injuries received. Her body was thrown into the canal, and only found some days later.

Bibliography.—Her works include *Die Akkumulation des Kapitals* (1913); *Die Krise der Sozialdemocratie* (1919) under the pseudonym "Junius"; *Briefe aus dem Gefängnis* (1920) and *Briefe an Karl und Luise Kautsky, 1896–1918. See* also G. Zinoviev, *Karl Liebknecht et Rosa Luxemburg* (1919); C. P. A. F. Liebknecht, *The Murder of Karl Liebknecht and Rosa Luxemburg* (1924).

LUXOR, more properly El-Aksur, "The Castles" (plur. of kasr), a town of Upper Egypt, on the east bank of the Nile, 450 mi. above Cairo by river and 418 mi. by rail. It is the centre for visitors to the ruins of and about Thebes, and has several fine hotels. There are Anglican and Roman Catholic churches, and a hospital opened in 1891. The district is the seat of an extensive manufacture of forged antiques.

The temple of Luxor is one of the greatest of the monuments of Thebes (*q.v.*). It stands near the river bank on the S.W. side of the town and measures nearly 300 yd. from back to front. There may have been an earlier temple here, but the present structure, dedicated to the Theban triad of Amen, Mut and Khansu, was erected by Amenhotep III. The great colonnade, which is its most striking feature, was apparently intended for the nave of a hypostyle hall like that of Karnak, but had to be hastily finished without the aisles. After the heresy of Amenhotep IV (Akhenaton), the decoration of this incomplete work was taken in hand by Tutenkhamon and Horemheb. The axis of the temple ran from southwest to northeast; a long paved road bordered by recumbent rams led from the façade to the temples of Karnak in a somewhat more easterly direction, and Rameses II adopted the line of this avenue in adding an extensive court to the work of Amenhotep, producing a curious change of axis. He embellished the walls and pylons of his court with scenes from his victories over Hittites and Syrians, and placed a number of colossal statues within it. In front of the pylon Rameses set up colossi and a pair of obelisks (one of which was taken to Paris in 1831 and re-erected in the Place de la Concorde). Alexander the Great rebuilt the sanctuary. The chief religious festival of Thebes was that of "Southern Opi," the ancient name of Luxor. The sacred barks of the divinities preserved in the sanctuary of Karnak were then conveyed in procession by water to Luxor and back again; a representation of the festal scenes is given on the walls of the great colonnade. The Christians built churches within the temple, and a mosque used to cover its western end. Clearance and restoration was begun by the Service des Antiquités in 1885, and has been vigorously pursued since. The principal street of Luxor follows the line of the ancient avenue.

LUXORIUS, Roman writer of epigrams, lived in Africa during the reigns of the Vandal kings Thrasamund, Hilderic and Gelimer (A.D. 496–534). He speaks of his poor circumstances, but, from the superscription *clarissimus* and *spectabilis* in one ms., he seems to have held a high official position. About a hundred epigrams by him in various metres (the elegiac predominating) have been preserved. They are after the manner of Martial, and deal chiefly with the games of the circus and works of art. Luxorius also wrote on grammatical subjects (*see* R. Ellis in *Journal of Philology,* viii, 1879). The epigrams are contained in the *Anthologia Latina,* edited by F. Bücheler and A. Riese (1894).

LUXURY. The word luxury is derived from the Latin *luxus,* which may be translated "superfluous abundance." As generally used, it implies the notion of a relatively large consumption of wealth for unessential pleasures. But there is no absolute definition of luxury, for the conception is essentially relative to both time and person. It is a commonplace of history that the superfluities of one generation may become the necessaries of a subsequent period; there is no hard and fast line which can be drawn between luxuries, comforts and necessaries. The private bath was one of the greatest luxuries of the Roman empire; in the 19th century its use was largely confined to the wealthy; today it may be ranked amongst the necessaries of life. Looked at from one important standpoint, luxury might be defined as any expenditure which is in excess of the normal and customary standard of living of the class to which the individual concerned belongs.

The problem of luxury is one which involves economic, social and ethical considerations.

The Economic Aspect.—Viewed from the economic standpoint luxury has undoubtedly played a great role in the history of economic development. W. Sombart in his *Luxus und Kapitalismus* has shown that the luxurious expenditure of the papacy and of the courts in the middle ages had a not unimportant share in the growth of modern capitalism. The rentals of distant estates were concentrated at some central spot; wealth was accumulated there; a relatively large market was created for the products of certain industries and the necessary conditions for the development of capitalist enterprise were fulfilled.

In France, the classic land of luxury, the continual drain of wealth from the countryside to Paris and Versailles combined as it was with a vicious system of taxation and the burdensome restrictions of feudal tenure, produced, on the one hand, a considerable amount of industrial activity carefully fostered by the mercantilist policy of Jean Colbert and his successors; but, on the other hand, it led eventually to the disruption of the old social order amidst the turmoil of the French Revolution. It is one of the paradoxes of history that a precisely opposite view and method of life—that of the Puritans, with their strong moral condemnation of luxury and their emphasis on the value of hard work and abstinence from all unnecessary consumption—should have contributed even more notably to the gron th of capital and to the expansion of industry and commerce.

In other directions, also, luxury has made its influence felt. Thus in Italy the rise of the merchant princes gave a new direction to the whole course of art, for the mediaeval church ceased to be the chief patron of the artist, who now had to conform in his work to the standards and tastes of those who provided the market for his products. The simple piety of the primitives gave place to the sumptuous paganism of the Renaissance period. and that in turn to the elaborate ornamentation and decorative inventiveness which was perhaps at its best in the metal work of Benvenuto Cellini, until at length the over-refinements of a decadent social life killed all artistic inspiration.

Luxury is the inevitable concomitant of the growth of wealth, which brings with it the increase and the differentiation of wants. The fact that the fundamental needs of mankind for a minimum of food, clothing and protection from the weather are relatively soon satisfied gives rise to a demand for greater variety and finer qualities as soon as income rises above the bare subsistence level. This demand, which is especially strong among the feminine portion of the human race has, in the past, been a great stimulus to economic progress for it has provided an enormously strong incentive to work and effort.

The attitude of the great majority of people towards the luxurious expenditure of the rich is a mixture of envy, often devoid of any feeling of resentment, and of approval based on popular economic reasoning. It is a very widespread belief that such expenditure is good for trade because it makes money circulate and therefore increases employment. The classical economists, down to and including Alfred Marshall, had no hesitation in declaring that this reasoning was based on a fallacy. They agreed that the maintenance of racing stables or private yachts, the purchase of magnificent furs or jewellery, does give employment to those engaged in the trades concerned, and that the localities in which these trades are situated benefit from such expenditure. But they argued that the fallacy of such reasoning lay in ignoring the fact that the aggregate real resources of producing power in a country are limited at any one time. A large amount of capital and labour is required to make and equip yachts and racing stables, and this capital and labour is withdrawn from other uses to which it would be put. If the wealth consumed extravagantly was saved and invested, the volume of capital would be increased, the rate of interest would tend to fall and there would be a larger demand for labour to co-operate in the production of goods consumed by other sections of the community. If, in a capitalist society, there was a sudden change in the standards of expenditure of the wealthy classes such that all expenditure commonly recognized as luxurious was regarded with strong social disapprobation, these persons would find themselves impelled to save on a much larger scale than formerly, and a great deal more capital would be available for production. But as the ultimate aim of production is consumption the net effect of the change of policy in regard to expenditure would be to transfer additional spending power to all the less wealthy members of the community. The latter would benefit by higher money wages, owing to the greater demand for their services, and from the still higher *real* wages, owing to the fall in the rate of interest and to the larger production of the type of commodities which they consume. Some proportion of this increased wealth would be consumed by the poorer classes in the form of luxuries, as we have defined this term above, or in an increased enjoyment of the quasi commodity, leisure. The ultimate consequences of such a change would depend, firstly, upon the economic and social effects of this transfer of real income to the poorer classes and secondly, upon the willingness of the wealthier classes to continue to work as hard and efficiently as formerly to produce incomes which they do not themselves enjoy by consumption, and the spending power of which they in fact transfer to other people. The classical view of the economic effects of luxurious expenditure was accepted thus far. Later, however, and particularly under the influence of the ideas put forward by Lord Keynes, a fresh turn was given to the discussion.

When closely examined the classical view is found to depend for its validity upon the assumption of full employment of the community's available resources. If there are idle resources and if the saving portion of the community prefer to hold their savings in the form of money rather than in the form of investing them in some income-yielding use (other than the purchase of old securities), then any additional expenditure on the part of any section of the community will increase the volume of employment and make the total national income larger than it would otherwise have been.

While it is true, on the one hand, that the country as a whole cannot save what it cannot invest, any given level of investment and saving may fall short of occupying fully all the resources of the economy. Under these conditions a decision by an individual to save rather than to spend part of his income may merely have the effect of inflicting an equivalent loss on other individuals. The saver will, it is true, hold a larger command over the community's wealth than before, whether in the form of money, or in the form of securities which have had to be sold by other members of the community in order to finance their losses, but the total savings of the community have not been increased, they have diminished, because of the resultant fall in the national output and income. It still remains true that the community will normally benefit more by an expansion of investment than by an increase of luxurious expenditure, but if the savings would otherwise run to waste in an increase of hoarding, then a rise in what is called the "propensity to consume" will increase the total volume of employment and output, and will not, as in the classical case, be at the expense of an equivalent amount of investment which would otherwise have been made. In this way the popular argument has partially come into its own again in relation to short period analysis and to certain phases of the trade cycle when there is a shortage of effective demand.

The Social Aspect.—As T. B. Veblen showed in his *Theory of the Leisure Class*, the evils of bad standards of expenditure are not confined to the wealthy classes from which they spring; they propagate and perpetuate themselves by example and imitation right down the social scale from top to bottom; what is called snobbishness is a very potent social force, but it is one which may as easily work for the good as for the harm of humanity. It has been well said that mankind is nowhere more vulgar than in the way in which it spends its income.

No amount of time, effort or thought is grudged to the acquiring of wealth, but when we come to consume it we dissipate the fruits of our labours often with small gain to ourselves and with unforeseen and undesired repercussions on the welfare of the community as a whole. What R. H. Tawney termed — in The *Acquisitive Society* — is the outcome of false social values inspired by the all-pervading impulse to acquire riches to the elimination, or at least repression. of other higher ideals.

While the churches wrangled over doctrine, they largely ignored the great problem of the art of spending which had become so large a part of the art of living.

The **Moral** Aspect. — Moralists of all ages have attacked luxury on ethical grounds — the Stoics, because it ran counter to their ideals of simplicity of life; the early Christian fathers, because they exalted asceticism and poverty into an ideal; the Puritans, because they feared lest the distractions and temptations of luxury might imperil the immortal soul and endanger its chances of salvation; the Socialists, because they hold unnatural and immoral the coexistence of luxury on the one side and poverty on the other.

In later times the tendency was increasingly for the moral judgment of luxury to be associated with the general problem of the unequal distribution of wealth—a view which, as is pointed out above, overlooks the fact that luxury is not confined to the richer sections of the community. The rigid condemnation of all luxury on moral grounds is untenable, if only for the reasons that there is no absolute measuring rod by means of which the ultimate social ethical value of expenditure can be tested, and that economic progress and changing standards of life so quickly alter contemporary notions of the types of expenditure that may be included under the category of luxuries. However, a great deal of luxury is undoubtedly a waste of life, not only because of the ill effects it may have upon the individuals, themselves, but also because the resulting satisfaction is frequently out of all proportion to the expenditure. As A. C. Pigou pointed out in his Economics of *Welfare*: "It is at least arguable, that, after a point, as growing wealth gives a man command over more and more luxuries the satisfaction that he gains from each one is, as it were, taken out of relaxed interest in the others, so that the satisfaction which he derives on the whole is not substantially increased."

Consumption has its ethical as well as its economic aspects and there are heavy moral responsibilities involved in the exercise by the individual of his right of disposal over the wealth which economic forces and social laws have placed in his hands.

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LUXURY TAXES. The imposition of indirect taxes, whether in the form of a general sales tax or of taxes on specific commodities, raises difficult questions in welfare economics. In the case of a general sales tax, since rich and poor are taxed alike on each pound or dollar spent, taxation will take a larger portion of low incomes than of high ones. In the case of new or increased taxes on specific commodities, the consequent rise in price may either reduce sales and output or, where demand is inelastic, reduce the demand for other commodities. Unless the taxed article is a luxury, consumed only by a small number of people, the tax will be regressive and social hardships may ensue.

In the late 18th and early 19th century, taxes were levied in England on carriages and manservants in order to secure revenue from the rich. Such taxes contrasted with those on corn, sugar and timber, which fell also on the poor, often calamitously. While the development of a progressive income tax has modified the whole fiscal structure, luxury taxes on certain commodities, like perfume and furs, have remained.

There are three problems relating to luxury taxes. First, they may lead to a heavy fall in demand and to a reduction in revenue. The English window tax (1695–1851) reduced the number of windows considerably. Against the background of a progressive tax system, a second problem arises even where demand is inelastic. High luxury taxation reduces the volume of private savings and consequently may increase the amount of taxation required for adequate revenue. The third problem concerns the definition of "luxury." Clergymen and doctors complained persistently in the middle of the 19th century that carriages were "*bona fide* articles required for the practice of a hard-working profession" and should be exempt from duty, as were carts and horses used by farmers and tradesmen. Apart from such burdens on special groups of consumers, "the luxuries of today become the necessities of tomorrow." High luxury taxation may inhibit the distribution of commodities which would fall rapidly in cost given greater demand.

The favourite argument used by exponents of luxury taxation has been moral rather than economic. Paternalist governments have imposed luxury taxes to restrict private expenditure in certain directions. In England from the 14th to the 16th centuries there was a wealth of sumptuary legislation, designed to repress the ostentation and extravagance of private persons. In the 19th and 20th centuries, increased emphasis has been placed on private expenditure upon alcohol, tobacco, entertainment and automobiles. Such expenditure is superfluous in the sense that a large part of it is in excess of what is required for economic efficiency and personal well-being, and governments have justified high taxation on such goods and services on the grounds that the uncontrolled consumption pattern is an unwise one.

Two additional considerations often enter this argument. In time of war it is often considered socially desirable to interfere with the consumption pattern. William Pitt introduced a wide range of sales taxes during the Napoleonic Wars, while during World War II a purchase tax was levied on a long schedule of commodities. In time of peace, also, there is often pressure to impose luxury taxation for reasons connected with the balance of payments. One of the motives of mediaeval sumptuary legislation was the reduction of imports of foreign materials. Similarly during the 18th century laws against the wearing of French lawns and laces were designed partly to protect English manuiacturers and partly as a weapon of offense against the French. In the 20th century import-restriction policies, since 1939, have often been associated with luxury taxation. (A. BRI.)

United States. — Unlike the bold groupings and sharply differentiated rates of the British excise and purchase taxes, the varied rates of U.S. excises reflect no clear-cut classification as to degree of essentiality. Perhaps the closest parallel to the British system is found in the heavy reliance upon liquor and tobacco taxes, an expression of the moralistic conception of luxury taxation. Thus, in the 1950s, these two taxes accounted for about 7% of total tax revenues of the central governments of Canada and the United States, as well as about 9% of the tax revenues of the 48 states.

Such revenue importance could only be achieved by heavy consumption in the face of very high tax rates. For example, in the United States the federal whisky tax in 1955 was $10.50 per proof gallon, to which the states typically added $1 to $3. Beer was taxed at $9 per barrel by the federal government, plus $1 to $3 in most states. To the federal cigarette tax of 8 cents per pack of zo, most states added 3 cents or 4 cents, and municipalities in several states added a third tax layer. The Canadian excises on whisky and beer were at much the same levels (plus a 10% federal manufacturers' excise tax), but the cigarette tax mas almost double that in the United States.

Apart from commodities whose consumption is thought to be harmful, those which legislators consider nonessential for a "reasonable" or "decent" standard of living or more likely to be bought by the rich than by the poor are often embraced in the concept of luxury taxation. Of about 50 items subject to U.S. excise taxation in the late 1950s, few met this dual test. The excises levied (mostly at 10%) on furs, jewellery, leather goods, silverware, cameras and films, admissions, dues and initiation fees and a few other items were widely recognized as taxes on nonnecessities. Moreover, consumer studies suggested that these taxes as well as those on new automobiles, electrical appliances, radios, television sets, phonographs and musical instruments were in fact progressive in their impact, taking a larger proportion of high than of low incomes. Yet even this list includes several items whose designation as luxuries would be challenged by many. The remaining federal excises—on transportation oi persons and property, telegraph and telephone communications, gasoline, auto parts, tires and tubes, electric light bulbs, matches, toilet preparations and a few others — fall out oi the luxury category entirely.

A different approach to luxury taxation, much less frequently found, seeks to single out the luxury component oi spending on a given object rather than taxing specified goods and services as luxuries. One example of this is the Massachusetts 5% tax on restaurant meals of $1 or more (a dividing line which may have singled out luxury dining in the 1930s when it was enacted, but did not serve this purpose after the post-World War II inflation). The federal rate differential between watches selling above and below $6; was another case in point. Difficulties of definition as well as administrative complexity militate against wide use of this approach. If these difficulties could be overcome, luxury components of spending on such basic items as food, clothing, furniture and shelter would become eligible for special taxation. (W. W. HR.)

LUYNES, CHARLES D'ALBERT (1578–1621), 1ST DUKE OF, was brought up at court and attended the dauphin, who later became Louis XIII. He was high in Louis's favour, and used his influence to intrigue against the queen mother Marie de Medici and her favourite Concini. Luynes, with Vitry, captain of the guard, arranged the plot that ended in Concini's assassination (1617) and secured all the latter's possessions in Italy and France. He was appointed captain of the Bastille and lieutenant general of Normandy, and married Marie de Rohan, daughter of the duke of Montbazon. In 1619 he negotiated the treaty of Angoulême by which Marie de Medici was accorded complete liberty. He was made governor of Picardy in 1619; suppressed an uprising of nobles in 1620; and in 1621 was appointed constable of France. Luynes undertook an expedition against the Protestants, but died at Longueville in Guienne, on Dec. 15, 1621.

See *Recueil des pièces les plus curieuses qui ont esté faites pendant le règne du connestable M. de Luynes* (2nd ed., 1624) and B. Zeller, *dtudes critiques sur le règne de Louis XIII: le connétable de Luynes, Montauban et la Valteline* (1879).

LUZÁN CLARAMUNT DE SUELVES Y GURREA, IGNACIO (1702–1754), Spanish critic and poet who introduced neoclassical theories into Spain, was born in Saragossa on March 28, 1702, but was brought up and educated in Italy, where he studied under the philosopher Vico and adopted the literary principles of classicism. Returning to Spain in 1733, he published *La Poe'tica o reglas de la poesía en general y de sus principales especies* in 1737. It is based largely on Lodovico Muratori's treatise on poetry, and to a lesser degree on earlier Italian commentators on Aristotle, as well as on Boileau and other French critics. He was elected to the Real Academia, held various government posts and died in Madrid on May 19, 1754. He translated from many languages, and published versions of Greek poets and Milton. Luzan's own poetry is much less important than his criticism.

La Poe'tica is typical of neoclassic literary theory, which Luzán saw as the means of rehabilitating Spanish literature. He severely censured the poetry and especially the drama of the 17th century, which he attacked for having forsaken the classical unities, for a lack of moral sense and for the superficiality of its characters. This criticism proved powerless to produce literary works of appreciable merit, but Luzán's influence was greater than can be measured by the overt failure of the neoclassic formula in Spain, and informs some of the most important writing of the first half of the 19th century. (J. F. SR.)

LUZERN (Fr. LUCERNE), the capital of the Swiss canton of the same name. It is one of the principal tourist centres of Switzerland, being situated on the St. Gotthard railway line, by which it is 59 mi. from Basel and 180 mi. from Milan. The nucleus of the town was the monastery, founded about 750 on the right bank of the Reuss by the abbey of Murbach in Alsace, of which it long remained a "cell." It is first mentioned in a charter of 840 under the name of "Luciaria," and the form "Lucerrun" is first found in 1252.

The germs of a municipal constitution appear in 1252, and in 1291 the Habsburgs purchased Lucerne from Murbach, an act that led a few weeks later to the foundation of the Swiss Confederation, of which Lucerne became the fourth member (the first town to be included) in 1332. It finally freed itself of Habsburg domination after the victory of Sempach (1386). That victory led also to the gradual acquisition of territory ruled by and from the town. At the time of the Reformation Lucerne clung to the old faith, of which ever since it has been the great stronghold in Switzerland, and the papal nuncio resided there from 1601 to 1873. In the 16th century, as elsewhere in Switzerland, the town government fell into the hands of an aristocratic oligarchy, whose power, though shaken by the peasant revolt (1653), lasted until 1798. Under the Helvetic republic (1798–1803) Lucerne was the seat of the central government, under the act of Mediation (1803–14) one of the six "Directorial" cantons and from 1815 to 1848 one of the three ruling cantons.

The patrician government was swept away by the cantonal constitution of 1831, but in 1841 they regained power, called in the Jesuits (1844) and so brought about the Sonderbund War (1847) in which they were defeated. The Radicals lost power in the canton in 1871, after which date the Conservatives became predominant in the canton, though in the town the Radicals were in the majority. Its prosperity has always been bound up with the St. Gotthard pass, so that the successive improvements effected on that route (mule path in the 13th century, carriage road 1820–30, and railway tunnel in 1882) hdve had much effect on its growth. Railways also ronnect Luzern with Meiringen, Bern, Zug, Geten and Lenzburg. Luzern is situated on the banks of the Reuss river,, just as it issues from the Lake of Lucerne, while to the southwest rises the range of Pilatus, balanced on the east by the ridge of the Rigi. To its north still stand nine of the towers that defended the old town wall.

The Reuss is crossed by two old wooden bridges, the upper being the Kapellbrucke (adorned by many paintings illustrating the history of Switzerland and the town and clinging to the Wasserthurm) and the lower the Muhlenbrucke (with paintings of the Dance of Death). The old Hofbriicke (on the site of the Schweizerhof quay) was removed in 1852.

The principal building is the twin-towered Hofkirche (dedicated to St. Leger or Leodegar) which, though in its present form it dates only from 1633–35, originally formed part of a Benedictine monastery. It has a 17th-century organ. The 16th-century town hall (Rathhaus) now houses the cantonal museum. Both the cantonal and the town libraries are rich in old books. The Lion monument, designed by Thorwaldsen, dedicated in 1821, and consisting of a dying lion hewn out of the living sandstone, commemorates the officers and men of the Swiss Guard, who were slain while defending the Tuileries in Paris in 1792. In the immediate neighbourhood is the Glacier garden, a series of potholes worn in the sandstone rock bed of an ancient glacier.

In 1799 the population numbered only 4,337, but had doubled by 1840. Thereafter the rise was rapid and continuous: 29,255 (1900); 47,066 (1930); 54,841 (1941) and 60,526 (1950). The majority are German-speaking.

For canton of Luzern, *see* LUCERNE.

LUZON, the main and largest island of the Philippines, located in the northern part of the archipelago. Area 40,420 sq.mi. Most of the island lies north of Manila in a north-south oriented rectangular area; south of Manila lies the volcanic Batangas peninsula and extending southeast of this is the long, narrow, irregular Bicol peninsula. The island has extreme dimensions of 460 mi. by 140 mi., and a coast line measuring 2,242 mi. In 1958 it had an estimated population of 10,780,965, or an over-all density of 267 people per square mile. Densities are very high along the northwest coast, in the Central plain and many parts of the Bicol peninsula. The east coast and the Sierra Madre mountains have very low population densities; the Mountain province and the Cagayan valley are moderately populated.

The more important mountain ranges are the Cordillera Central in the north, the Sierra Madre following much of the east coast and the Zambales range on the central west coast. Mt. Pulog, 9,606 ft., in the Cordillera Central, is the highest peak. Isolated volcanic cones, as the near perfect Mt. Mayon, 7,943 ft., are found in the Bicol peninsula.

Agriculturally Luzon is the leading island, producing over 65% of the country's rice; the Central Luzon plain, stretching for 100 mi. N. of Manila, is the chief centre. On the Bondoc and Bicol peninsulas are found the most extensive coconut plantations in the world; this is a leading area for the export of copra. The southern end of the Bicol peninsula is noted as a producer of abacá while both the Ilocos provinces and the Cagayan valley provide tobacco surpluses. Spectacular rice terraces have been built by the peoples of the Mountain province. Sugar cane is an important cash crop in the Central plain and in Batangas. Manufacturing is largely limited to Manila and suburbs, a notable exception being the modern petroleum refinery at Batangas.

Iron, gold and manganese are mined in the Camarines provinces while Zambales is noted for the production of both chromite and copper. The Cordillera Central produces large amounts of gold and copper and has good pine forests which provide considerable timber for the mining industry. Other forest areas, notably aiong the east coast, produce excellent hardwoods for cabinet work and the production of quality veneers.

Administratively, the island is divided into 24 provinces, Abra, Albay, Bataan, Batangas, Bulacan, Cagayan, Camarines Norte, Camarines Sur, Cavite, Isabela, Laguna, La Union, Mountain, Nueva Ecija, Nueva Vizcaya. Pampanga, Pangasinan, Quezon, Sorsogon, Tarlac (*qq.v.*), Rizal, Zambales, Ilocos Norte and Ilocos Sur. Its chartered cities include Baguio, Manila, Quezon and San Pablo (*qq.v.*).

For the ethnology and history of Luzon *see* PHILIPPINES, REPUBLIC OF THE. (R. E. HE.)

LUZZATTI, LUIGI (1841–1927), Italian economist and financier, was born of Jewish parents at Venice on March 11, 1841. He studied law at Padua, was driven into exile by the Austrian police for a short time, became professor of constitutional law at Padua (1867), at Perugia (1894), and finally at Rome (1898).

Luzzatti popularized in Italy the economic ideas of Schultze-Delitzsch, worked for the establishment of a commercial college at Venice, and contributed to the spread of people's banks on a basis of limited liability throughout the country.

An enthusiast for all forms of co-operation, Luzzatti founded the first co-operative store in Italy. In 1869 he was appointed by Minghetti under secretary of state to the ministry of agriculture and commerce, in which capacity he abolished government control over commercial companies and promoted a state inquiry into the conditions of industry.

Though theoretically a free trader, he helped to create the Italian protective system. In 1877 he participated in the commercial negotiations with France. in 1878 compiled the Italian customs tariff and subsequently took a leading part in the negotiations of all the commercial treaties between Italy and other countries.

He was minister of the treasury in four cabinets between 1891 and 1909. During his last term of service at the treasury he achieved the conversion of the Italian 5% debt (reduced to 4% by the tax) to $3\frac{3}{4}$% to be eventually lowered to $3\frac{1}{2}$%; although the actual conversion was not completed until after the fall of the cabinet of which he formed part the merit is entirely his.

Luzzatti was minister of agriculture and commerce in 1909, and in 1909–11 prime minister. He received many honours, including the title of minister of state for life. He died on March 29, 1927.

LUZZATTO, MOSES HAYIM (1707–1747), Hebrew dramatist and mystic, was born in Padua 1707, and died at Acre in 1747. He attacked Leon of Modena's anti-Kabbalistic treatises, and as a result of his conflict with the Venetian Rabbinate left Italy for Amsterdam, where, like Spinoza, he maintained himself by grinding lenses. There, in 1740, he wrote his popular religious manual the Path of the Upright (Messilath *Yesharim*) and other ethical works. Luzzatto's most lasting work is in Hebrew drama. His best-known compositions are the Tower of Victory (*Migdal 'Oz*) and Glory to the Upright (Layesharim Tehillah).

See Grätz, *History of the Jews,* v, ch. vii; I. Abrahams, *Jewish Life in the Middle Ages,* pp. 190, 268; N. Slouschz, *The Renascence of Hebrew Literature,* ch. i.

LVIV (Ukr. Lvov; Pol. Lwow), the capital of Lvov oblast of the Ukrainian Soviet Socialist Republic, lying 850 ft. above sea level on part of the continental divide between the Vistula and Dniester basins, was founded in 1250 by Danilo Romanovich, prince of Halicz (Halych). In 1340 the principality became part of Poland. King Casimir the Great built a new city centre in a basin surrounded by hills, replaced the old wooden castle by one of stone and surrounded the city with a wall. The economic progress of Lwow began in 1380 when it received the "right of emporium," which secured it a virtual monopoly of the eastern trade. By the end of the 14th century it had become the most important and populous city of Poland.

A Roman Catholic archbishop of the Latin rite resided there from 1412 and one of the Armenian rite from 1626. A Greek Catholic or Uniate see was transferred there from Halich in 1807. The Roman Catholic cathedral (1370) was rebuilt at the end of the 15th century and restored in the 18th. The Armenian cathedral was built in 1364 (twice restored since) and the Jewish synagogue in 1582. The so-called Wallachian Uniate church, a beautiful Renaissance building, was completed in 1629. The Uniate cathedral of St. Yury was built in Baroque style in 1743–58.

Bogdan Chmielnicki (*q.v.*) besieged Lwow unsuccessfully in 1648 and 1655, but the Swedes took and plundered it in 1704. King John Casimir founded a university there in 1661. In 1772, at the first partition of Poland, Lwow became Austrian. When autonomy was granted to Galicia, Lwow became the capital of the province and seat of the Galician diet or *sejm*. The constitutional era favoured the revival of Lmow, the population of which rose from 87,000 in 1870 to 206,113 in 1910. The city mas occupied by the Russians from Sept. 3, 1914, to June 22, 1915. On Nov. 1, 1918, Lwow was occupied by the Ukrainian Nationalists but the Poles freed it on Nov. 22. From Sept. 22, 1939, it was occupied by the Soviet army; on June 30, 1941, it fell to the Germans and was reoccupied by the Soviet army on July 27, 1944. By the Soviet-Polish treaty of Aug. 16, 1945, eastern Galicia and Lwow became part of the Ukraine. Its population in 1959 was 410,000.

(K. SM.)

LVOV, PRINCE GEORGE EUGENIEVICH (1861–1925), Russian statesman, belonged to the old Russian nobility. He spent the greater part of his life in Zemstvo (local government work), being a member of the executive board of the Tula Zemstvo from 1888 and president, 1902–05. In 1905 he was elected member of the first state duma and joined the right wing of the constitutional democratic (kadet) party. During the Russo-Japanese War and World War I he took an active part in the organization for the relief of sick and wounded soldiers and in the latter war was president of the All-Russian Union of Zemstvos. On March 14. 1917, Lvov was elected prime minister and minister of the interior of the first Russian provisional government. His government proved a complete failure. A new coalition cabinet was formed on May 16, and Lvov again accepted the leadership of the cabinet and the portfolio of the interior, but he had no real influence in political life, and he resigned from both offices on July 7. (See RUSSIA.) After the Bolshevist revolution in November, Lvov was arrested and imprisoned, but he escaped to Siberia and later settled in Paris. He died on March 6, 1925.

LYALLPUR, a municipality, tehsil and district in the Multan division of West Pakistan. The municipality (pop., 1951, 179,127), 75 mi. west of Lahore, named after Sir James Lyall, lieutenant governor of the Punjab, 1887–92, is a centre of the cotton-ginning and pressing industry.

LYALLPUR TEHSIL had a population of 702,074 in 1951.

LYALLPUR DISTRICT was formed in 1904 as the "Chenab colony," being mainly the waste portion of Jhang district, irrigated by the Lower Chenab canal. Area 3,534 sq.mi.; pop. (1951) 2,152,863.

LYAUTEY, LOUIS HUBERT GONZALVE (1854–1934), French marshal, was born at Nancy (Meurthe-et-Moselle) on Nov. 17, 1854. Having passed through St. Cyr and the Staff college, he first served as a cavalry officer, and was then appointed in 1894 to the staff of the troops in Indochina, where he took part, under Gen. Joseph Gallieni, in the operations against the pirates of upper Tongking. He accompanied General Gallieni to Madagascar, where he applied himself to working out and putting into practice new and eminently successful methods of colonial government. Having returned to his regiment as its colonel, he was soon after appointed to the command in the territory of Ain Sefra, which was being disturbed by incursions from Morocco. He was then placed in command of the Oran division, and was entrusted with the carrying out of international agreements with regard to Morocco. Having restored order on the Algerian-Moroccan frontier, as far as Moulouya and Guis, he took command of the 10th corps at Rennes.

In April 1912, in view of the serious situation at Fez. the government sent him to Morocco as high commissioner and resident general to quell disturbances and to consolidate the recently declared protectorate. Immediately on his arrival he relieved Fez and initiated the work of pacification and colonization which was to result in a few years in the creation of a well-organized government on a solid basis. On the declaration of World War I, although formally ordered by the government to evacuate the interior of Morocco, so as to liberate the greater part of his forces, he maintained his ground for four years against all attacks, while he actually increased the subjugated territory.

In Dec. 1917 he was appointed war minister, but resigned after three months in order to return to Morocco. From 1920 to 1924 he conquered the Atlas, and established a defensive barrier to the north of Ouergha. As a reward for these services he was made a marshal of France in Feb. 1921. He organized a victorious resistance to the attacks of the Rifi under Abdel Krim, and did not resign the post of resident general until order was completely restored in 1925 (*see* MOROCCO). He was made a member of the French academy in 1914, and wrote numerous articles on colonial administration.

Lyautey died July 27, 1934.

See his *Lettres de Tonkin et de Madagascar, 1894–99* (1920); and a volume of speeches entitled *Paroles d'action, 1900–26* (1927); also Britsch, *Le Maréchal Lyautey* (1921).

(M. GU.)

LYCANTHROPY. This term, though by derivation strictly applicable only to the taking by men of wolf forms, is applied generally to the belief in the transformation of men into wolves or other carnivorous animals, the forms taken being ordinarily those of the most formidable wild animals of the country—bears in Scandinavia, wolves on the Continent of Europe, jaguars in South America, tigers and leopards or hyenas in Asia or Africa, the latter form being particularly associated with attacks on corpses rather than on living beings. The actual practice of lycanthropy is clearly associated with a form of hysteria and a pathological condition (frequently recorded in pregnant women) manifesting a depraved appetite and an irresistible desire for raw flesh, often that of human beings, frequently accompanied by a belief on the patient's part that he or she is transformed into an animal. In the Malay race such a state is deliberately induced by suggestion in persons subject to a form of extreme suggestibility known as latah. Cases of tiger spirits and the like induced to enter human bodies and resulting in similar symptoms must be classed with latah forms of the affliction, while the salves, skins, girdles, etc., used by wer-wolves particularly in Europe, to effect transformation are probably to be regarded as material aids to hallucination.

Ideas on lycanthropy have also become confused with beliefs as to the separable soul which often appear in cognate forms. Beliefs in witches and their familiar spirits, in the power of witches to assume other bodily shapes, to alienate their souls or their vital principles, and keep them for safety in some obscure animal or plant in distant places; belief in the general possession of a bush soul, or nagual, as in central America; belief in totem ancestors, and in the re-incarnation of the soul in predatory creatures, such as tigers, alligators and sharks (see METEMPSYCHOSIS) ; belief in vampires, belief in possession by evil spirits—all these ideas associated with the experienced facts of lycanthropy have engendered a large number of variable, confused and sometimes fantastic beliefs associated with lycanthropy in various parts of the world.

The lycanthropist was known to the Greeks, who spoke also of kynanthropy, and Marcellus of Sida describes men as usually attacked early in the year, frequenting cemeteries and living like dogs and wolves. The Romans used a more general term *Versipellis* (cf. English "turnskin") for lycanthropists; Virgil (Ecl. viii.) ascribes metamorphosis into wolf form to the action of drugs. Pliny gives a story of an hereditary transformation associated with Jupiter Lycaeus; Agriopas describes a man as turned into a wolf after assisting at a human sacrifice to the same god, and Petronius tells a typical wer-wolf story. In Scandinavia and England lycanthropy seems to have been associated with outlawry, and the term berserker (*q.v.*) probably implies a man who was not only subject to excesses of bestial fury but who wore garments of bear or wolfskin. In the case of berserker the lycanthropic tendency seems to have been involuntary, but in Europe generally it is ascribed to deliberate choice and throughout the middle ages persons were believed to use magical means to transform themselves into wolves. The tradition is not extinct on the continent of Europe, and in the British Isles still lingers (in Somersetshire and Arran, for instance) in the belief in old women who turn themselves into hares. If the hare be hurt a corresponding hurt remains in the human body, which is characteristic of the belief generally. The usual method of effecting the change in Europe was by rubbing with magic salve or by putting on a girdle of wolf—or sometimes of human skin. Involuntary transformation also occurs as the result of enchantment as in Marie de France's poem "Bisclaveret," or of miracles such as that of St. Patrick who changed Veretius, king of Wales, into a wolf. Although in the European form transformation is usual, another type of lycanthropy is described by Rhanaeus as occurring in Courland, in which there is no bodily transformation; the human body remains in a cataleptic trance but in such sympathy with a real wolf attacking cattle that the human limbs move and twitch as the wolf commits his depredations. This form of lycanthropy corresponds precisely with a form taken in Assam. The wer-wolf is called vrkolak by Bulgars and Slovaks, and by modern Greeks βρυκόλακας. Here again the body remains cataleptic while the soul enters a wolf. After its return the body is exhausted and aches as after violent exercise. This form is connected in popular belief with vampires, and Serbs give the same name *vlkoslak* to both, thus affording a link between the corresponding wer-tiger and vampire beliefs in Assam, where the vampire's astral body devours persons' livers and causes their death.

Wer-wolves (*loup-garou*) appear to have been particularly active in France during the 16th century, but by the middle of it the true nature of the malady was recognized. In the cases of Roulet tried at Angers in 1598 and of Jean Grenier in 1603 at Bordeaux the accused, though convicted, were treated as insane. The description given of Roulet is not unlike those given of the "wolf children" who turn up from time to time in India, and in the latter case the wer-wolf asserted that he became a lycanthropist under the bidding of a supernatural being who came to him in the forest, an account identical with that given by Sema wer-leopards in Assam. Cases of cannibalism are recorded in Scotland in the 15th century, but the cannibals do not seem to have been even accused of being wer-wolves, though the belief lingered, and Verstegan (Restitution of Decayed Intelligence, 1625), says of wer-wolves that they "doe not onely unto the view of others seem as wolves, but to their owne thinking have both the shape and nature of wolves . . . and dispose themselves as very wolves." In Asia Minor we find the belief in Armenia, where sinful women are punished by becoming lycanthropists at the bidding of a spirit who brings them a wolf skin. They eat their own children. Herodotus mentions the Neuri, a Scythian tribe, as lycanthropists who changed into wolf form annually, and associates them with head-hunters; and in Assam we still find head-hunting Nagas subject to lycanthropy individually and believing that there are neighbouring tribes who are wer-tigers communally. The belief in lycanthropy is current in India in connection with both the wolf and the tiger. Both sexes of the Kols of Central India are believed to turn into tigers, and Dalton reports a case of a Kol tried for murder who had followed the tiger, which had devoured his wife, to the house of another Kol named Pusa. This man's own relations said he had long been suspected of such malpractices and abetted the killing of him, and explained that they had known of his devouring an entire goat one night and that he had roared like a tiger while doing so, and that on another occasion he had expressed a longing for a particular bullock, and the same night the bullock was killed by a tiger. The "wolf children" who appear periodically, whether or not they have actually been suckled by wild animals, often display symptoms of a depraved appetite similar to those of lycanthropy. A case occurred in Bhagalpur between 1912 and 1919 in which' one Rupa Sao, a shop-keeper, attacked and killed a little girl by biting her throat. He was convicted of murder, but the High Court, on a reference, ordered him to be confined as a lunatic. In Assam some tribes are lycanthropic while their neighbours are not; thus the Garos are, but not the pure Khasi; the Sema Nagas are, but not the Angami Nagas; while among many tribes such as the Kachari there are clans claiming descent from or relationship with tigers. The Angami believe that lycanthropy is caused by drinking from a certain well; but the Sema, who are subject to lycanthropy, both men and women, regard it to be involuntary and acquired normally under supernatural influence. The body is not transformed, but falls into a mild cataleptic fit during which the soul is inhabiting the body of a real leopard. Apparently some sympathetic association is set up between the human being and a wild animal, as in the Ao Naga tribe a relationship of this kind is set up without any lycanthropic symptoms on the part of the human being (see Mills, *The Ao Nagas*, pp. 250 seq.). The Lhota Naga medicine men have leopard familiars, but generally the Naga idea of lycanthropy rather suggests the central American idea of the *Nagual* or bush soul. Wer-tigers are believed in in Burma, where Tamans of the Chindwin valley are reputed to transform themselves into tiger form by rolling on earth on which they have micturated. In Malaya lycanthropy is common and is associated with latah, as it appears to be a regular amusement to hypnotize a boy subject to this disorder and to cause him to think he is a civet cat and behave as such, running on all fours and devouring live chickens. Skeat (Malay Magic, p. 160–163) mentions the case of one Haji 'Abdăllah caught naked in a tiger trap in Sumatra, but the wer-tigers of the Malay Peninsula are thought invulnerable in their transformed state—a curious exception to the almost universal belief that a wound on the animal causes a corresponding injury on the human form. In the Celebes the Toradja belief approximates to that of the Naga hills, the soul, *lamboyo,* which undergoes transformation, being apparently identical with the *anoana* of the Poso-Alfures (see METEMPSYCHOSIS). As in the Naga hills the lycanthropic habit may be acquired by eating food left by a lycanthropist. In Java the practice may be voluntary, acquired by spells, etc., or may be inherited, as in Assam, and this view has no doubt some pathological justification. As by the Khonds of India, the transformation is sought in Java for purposes of revenge, or to guard the crops, as in Yucatan, which possibly brings lycanthropy into connection with fertility cults, as does the use of an animal form and the association with witches in Europe.

In Africa the leopard and the hyaena are the animals usually connected with lycanthropists, who are generally women in Abyssinia, where the lycanthropist is regarded as possessed and belongs as a rule to the blacksmith class The Bondas, however, claim actual transformation, which is reported to have been witnessed by a European who also claims to have shot hyaenas with gold ear-rings in their ears. In West Africa an intimate relation is created by a blood bond between a man and an animal, and, as in the Naga hills, if the latter die the former will also die, though in the Naga hills it is (significantly) not until he hears of the death of the leopard. The Bori dancing of Nigeria also seems to connect in some respects with the *latah* of Malaya. How strong the instinct of the beast may be can be judged from Tremearne's account of a child of one of the cannibal tribes found in the bush and brought up in an institution where, having heard of the death of another child, he managed to get at the corpse and eat its face (Tailed Head-Hunters of Nigeria, p 184). The societies of "human leopards" and "human alligators" in West Africa appear to be organized manifestations of a depraved taste for human flesh like that displayed in the hyaena forms of lycanthropy combined with ideas akin to those underlying head-hunting (*q.v*), and ghouls in Syria have also been associated with temporary wolf or hyaena forms. That this propensity is not entirely destroyed by civilization is shown by a case which occurred in 1849 in Paris, when an officer was convicted of digging up and mutilating corpses in cemeteries under pathological conditions suggesting lycanthropy. The outbreaks of cattle-maiming that occur from time to time in Great Britain are probably likewise attributable to a survival of the lycanthropic instinct.

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(J. H. H.)

LYCAON, a mythical king of Arcadia. At Mount Lycaeus a very extraordinary ceremony in honour of *Zeus Lukaios* took place; it is alleged (Plato, Rep, viii., 565 D) that a man was sacrificed to him, and his entrails put with those of more usual victims; that anyone who tasted them became a wolf; to which later authors (see especially Pausanias, viii., 2, 6, with Frazer's note) add that the man thus transformed belonged to a particular clan, and that he remained a wolf for nine years (a sacred number), after which he might become a man once more if in that time he had not tasted human flesh again. The whole story is unpleasantly suggestive of the Lion and Leopard societies of Africa. In explanation the following story was told. Lycaon, in early days, was an impious and cruel king. Having occasion to entertain Zeus, he, or his sons, set before him human flesh (in some versions, the flesh of Lycaon's own son, Nyctimus). The god was not deceived, and in wrath caused the deluge which in Deucalion's time devastated the earth. It has several times been suggested that behind the figure of Lycaon is concealed some ancient local god, afterwards identified with Zeus; a theory in no way impossible, but which leads us little further, since there is no agreement as to the nature of the supposed god.

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(H. J. R.)

LYCAONIA, a region in the interior of Asia Minor, north of Mt. Taurus, bounded on the east by Cappadocia, on the north by Galatia, on the west by Phrygia and Pisidia; to the south it extended to the chain of Mt Taurus, where it bordered on the country popularly called Cilicia Tracheia The boundaries of Lycaonia varied greatly at different times. It is mentioned by Xenophon as traversed by Cyrus the younger on his march through Asia. That author describes Iconium as the last city of Phrygia; and in Acts xiv. 5 St. Paul, after leaving Iconium, crossed the frontier and came to Lystra in Lycaonia.

Lycaonia is described by Strabo as a cold region of elevated plains, affording pasture to wild asses and tc sheep. Amyntas, king of Galatia, to whom the district was for a time subject, maintained there not less than 300 flocks. It forms part of the interior tableland of Asia Minor, and has an elevation of more than 3,000ft. It suffers from want of water, aggravated in some parts by abundance of salt in the soil, so that the northern portion, extending from near Iconium to the salt lake of Tatta and the frontiers of Galatia, is almost wholly barren. In ancient times great attention was paid to storing and distributing the water, so that much land now barren was formerly cultivated and supported a large number of cities

The plain is interrupted by some minor groups of mountains, of volcanic character, of which the Kara Dagh in the south rises above 7,000ft.

The Lycaonians were to a great extent independent of the Persian empire, and were like their neighbours, the Isaurians, a wild and lawless race of freebooters; but their country was traversed by one of the great natural lines of high road through Asia Minor, from Sardis and Ephesus to the Cilician gates, and a few considerable towns grew up along or near this line. The most important was Iconium, in the most fertile spot in the country, of which it was always regarded by the Romans as the capital. It was the capital of the Seljuk Turkish empire for several centuries. A little farther north, stood Laodicea (Ladik); and in the south, near the foot of Mt. Taurus, was Laranda, now called Karaman, which has given name to the province of Karamania. Derbe and Lystra, which appear from the Acts of the Apostles to have been considerable towns, were between Iconium and Laranda. Lycaonia was Christianized very early; and its ecclesiastical system was more completely organized during the 4th century than that of any other region of Asia Minor.

After the defeat of Antiochus the Great (*q.v.*), Lycaonia was given by the Romans to Eumenes II., king of Pergamos. About 160 B.C. part of it was added to Galatia; and in 129 B.C the eastern half (usually called during the following 200 years Lycaonia proper) was given to Cappadocia. Its administration and grouping changed often under the Romans. In A.D. 371 Lycaonia was first formed into a separate province.

The Lycaonians appear to have retained a distinct nationality in the time of Strabo, but their ethnical affinities are unknown. The mention of the Lycaonian language in the Acts of the Apostles (xiv. 11) shows that the native language was spoken by the common people at Lystra as late as A.D. 50.

See Sir W. M. Ramsay, *Historical Geography of Aria Minor* (1890), *Historical Commentary on Galatians* (1899), and *Cities* of St. *Paul* (1907); M. Delahaye, *Gaianopolis* (1910).

LYCEUM, the name of a gymnasium and garden with covered walks near the temple of Apollo Lyceus at Athens (Gr. Λύκειον). Aristotle taught here, and hence the name was applied to his school of philosophy. The name has been used in many languages for places of instruction, etc. In France the term *lycée* is given to the larger secondary schools which are administered by the State.

LYCEUMS AND CHAUTAUQUAS. Early in 1826 Josiah Holbrook, of Derby, Conn., outlined a plan for a world-wide federation for the advancement of learning, calling it a lyceum, from the place where Aristotle lectured to the youth of Greece. His plan provided for organizations graduated from the community to an international lyceum, the latter to have 52 vice-presidents chosen from distinguished scholars and men of affairs from all over the world. This international organization was never realized, but a national (U.S.) lyceum was organized in New York city in 1831, and flourished for eight years. It included delegates from at least eight State lyceums which, in turn, embraced scores of county and local lyceums.

That the lyceum answered an existing need is shown by the rapid spread of its local branches. The Millbury, Mass., branch was organized in Nov. 1826. Within two years 100 other branches, and by 1834 nearly 3,000 branches, in practically every State in the Union, had been established. These local lyceums were voluntary associations for self-culture, community instruction and discussion of public questions. Essays, debates, discussions and lectures, all home-talent productions, were presented at weekly meetings. After about a decade the custom of inviting outside lecturers, to whom fees were paid, became established. Lowell, Thoreau, Beecher, Holmes, Greeley and others were among those who frequently addressed the lyceums. Many of Emerson's essays were written for lyceum lectures.

The last convention of the national lyceum, in 1839, was the most largely attended and most enthusiastic held. It formed many ambitious plans, adjourned, and never met again. The cause of this sudden demise is not known. In its eight years of life, it accomplished definite and far-reaching results. It forwarded education in Cuba, Venezuela and Mexico; it inspired many cultural movements, some of which still exist, and all of which made important contributions to American education. The lapse of the national lyceum did not affect the local branches, which flourished until the Civil War. A demand for attractions other than lectures led the bureaux to supply musicians, readers and entertainers.

Parallel with the lyceum movement is the chautauqua, which began at Fair Point (later called Chautauqua), N.Y., where a Methodist Episcopal camp meeting was annually conducted. Rev. (later bishop) John H. Vincent and Lewis Miller successfully undertook to change that camp meeting into an assembly for the study of the Bible and Sunday school methods. The first such assembly was held in 1874. Gradually the purpose expanded until it embraced the whole field of education, with popular entertainments included. Chautauqua institution, at Chautauqua, N.Y., annually conducts a ten-week assembly. This assembly was quickly copied by many communities throughout the land, each operating independently of all others, and each engaging its talent either directly or through the lyceum bureaux, which thus became a connecting link between the two movements. Their programmes were attractive combinations of lectures, music and entertainments (with drama added in later years). Distinguished men and women have contributed through these programmes towards the creation of an American culture and an informed public opinion. The wasteful extravagance resulting from the independent operation of these rapidly multiplying assemblies led to the development, in 1904, of the circuit chautauqua plan. The lyceum bureaux led in this development, organizing chautauqua committees in a circuit of towns to which a standardized programme of lectures, music and entertainment was supplied.

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LYCHNIS, a genus of plants of the pink family, Caryophyllaceae (*q.v.*), including numerous species, several of which are cultivated. L. ckalcedonica (Maltese cross), three feet high, has dense heads of bright scarlet flowers, both single and double. L. *coronata,* one to two feet high, has clusters of scarlet, crimson, pink and white flowers.

Other garden species are L. fulgens and L. haageana. L. *flos-cuculi* is the ragged robin. Several species are native to western North America, including L. *drummondi,* found from Manitoba to Nebraska and west to the Pacific coast. All are hardy herbaceous perennials.

LYCIA, a district in the south-west of Asia Minor, occupying the coast between Caria and Pamphylia, and extending inland as far as the ridge of Mt. Taurus. It is a rugged, mountainous country, traversed by offshoots of the Taurus range, which terminate in lofty promontories. The coast is indented by a succession of bays—the most marked of which is the Gulf of Macri (anc. *Glaucus* Sinus) in the extreme west. A number of smaller bays and broken, rocky headlands, with a few small islets, constitute the coast-line thence to the south-east promontory of Lycia, known in ancient times as the "Sacred Promontory" (*Hiera* Akra). Though the mountain ranges of Lycia are all offshoots of Mt. Taurus, in ancient times several of them were distinguished by separate names. Such were Daedala in the west, adjoining the Gulf of Macri, Cragus on the sea-coast, west of the valley of the Xanthus, Massicytus (10,000ft.) nearly in the centre of the region, and Solyma in the extreme east above Phaselis (7,800ft.). The steep and rugged pass between Solyma and the sea, called the Climax ("Ladder"), was the only direct communication between Lycia and Pamphylia.

The only considerable rivers are: (1) the Xanthus, which descends from the central mass of Mt. Taurus, and flows through a narrow valley till it reaches the city of the same name, below which it forms a plain of some extent before reaching the sea, and (2) the Limyrus, which enters the sea near Limyra. The small alluvial plains at the mouths of these rivers are the only level ground in Lycia, but the hills that rise thence towards the mountains are covered with a rich arborescent vegetation. The upper valleys and mountain sides afford good pasture for sheep, and the main Taurus range encloses several extensive upland basin-shaped valleys (*vailas*). (See ASIA MINOR.)

According to Artemidorus, the towns that formed the Lycian league were 23 in number; but Pliny states that Lycia once possessed 70 towns, of which only 26 remained in his day. Recent researches have confirmed the fact that the sea-coast and the valleys were studded with towns. On the Gulf of Glaucus stood Telmessus, while a short distance inland were the small towns of Daedala and Cadyanda. At the entrance of the valley of the Xanthus were Patara, Xanthus itself, and, a little higher up, Pinara on the west and Tlos on the east side of the valley. Myra, one of the most important cities of Lycia, occupied the entrance of the valley of the Andriacus; on the coast between this and the mouth of the Xanthus stood Antiphellus, while in the interior, at a short distance, were found Phellus, Cyaneae and Candyba. In the alluvial plain formed by the rivers Arycandus and Limyrus stood Limyra. Arycanda commanded the upper valley of the river of the same name. On the east coast stood Olympus, one of the cities of the league, while Phaselis, a little farther north, which was a much more important place, never belonged to the Lycian league and appears always to have maintained an independent position.

History.—The name of the Lycians, Lukki, is first met with in the Tel el-.%mama tablets (1400 B.C.), and in the list of the nations from the eastern Mediterranean who invaded Egypt in the reign of Mineptah, the successor of Rameses II. At that time they seem to have occupied the Cilician coast. Their occupation of Lycia was probably later and, since the Lycian inscriptions are not found far inland, we may conclude that they entered the country from the sea. According to Herodotus (i. 173; vii. 92), the original inhabitants of the country were the Milyans and Solymi, the Lycians being invaders from Crete. In this tradition there is a reminiscence of the fact that the Lycians had been sea-rovers before their settlement in Lycia. The Lycian Sarpedon was believed to have taken part in the Trojan war. The Lydians failed to subdue Lycia, but after the fall of the Lydian empire it was conquered by Harpagus, the general of Cyrus (i. 171). While acknowledging the suzerainty of Persia, however, the Lycians remained practically independent, and for a time joined the Delian league (*q.v.*). They were incorporated into the empire of Alexander, but, even after their conquest by the Romans, preserved their federal institutions as late as the time of Augustus. Under Claudius, Lycia was annexed to the Roman empire and united with Pamphylia; Theodosius made it a separate province.

Antiquities. — Few parts of Asia Minor were less known in modern times than Lycia up to the 19th century. Visits of Sir Charles Fellows to the country in 1838 and 1840 were followed by an expedition sent by the British Government in 1842 to transport to England the valuable monuments now in the British Museum. The monuments thus brought to light are among the most interesting of those discovered in Asia Minor, and prove the existence of a distinct native architecture, especially in the rock-cut tombs. But the theatres found in almost every town, some of them of very large size, are sufficient to attest the influence of Greek civilization; and this is confirmed by the sculptures, which are for the most part Greek.

Numerous inscriptions have been discovered in the native language of the country, written in an alphabet peculiar to Lycia. A few of these inscriptions are bilingual, in Greek and Lycian, and the clue thus afforded to their interpretation has been followed up. (*See* ANATOLIAN LANGUAGES.)

The alphabet was derived from the Doric alphabet of Rhodes, but ten other characters were added to it to express sounds not found in Greek. The attempts to connect the language with the Indo-European family have been unsuccessful. Most of the inscriptions are sepulchral; by far the longest and most important is that on an obelisk found at Xanthus.

Lycian art was modelled on that of the Greeks. The rock-cut tomb usually represented the house of the living, with an elaborate façade, but in one or two instances, notably that of the so-called Harpy-tomb, the facade is surmounted by a tall, square tower, in the upper part of which is the sepulchral chamber. Lycian sculpture followed closely the development of Greek sculpture, and many of the sculptures with which the tombs are adorned are of a high order of merit. The exquisite bas-reliefs on a Lycian sarcophagus now in the museum of Constantinople are among the finest surviving examples of classical art. The bas-reliefs were usually coloured. For the coinage, *see* NUMISMATICS: *Asiatic Coins.*

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LYCOPHRON, Greek poet and grammarian, was born at Chalcis in Euboea. He flourished at Alexandria in the time of Ptolemy Philadelphus (285–247 B.C.), for whom he arranged the comedies in the Alexandrian library. As a result he wrote a treatise On *Comedy.*

His own work was mostly in tragedy; Suïdas gives 20 titles, but only a few fragments survive. One poem, the *Alexandra* or *Cassandra,* in iambics, has been preserved. The poem, in which Cassandra prophesies the future of Troy and later events, is a masterpiece of erudition, full of archaisms and obscurities, and poetically quite worthless. It was very popular in the Byzantine period, and annotated by the Tzetzes brothers. The fragments of his tragic verse are very much superior to this.

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LYCOPODIUM is a genus of the Lycopodiaceae, a family of the Lycopsida, a subdivision of the vascular plants comprising the club mosses and their allies, fossil and living. The lycopods are spore-bearing near-herbs; their stems, covered with small, simple leaves, more or less spirally arranged, may be erect, prostrate, creeping, or epiphytic and pendent. No lycopod stem has a cambium. The fertile leaves (sporophylls) may be somewhat similar to the vegetative leaves, in which case they are present in alternating zones on the stem, or they may be aggregated in conical strobili at the tips of branches. In this case, the sporophylls may differ markedly in size and shape from the vegetative leaves. Each sporophyll bears on its upper surface a single, kidney-shaped spore case (sporangium) which produces large numbers of thick-walled, cutinized spores. Very few of these spores appear to germinate in nature. The evidence suggests an inability to absorb water. Scarifying the spore wall or centrifuging the spores in water at considerable speed causes many more to germinate.

When grown on a sugar-mineral salt nutrient medium, the germinated spores grow well and all species tried produce green, much-branched, rhizoid-bearing, hermaphroditic prothallia. By contrast, in the limited number of cases described from nature since the mid-19th century, the prothallia are green and branched if on the surface of the ground or somewhat colourless and fleshy if below.

The prothallia of all species described prove to have an endophytic fungus in symbiotic relation, possibly obligate.

Probably 200 or more species of lycopods exist, nearly cosmopolitan in distribution, but most abundant in the tropics. The 13 species found in North America occur most abundantly in the cool, wooded regions of the eastern United States and Canada.

The Pacific coastal states and adjacent parts of Canada have only nine of these species. Great Britain has five, chiefly in mountainous districts.

The small size of the spores of *Lycopodium* and their high content of finely divided oil droplets make for inflammability. They have been used, as lycopodium powder, in fireworks and in flash-light photography.

See also PTERIDOPHYTA. (R. H. WE.)

LYCURGUS (Gr. Λυκοῦργος), in Greek history, the reputed founder of the Spartan Constitution. Plutarch opens his biography of Lycurgus with these words: "About Lycurgus, the lawgiver, it is not possible to make a single statement that is not called in question. His genealogy, his travels, his death, above all, his legislative and constitutional activity have been variously recorded, and there is the greatest difference of opinion as to his date." Nor has modern historical criticism arrived at any certain results. Many scholars, indeed, suppose him to be in reality a god or hero, appealing to the existence of a temple and cult of Lycurgus at Sparta as early as the time of Herodotus (i. 66) (cf. *Camb. Ancient Hist.*, vol. iii.). If this be so, he is probably to be connected with the cult of Apollo Lycius or with that of Zeus Lycaeus. But the majority of modern historians agree in accepting Lycurgus as an historical person, however widely they may differ about his work.

According to the Spartan tradition preserved by Herodotus, Lycurgus was a member of the Agiad house, son of Agis I. and brother of Echestratus. On the death of the latter he became regent and guardian of his nephew, Labotas (Leobotes), who was still a minor. Other accounts give him a different origin, and make him regent for Charillus. According to Herodotus he introduced his reforms immediately on becoming regent, but the story which afterwards became generally accepted represented him as occupying for some time the position of regent, then spending several years in travels, and on his return to Sparta carrying through his legislation when Charillus was king. He is said to have visited Crete, Egypt and Ionia, and some versions even took him to Spain, Libya and India. In any case details of his life are almost certainly mythical. Herodotus derives his constitutional ideas from Crete, but there is a 5th century tradition ascribing them to the initiative of Delphi.

The Reforms. — Herodotus says that Lycurgus changed "all the customs," that he created the military organization and instituted the ephorate and the council of elders. To him, further, are attributed the foundation of the apolla (the citizen assembly), the prohibition of gold and silver currency, the partition of the land (γῆς ἀναδασμός) into equal lots, and, in general, the characteristic Spartan training (ἀγωγή). Some of these statements are certainly false. The council of elders and assembly are not peculiar to Sparta, the ephorate is not generally allowed to be his, and the partition of land never seems to have taken place at Sparta at all—it is probably an attempt to give traditional sanction to the ideals of Agis and Cleomenes in the 3rd century. We may conclude that Lycurgus did not create any of the main elements of the Spartan Constitution, though he may have regulated their powers and defined their position. But tradition represented him as finding Sparta the prey of disunion, weakness and lawlessness, and leaving her united, strong and subject to the most stable Government which the Greek world had ever seen. Probably Grote comes near to the truth when he says that Lycurgus "is the founder of a warlike brotherhood rather than the lawgiver of a political community." To him we may attribute the unification of the several component parts of the State, the strict military organization and training which soon made the Spartan hoplite the best soldier in Greece, and above all the elaborate and rigid system of education which rested upon, and in turn proved the strongest support of, that subordination of the individual to the State which, perhaps, has had no parallel in the history of the world.

Lycurgus's legislation is very variously dated, and it is not possible either to harmonize the traditions or to decide with confidence between them. Tradition substantially agrees in placing him in the 9th century.

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LYCURGUS (*c.* 396–325 B.C.), son of Lycophron, one of the "ten" Attic orators. He shared with Demosthenes and Hypereides the leadership of the opposition to Philip. He left the care of external relations to his colleagues, and devoted himself to internal organization and finance. He managed the finances of Athens for twelve successive years (338–326), at first directly as treasurer of the revenues (ὁ ἐπὶ τῇ διοικήσει) for four years, and in two succeeding terms, when the actual office was forbidden him by law, through his son and a nominal official chosen from his party. Part of one of the deeds in which he rendered account of his term of office is still preserved in an inscription. During this time he raised the public income from 600 to 1,200 talents yearly. He increased the navy, repaired the dockyards, and completed an arsenal, the σκευοθήκη designed by the architect Philo. He also reconstructed the great Dionysiac theatre and the gymnasium in the Lyceum, and built the Panathenaic stadium on the Ilissus. He proposed a law that statues of the three great tragedians should be erected in the theatre, and that their works should be carefully edited and preserved among the state archives. Alexander the Great demanded his surrender, but the people refused to give him up. He died while president of the theatre of Dionysus, and was buried on the road leading to the Academy at the expense of the state. (*See* Hicks, *Greek Historical Inscriptions,* no. 145.)

Lycurgus was a man of action; his orations, of which fifteen were published, were criticized by the ancients for their awkward arrangement, harshness of style, and the tendency to digressions about mythology and history, although their noble spirit and lofty morality were highly praised. The one extant example, *Against Leocrates,* fully bears out this criticism. After the battle of Charroneia (338), in spite of the decree which forbade emigration under pain of death, Leocrates had fled from Athens and on his return was impeached by Lycurgus but acquitted.

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LYCURGUS, "The Logothete" (1772–1851), Greek leader in the War of Independence, was born in the island of Samos. He was educated at Constantinople and accompanied Constantine Ypsilanti when he was appointed hospodar of Wallachia and served Ypsilanti's successor, Alexander Soutzos, as treasurer and chancellor (Logothete). In 1802 he returned to Samos. When the War of Independence began he induced his countrymen to declare Samos independent, and was chosen ruler. His share in the War of Independence is chiefly memorable because he provoked the massacre of Chios in 1822. He was afterwards deposed by the Samians, but recovered some influence and had a share in the defence of Samos against the Turks in 1824. When the island was left under the authority of Turkey by the protocol of the 3rd of February 1830, he helped to obtain autonomy for the Samians. He retired to Greece and died on May 22, 1851.

See G. Finlay, *History of the Greek Revolution* (London, *1861).*

LYDD, a municipal borough which comprises the old town of Lydd, Dungeness, Lydd-on-Sea and Greatstone, in the Folkestone and Hythe parliamentary division of Kent, Eng., about 30 mi. S.S.W. of Canterbury by road. Pop. (1951) 2,774. Area 18.6 sq.mi. After the Norman Conquest Lydd became a seaport of some consequence, but it now stands nearly 3 mi. inland. The borough however has 9½ mi. of coast line, including Dungeness (*q.v.*) point with its lighthouse and fishing industry. At some time before the reign of Edward I Lydd was made a member of the Cinque Port of Romney, and in 1290 it was granted the same liberties and free customs as the Cinque Ports on condition of supplying the crown with one ship and crew. This charter was confirmed by Edward III in 1364. Its incorporation was granted in 1885. The church of All Saints, with a portion of the original stone Saxon church, has a Perpendicular tower with rich vaulting within; the tower is a widely known landmark. On and adjacent to land known as the Rypes, granted to the barons of Lydd as a reward for their valour in repelling the Danes, are a large military camp and mortar ranges and an extensive housing estate. Close to the north-eastern approach to the town is Lydd (Ferryfield) airport with a 20-minute car ferry service to the continent. The borough is mainly agricultural and there are extensive beach quarrying plants. The coastal area attracts a great many summer visitors.

LYDEKKER, RICHARD (1849–1915), F.R.S. (1894), English naturalist and geologist, was born in London on July 25, 1849, and educated at Trinity college, Cambridge. From 1874 to 1882 he was on the staff of the geological survey of India. He died at Harpenden on April 16, 191j.

His works include *Catalogues* (10 vol., 1891) of the fossil mammals, reptiles and birds in the British Museum; *A Manual of Palaeontology* (with H. A. Nicholson, 2 vol., 1889); *Phases of Animal Life* (1892); *The Royal Natural History* (with W. H. Fowler, 8 vol., 1893–96); *The Great and Small Game of India, Burma and Tibet* (1900).

LYDENBURG, a town in the Transvaal, 25° 10′ S., 30° 40′ E., altitude 4,860 ft. Pop. (1951) 4,646 (2,363 white). The surrounding district is devoted largely to sheep farming, and cotton, tobacco and wheat are grown. Gold is produced in the neighbourhood. The town was founded by Boers in 1846. Ten years later they separated from their brethren and proclaimed an independent republic, which was, however, incorporated in the South

African republic of 1860. The first successful gold field in the Transvaal was opened there, but it was not until 1910 that railway communication was established.

LYDFORD, a village in the Tavistock rural district of Devonshire. Eng.. about 22 mi. N. of Plymouth by road. Pop. of parish (1951) 2,071. The village is on the small river Lyd, which traverses the deep narrow chasm of Lydford gorge, a famous Devon beauty spot; and at a little distance a tributary stream forms a cascade, known as the White Lady, with a fall of 150 ft.

Lydford was one of the four Saxon boroughs of Devon, and possessed a mint in the days of Aethelred the Unready. It first appears in recorded history in 997, when the Danes made a plundering expedition up the Tamar and Tavy as far as "Hlidaforda." In the reign of Edward the Confessor it ranked after Exeter, but the Domesday survey relates that 40 houses had been laid waste since the Conquest, and the tonn never recovered its prosperity. The history from the 13th century centres round the castle, built in 1195 and in the reign of Ednard III fixed as the prison of the stannaries and the meeting place of the forest courts of Dartmoor. A guild at Lydford is mentioned in 1180. and the pipe roll of 1195 records a grant for the re-establishment of the market. In 1238 the borough was bestowed by Henry III on Richard. earl of Cornwall, who in 1268 obtained a grant of a Wednesday market and a three days' fair at the feast of St. Petrock. The borough was never incorporated by charter, and only once, in 1300, returned members to parliament. In the 18th century the castle was restored and again used as a prison and as the meeting place of the manor and borough courts. The castle keep remains.

LYDGATE, JOHN (*c.* 1370–*c.* 1450), English poet, was born at the village of Lydgate near Newmarket. Probably he was educated at the school attached to the Benedictine abbey at Bury St. Edmunds, and in his *Testament* he has drawn a lively picture of himself as a typical orchard-robbing boy, who had scant relish for matins, fought, and threw creed and paternoster at the cock. He was ordained subdeacon in 1389. deacon in 1393, and priest in 1397. Lydgate passed as a portent of learning, and, according to Bale, he pursued his studies not only at both the English universities but in France and Italy. Certainly he knew France. and he visited Paris in an official capacity in 1426. It is improbable that he lived many years after 1446, when John Baret, treasurer of Bury, signed an extant receipt for a pension which he shared with Lydgate, and which continued to be paid till 1449. If it be true, as Bishop Alcock of Ely affirms, that Lydgate wrote a poem on the loss of France and Gascony, he must have lived two years longer, which would indicate the year 1451, or thereabouts, as the date of his death.

In 1434 Lydgate retired from the priorate of Hatfield Broadoak (or Hatfield Regis), to which he had been appointed in June 1423. After 1390—but while he was still a young man—he made the acquaintance of Geoffrey Chaucer, with whose son Thomas he was intimate. This friendship appears to have decided Lydgate's career. and in his *Troy Book* and elsewhere are reverent and touching tributes to his "master." The themes of his more ambitious poems can be traced to Chaucerian sources.

Lydgate is a most voluminous writer. *The Fall of Princes* alone comprises 7,000 stanzas; and his authentic compositions reach the enormous total of 140,000. As the result the bulk of his composition is wholly or comparatively roughhewn. That he was capable of finished work is shown by two allegorical poems—the *Complaint of the Black Knight* and the *Temple of Glass* (once attributed to Hawes), in which he reveals himself as a not unworthy successor of Chaucer. For a couple of centuries Lydgate's reputation equalled, if it did not surpass, that of his master. This was in a sense only natural, since he was the real founder of the school which ruled English letters during the long interval between Chaucer and Spenser. One of the most obvious defects of this school is excessive attachment to polysyllabic terms. John Metham is amply justified in his censure—

> Eke John Lydgate, sometime monk of Bury,
> His books indited with terms of rhetoric
> And half-changed Latin, with conceits of poetry.

But Lydgate is lucid in style; and his writings are read more easily than Chaucer's. In spite of that, Lydgate is characteristically mediaeval—mediaeval in his prolixity, his platitude, his want of judgment and his want of taste; mediaeval also in his pessimism, his Mariolatry and his horror of death.

Dr. Schick's preface to the *Temple of Glass* embodies practically all that is known or conjectured concerning this author, including the chronological order of his works. With the exception of the *Damage and Destruction in Realms—an* account of Julius Caesar, his wars and his death—they are all in verse and extremely multifarious—narrative, devotional hagiological, philosophical and scientific, allegorical and moral, historical. satirical and occasional. *The Troy Book,* undertaken at the command of Henry V, then prince of Wales, dates from 1412–20; *The Siege of Thebes* from 1420–22; and *The Fall of Princes* toward 1430. His last work was *Secreta Secretorum* or *Secrets of Old Philosophers,* rhymed extracts from a pseudo-Aristotelian treatise. Lydgate certainly possessed extraordinary versatility, which enabled him to turn from elaborate epics to quite popular poems like the *Mumming at Hertford, A Ditty of Women's Horns* and *London Lickpenny.*

See publications of the Early English Text Society, especially the *Temple of Glass,* edited by Dr. Schick: Koeppel's *Lydgate's Story of Thebes, eine Quellenuntersuchung* (Munich, 1884), and the same scholar's *Laurents de Premierfait und John Lydgates Bearbeitungen von Boccaccios De Casibus Illustrium Virorum* (Munich, 1885); Warton's *History of English Poetry;* Ritson's *Bibliotheca Anglo-Poetica;* Furnivall's *Political Poems* (E.E.T.S.); and Sidney Lee's article in the *Dict. Nat. Biog.*

LYDIA, a district of Asia Minor. the boundaries of which are difficult to fix, partly because they varied at different epochs. The name is found (*c.* 660 B.C.) under the form of *Luddi* in the inscriptions of the Assyrian king Assur-banipal. In Homer we read only of Maeonians (*Zl.* ii. 865, etc.), and the place of the Lydian capital Sardis is taken by Hydē (*Il.* xx. 385). According to Herodotus (i.7). the Meiones (called Maeones by other writers) were named Lydians after Lydus, the son of Attis. in the mythical epoch which preceded the rise of the Heraclid dynasty. In historical times the Maeones were a tribe inhabiting the district of the upper Hermus. The Lydians must have been an allied tribe which bordered upon them to the north-west, and occupied the plain of Sardis or Magnesia. They were cut off from the sea by the Greeks, who were in possession, not only of the Bay of Smyrna, but also of the country north of Sipylus. Northwards the Lydians extended at least as far as the Gygaean lake and the Sardenē range. The plateau of the Bin Bir Tepē, on the southern shore of the Gygaean lake, was the chief burial-place of the inhabitants of Sardis, and is thickly studded with tumuli, among which is the "tomb of Alyattes" (260ft. high). Next to Sardis the chief city was Magnesia (*q.v.*) ad Sipylum in the neighbourhood of which is the famous seated figure of "Niobe" (*Il.* xxiv. 614–7), cut out of the rock, and probably intended to represent the goddess Cybele, to which the Greeks attached their legend of Niobe. Under the Heraclid dynasty the limits of Lydia must have been already extended, since the authority of Gyges reached as far as the Troad. The successes of Alyattes and of Croesus finally changed the Lydian kingdom into a Lydian empire, and all Asia Minor westward of the Halys, except Lycia, owned the supremacy of Sardis. Lydia never again shrank to its original dimensions. After the Persian conquest the Maeander was regarded as its southern boundary, and in the Roman period it comprised the country between Mysia and Caria on the one side and Phrygia and the Aegean on the other.

Lydia proper was exceedingly fertile. The hill-sides were clothed with vine and fir, and the rich broad plain of Hermus produced large quantities of corn and saffron. The climate of the plain was soft but healthy. The Pactolus, nhich flowed through the centre of Sardis, into the Hermus, was believed to be full of golden sand. Maeonia on the east contained the curious barren plateau known to the Greeks as the *Katakekaumenē* ("Burnt country"), once a centre of volcanic disturbance. The Gygaean lake (where remains of pile dwellings have been found) still abounds with carp.

Race and Religion.—The Lydian race was probably a mixed one, consisting of aborigines and Aryan immigrants. It was characterized by industry and a commercial spirit. The religion of the Lydians resembled that of the other civilized nations of Asia Minor. It was a nature worship, which at times became wild and sensuous. By the side of the supreme god Medeus stood the sun-god Attis, as in Phrygia the chief object of the popular cult. He was at once the son and bridegroom of Cybele (*q.v.*), or Cybebe, the mother of the gods, whose image was adored on the cliffs of Sipylus (Paus. iii. 22). At Ephesus, where she was adored under the form of a meteoric stone, she was identified with the Greek Artemis (see also GREAT MOTHER OF THE GODS). The priestesses by whom she was served are depicted as armed with the double-headed axe, and the dances they performed in her honour with shield and bow gave rise to the myths which saw in them the Amazons (*q.v.*) a nation of woman-warriors. The pre-Hellenic cities of the coast—Smyrna, Samorna, (Ephesus), Myrina, Cyme, Priene and Pitane,—were all of Amazonian origin, and the first three of them have the same name as the Amazon Myrina, whose tomb was pointed out in the Troad. The prostitution whereby the Lydian girls gained their dowries (Herod. i. 93) was a religious exercise, as among the Semites, which marked their devotion to the goddess Cybele.

Lydian Dynasties.—According to the native historian Xanthus (460 B.C.) three dynasties ruled in succession over Lydia. The first, that of the Attiads, is mythical. To this mythical age belongs the colony which, according to Herodotus (i.94), Tyrsenus, the son of Attis, led to Etruria. Xanthus, however, puts Torrhebus in the place of Tyrsenus, and makes him the eponym of a district in Lydia. The second dynasty was also of divine origin, but the names which head it prove its connection with the distant East. The Hittites, an Oriental people, deeply imbued with the elements of Babylonian culture, had overrun Asia Minor and established themselves on the shores of the Aegean before the reign of the Egyptian king Rameses II. Their subject allies include the Mysians and the Dardani of the Troad, while the Hittites have left memorials in Lydia. G. Dennis discovered an inscription in Hittite hieroglyphics attached to the figure of "Niobe" on Sipylus. We learn from Eusebius that Sardis was first captured by the Cirnmerii 1078 B.C.; and since it was four centuries later before the real Cimmerii (*q.v.*) appeared on the horizon of history, we may perhaps find in the statement a tradition of the Hittite conquest. As the authority of the Hittite satraps at Sardis began to decay the Heraclid dynasty arose. After lasting five hundred and five years, the dynasty came to an end in the person of Sadyattes. The name Candaules, given him by Herodotus (i.7), meant "dog strangler," and was a title of the Lydian Hermes. Gyges (*q.v.*) put him to death and established the dynasty of the Mermnads, 687 B.C. Gyges initiated a new policy, that of making Lydia a maritime power; but towards the middle of his reign the kingdom was overrun by the Cimmerii (*q.v.*). The lower town of Sardis was taken, and Gyges sent tribute to Assur-banipal, as well as two Cimmerian chieftains he had himself captured in battle. A few years later Gyges joined in the revolt against Assyria; the Cimmerian hordes returned, Gyges was slain in battle (652 B.C.), and Ardys his son and successor returned to his allegiance to Nineveh. Alyattes, the grandson of Ardys, finally succeeded in extirpating the Cimmerii, as well as in taking Smyrna, and thus providing his kingdom with a port. The trade and wealth of Lydia rapidly increased, and the Greek towns fell one after the other before the attacks of the Lydian kings. Alyattes's long reign (609–560) saw the foundation of the Lydian empire. All Asia Minor west of the Halys ackno ledged his sway. The Greek cities were allowed to retain their own institutions and government on condition of paying taxes and dues to the Lydian monarch, and the proceeds of their commerce thus flowed into the imperial exchequer. The result was that the king of Lydia became the richest prince of his age. Alyattes was succeeded by Croesus (*q.v.*), who had probably already for some years shared the royal power. He reigned alone only 15 years, Cyrus (*q.v.*) the Persian after an indecisive battle on the Halys, marching upon Sardis, and capturing both acropolis and monarch (j46 B.C.).

Persian Conquest.—The revolt of the Lydians under Pactyas, whom Cyrus had appointed to collect the taxes, caused the Persian king to disarm them. Sardis now became the western capital of the Persian empire, and its burning by the Athenians was one of the contributing causes of the Persian War. After Alexander the Great's death, Lydia passed to Antigonus; then Achaeus made himself king at Sardis, but was defeated and put to death by Antiochus. The country was presented by the Romans to Eumenes, and subsequently formed part of the proconsular province of Asia. By the time of Strabo (xiii. 631) its old language was entirely supplanted by Greek. (See ANATOLIAN LANGUAGES.)

The Lydian empire may be described as the industrial power of the ancient world. The Lydians were credited with introducing or inventing the game of dice and also coined money. The oldest known coins are the electrum coins of the earlier Mermnads (Madden, *Coins of the* Jews, pp. 19–21), stamped on one side with a lion's head or the figure of a king with bow and quiver; these were replaced by Croesus with a coinage of pure gold and silver. The electrum coins of Lydia were of two kinds, one weighing 168.4 grains for the inland trade, and another of 224 grains for the trade with Ionia. The standard was the silver mina of Carchemish which contained 8,656 grains. Originally derived from Babylonia, this standard was passed on to Asia Minor during the Hittite conquest, but was eventually superseded by the Phoenician mina of 11,225 grains (see also NUMISMATICS). The inns, which the Lydians were said to have been the first to establish, were connected with their attention to commercial pursuits (Herod. i.94). Their literature has wholly perished. They were celebrated for their music and gymnastic exercises, and their art formed a link between that of Asia Minor and that of Greece. Lydian sculpture was probably similar to that of the Phrygians. Phallic emblems, for averting evil, were plentiful; the summit of the tomb of Alyattes is crowned with an enormous one of stone, about 9 ft. in diameter.

The tumulus itself is 281 yds. in diameter and about half a mile in circumference. It has been partially excavated, and a sepulchral chamber discovered in the middle, composed of large well-cut and highly polished blocks of marble. The stone basement which, according to Herodotus, formerly surrounded the mound has disappeared.

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LYDUS ("THE LYDIAN"), **JOANNES LAURENTIUS,** Byzantine writer on antiquarian subjects, was born in A.D. 490. From an early age until his dismissal in 552 he held high court and state offices. The date of his death is not known, but he probably did not survive Justinian (d. 565). Of his literary works there survive: (1) De Ostentis (Περὶ διοσημειῶν), on the origin and progress of the art of divination; (2) De *Magistratibus reipublicae* Romanae (Περὶ ἀρχῶν τῆς Ῥωμαίων πολιτείας); (3) De *Mensibus* (Περὶ μηνῶν), a history of the different festivals of the year.

The chief value of these books consists in the fact that the author made use of the works (now lost) of old Roman writers on similar subjects.

Editions of (1) by C. Wachsmuth (1897), of (2) and (3) by R. Wünsch (1898–1903); *see* also Christ-Schmid, *Geschichte der Gr. Lit.;* and Klotz in Pauly-Wissowa, *Realencyclopädie.*

LYE, the name given to the solution of alkaline salts obtained by leaching or lixiviating wood ashes with water; to solutions of a caustic alkali (sodium or potassium hydroxide); or, more generally to any strong alkaline solution especially one used as a detergent.

In the United States it is the trade name for sodium hydroxide. (*See* ALKALI; ALKALI MANUFACTURE.)

LYELL, SIR CHARLES (1797–1875), British geologist, son of Charles Lyell of Kinnordy, Forfarshire, was born on Nov. 14, 1797, on the family estate in Scotland. His father (1767–1849) was known both as a botanist and as the translator of the Vita *Nuova* and the *Convito* of Dante: the plant *Lyellia* was named after him. As a boy Lyell had a strong inclination for natural history, especially entomology. In 1816 he entered Exeter college, Oxford, where the lectures of William Buckland first attracted him to geology. After graduating he entered Lincoln's Inn, and in 1825 he was called to the bar, and went on the western circuit for two years. In 1819 he had been elected a fellow of the Linnean and Geological societies, communicating his first paper, "On a Recent Formation of Freshwater Limestone in Forfarshire," to the latter society in 1822, and acting as one of the honorary secretaries in 1823. In that year he went to France, and in 1824 made a geological tour in Scotland in company with Buckland. In 1826 he was elected F.R.S., and in 1827 he finally abandoned law for geology.

He had already begun to plan his chief work, *The Principles of Geology* (3 vols., 1830–33). With Sir Roderick Murchison he wrote joint papers on the volcanic district of Auvergne and the Tertiary formations of Aix-en-Provence. He then studied the marine remains of the Italian Tertiary strata, and conceived the idea of dividing this geological system into three or four groups, characterized by the proportion of recent to extinct species of shells. To these groups, after consulting William Whewell as to the best nomenclature, he gave the names later universally adopted—Eocene *(dawn of recent),* Miocene *(less of recent)* and Pliocene *(more of recent)*—and with the assistance of G. P. Deshayes he drew up a table of shells in illustration of this classification. Between 1830 and 1876 12 editions of *The Principles of Geology* were published, each so much enriched as to form a complete history of the progress of geology during that interval.

In 1838 Lyell published the *Elements of Geology,* which became a standard work on stratigraphical and palaeontological geology. This book, which was based on lectures, went through six editions in Lyell's lifetime. In his third great work, *The Antiquity of Man* (1863), he gave a general survey of the arguments for man's early appearance on the earth, derived from the discoveries of flint implements in post-Pliocene strata in the Somme valley and elsewhere; he discussed also the deposits of the Glacial epoch, and in the same volume he first gave in his adhesion to Charles Darwin's theory of the origin of species.

In 1833 Lyell married Mary (1809–1873), eldest daughter of Leonard Horner, who was thenceforward associated with him in all his work.

In 1834 Lyell went to Denmark and Sweden, the result of which was his Bakerian lecture to the Royal society "On the Proofs of the gradual Rising of Land in certain Parts of Sweden." He also brought before the Geological society a paper "On the Cretaceous and Tertiary Strata of Seeland and Moen." In 1835 he became president of the Geological society. In 1837 he was again in Norway and Denmark, and in 1841 travelled through the United States, Canada and Nova Scotia. This last journey, together with a second one to America in 1845, resulted not only in papers, but also in two works not exclusively geological, *Travels in North America* (1845) and *A Second Visit to the United States* (1849). He estimated the rate of recession of the falls of Niagara, the annual average accumulation of alluvial matter in the delta of the Mississippi, and studied those vegetable accumulations in the "Great Dismal Swamp" of Virginia, which he afterward used in illustrating the formation of beds of coal. He also studied the coal formations in Nova Scotia. and discovered, in company with Sir John W. Dawson (*q.v.*) of Montreal, the earliest known land shell, *Pupa vetusta,* in the hollow stem of a Sigillaria.

On a visit to Madeira and Teneriffe he accumulated evidence on the age and deposition of lava beds and the formation of volcanic cones. He revisited Sicily in 1858, and his observations upon the structure of Etna refuted the theory of "craters of elevation" upheld by Christian von Buch and Jean Élie de Beaumont. (See *Phil Trans.,* 1859.)

Lyell was knighted in 1848 and created a baronet in 1864, in which year he was president of the British association at Bath.

In later life he became blind. He died on Feb. 22, 1875, and was buried in Westminster Abbey.

The LYELL **MEDAL** was established in 187; under the will of Sir Charles Lyell, to be awarded annually (or from time to time) by the council of the Geological society. The medallist might be of any country or either sex. It was stipulated not less than one-third of the annual interest of a sum of £2,000 would be awarded with the medal, the remaining interest, known as the Lyell Geological fund, would be given in one or more portions at the discretion of the council for the encouragement of geological science.

See *Life, Letters and Journals of Sir Charles Lyell, Bart.,* edited by his sister-in-law, Mrs. Lyell, 2 vols. **(1881)**; *Charles Lyell and Modern Geology,* by T. G. Bonney **(1895)**.

LYLY, **JOHN** (1554?–1606), English author most famous for his novel, *Euphues,* was born in Kent in 1553 or 1554. After leaving Oxford, he apparently entered the service of Lord Delawarr, and in 1580 that of Edward Vere, earl of Oxford. In 1578 he soared to fame through the publication of *Euphues, or the Anatomy of Wit. Euphues and His England* appeared in 1580. The most fashionable English writer in the 1580s, Lyly was praised as the creator of "a new English," and as Edward Blount, his first editor, reported in 1632 (in the *Sixe Court Comedies),* "that Beautie in Court, which could not Parley, *Euphueisme,* was as little regarded; as shee which now there, speakes not French."

After the publication of *Euphues,* Lyly abandoned the novel and devoted himself almost entirely to playwriting. It is known that *c.* June 1583, through Oxford's influence, he gained control of the first Blackfriars theatre and dabbled in theatrical ventures that led, a year later, to brief imprisonment for debt. In this theatre his earliest plays, *Campaspe* and *Sapho and Phao,* were produced by a company called Oxford's boys, perhaps a short-lived amalgamation of Paul's boys and the children of the Chapel. That Lyly ever served as vice-master of Paul's (a nonexistent post), as has been alleged, seems rather implausible. All that remains certain is that all Lyly's plays, except *The Woman in the Moon,* were presented by Paul's boys, either alone or with the Chapel children.

Pappe With an Hatchet (1589) was a tract in defense of the bishops in the Marprelate controversy. About the same time (probably in 1588) Lyly presumably received at least a promise of the reversion of the mastership of the Revels whenever Edmund Tylney (appointed 1579) should retire. After the inhibition of Paul's boys *(c.* 1590), however, Lyly's fortunes rapidly declined. Though a member of parliament during the 1590s, he apparently suffered from both a meagre income and a disastrously waning popularity caused by the rise of Thomas Kyd, Robert Greene, Christopher Marlowe and Shakespeare. Nor was the mastership of the Revels any nearer; Tylney held the post till 1610. In despair Lyly finally addressed to Elizabeth I two bitter petitions, dated conjecturally 1598 and 1601. In the first he complained of having wasted ten years hanging about the court in hope of preferment; his increasing despondency may be gauged from the singularly reckless tone of the second. "Thirteene yeeres your Highnes servant: but yet nothinge. Twenty frendes, that though they saye they will be suer, I finde them suer to be slowe. A thousand hopes, but all nothinge, a hundred promises, but yet nothinge. Thus castinge up the Inventorye of my frendes, hopes, prommisses and tyme: the *summa totalis* amounteth in all to just nothinge." Blount says vaguely that Elizabeth "graced, and rewarded" him, but of this there is little evidence, though he may have received something out of the Essex forfeitures. He was buried in London on Nov. 30. 1606. He had married in 1583 Beatrice Browne of Mexborough, Yorkshire, by whom he had several children.

Comedies.—The dating of Lyly's plays remains conjectural, though scholarly opinion has settled upon the following dates of probable composition: *Campaspe* and *Sapho and Phao* (1583, in this sequence); *Gallathea* (1584); *Endimion* (1586–87); *Love's Metamorphosis* and *Midas* (1589, in this sequence); *Mother Bombie* (1589–90); and *The Woman in the Moon* (1594–95). Of these all but the last are in prose. During the 1590s Lyly also wrote a number of entertainments for aristocratic audiences. Lyly's comedies mark an enormous advance upon those of his predecessors and give him a secure place among the playwrights who distinguished the last two decades of Elizabeth's reign. His skill in acclimatizing to England Italianate pastoral and Latinate comedy of intrigue; his ability to bring together into a cohesive plot fanciful and mythological characters and characters from the lower ranks of English life; his delicate analysis by allegorical means (both topical and philosophical) of the nature of love, as the Renaissance understood it; and the grace and charm of his witty dialogue set aesthetic standards that younger, more gifted dramatists dared not ignore. How these standards were met and surpassed by Shakespeare can be seen in such plays as *A Midsummer flight's Dream* and *As You Like It*. Lyly's classical and pastoral plots and characters, and his lapses into Renaissance pedantry, may seem anemic to modern readers; nevertheless his finest play, *Endimion,* precious though it be, remains a masterpiece. Francis Meres in *Palladis Tamia* (1598) cites Lyly as among "the best for comedy," and Ben Jonson lists him among the foremost rivals whom Shakespeare outsung.

Euphues.—It was as the author of *Euphues,* however, that Lyly made his most enduring impression upon the Elizabethan world. This essentially Renaissance "novel" introduced a new sense of form into English prose style. Lyly's preoccupation with the exact arrangement and selection of words, with balance, antithesis and alliteration, demonstrated that the English language could be disciplined into a flexible vehicle capable of competing on equal terms with Latin and Greek. Lyly was not the first to experiment with the artificialities of euphuism (*q.v.*), but he brought the style to its highest point and through his very exaggerations conferred a lasting benefit upon English prose. Euphuism served as one model for the malleable prose of Shakespeare, who paid Lyly the final compliment of parodying the style in 1 *Henry* IV (II, iv), where Hal and Falstaff in the famous "play extempore" burlesque Ring Henry's euphuistic grandiloquence.

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(W. N. KG.)

LYME REGIS, a municipal borough and seaside town in the West Dorset parliamentary division of Dorsetshire, Eng., 25 mi. W. of Dorchester by road. Pop. (1951) 3,200. Area 1.9 sq.mi. It is situated at the mouth of a narrow valley opening upon a fine coast line of almost vertical cliffs made of horizontal layers of blue-gray limestones and shales which contain many fossils. The beach is shingle with sand at low tide and there is a small harbour between the jetty, on the east, and the massive curved wall known as the Cobb, which also forms a pier. The picturesque town, built on a steep hill, contains many Georgian houses and the church of St. Michael the Archangel, which is mainly Perpendicular with a Norman tower. The chief industry is the tourist trade. A Royal Air Force marine craft unit base was established in 1938.

Three manors of Lyme are mentioned in 1086 and the town was first known as Lyme Regis in 1316. It was a port in 1234 and was granted a charter by Edward I in 1284, making it a free borough with a merchant guild. At that date it was trading with France and by 1311 it was an important port. Further charters were granted by Elizabeth I (1591), James I, Charles II and William III. Lyme returned two members to parliament from 1295 to 1832 when the membership was reduced to one; it was disfranchised in 1867. Fairs were granted in 1553 for Feb. 1 and Sept. 20, but are no longer held. In 168j James, duke of Monmouth, landed at the Cobb which is also associated with Jane Austen's *Persuasion.* Sir George Somers (1554–1610), who first settled the Bermudas, Thomas Coram (1668–1751), who started the Foundling hospital, and Mary Anning (1799–1847), who in 1811 found the fossilized remains of an ichthyosaurus which is now in the British museum (South Kensington), London, were natives of Lyme.

LYMINGTON, a municipal borough and seaport in the New Forest parliamentary division of the county of Southampton (geographical Hampshire), Eng., on the river Lymington where it flows into the Solent, and 18 mi. S.W. of Southampton by road. It is bordered on the north by the New forest. Pop. (1951) 22.699. Area 21.5 sq.mi. Stone Age flint instruments and a Bronze Age burial urn have been found in the district and nearby was a Roman camp. In Domesday Book. Lymington is called Lentune and its first charter, one of the earliest in England. was granted by Baldwin de Redvers, 2nd earl of Devon, in 1150 and celebrated in 1950 by a week's festivities. The 6th earl granted another charter extending the borough (called old and new boroughs) to contain about 105 ac.; this remained unaltered until 1888 when Old and New Lymington were formed. The charter of Isabella de Fortibus, in 1270. gave almost complete freedom to the burgesses. These charters were later confirmed but no alteration has ever been made by the crown. The charter of 1605, formally incorporating the borough, remained in force until 1835 when. under the Municipal Corporations act, the government of the town (by a mayor and burgesses) was reformed. In 1932 the borough was extended to include Milford, New Milton (a holiday resort), Barton-on-Sea (famous for fossils), Hordle, Pennington (where there is a bird sanctuary on the marshes) and part of Sway. From 1584 until 1867, when the number was reduced to one, two members were returned to parliament; in 1885 the representation was merged in that bf the county. Two fairs were granted in the 13th century and were for centuries important events in May and October. The present Saturday market is also ancient but declined in magnitude with the coming of the railways.

The first mention of salt works, later very important, is in a grant of tithes to Quarr abbey in 1147. The old borough was made a port in Henry I's reign and rivaled Southampton in prosperity, chiefly owing to the salt industry. By 1845 the salt pans, or salterns, were worked out and the industry came to an end. Yachting and the building of yachts and other craft has been carried on since the early 19th century and the other main industry (established in 1919) is the making of piston rings. Regular passenger and car ferries serve Yarmouth in the Isle of Wight.

LYMPH AND LYMPHATIC SYSTEM. The lymphatic system consists of two main components: (1) a system of closed tubes. the lymphatics, containing a fluid, the lymph; and (2) the lymphoid complex, an aggregate of different types of lymphoid tissue containing varying combinations of cells, among which lymphocytes predominate. Scattered lymphocytes also occur in large numbers throughout the body. Though the two main components of the lymphatic system are closely associated, they are best considered separately for descriptive purposes.

This article is divided into the following sections:

4. Function of the Lymphocyte
5. Lymphoid Tissue and Virus Infections
6. Lymphoid Tissue and the Endocrine System

IV. Diseases of the Lymphatic System
1. Lymphadenitis
2. Tuberculous Lymphadenitis
3. Lymphangitis
4. Filarial Infestation: Elephantiasis
5. Reticuloses
6. Hodgkin's Disease (Lymphadenoma)
7. Reticulo-Sarcoma
8. Leukemia

I. LYMPH AND LYMPHATICS

In the higher animals the blood vessels form, with one or two possible exceptions, a closed system in which the most numerous vessels are the thin-walled capillaries. Through the capillary walls materials pass from the blood to the tissue fluid, which surrounds the individual cells and is in close contact with them. The term "tissue fluid" is a convenient one, but it must be emphasized that under normal circumstances it contains little if any free fluid. It consists of a gelatinous material, through which fluid can readily pass, but is not normally "free" in the sense that it forms localized accumulations. The water is associated with the colloid gel which forms the ground substance of the connective tissue, consisting in the main of mucopolysaccharide protein complexes, in which are embedded in varying proportions collagen and elastic fibres. It is probable that fluid moves through the connective tissues in thin films, between and around the fibres, by the action of surface forces. P. D. McMaster and R. J. Parsons (1939) refer to these as "captured" films. It is only when there is inflammatory or other edema that the accumulation of free fluid in pools may be observed, due to hydration of the colloid gel beyond a certain point.

The tissue fluid acts as a middleman in the transport of substances between the blood and the tissue cells (see also CIRCULATION OF BLOOD). Water and crystalloids can diffuse freely and rapidly in and out of the blood through the endothelium of the blood capillary. In addition, the hydrostatic pressure in the capillary causes fluid to filter out into the tissues. The extent and speed of the movement of water and crystalloids has been shown very clearly by the use of heavy water (G. Hevesy and C. F. Jacobsen, 1940) and radioactive isotopes. L. B. Flexner and his colleagues showed that in man 105% of plasma water and 78% of plasma sodium are exchanged per minute, while in the guinea pig the water exchange is even greater (140%). The absolute figures in man may be gauged from the fact that in the human adult the total blood volume is about 5 l., and of this approximately 3 l. are plasma, separated by the capillary endothelium from 10–12 l. of extravascular tissue fluid. Rapid fluid movements are essential if the composition of the tissue fluid is to remain reasonably constant.

Though the capillary endothelium so readily permits the free passage of water and crystalloids, it holds back most of the blood proteins. However, possibly as a result of the relatively high pressure of blood within the capillary, protein molecules do occasionally escape into the tissues. Over a 24-hour period something like 50% or more of the total plasma proteins leave the blood, the smaller albumin molecules escaping more frequently than the larger molecules such as globulin. Furthermore, in some parts of the body, protein leaves the blood stream more freely than in others. Once the protein molecules have passed out of the blood capillaries they cannot be directly reabsorbed into the blood. Some of this extravascular protein may be used by the tissue cells, but most of it can be removed only via the lymphatic capillaries. The prime purpose of the lymphatic system is thus to drain away from the tissues any excess protein which has escaped from the blood vessels and ultimately to return it to the blood by the main lymph ducts entering the veins. It would follow from this that wherever there are blood capillaries, lymphatic capillaries must also be present. In general this is true, and exceptions, such as the central nervous system, the bone marrow, the splenic pulp and possibly the skeletal muscle bundles, are due to local circulatory peculiarities which render the presence of lymphatics unnecessary.

1. Structure and Arrangement of Lymphatic Vessels.—The lymphatics begin as a network of capillaries with blind extremities; like the blood capillaries they are separated from the tissue fluid by a continuous layer of thin cells called endothelium (see fig. 1). Though this endothelium looks very like that of the blood capillary, it is much more freely permeable, to large molecules such as protein and even to particulate matter, which therefore readily enters the lymphatics after injection into the tissue spaces. It was at one time thought that the lymphatics communicated directly with the tissue spaces, through small openings or stomata, but it is now believed that the lymphatic system is completely closed. From the network of lymphatic capillaries there emerge plexuses of larger vessels with thicker walls, but unlike the veins these do not undergo progressive increase in calibre as they near their destination. The smallest lymph capillaries consist of a single layer of flattened endothelial cells, but the larger vessels resemble veins in having an inner coat of endothelium, a middle unstriped muscle coat and an external fibrous coat.

Valves are numerous, even in vessels of very small calibre, though they are not present in the capillaries. They usually consist of two cusps, set so as to prevent flow toward the periphery. When the vessels are engorged the sites of the valves are marked by constrictions, producing a beaded appearance. The lymph plexuses of the organs and tissues are drained by the lymphatic trunks, which usually course with the main blood vessels of the part. The main trunks from the hind limbs and abdominal organs are united into one large vessel, the cisterna chyli, from which the thoracic duct passes up on the left side of the esophagus to drain into the commencement of the left innominate vein. A smaller duct, the right lymph duct, drains the right side of the head and neck and the right upper limb, entering the commencement of the right innominate vein (fig. 3). In addition. a number of other lymphatico-venous communications may occur irregularly in the thorax and abdomen. Lymph vessels coming from organs or limbs pass at some part of their course through one or more lymph nodes, and it must be rarely, if ever, that lymph reaches the venous system without passing through at least one node.

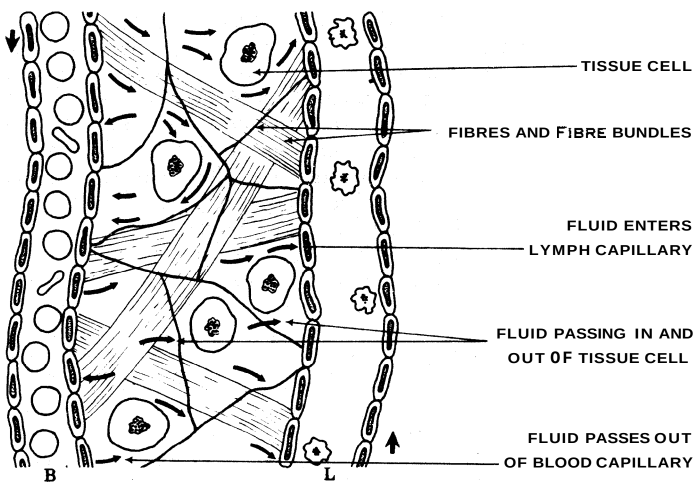
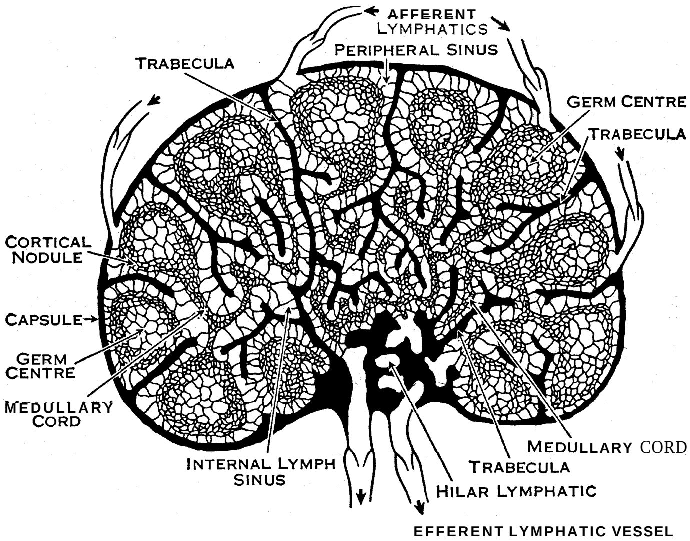


FIG. 1—DIAGRAM SHOWING FLUID EXCHANGES TAKING PLACE IN ACTIVE TISSUE.

Arrows indicate the direction of flow of the fluid as it comes from the blood vessels and passes between the tissue cells into the lymph capillary, where it forms lymph. Arrows also indicate fluid exchange between the cells and surrounding tissue fluid. (Key: B = blood capillary; L = lymphatic capillary)

In certain fishes are seen vessels—venous lymphatics—which contain blood and lymph in varying proportions. In these animals the lymph vessels do not possess valves, and fluid is driven through them by contractile lymph hearts. In amphibia and reptiles lymph is no longer mixed with blood; lymphatic valves have not yet appeared, but functional lymph hearts are present, to effect a sluggish but direct flow of lymph to the blood. In most birds the lymph hearts disappear after embryonic life and the lymph vessels contain valves, just as do those of mammals.

2. Composition of Lymph. — Lymph is the colourless or yellowish fluid, containing formed elements, salts and varying amounts of protein and fat, which fills the lymphatic vessels. There is general agreement that the crystalloids of lymph are substantially identical with those of the tissue fluid. Like it, they consist chiefly of the cations, sodium, potassium, calcium and magnesium, and the anions, chloride, bicarbonate and phosphate. C. K. Drinker and his associates brought forward considerable evidence that



ADAPTED FROM A. A. MAXIMOW AND W. BLOOM, "A TEXTBOOK OF HISTOLOGY," 6TH ED., 1952; BY COURTESY OF W. B. SAUNDERS AND CO.

FIG. 2.— LYMPH NODE

this identity with the tissue fluid extends to the protein content also; *i.e.,* that peripheral lymph can fairly be regarded as the counterpart of tissue fluid. which undergoes little if any modification as it crosses the extremely permeable lymphatic endothelium.

Lymph derived from the intestine differs from lymph in other situations. since it is intimately associated with the absorption of several substances. If the animal has been fed some time previously with a fatty meal, the lymph has a milky appearance, which is due to the presence of innumerable fine droplets of fat (chylomicrons) about 0.5μ–0.75μ in diameter. The fat is absorbed by the lymphatics of the small intestine. which because of their white appearance during digestion are called lacteals. Among other substances known to be absorbed from the intestine via the lymphatics are vitamin K and certain sterols.

3. Amount of Lymph. — No precise data are available on the total lymph flow. Most of the information is based on thoracic duct lymph flow in anesthetized animals, and from this it would appear that the flow is about 2 ml. per kilogram per hour in nonruminants, and rather more than this in ruminants. The flow of lymph in all the other ducts combined is about 50% of the thoracic duct flow. Direct measurements had not been made in man, except for a feu- diseased persons in whom the flow ranged from 0.3 1. to 2.8 1. a day. The total volume of all the lymph in the lymphatics and lymphoid tissues at any given time cannot be accurately determined.

4. Relation of Lymph to Lymphoid Tissue. — In the lymph glands the lymphoid tissue is traversed by a lymph stream which reaches the glands by afferent lymph vessels and leaves them by efferent vessels. The subepithelial lymphoid tissue (nasopharyngeal and intestinal, as also the thymus) possesses efferent but not afferent vessels. The lymphoid tissue of the spleen is related to the blood stream and possesses neither afferent nor efferent lymph vessels. In the case of lymph glands, lymph which has not yet traversed a gland is known as peripheral lymph. If it has passed through one gland but still has to flow through another, it is intermediate lymph, while if it is on its way to the blood without further glandular interruption it is central lymph.

5. Formed Elements in Lymph. — The majority of the white cells in central lymph are lymphocytes, of which about 95% are small br medium lymphocytes and 5% large basophilic cells, capable of mitosis (*i.e.,* cell division). A few monocytes and granulocytes may be present. Most studies of central lymph have been made on lymph from the thoracic duct. The actual number of cells present at any time is quite variable. both in the same and in different species. In general, the smaller the animal, the greater the concentration of lymphocytes. In the dog and cat J. M. Yoffey and C. K. Drinker found that peripheral lymph contained a mean lymphocyte count of 280 and 370 per cubic millimetre, while thoracic duct lymph contained 7,800 and 12,000 lymphocytes per cubic millimetre, respectively. The lymphocyte count in thoracic duct lymph may on occasion greatly exceed this figure. Peripheral lymph contains small numbers of red and white cells, while central and intermediate lymph contain large numbers of white cells, almost entirely lymphocytes, which are being carried in the lymph to the blood stream.

6. Mode of Production of Lymph. — The forces subserving the transference of substances through the blood capillary wall to the lymphatic vessels appear to be of a physical character, though the capillary endothelium, being composed of living cells. is capable of altering its degree of permeability. It appears to be at all times freely permeable to dissolved salts. but its permeability to protein is variable. The physiological conditions under which this permeability alters are not known, but under various pathological conditions the proteins are able to pass freely through the injured epithelium, as also are the formed elements of the blood in lesser degree.

It is now considered that there are three forces producing a transference of fluid and dissolved substances from the interior of the capillary to the tissue spaces; they are blood pressure, diffusion and osmosis. The excess hydrostatic pressure existing in a blood capillary over that in the extravascular tissue spaces causes a filtration through the endothelial wall of fluid mith the same composition in salts as blood but varying in protein content. At the same time diffusible substances at a greater concentration in the blood tend to pass to a region of lesser concentration in the tissues. The third force. that of osmosis, depends on the fact that water passes through the capillary more quickly than salts and even more quickly in relation to the plasma proteins. Thus if a hypertonic solution of sodium chloride is injected intravenously there is a passage of water from the tissues to the blood, which becomes greatly increased in volume, with a concomitant dessication of the tissues. At the same time salt passes more slowly from the blood into the tissues until a new equilibrium is reached. In the reverse direction similar changes would follow an increased molecular concentration in the tissues. These factors would be sufficient to account for the major part of the exchange of water and dissolved substances between blood and tissues.

Osmotic pressure of the plasma proteins, however (as first clearly pointed out by E. H. Starling in 1896), is essential for maintaining the full balance of fluid exchange through the capillary membrane. According to what is now known as the Starling hypothesis, the endothelium of the blood capillary functions as a semipermeable membrane in relation to the plasma proteins. At any given time the amount of plasma protein which leaks through the capillary wall is small in relation to that which does not. and the protein within the capillary exerts an osmotic pressure of about 30–40 mm. Hg (mercury). There are thus two opposed forces. The capillary pressure causes water to pass out of the capillary into the tissues, while the osmotic pressure of the plasma proteins causes it to be absorbed from the tissues into the capillary. The most important of the plasma proteins for this purpose is the albumin, which has a molecular weight of 69,000. "Whereas capillary pressure determines transudations the osmotic pressure of the proteids of the serum determines absorption." The truth of Starling's hypothesis was confirmed by direct measurement of the pressure changes in individual capillaries in the frog's mesentery (E. M. Landis, 1927). Later J. R. Pappenheimer and A. Soto-Rivera (1948), using an isolated mammalian hindleg preparation, showed that the same was true for mammalian capillaries and that, in respect of the absolute figures for the capillary pressure and the osmotic pressure of the plasma proteins, the rate of fluid transfer depended on the net difference between these two forces.

A number of additional factors, though they do not affect the essential validity of Starling's view, call for consideration. Thus there is some protein in the tissue fluid and it exerts an osmotic pressure in the opposite direction to the plasma proteins. The effective osmotic pressure of the plasma proteins is therefore lessened by this amount. Furthermore, Landis showed by direct measurement that there is a fall in pressure from the arterial to the venous end of the capillary, with corresponding differences in the final fluid exchange. It is estimated that at the arterial end of the capillary the hydrostatic pressure is greater than the osmotic, whereas at the venous end it is lower. At the arterial end, therefore, the excess of hydrostatic pressure causes fluid to flow from the capillary to the tissue spaces. At the venous en3 the excess of osmotic pressure produces the reverse phenomenon and fluid passes from the tissue spaces into the capillary. The difference between the two ends may be diminished. however, by the fact that, as first suggested by F. P. Rous. the permeability of the blood capillary is not the same throughout its length, but exhibits a gradient, increasing from the arterial to the venous end.

The balance between the forces controlling fluid exchange is very nicely regulated, and it is possible that if it were not for the leakage of protein, lymphatics would be quite unnecessary. There are regions of the body in which. when at rest, the lymphatic system plays very little part, so that a constant interchange between blood and tissue fluid can take place without the production of a single drop of lymph. If a cannula is inserted into the main lymph trunk of a limb at rest almost no lymph can be obtained. If, however, the limb is thrown into action, the arterioles and capillaries of the part dilate and the hydrostatic pressure in them consequently increases; that is to say, the length of the capillary in which resorption can occur, by virtue of the excess of osmotic over hydrostatic pressure. is lessened so that fluid tends to accumulate in the tissue spaces. That it does not normally accumulate there is due to the fact that it is taken away by the lymphatics.

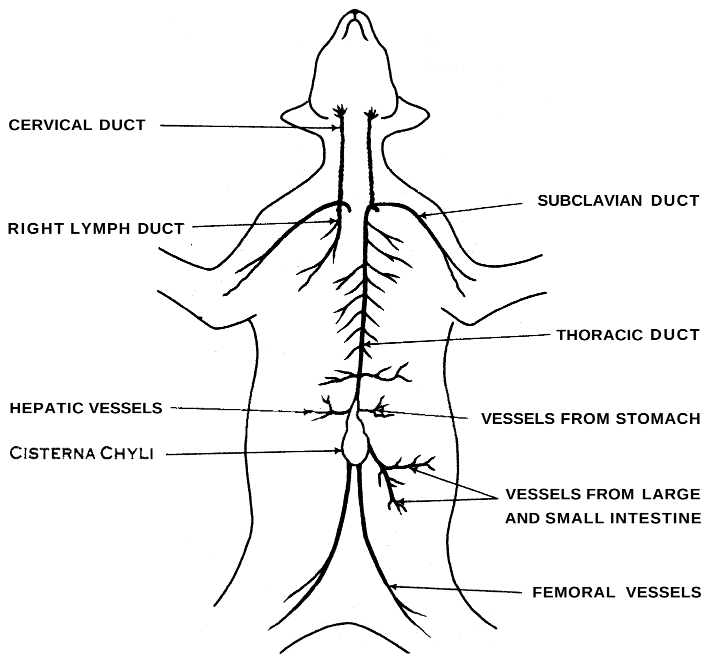
It must be emphasized, however, that the lymphatic vessels cannot deal with large quantities of fluid and if there is more than a moderate increase in the escape of fluid from the blood capillaries, it accumulates in the tissues, which become waterlogged and edematous.

7. Structure and Properties of Blood Capillary **Endothelium.**—The formation and drainage of lymph involve the passage of fluid first through the endothelium of the blood capillary and second through that of the lymphatic capillary. The lymphatic capillaries appear to consist solely of cells joined by intercellular cement. The blood capillary has the same essential structure. but in addition there is usually a pericapillary sheath of fine connective tissue, while on the inner surface of the endothelium there may be a noncellular lining derived from the plasma proteins (R. Chambers and B. W. Zweifach, 1947). The intercellular cement is readily demonstrated in most capillaries by the reduction of silver nitrate. It may well be that the cement lines constitute areas of increased permeability. Electron microscope studies suggest that true capillary pores may in fact exist in certain situations.

The distinctive feature of lymphatic endothelium is its great permeability. Not only do large protein molecules pass through it readily, but even solid particles such as india ink, bacteria or cells. This fact is the basis of the classical method of demonstrating lymphatics, namely, interstitial injection—the injection of a particulate suspension into the tissue spaces or interstices, whence the particles readily enter the adjacent capillaries. This property can readily be demonstrated in the lymphatics of the peritoneal surface of the diaphragm. If a suspension of graphite is injected into the peritoneal cavity of a rabbit, the subperitoneal lymphatics can be seen filled with the black material. Red cells, too, can be removed by this route from the peritoneal cavity in considerable numbers; and F. C. Courtice, J. Harding and A. W. Steinbeck showed that they reach the blood stream through the right lymph duct. There appears to be a slow steady movement of cells from the blood stream through the tissues and into the lymphatics. The precise significance of this is not clear.

The high degree of permeability of the lymphatic endothelium has a further consequence in that substances of low molecular weight which have been absorbed by lymph capillaries may, during their passage along these channels. diffuse out again into the surrounding tissue fluid to be reabsorbed by the blood vessels or by other lymphatics. An interesting observation on the permeability of lymphatic vessels to diffusible substances was made by M. R. Lewis. If histamine or adrenaline is inserted into the skin by puncture, some of the substance is taken up into the lymphatics, but leakage out again into the tissue fluid occurs during passage up the lymphatics, as is shown by the occurrence of a reddish line of dilated capillaries and venules in the case of histamine, and a white line due to the contraction of these vessels in the case of adrenaline.

8. Propulsion of Lymph.—Lymph hearts (that is, organs for pumping lymph through the lymphatic vessels) are not present in mammals. Rhythmical contraction of lymphatic vessels has occasionally been noted (*e.g.*, in the mesenteric lymph vessels of the rat and guinea pig), but, in the main, the propulsion of lymph in mammals is due to extrinsic and not intrinsic forces. In the first place, the slight tissue pressure helps to drive fluid from the tissue spaces into the lymphatic capillaries. Though the head of pressure is not great (in the mouse's ear 1.9 cm. of water outside the lymphatic capillary, 1.2 cm. in its lumen), it exerts a continual effect, augmented by movement. All the larger and most of the smaller lymphatic trunks are liberally supplied with valves, which consist usually of two cusps and which permit the flow of lymph in one direction only, namely to ard the heart. In the limbs, movement and muscular contraction are the main propelling agents. If a cannula is inserted into a lymph trunk in a limb, no lymph flows if the limb is at rest, but there is considerable flow if it is either massaged or made to move, whether actively or



FROM YOFFEY AND COURTICE, "LYMPHATICS, LYMPH AND LYMPHOID TISSUES"; REPRODUCED BY PERMISSION OF EDWARD ARNOLD (PUBLISHERS) LTD.

FIG. 3.—SCHEME OF THE MAIN LYMPH VESSELS IN MAMMALS

passively. In the intestine, contraction squeezes out lymph very effectively into the cisterna chyli and the thoracic duct. This can be shown readily by observing the great increase in thoracic duct lymph flow after the administration of drugs such as pilocarpine which stimulate peristalsis. Once lymph has found its way into the cisterna chyli (see fig. 3), the pressure changes associated with each inspiration—namely, increased intra-abdominal pressure expelling it from the abdomen, and negative intrathoracic pressure sucking it into the thorax and great veins—form the final link in the chain of extrinsic propelling agents.

In some situations, an additional aid to lymph flo may be the transmitted pulsation from adjacent arteries; *e.g.*, the aorta and the thoracic duct. Occasionally, the lymph vessels may even form plexuses around the arteries.

9. Pressure in Tissue Spaces.—The relation between the tissue pressure and that within the lymphatic capillaries raises the problem of the patency of these vessels, which might be expected to collapse if the pressure of the fluid outside them were greater than that inside. This might conceivably be an even more difficult problem nhen the tissue pressure is increased as in cases of edema. It was long ago observed. however. by W. A. Gaskell that fibres passed from the walls of the lymphatic vessels into the surrounding tissues in the epiglottis, so that if the tissues became swollen with fluid, these fibres were pulled on and helped to keep open the lumen of the vessel to which they were attached. These observations later were confirmed by B. D. Pullinger and H. W. Florey in experimentally induced edema in the ear of the mouse. in which fine argyrophilic connective tissue fibres could be demonstrated passing from the walls of widely patent lymph capillaries into the surrounding edematous tissues.

II. LYMPHOID COMPLEX, LYMPHOID ORGANS AND LYMPHOID TISSUES

The second great component of the lymphatic system consists of the lymphoid complex, a group of organs and tissues formed by: (1) lymph nodes; (2) subepithelial lymphoid tissues, lying under the mucous membrane of the alimentary canal; (3) the spleen; (4) the thymus; and (5) hemolymph nodes. In addition, there are large numbers of lymphocytes scattered throughout the connective tissues, especially abundant in the bone marrow.

1. Total Amount of Lymphoid Tissue.—It is difficult to assess the total amount of lymphoid tissue in the body, and the method which has been employed, namely the careful dissection and weighing of all the scattered lymphoid masses, is far from ideal. E. Andreasen estimated that in young adult rats the total amount of lymphoid tissue. including the thymus, is 0.5%–1% of the body weight.

2. Age Changes.—Lymphoid tissue undergoes age changes. Well developed until puberty, when it reaches its maximum, it then undergoes atrophy. In old age the thymus and subepithelial lymphoid tissues have for the most part disappeared, but the spleen and lymph nodes persist.

3. Relation Between Different Members of the Lymphoid Complex.—Though all members of the lymphoid complex are referred to as lymphoid tissue, there are marked points of difference. In the case of the thymus. it has been questioned whether it really is a lymphoid organ. and it has been suggested that though the thymic cells bear a superficial resemblance to lymphocytes they do in fact form a distinct cell species. However, thymocytes and lymphocytes both have the same characteristic movement, the nucleus forming a rounded head, the cytoplasm a short stumpy tail.

There are significant differences between the members of the lymphoid complex in the ability to form antibodies. The spleen can. when required, produce large amounts of antibody, the thymus none, while the lymph nodes are intermediate in this respect.

4. Lymph Nodes.—Lymph nodes or lymph glands are the most numerous of all the lymphoid organs. They are pink bodies situated on the course of the lymphatics and they therefore possess both entering (afferent) and draining (efferent) lymph vessels. They are rounded or bean-shaped (see fig. 2) and vary in size from small nodules to flattened masses perhaps two inches long, large nodes being commonest in the groin. Each node has a fibrous capsule from which trabeculae pass toward the interior, where they break up and interlace to form a network, the intervals being filled by lymph sinuses and cell columns. Beneath the capsule of the node is a peripheral lymph sinus into which the afferent lymphatic vessels enter, usually from the convexity of the node. Subsidiary lymph sinuses traverse the node from the peripheral sinus and are collected together at the hilus (where the blood vessels enter) as one or more efferent lymphatic trunks. The node is subdivided by the internal lymph sinuses and trabeculae into rounded nodules of lymphoid tissue in the cortical region and elongated cords in the medullary region. In the centre of each cortical nodule there may be a lighter area of large cells, the germ centre, while considerable regions may be occupied by diffuse lymphoid tissue without any nodules. The complete endothelial lining of the entering lymphatic vessels is not continued to line the sinuses of the node. which are rather spaces in the reticular tissue. often traversed by fine bridgelike strands of reticulum, to which adhere many large, flattened, reticulo-endothelial cells. These latter cells, in contrast to the lymphocytes, are highly phagocytic and readily take up foreign particles which enter by the lymph. Thus the thoracic nodes of city dwellers are black from carbon strained off in its passage from the lungs. In a similar way, invading bacteria which have been taken up by the lymphatics tend to be arrested in the nodes draining the affected region.

The exact position of the various groups of lymph nodes is very important from a medical point of view. The tendency for an infection to spread to the draining lymph nodes just mentioned is a case in point. Another is the tendency of malignant tumours to spread and involve the lymph nodes. It is not possible here to describe in detail the positions of the nodes and groups of nodes. Full descriptions are given in treatises on anatomy.

Besides being adapted to filtering off foreign particles, the slow seepage of the lymph through the node permits easy entry of cells from the node into the lymph. Indeed, lymphocytes that are formed in the node and then enter the lymph as it traverses the node are an important source of the free lymphocytes of the blood. Lymphocyte formation can occur in diffuse lymphoid tissue even in the absence of germinal centres, but the latter seem to develop whenever maximal production of lymphocytes is required.

Lymph nodes reach their highest development in mammals. Simpler nodes are present in marsupials. Among the birds only certain aquatic species possess them, but they are of very simple structure and are present only in certain situations; viz., a pair at the thoracic inlet and a similar pair in the abdomen. In some birds there are quite appreciable accumulations of lymphoid tissue in the walls of blood vessels. In fishes and amphibia lymphoid tissue does not occur by itself. but is found in the lympho-myeloid organs, where it is closely associated with tissue which forms myelocytes, granulocytes and erythrocytes.

5. Subepithelial Lymphoid Tissues.—The subepithelial lymphoid tissues lie under, and in close association with. the mucous membrane of certain parts of the alimentary canal. At the upper end are situated the palatine tonsils, the nasopharyngeal tonsils (known as adenoids when enlarged) and the lingual tonsil, which lies posteriorly on the dorsum of the tongue. These three sets of tonsils thus form a group surrounding the entrance to the pharynx. Throughout the intestine there occur solitary nodules, but they are most numerous in the small intestine: in the terminal part of which they also form large aggregations known as Peyer's patches. The submucosa of the appendix is closely packed with lymphoid tissue. The subepithelial lymphoid tissues have a simpler type of organization than lymph nodes. As they have no afferent lymph vessels and therefore no lymph sinuses traversing them, the subepithelial lymphoid tissues consist of lymphoid nodules with germ centres and a variable amount of diffuse lymphoid tissue, surrounded by a network of lymphatic capillaries.

6. Lymphoid Tissue in the Spleen.—The spleen is enclosed in a capsule which is muscular and contractile in many animals, but in man is mainly fibroelastir. From the capsule trabeculae ramify throughout the organ, forming a framework the meshes of which are occupied by the splenic pulp. The latter is of two types, the white pulp, which is composed of lymphoid tissue as described above, and the red pulp. This consists of venous sinuses among which are a spongy network of cells, the splenic cords, containing lymphocytes and numerous macrophages, either free, or arranged as a network (the pulp reticulum). On the cut surface of the organ the white pulp is visible as rounded or elongated gray areas up to one millimetre in' diameter, sometimes known as the Malpighian bodies, and usually surrounding the arteries. No lymphatic channels are present in the pulp, which possesses instead

a highly specialized blood vascular arrangement which allows intimate contact of the cellular and fluid elements of the blood with the lymphoid and reticulo-endothelial cells of the pulp. This permits the spleen, quite apart from its reservoir function, to entrap foreign particles circulating in the blood stream in the same fashion as a lymph node arrests particles in the lymph stream. (See also SPLEEN.)

7. Thymus.—The thymus, situated in man behind the upper end of the sternum, consists of a dense mass of round cells embedded in a reticular framework. Draining lymphatics are present, but no entering lymphatics. Besides the small round cells or thymocytes, groups of epitheliallike cells (Hassall's corpuscles) are present. Controversy still exists as to whether the thymus is a true lymphoid organ, for in some ways it reacts differently from lymphoid tissues elsewhere, though the differences are usually of degree rather than of kind. On the whole, the available evidence appears to favour the view that the thymocyte and the small lymphocyte are identical; in tissue culture they both show the same type of distinctive movement. The thymocytes tend to be the smallest of the small lymphocytes, with a bare minimum of cytoplasm, resembling most closely the small lymphocytes in bone marrow. The evidence suggests that the thymus is the most vigorous cell producer of all the lymphoid organs, being four to six times as active as lymph node tissue. (See also THYMUS.)

8. Hemolymph Nodes.—These bodies are similar to simple lymph nodes but their sinuses contain blood. They are most conspicuous in ruminants such as the sheep. In man they are found only within the abdomen and are of very small size and minor physiological importance. They are in all probability lymph nodes whose afferent lymph vessels have contained an abnormally large number of erythrocytes, which then accumulate in the sinuses of the nodes.

9. Lymphoid Tissue in Bone Marrow.—Certain aspects of this question are considered in the discussion below on the fate of the lymphocyte. Here it need only be noted that mammalian bone marrow does not normally contain organized lymphoid tissue of the type associated with lymphocyte production in all other situations. It may contain scattered small lymphocytic aggregates, and it usually has a large number of small lymphocytes, which seem not to have been formed in the marrow but to have entered it from the blood.

10. Functions of Lymphoid Tissue.—Two main functions have been assigned to lymphoid tissue: (1) defense and (2) lymphocyte formation. The defense theory was originated by R. Virchow, who maintained that noxious particles entering the lymph stream were held up in the sinuses of the nodes. This simple barrier theory was later extended to include antibody production. The view that lymphocyte production is an important function of lymphoid tissue received a strong impetus from the observation by W. Flemming (1885) that the germinal centres contained abundant mitoses.

III. LYMPHOCYTES

Lymphocytes are often described in terms of size as large. medium or small, though there are other differences associated with these size relationships. The most numerous cell type—and also still the centre of acute controversy—is the small lymphocyte. In fresh wet preparations of blood or lymph the small lymphocytes are rounded cells. usually about eight microns in diameter. The nucleus almost fills the cell and is round, oval or bean-shaped. If kept at body temperature the lymphocytes move about rapidly for short periods, and then round off to a resting state in which small pseudopodia may form and retract. The movement is distinctive. since the nucleus forms a rounded head and the cytoplasm the tail. The number of moving cells increases from the first to the ninth hour, by which time most of the cells are moving. This is in contrast to the behaviour of the polymorphs. which are most active initially but are almost rounded and inactive after six hours.

The cytoplasm of the lymphocyte is clear, and mitochondria can be seen in unstained cells. In fixed preparations treated with Romanowsky stains the nucleus of the lymphocyte is coloured an intense dark purple, while the cytoplasm is a clear pale blue, though in the large lymphocytes it may be much more basophilic. Ultraviolet absorption studies indicate that the nucleus of the small lymphocyte contains the diploid number of chromosomes.

1. Genetic Relations of Lymphocytes.—Lymphocytes develop either from other lymphocytes or from nonlymphocytic precursors in the various lymphoid tissues, but the details of their origin and development are matters of dispute, as part of the larger question of the origin and interrelationships of blood cells generally. M. M. Wintrobe (1946) emphasized that one of the main points of disagreement between the proponents of the various general theories of blood formation is in regard to what constitutes a lymphocyte. With regard to developmental potentialities, the question has been most acute in relation to the small lymphocyte.

It has been maintained on the one hand that the small lymphocyte is totipotential. capable of developing into all the other cells of the blood and connective tissue, and on the other hand, that it is incapable of further development; intermediate views have been held. If the small lymphocyte is totipotential, then it must be regarded as a specialized form of the primitive mesenchymal cell, reduced to the smallest possible size to facilitate rapid mobilization and transport through the blood stream from one part of the body to another.

2. Production of Lymphocytes and Entry Into **Blood.**—The study of lymphocyte production is beset with many difficulties. Newly formed lymphocytes may enter the blood indirectly, by first entering the lymph stream, or directly, by passing through the walls of the blood capillaries in lymphoid tissue. The indirect entry lymphocytes reach the blood by the thoracic duct, the right lymph duct or other and irregular lymphatico-venous communications. In the past, it was assumed that most of the lymphocytes enter the blood by way of the thoracic duct. and numerous quantitative studies have been based upon this assumption. In a typical experiment, samples of lymph are collected at intervals from the thoracic duct over a period of several hours. Then from the total volume of lymph flow. and the number of lymphocytes per unit volume, it can readily be calculated that the number of lymphocytes entering the blood stream a day by this route alone is considerably in excess of the total number of lymphocytes in the blood. Since there is no clear evidence that lymphocytes are destroyed while in the blood, it must be assumed either that there is a continuous circulation of lymphocytes between blood and lymph, or that the lymphocytes leave the blood stream and are continually replaced by the newly formed cells which are entering it. J. M. Yoffey (1936) estimated that in the dog the blood lymphocytes were replaced about $2\frac{1}{2}$ times a day, and termed this the daily replacement factor (D.R.F.). A. G. Sanders. H. W. Florey and J. M. Barnes found in the rabbit a D.R.F. of about five; and in general. the smaller the animal the higher the D.R.F. Studies of cell multiplication in the lymphoid tissues themselves suggest that lymphocyte formation may be considerably more active than the thoracic duct data indicate. As to the relative contribution of the different members of the lymphoid complex, it is probable that the thymus is the most active of all the lymphocytopoietic tissues and that the intestinal and mesenteric lymphoid masses rank next in importance.

3. Fate of the Lymphocytes.—H. S. Sjövall (1936) maintained that the lymphocytes continually recirculated between blood and lymph. and experiments involving prolonged drainage of thoracic duct lymphocytes have been interpreted as supporting this view. It is, however, difficult to reconcile this with the active synthesis of deoxyribonucleic acids (DNA) in lymphoid tissues. The existence of a very rapid turnover for lymphocytes poses acutely the question of the fate of these cells. It is unlikely that lymphocytes undergo degeneration on any considerable scale while in the blood stream. It is also improbable that there are large numbers of lymphocytes lost to the body by migration through the epithelium of the intestine. though a certain number may be so.

Lymphocytes are constantly migrating into the connective tissues. but there is no evidence to prove that this extravascular migration occurs on a sufficiently large scale to account for the "disappearance" of the lymphocytes. Another suggestion is that the lymphocytes are filtered out of the biood into the bone marrow. This concept would fit in admirably with the view that lymphocytes are totipotential and capable of developing into the other blood cells, but on this point there is no general measure of agreement. From a quantitative point of view. it is significant that very large numbers of lymphocytes occur in normal marrow. and all the evidence points to their reaching the marrow from the blood. The number of lymphocytes present in the marrow is more than adequate to account for the numbers daily disappearing from the blood.

The question of the transformation of lymphocytes into other cells has ,been extensively investigated not only in the tissues of the organism but also in living organisms by the technique of tissue culture. Some observers have claimed that starting with pure cultures of lymphocytes they have noted the subsequent appearance of monocytes. macrophages, fibroblasts, granulocytes and erythroid cells. But their claims have not met with general acceptance.

4. Function of the Lymphocyte.— It has long been widely held that the lymphocyte plays a part in the defense mechanisms of the body. Many familiar observations form the basis for this belief, among them the increase in the blood lymphocytes in many infectious diseases; the accumulation of lymphocytes around areas of subacute or chronic inflammation, especially when due to organisms such as those of syphilis and tuberculosis; the mantle of lymphocytes around an invading tumour; and the collections of lymphocytes in parts subjected to mechanical or chemical irritation. The anatomical arrangement of the masses of lymphoid tissue has been advanced as support for the protective role of the lymphocyte. Thus the tonsillar ring of lymphoid tissue is often described as guarding the gateway to the alimentary canal from the entry of organisms; a similar protective function is assigned to the lymphoid nodules of the intestine, while the disposition of lymph nodes as filters along the course of the lymph stream has given further support to these views.

Direct factual evidence has become available about the role of the lymphocyte in these defense processes. The small lymphocyte lacks phagocytic powers and is incapable of producing antibodies to bacteria or foreign proteins. In 1935 P. D. McMaster and S. Hudack, following up earlier work, demonstrated specific agglutinins in the lymph nodes draining an infected area, though they were unable to show which cells were responsible. W. E. Ehrich and T. N. Harris (1942) found that the injection of antigen into the pad of a rabbit's foot was followed by a hyperplasia of the popliteal node, with an increase in the cell count and the antibody content of the lymph issuing from a cannula inserted into the efferent lymphatic. But subsequent work led Ehrich and his collaborators to the view put forward by A. Fagraeus (1948) and others, that it was the plasma cell which was in the main responsible for antibody formation, not the lymphocyte. A. Coons and his co-workers applied an ingenious technique involving the use of fluorescent antigen and antibody, as a result of which they showed not only that it is not the small lymphocyte in lymph nodes which is responsible for antibody formation. but that the plasma cells which are responsible are derived from the primitive reticular cells and large lymphocytes from which small lymphocytes also arise.

The part played by the reticulo-endothelial cells is not altogether clear. F. R. Sabin (1939) used a coloured antigen to study antibody production, and suggested that this process occurred in the phagocytic cells of the reticulo-endothelial system which ingested the antigen. It was later shown that antigen was indeed retained for 11 weeks and longer in the macrophages of lymphoid organs, even though these cells were not in themselves responsible for antibody formation. It would appear, therefore, that when antigen reaches a lymph node it is taken up mainly by the reticulo-endothelial cells, and that subsequently the node reacts by producing increased numbers of both plasma cells and lymphocytes. The plasma cells remain in the node and are a source of antibody; the lymphocytes are discharged in the efferent lymph and enter the blood. When the antigenic stimulation is at an end the formation of plasma cells ceases and lymphocytopoiesis becomes once again the dominant activity. Antibody formation proceeds most actively in the spleen. to a lesser extent in lymph nodes, and seems to be completely absent in the thymus. (See IMMUNITY.)

5. Lymphoid Tissue and Virus Infections.— In the case of virus infections, lymph nodes may constitute a mechanism for the dissemination of virus particles. Viruses are cytotropic, and when from a focus of infection they enter the lymphatics and come to the regional lymph nodes, they obtain access to the various cells, including the lymphocytes. When virus-containing lymphocytes leave the node they take virus with them to the blood stream, and so it becomes rapidly disseminated through the body. This mechanism of virus transport was first shown in the case of vaccinia. Viruses such as those of poliomyelitis were long thought to be exclusively neurotropic in their spread, but there is an increasing body of evidence to suggest that even with these viruses the lymphoid mode of dissemination may occur.

6. Lymphoid Tissue and the Endocrine System.—There exists only scanty information about the mechanisms by which the growth of lymphoid tissue is controlled. A good deal of attention has been directed toward the possibility of lymphoid tissue's being controlled through the endocrine system, more especially the adrenal glands. From the time when Thomas Addison (1855) first noted a lymphoid tissue hyperplasia in one of the 11 cases on which he based his description of the disease named after him, evidence has steadily accumulated to indicate a close connection between lymphoid tissue and the adrenal cortex. H. Selye (1937), in his first account of the adaptation syndrome. emphasized the role of the pituitary in stimulating the secretion of the adrenal cortex with resultant atrophy of the thymus. T. F. Dougherty and A. White in 1944 attributed an important role to the pituitary adrenotropic hormone in the regulation not only of the lymphocytes but also of the other cellular elements of the blood.

IV. DISEASES OF THE LYMPHATIC SYSTEM

A distinction must be drawn between. on the one hand, those conditions which primarily affect the lymphatic system, and, on the other, the reactions of the lymphatic system to disease of some other system or systems. Important in the latter connection is the role of the lymphatic system in edema and in the dissemination of tumours or bacteria. For information on these topics ***see*** CANCER; EDEMA; etc.

1. Lymphadenitis.— This disease, an inflammatory infection of lymph nodes, is characterized by hyperemia of. and exudation into, the lymph node, which becomes firmer. redder and enlarged. Three varieties may be distinguished: simple, suppurative and tuberculous. The cause is the arrest in the node of toxic or infective material, usually of viral or bacterial origin. This may occur in several of the acute infectious diseases, notably scarlet fever, diphtheria and German measles; and the infectious material may reach the lymph nodes either through the lymphatic vessels or from the blood stream. The lymph nodes of the neck are often enlarged, especially in children when chronic infection is present in the tonsils. In chronic infectious diseases such as syphilis and typhoid fever, many groups of nodes may be involved. Simple lymphadenitis usually subsides of its own accord if viral in origin, but it may progress to suppuration if the causal agent is pyogenic.

2. Tuberculous Lymphadenitis.— This is due to infection of the lymph nodes with the tubercle bacillus. Involvement of the draining nodes in this way is apt to follow tuberculous disease in any situation, as there is a particular tendency for the organisms to spread by the lymphatics. Thus, in pulmonary tuberculosis, the bronchial and mediastinal nodes are commonly involved in the process. Especially in young children. these nodes may become massively enlarged, even when the primary focus in the lung itself is small. In the neck there may be extensive involvement of many nodes with no obvious primary focus. In this case, although the matter has been considerably disputed, there is a good deal of evidence pointing to the tonsil as a common portal of entry.

Tuberculous disease is also not uncommon in the mesenteric lymph nodes. In this instance, the infection is from swallowed organisms. A sufferer from pulmonary tuberculosis may swallow some of his infected sputum instead of expectorating it, and so set up an intestinal and mesenteric infection. Afore important, however, is the abdominal tuberculosis resulting as a primary infection in children from the ingestion of milk from tuberculous cows.

The earliest manifestations of tuberculous lymphadenitis are an enlargement of the node and the formation within it of minute tubercles. It is possible in this stage for spontaneous healing to occur. but the disease often progresses to caseation, in which death of the tissue occurs and is followed by conversion of the dead material into a cheesy mass. This latter stage may end in calcification. but often the caseous material softens, so that the node may become a single abscess cavity. If left to itself, the "cold abscess" (as it is called) sooner or later penetrates the capsule of the node into the surrounding connective tissues. where it may track for some distance. In disease of the cervical nodes, the abscess may penetrate the skin at one or several points. through which the caseous contents are discharged. In diseases of internal nodes such as the mediastinal. the abscess may ulcerate into a blood vessel. with a resulting general dissemination of the disease. (See also TUBERCULOSIS.)

3. Lymphangitis.—In cases where an infective agent such as a hemolytic streptococcus is very virulent. there may be seen thin red lines in the skin tracking from the focus of infection (which may be quite trivial) toward the nearest group of lymph nodes. These lines indicate the spread of the organisms up the superficial lymphatics. The draining node may arrest the process, but in very severe cases localization of the infection may not occur, and organisms will then enter the blood stream.

4. Filarial Infestation: Elephantiasis.— A chronic lymphangitis occurs in filarial infestation. The adult worms, both male and female. live in the lymphatics. commonly those of the lower abdomen. pelvis or groin. The young microfilariae pass into the blood stream. The presence of the adult parasites in the lymphatic trunks causes obstruction. peripheral dilatation and irritation of the vessels. In certain cases the condition of elephantiasis may then supervene, possibly as a result of superadded infection. In the majority of such cases a lower limb is the part affected, (*See* also FILARIASIS.)

5. **Reticuloses.**—Mention has already been made of the diverse types of cells n-hich are present in lymphoid tissue. It is not surprising therefore that primary diseases of this tissue should present. as in fact they do present. a bewildering variety of appearances and behaviour. Particularly is this the case in the hyperplastic conditions, and especially so in neoplastic (tumorous) conditions, where there is often a marked tendency for the cells of the tumour to revert to more primitive types. In such a confusing group of diseases classification is difficult and at the best only provisional. Where knowledge is scanty, definite opinions cannot be expressed. Nevertheless. the term reticulosis. or reticulo-endotheliosis, has been introduced by pathologists to include any systematized overgrowth of lympho-reticular tissue. whether neoplastic or non-neoplastic. Included in this category are Hodgkin's disease (lymphadenoma), lymphosarcoma, reticulosarcoma, leukemia. the generalized lipoidoses. as well as the systematized lymphadenitis seen in syphilis, kala azar. malaria and typhoid fever.

6. Hodgkin's Disease **(Lymphadenoma).**—This disease, fully described by Thomas Hodgkin in 1832, is characterized by a progressive enlargement of the lymph nodes all over the body, generally starting in the nodes of the neck. The majority of cases occur in young adult males. The first sign is usually the enlargement of a node in the neck, followed by progressive growth of the nodes in the submaxillary region and axilla. The inguinal group is early involved. and the abdominal nodes later. The swellings are at first painless. but in the later stages of the disease symptoms occur as a result of pressure on surrounding organs. When the disease starts in the deeper groups of nodes. the first symptom may be pain in the chest and cough, or pain in the abdomen. or pain and edema in the legs. For a long time the-nodes remain discrete and rubbery. but in the latter stages of the disease they may become mntted together. In the majority of cases the spleen enlarges. Secondary anemia is common, slight irregular fever may be present; and eventually a great and progressive emaciation takes place.

The course of the disease is slowly and progressively fatal. In the early stages, treatment may cause rapid decrease in the size of the masses, but when the nodes have become fibrotic there is little response.

Microscopic examination of the nodes shows a gradual replacement of the normal architecture of the lymphoid tissue by larger cells of various types, including giant cells with several nuclei. Areas of necrosis often occur. There is a marked and characteristic increase of reticulum (shown by silver staining) and. in the later stages of the disease. of dense fibrous tissue, which may almost obliterate the proliferating cells.

7. **Reticulo-Sarcoma.**—This group comprises frankly malignant tumours of various types. including (among many others) those formerly classed as "lymphosarcoma" and the so-called "Hodgkin's sarcoma." They are, in general, more rapidly fatal than is Hodgkin's disease. and present a great variety of appearances and behaviour, in keeping with the multiple potentialities of the cell of origin (a relatively undifferentiated reticulo-endothelial cell) and the higher degree of malignancy. Although rare exceptions have been reported, overflow of the malignant cells from the lymphoid tissues into the blood stream does not occur. a feature which serves to distinguish these affections from leukemia.

8. Leukemia. — There are two main types of leukemia. namely, lymphatic and myelogenous. Lymphatic leukemia affects the lymph nodes most obviously. though it has been suggested that it may begin in the thymus. Myeloid leukemia is primarily a disease of the bone marrow, in which the enlargement of the lymph nodes is a secondary phenomenon due to the infiltration of the nodes by the proliferating myeloid cells. In chronic lymphatic leukemia the lymph nodes, liver and spleen become greatly enlarged. owing to the accumulation of great numbers of lymphocytes. In contradistinction to Hodgkin's disease, the nodes do not remain discrete, but soon become matted together. In addition, there is usually a great increase in the circulating lymphocytes of the blood. a phenomenon which does not occur in Hodgkin's disease or reticulo-sarcoma. More rarely the condition is acute, and in these cases the primitive lymphoblasts may be present in the blood. although the lymph nodes are only slightly enlarged. Death may occur in a few weeks in such cases.

The outcome of leukemia is inevitably fatal. after a long or short course. depending mainly on the acuteness of the process. Treatment directed to the bone marrow and lymphoid organs may arrest the process for a time. See also BLOOD; LEUKEMIA.

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LYMPHOGRANULOMA VENEREUM, a venereally acquired virus infection of lymph channels and nodes which may be manifested by ulcerations. rectal strictures and enlargement of lymph nodes and the genitalia. *See* VENEREAL DISEASES.

LYNBROOK, a village in Nassau county. on Long Island, N.Y., U.S., about 2 mi. E. of the New York city line. Primarily a residential community. Lynbrook also has light industry including electronic supplies. plastic buttons, hats, laboratory supplies and several mail order houses. The village was incorporated in 1911.

For comparative population figures see table in NEW YORK: *Population.* (M. *H.* LE.)

LYNCH, BENITO (1885–1951), Argentinean novelist and short-story writer, whose works examine the psychology of uncomplicated persons at everyday activities. was born in Buenos Aires in 1885, of Irish ancestry. From his second until his tenth year he lived on a cattle ranch in the province of Buenos Aires, gaining an intimate knonledge of rural life. Being of independent means, he preferred later to live quietly and do his writing in La Plata. He died in Buenos Aires on Dec. 23. 1951.

Lynch's first important novel. *Los caranchos de la Florida* (1916), although somewhat melodramatic. opened a modern phase of the gaucho novel in Argentina. In the major novels *Raquela* (1918), *El inglés de los güesos* (1923)—generally considered his best work—and *El romance de un gaucho* (1933), he gives a unique interpretation of country folk in Argentina, diverging from the usual dramatic or sensational myth of the gaucho and using a simple. ironic style. His art is intuitive rather than intellectual, and his general approach is that of realism. Lynch's skill in shorter forms is best shonn in the novelette *El antojo de la patrona* (1925) and the stories in *De los campos porteños* (1931).

See Arturo Torres-Rioseco, *Grandes novelistas de la América Hispana,* vol. i (1941). (A. Cs.)

LYNCHBURG, a city adjacent to but independent of. Campbell county in central Virginia, U.S., is located on the James river in the foothills of the Blue Ridge, 50 mi. E.N.E. of Roanoke. It was settled largely by Quakers in 1757 at a ferry established by John Lynch, after whom it was named. Despite its steep hills. it became a tobacco market of importance. Hogsheads of tobacco were rolled in from surrounding fields, lowered by ropes to the river below, and poled in flatboats to the tidewater at Richmond. Strict attention to grading made Lynchburg famous for its dark-leaf tobacco. which, flavoured with licorice, became a favourite chewing tobacco throughout the south.

The village was incorporated as a town in 1805, and by 1829 had grown into a bustling place of 4.630 inhabitants, with warehouses and stores. The importance of Lynchburg was enhanced by the construction of the James river canal in 1840 which enabled horse-drawn barges and packets loaded with freight and passengers to move between the town and Richmond. Canal traffic was gradually replaced by railroad transport in the 1850s. The town was incorporated as a city in 1852.

During the American Civil War it was an important Confederate supply base and link in communication between besieged Richmond and the west. After the war Lynchburg boomed. It acquired additional railroad connections and increased in population to 19,000 by the end of the 19th century. The city developed into a shoe and iron manufacturing centre and. although the change in smoking taste from dark to bright tobacco in the form of cigarettes shiited the centre of tobacco growing away from the red clay soils surrounding Lynchburg, the city continued to grow moderately. acquiring textile mills, garment factories and tool shops, Manufactures include drugs and cosmetics. hosiery, batteries. machine gears and steel products. Lynchburg was the home of Jubal Anderson Early, famous Confederate general. and John W. Daniel. orator and senator, and was the birthplace of Carter Glass. Samuel Untermyer and Robert L. Owen. authors of the Federal Reserve act (1913). It is the seat of Lynchburg college (affiliated with Christian Church and chartered 1903 as Virginia Christian college); Randolph-Macon Woman's college (Methodist. 1891) and Virginia Theological seminary and college (Segro, 1888). Sweet Briar college for women (private, 1901) is 11 mi. N.N.E. *Etude,* the music publication, was founded there by Theodore Presser in 1883. The Lynchburg Little Theatre dates from 1920.

The city adopted the council-manager form of municipal government in 1920. Pop. (1960) 54,790. (F. B. S.)

LYNCHING AND LYNCH LAW are terms loosely used to designate various forms of mob violence peculiar to the United States from the middle of the 18th century. The mob executes the offender, often also torturing him and mutilating his body, without trial and regardless of existing courts of law, under the pretense of administering justice. The origin of the terms is uncertain, but the commonly accepted explanation is that they derive from Charles Lynch, a Virginia farmer and patriot, who, during the American Revolution, headed an irregular organization formed to punish thieves, outlaws and Tories. *(See* Thomas Walker Page, "The Real Judge Lynch," in *Atlantic Monthly,* vol. lxxxviii [Dec. 1901].) The legal definition of lynching varies from state to state. but it includes the execution, without due process of law by three or more persons, of an individual suspected or convicted of a crime, or accused of an offense contrary to prevailing custom. Some states require that the lynch victim must have been in the hands of a peace officer before being seized by the mob.

The summary killing of an individual by a mob as a penalty for real or supposed crime has been practiced in all countries where unsettled conditions prevailed; and informal organizations of people have attempted to supplement or replace legal procedure by dealing with criminals outside the law. Hence American lynching is sometimes compared to such historic forms of private administration of criminal justice as the *Vehmgericht* in medieval Germany, the gibbet law and Cowper justice of border districts in England. the Jedburgh justice in Scotland, and the *Santa Hermandad* in Spain. Likewise the pogroms of Russia and Poland, and the treatment of Jews in Germany under Hitler in more modern times, are somewhat similar to lynching practices.

The English colonists in America were not slow to follow the old world practice of taking the law into their own hands, and mob law prevailed in the colonies prior to the Revolution. Examples are to be found in the extralegal organizations to punish Indian scalpers in New England; in the Rangers of Pennsylvania; in the Regulators of New York and North Carolina; and in the popular tribunals organized during the Revolution to mete out speedy punishment to robbers, bandits and Loyalists. Development of civil institutions did not keep pace with the westward expansion of population after independence had been gained, and the frontiersmen established agencies outside the law to deal aith horse thieves. gamblers, murderers and others who violated generally accepted standards of conduct. The region beyond the Appalachian mountains furnished many examples of lynch law. Frontiersmen demanded immediate and personal justice. They were impatient of legal forms and technicalities, and they chose to take the law in their own hands. The extralegal governments of the state of Franklin and the Oconee republic. and the extralegal organizations of Squatters associations in the midwest and vigilantes of California and the Rocky Mountain frontier played an important role in the development of the great west. But the disregard of law and order fostered by frontier conditions carried over into mob violence and lynching long after the frontier stage of society had ended.

Conditions in the southern states also fostered a lawless spirit. Frontier conditions persisted until after the Civil War, but far more significant was the prevalence of slavery and a growing sectional bitterness over the institution. Southerners exercised their absolute control over slave property by flogging even to death their refractory slaves. Later they resorted to mob violence with increasing frequency and severity against persons accused of tampering with slavery. Vigilance committees flogged, tarred and feathered and hanged abolition agitators and persons accused of aiding fugitive slaves. After the Civil War, southerners organized the Ku Klux Klan, the Order of the White Camellia and similar bodies which molested and frightened the former slaves out of the exercise of their civil rights and lynched untold numbers of Negroes. These practices carried over into the later south as did frontier practices in the west. But the south and the west held no monopoly on lynching. Only Massachusetts, New Hampshire, Rhode Island and Vermont have a clean record in this respect.

The victims of western lynchings were largely white men, although a few Negroes were lynched, and the major offenses aith which they were charged were murder and crimes against property. In the south lynching crystallized into a traditional method of summarily punishing Negroes for offenses, chiefly murder and rape, against whites. Some few whites were lynched in the south, and occasionally Negroes lynched white men.

Fairly reliable data on lynchings are available since 1882. Compiled largely at Tuskegee institute in Alabama and published in the annual *Negro Year Book,* these data show that, between 1882 and 1951, 4,730 persons were lynched in the United States Of these 1,293 were whites and 3.437 were Negroes. The crimes charged against the victims were: homicide 41%, rape and attempted rape 25.3%, robbery and theft 4.9%, felonious assault

4.3%, insult to whites 1.8%, and all others 22.7%. Between 1882 and 1901 the largest number lynched in any one year was 230, the smallest number 96; and between 1902 and 1935 the largest number lynched in any one year was 99, the smallest number was 8.

Gradually public criticism of mob violence brought about a reduction of lynching. Chief among the agencies effecting the decline were the National Association for the Advancement of Colored People, the Southern Commission on Interracial Cooperation, the Association of Southern Women for the Prevention of Lynching, and the Southern Regional Committee. Individual journalists and educational and religious leaders, both white and Negro, also played a prominent role in the movement. They worked to elevate the economic and social position of the Negro and to improve relations between whites and Negroes. They have emphasized the harmful consequences of lynching in debasing the reputation of the south, in brutalizing those who participate in lynchings, and in the general disrespect for law, order and human rights which lynchings tend to develop. All the southern states as well as several in the north and west have enacted legislation looking toward the punishment of those who participate in mob violence and lynchings. Between 1947 and 1959, 44 persons were indicted for participating in lynchings. One was convicted and sentenced to death, five were sentenced to life imprisonment, and others received shorter prison terms.

After 1935 the number of lynchings drastically declined. Between 1935 and 1952 only 61 lynchings were recorded; between 1947 and 1959 there were only 9 while 61 were prevented. The character of lynch mobs has also changed: mobs have become more secretive; there have been few or no spectacular man hunts; and mob leaders no longer boast that they serve race, tradition and justice.

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(F. M. G.)

LYNDHURST, JOHN SINGLETON COPLEY, 1ST BARON (1772–1863), lord chancellor of England, was born at Boston, Mass., on May 21, 1772, the son of John Singleton Copley, the painter. He was educated at an English private school and at Cambridge university, where he was second wrangler and fellow of Trinity college. Called to the bar at Lincoln's Inn in 1804, he gained a considerable practice and was raised to the dignity of serjeant-at-law in 1813. As one of the counsel for James Watson, tried in 1817 for his share in the Spa Fields riot, he so distinguished himself as to attract the attention of the Tory government, under whose patronage he entered parliament as member for Yarmouth, Isle of Wight. Later he sat for Ashburton (1818–26) and for Cambridge university (1826–27). He was appointed king's serjeant and chief justice of Chester in 1818, solicitor general in 1819 (with a knighthood), attorney general in 1824, master of the rolls in 1826, and lord chancellor in April 1827 (in George Canning's ministry), with the title of Lord Lyndhurst. In this latter capacity he was particularly acceptable to George IV on account of his anti-Catholic views; but in 1829 he supported the government's Catholic relief bill.

During this period it was unusual for the lord chancellor to retire on a change of government, unless it was a "total" change, as in 1806 and 1830. Lord Lyndhurst, the supremely successful careerist of his time, would have welcomed an invitation to remain in office under Lord Grey in Nov. 1830. However, political necessity compelled the Whigs to appoint Henry Brougham, and although Lyndhurst was made lord chief baron of the exchequer (1831–34), this did not prevent him from vigorously opposing the Whig reform bill. He was again lord chancellor in Sir Robert Peel's brief administration of 1834–35. During Lord Melbourne's ministry (1835–41) he figured conspicuously as an obstructionist in the house of lords. In these years it was a frequent practice with him, before each prorogation of parliament, to entertain the house with a "review of the session," in which he mercilessly attacked the Whig government. His former adversary Lord Brougham, disgusted at his treatment by the Whig leaders, soon became his most powerful ally in opposition, and the two dominated the house of lords. In the Peel administration of 1841–46 he resumed the office of lord chancellor for the last time. As Peel never had much confidence in Lord Lyndhurst, the latter did not exert so great an influence in the cabinet as his position and experience entitled him to do. But he continued a loyal member of the Tory party. He died in London on Oct. 12, 1863.

Of Lord Lyndhurst as a judge opinions have differed; there is authority, including Lord Selborne himself, for the view that he was not a just chancery judge. His heart was not in the business. But the qualities of a just chancellor in those days were of a very special order, and in the house of lords he was more at home, though the estimate must stand that he was "a judge for the parties rather than a judge for the lawyers." His greatest moment in the house of lords was his success in averting what would have been a disastrous precedent—the attempt of lay members to vote in an appeal to the house of lords, theoretically permissible, but a violation of a strict constitutional understanding (Daniel O'Connell's case, Sept. 4, 1844).

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(A. AL.)

LYNDSAY, SIR DAVID (*c.* 1485–*c.* 1555), Scottish poet, and author of *Ane Satyre of the Thrie Estaits,* the only surviving Scots morality play, was the son of David Lyndsay of the Mount, near Cupar-Fife, and of Garmylton in East Lothian. He may have been at St. Andrews *c.* 1508. Entering the service of James IV, he became usher to the infant prince born in 1512, and married Janet Douglas, a court seamstress, *c.* 1522. Dismissed from court in 1524, when his charge, now James V, fell under the control of the Douglas faction, he returned to the king's service four years later. He acted as chief herald from *c.* 1530, and became Lyon king of arms in 1542. His duties took him on several missions overseas. In 1531 he accompanied a Scottish ambassador to Flanders, in 1536 he went with the royal envoys to France to negotiate a marriage alliance and after James's death in 1542 he went to the courts of Henry VIII, Charles V and Francis I, to return orders conferred on his master. Little is known of his last years.

Most of his verse, with a work on heraldry, was written during his prosperous years at court. It survives as follows:

(1) *The Dreme;* 1,134 ll. (?1528) is a vision of John Commonwealth and the ill-condition of Scotland, written in an old tradition, with a delightfully personal epistle to the king. This is his earliest surviving, though probably not his first, work in verse; he reminds James of the many stories he had "done discryve" for him in the nursery.

(2) *The Testament and Complaynt of Our Soverane Lordis Papyngo* (completed Dec. 1530; stanzaic, 1,185 ll.), is a mixture of satire, comedy and moral instruction. The king's parrot, dying, gives advice to king and court and makes its testament. This poem again illustrates Lyndsay's preoccupation with mutability and with the corruption of the commonweal. The prologue contains a valuable catalogue of Scots poets.

(3) *An Answer quhilk Schir David Lyndsay maid to the Kingis Flyting* (?1536) is a short and ribald example of the satirical *genre* best illustrated by William Dunbar and Walter Kennedy (*qq.v.*) and apparently popular at court. James V's contribution has not survived.

(4) *The Complaynt and Publict Confessioun of the Kingis Auld Hound callit Bagsche* (*c.* 1536) is a short didactic piece, satirizing court life through the mouth of the dog—a device used by Dunbar and others and revived by Robert Burns.

(5) *The Deploratioun of the Deith of Quene Magdalene* (1537).

(6) *The Justing betuix James Watsoun and Jhone Barbour Servitouris to King James the Fyft* is a burlesque description of a jousting said to have been part of James's wedding celebration in

1538. again in a traditional mode.

(7) *Kitteis Confessioun* and (8) *Ane Supplicatioun directit to the Kingis Grace in Contemptioun of Syde Taillis,* both of uncertain date, are short satires in couplets. The first is an attack, in a comic framework, on the confessional; the second calls for the abolition of the absurdly long trains then in fashion among women.

(9) *The Tragedie of the Cardinall* (1547) is a rather tedious piece of moralizing on the pattern of Boccaccio's *De Casibus Virorum Illustrium* (434 ll.).

(10) *The Historie of Ane Nobill and Vailyeand Squyer, William Meldrum* (written after 1550) is a vigorous tale of love and war, celebrating, in the romance tradition, the heroic life of a Fifeshire laird (1,594 ll. in 8-syllable couplets), with a pendant fictitious testament (36 stanzas). This is the liveliest and most nearly nondidactic of Lyndsay's poems, and the last and most original of Scottish romances.

(11) *Ane Dialog betuix Experience and ane Courteour of the Miserabyll Estait of the World* (?1553; 6,333 ll.), commonly known as the *Monarche,* is a universal history from the Creation to the fifth (papal) empire, with a view of the last judgment, in four books. Stanzaic complaints are inset in the couplet narrative. The matter of the poem is drawn mainly from such authors as Josephus and Orosius, and is its only attraction. The style is flat, and the solemnity of tone is seldom relieved.

(12) *Ane Satyre of the Thrie Estaits* is the only complete Scots morality play to survive. It began as an interlude of "the mysdemeanours of Busshops Religious persones and preists within the Realme." written for the feast of the Epiphany at Linlithgow palace in 1540. Enlarged, with a deal of coarse comedy, it was performed at Cupar, Fife, on June 7, 1552; and again on the slopes of the Calton hill, Edinburgh, on Aug. 12, 1552, before the queen regent "and ane greit part of the Nobilitie . . . fra .ix. houris afoir none, till .vi. houris at euin." It is a dramatic representation of the crucial issues of the mid-century in religion, government and social life, with all Scotland crowded on the stage. Some of the long didactic speeches are nobly rhetorical; the comic passages are written in a strong, colloquial Scots. There is something here for every class of society; each is mirrored, admonished and entertained. Lyndsay draws freely from a range of poetic genres: sermon, farce, debate, satirical "character," and song. The perennial interest and power of the Satyre was revealed by the brilliant revival at the Edinburgh festival of 1948.

BIBLIOGRAPHY.—*Manuscripts: Ane Dialog* survives in a manuscript at Lambeth palace, London; the Bannatyne manuscript (1568), in the National Library of Scotland, contains the "banns" and the "mirry Interludis" of the version of the *Satyre* performed at Cupar; *The Register of Arms* (1542; published 1821, 1878), an authoritative document on Scottish heraldry, in the National library oi Scotland.

Editions: Most minor pieces were included in the Paris (1558) or Edinburgh (1559, 1568) editions; the *Papyngo* was first published in London in 1538 (there may have been an earlier edition), *Ane Dialog* at St. Andrews (1554), *The Historie of Squyer Meldrum* at Edinburgh (1582; earliest surviving edition, 1592) and *Ane Satyre* at Edinburgh (1602); H. Charteris published a collected edition at Edinburgh (1569). The first critical editions are by F. Hall, J. Small and J. A. H. Murray, for the Early English Text Society, 5 parts (1865–71), and by D. Laing, 2 vol. (1871); 3 vol. (1879). The standard edition is by D. Hamer, for the Scottish Text Society, 4 vol. (1931–36). Modern editions of single works are *Ane Satyre of the Thrie Estaits,* by J. Kinsley (1954), with a critical discussion by A. M. Mackenzie and an account of the 1948 revival by I. Brown; *The Historie of Squyer Meldrunz,* by J. Kinsley (1959), with critical discussions.

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LYNEDOCH, THOMAS GRAHAM, 1ST BARON (1748–1843), British general. was born on Oct. 19, 1748. Graham was traveling in the Mediterranean when he fell in with Lord Hood's fleet on its way to Toulon. He joined it as a volunteer, served on Lord Mulgrave's staff during the British occupation of Toulon, and returned, after the failure of the expedition, to Scotland, where he organized a regiment of infantry, the 90th Foot, Perthshire Volunteers (now 2nd Battalion Scottish Rifles). Graham's men were the first regiment in the army to be equipped and trained wholly as light infantry. In the same year (1794) Graham became member of parliament, in the Whig interests, for the county of Perth. He saw some active service in 1795, being then a brevet colonel; in 1796 he was appointed British commissioner at the headquarters of the Austrian army in Italy. He sat for Perthshire in parliament until the year 1807. Graham was with Moore in Sweden in 1808 and also in Spain from 1808 to 1809. In 1809 he became a major general, and after taking part in the disastrous Walcheren expedition he was promoted lieutenant general and sent to Cadiz (1810).

In 1811, acting in conjunction with the Spanish army under General la Peña (*see* PENINSULAR WAR), he took the offensive, and won the brilliant action of Barossa (March 5). The victory was made barren of result by the timidity of the Spanish generals. After refusing with contempt the offer of a Spanish dukedom, he resigned his command in the south and joined Wellington in Portugal. He took part in the siege of Ciudad Rodrigo, and commanded a wing of the army in the siege of Badajoz and the advance to Salamanca. In July 1812, his eyesight becoming seriously impaired, he went home, but rejoined in time to lead the detached wing of the army in the wide-ranging maneuvre which culminated in the battle of Vittoria. Graham captured San Sebastian (Sept. 9, 1813). He then went home, hut in 1814 accepted the command of a corps to be dispatched against Antwerp. His assault on Bergen op Zoom mas, however, disastrously repulsed (Feb. 3, 1814). At the peace Graham was created Baron Lynedoch of Balgowan in the peerage of the United Kingdom. He died at London on Dec. 18, 1843.

LYNN, a city of Essex county, Mass., U.S., on the northern shore of Massachusetts bay. 11 mi. N.E. of Boston.

In 1629 Edmund and Francis Ingalls came south from Salem into the Indian territory of Nahanteau and established a settlement called Saugus. It was organized as a village in 1631, and in 1637 was renamed after Lynn Regis (King's Lynn) in England, the home of the pastor. It was incorporated as a city in 1850.

Lynn harbour was not particularly good and many of the pioneers turned to farming, but the beginnings of industry appeared very early. The first smelting works in America was built there in 1643, several tanneries were established during the same period, and shoemaking, beginning in 1635, had by the middle of the 18th century brought prominence and prosperity to the town. A century later, the introduction of the sewing machine and steam power led to the development of the factory system, an influx of immigrant workmen and Lynn's emergence as the foremost shoe centre in the country.

During the 1930s shoe manufacture declined in importance and by the second half of the 20th century electrical machinery and transportation equipment had become the principal manufactures. Pop. (1960) 94,478. (L. G. BA.)

LYNTON and **LYNMOUTH,** seaside villages in the Lynton urban district (pop., 1951, 2,120) of Devon, Eng., on the Bristol channel; they lie about 17 mi. N.E. of Barnstaple. Both are summer resorts. Lynmouth is at the mouth of the East and West Lyn rivers, while Lynton is on the cliff top 500 ft. above. The villages are situated approximately in the centre of the Exmoor National park in which is the Doone valley, made famous by R. D. Blackmore's novel *Lorna Doone;* a part of the valley of the East Lyn (owned by the National Trust), here called Badgworthy water; and Watersmeet, where two streams, the East and West Lyn, join. In Aug. 1952 the little Lyn, swollen by rains, changed course and ravaged Lynmouth, killing 31 persons. There are some prehistoric remains near Castle rock, Lynton.

LYNWOOD, a residential city of Los Angeles county. Calif., is S.E. of Los Angeles. Its origin dates from the building of the Lynwood dairy in 1896, the land being part of an early Spanish grant, the Rancho San Antonio. Actual development began in 1913 when the opening of an 800-ac. subdivision followed completion of the Pacific Electric railway.

Lynwood has over 100 small industries within the city limits. but a majority of the residents are employed in the surrounding metropolitan area. Schools from kindergarten through high school are combined in a single unified district. The city has a 400-bed hospital, a large civic centre, completed in 1957 and a swimming pool built to Olympic specifications. Incorporated in 1921, Lynwood established the council-manager form of government in 1945. For comparative population figures see table in CALIFORNIA: Population. (R. C. GM.)

LYNX, a genus of mammals of the family Felidae (see CARNIVORA). Lynxes are found in the north temperate regions of both the old and new worlds; they are smaller than leopards and larger than true wildcats. with long limbs, short stumpy tail, ears tufted at the tip and pupil of the eye linear when contracted. They have extraordinary powers of vision. Their fur is generally long and soft, and always longish upon the cheeks. Their colour is light brown or gray, with generally darker spots. Their food consists of any mammals or birds which they can overpower. In Canada the number of lynxes is governed each year by the number of hares; their chief diet, produced the previous year. They frequent rocky places and forests, being active climbers and passing much of their time among the branches of the trees. Their skins are of considerable value in the fur trade. The northern lynx (L. *lynx*) of Scandinavia, the U.S.S.R., northern Asia and until relatively recently of central Europe inhabited Britain during the Pleistocene age. The pardine lynx (L. *l.* pardinus) from southern Europe is handsome, rufous above and white beneath. Several lynxes are found in North America; the most northerly is the Canadian lynx (L. *canadensis*); the bay lynx (L. *rufus*), with a rufous coat, ranges from southern Canada south to Mexico and lower California.

LYON, MARY (MASON) (1797–1894), U.S. educator and pioneer in the field of higher education for women, was born on Feb. 28. 1797, on a farm near Buckland, Mass. She began to teach when she was 17, and in 1817, with earnings from spinning and weaving, she went to Sanderson academy, Ashfield, where she was distinguished by her extraordinary mental quickness. She supported herself there and at the other academies she attended by teaching, her desire to acquire and impart learning seeming insatiable. Her success as a teacher and administrator and the demand for the young women she trained led to her plan for "a permanent institution consecrated to the training of young women for usefulness . . . designed to furnish every advantage which the state of education in this country mill allow . . . to put within reach of students of moderate means such opportunities that none can find better." She was aided in this effort by Edward Hitchcock, the geologist, with whom she had studied. This assistance, reinforced by her own enthusiasm and practical common sense, secured for her plan the necessary financial support. In 1835 a site was selected near the village of South Hadley and Mt. Holyoke. The school was incorporated in 1836 as Mt. Holyoke Female seminary; and on Nov. 8, 1837. it opened with Mary Lyon as principal and Eunice Caldwell, afterward well known as Mrs. J. P. Cowles of Ipswich academy, as assistant. Miss Lyon died at Mt. Holyoke on March 5, 1849. having served nearly 12 years as principal of the seminary. Her work at Mt. Holyoke represented an important step in the higher education of women.

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LYON, NATHANIEL (1818–1861), U.S. soldier during the early phase of the American Civil War. was born in Ashford, Conn., July 14. 1818. After graduating from the U.S. Military academy in 1841 he was assigned to fighting the Seminole Indians in Florida. He served in the Mexican War. and after spending several years in California was sent to "Bleeding Kansas" in 1854. He joined the Republican party and wrote several articles for the *Manhattan* (Kans) Express attacking Buchanan and Douglas and supporting Abraham Lincoln. Lyon was transferred to St. Louis on Feb. 6. 1861. He immediately got in touch with Francis P. Blair. Jr., and other leading Gnionists in that city. After Blair's intercession. Lyon was placed in command in eastern Missouri. He seized the Confederate base at Camp Jackson on May 10, 1861, and began the arming of Union volunteers. He took part in a final attempt at compromise, meeting with Blair, Maj. Gen. Sterling Price and the secessionist governor, Claiborne F. Jackson. at the Planters hotel. The attempt failed and Lyon commented upon its conclusion. "This means war." On June 13, Lyon moved up the Missouri river with 2,000 regulars, capturing the Missouri capital at Jefferson City, June 15, and Boonville, June 17. He followed the Confederate forces into southwestern Missouri, finally bringing them into battle at Wilson's creek, Aug 10. Although Lyon himself was killed and his forces defeated, his prompt actions in eastern and central Missouri were a large factor in saving that state for the Union. See also MISSOURI History. (J. M. WO.)

LYONIA, a genus of evergreen or deciduous shrubs of North America and Asia, belonging to the heath family. They have alternate, short-petioled leaves and white or pinkish flowers in axillary clusters or racemes or panicles. Three species are common in the eastern United States and may sometimes be grown as ornamentals. these are, male berry or he-huckleberry (L. *ligustrina*), a deciduous shrub to 12 ft.. bearing oval leathery leaves, occurring from Maine to Florida. fetterbush (L. *lucida*), an evergreen nith lustrous leaves, to 6 ft. high, found from Virginia to Florida, and staggerbush (L. *mariana*). a deciduous shrub to 6 ft.. found from Rhode Island to Florida. (J. M. BL)

LYONNAIS, THE, a former province or *gouvernement* of France, bounded on the north by Burgundy, on the east by the Saône and Rhône rivers (separating it from Dombes and from Dauphiné), on the south by Languedoc and on the west by Auvergne and by the Bourbonnais and comprising not only the pays of the Lyonnais proper (the hinterland of Lyons, *q.v.*) and of the Franc-Lyonnais (around Vimy, now Neufville-sur-Saône) but also those of the Beaujolais and of Forez (taken by Francis I from the constable-duke of Bourbon). It is now divided between the *départements* of Rhône and of Loire.

LYONNESSE, LYONESSE, LEONNOYS or LEONAIS, a legendary country off the south coast of Cornwall. Eng. Lyonnesse is the scene of many incidents in the Arthurian romances, and especially in the romances of Tristan and Iseult. It also plays an important part in Cornish tradition and folklore. Early English chronicles, such as the *Chronicon* e *chronicis* of Florence of Worcester (d. 1118), described minutely and without a suggestion of disbelief the flourishing state of Lyonnesse and its sudden disappearance beneath the sea. The legend may be an exaggerated version of some actual subsidence of inhabited land.

LYONNET, PIERRE (1707–1789), Dutch naturalist and insect anatomist, was born at Maastricht, Holland, on July 22, 1707, and after being trained as a lawyer, devoted most of his time to engraving objects of natural history. He made the drawings for Lesser's Theology *of* Insects (1742) and for A. Trembley's treatise on hydra, *Mémoires pour servir à l'histoire d'un* genre de *Polypes d'eau douce* (1744). Finally he produced a monograph on insect anatomy published in 1760 under the title *Traité anatomique de* la Chenille *qui ronge* le bois de *Saule*. He engraved his own figures on copper. and his drawings are remarkable not only for their skill but also for the extraordinary amount of detail shown. He distinguished no fewer than 4.041 separate muscles in the caterpillar of the goat moth and showed the nerves and tracheae in a manner never previously attempted. The extraordinary character of these dranings caused a sensation. and Lyonnet was accused of using his imagination. In a second edition, published in 1762, Lyonnet ansnered his critics by giving drawings of his instruments and a description of his methods. His monograph remains one of the most beautiful accounts of insect anatomy ever published. He died at The Hague on Oct. 10. 1789. Notes and drawings intended for a *Recueil historique*, illustrated by 54 plates dealing with various insects were published in the *Mémoires du Musée d'Histoire naturelle* (1829–32). (ED. HE.)

LYONS, SIR JOSEPH (1848–1917), British businessman, was born in London on Sept. 29, 1848, and educated at a Jewish school. In early life he studied painting and exhibited at the Royal institute, but by 1886 he had turned to business enterprises, in conjunction with the brothers Isidore and Montague Gluckstein. This led to the foundation of the catering firm of J. Lyons and Co., Ltd., of nhich he became chairman. He began by catering at public exhibitions, and next opened teashops in London, the first in 1894. Twenty years later these numbered more than 200 and provided inexpensive food for the large numbers of clerical workers and junior members of professions. Later he opened several restaurants of a more ambitious nature. as well as hotels, on the no-tipping principle. He was knighted in 1911, and died in London on June 22, 1917.

LYONS, RICHARD BICKERTON PEMELL LYONS, 1ST EARL (1817–188j), British diplomat. elder son of the first Lord Lyons (see above), was born at Lymington, Hampshire, on April 26, 1817. He was educated at Winchester and Christ Church, Oxford, and entered the diplomatic service as attaché to his father at Athens, in 1839. He served at Dresden, Florence and Rome, in turn, and went to Washington. D.C.. as British minister in 1859, remaining until 1865. During the Civil War his tact helped to prevent an Anglo-American war from arising out of the arrest of Confederate envoys on the British mail steamer "Trent." After a brief spell as ambassador at Constantinople, he succeeded Lord Comley in 1867 at the Paris embassy, where he remained for 20 years. Emperor Napoleon III trusted him, and he took part in the secret and fruitless disarmament negotiations early in 1870.

An exceptionally able and judicious public servant, Lyons had the rare gift of making no enemies, and enjoyed the full confidence of successive governments in London and Paris alike, even when French opinion was as intensely inflamed against Great Britain as it was in the early days of the British occupation of Egypt and during the Boulanger crisis. In-1886 he refused an offer from Lord Salisbury of the foreign secretaryship, as his health was giving way. He had succeeded to the barony in 1858, and was advanced to a viscountcy in 1881 and an earldom in 1887; as he never married, and his brother had been killed in the Crimea, his titles became extinct on his death in London on Dec. j, 1887.

See Lord Newton, *Lord* Lyons, 2 vol. (London, 1913).

(M. R. D. F.)

LYONS, the chief town of the *département* of the RhBne, France, the seat of an archbishop and the headquarters of a military region, lies 319 mi. S.E. of Paris and 219 mi. N. of Marseilles by rail. Sheltered by the foothills of the Massif Central to the west and by the southern heights of the Jura mountains to the northeast, Lyons is situated at the confluence of the Rhône and Saône, on the narrow peninsula between the rivers and on their opposite banks. Pop. (1954 census) 462,657.

The contrasting heights of the hills on which the city is built, varying from 450 to over 1,000 ft., give Lyons an unusually picturesque appearance. The summit of Fourvière on the right bank of the Saône is reached by funicular railway and offers the best view of the whole town—of its rivers, its 27 bridges, and roofs of pinkish tiles. At Fourvière (Forum *vetus*) excavations begun in 1933 have revealed a theatre of the Graeco-Roman type and an odeum (for musical contests) of the 1st and and centuries A.D. The hill, covered with convents and hospitals, is dominated by the church of Notre Dame de Fourvière. This modern basilica (1894), with its elaborate marble and mosaic decoration, is a place of pilgrimage. Close by, a metal tower 262.5 ft. high, built in 1893, supports the television aerials. Bordering the right bank of the SaBne, "Old Lyons," grouped around the cathedral, is an extraordinary accumulation of medieval and Renaissance buildings having great windows and inner courtyards with galleries and turrets. The cathedral, dedicated to St. John the Baptist, was built between the 12th and 15th centuries. Its apse is a masterpiece of Lyonnais Romanesque; the Gothic nave dates from the 13th and 14th centuries as does the fine stained glass in the choir; there is some remarkable carving on the west front. At the northern point of the Fourvikre promontory is the church of St. Paul with its octagonal lantern tower dating from the 12th century. The exchange (by J. Soufflot), now a Protestant church, and the archbishop's palace (since 1911 housing the municipal library) are both 18th-century buildings. The ponderous law courts are of the following century. On the peninsula, among buildings of diverse styles, traces of the old medieval city can be seen here and there. The Romanesque porch of St. Pierre-des-Terreaux and the oldest church in Lyons, St. Martin d'Ainay (1107), are examples. The straight roads running from north to south on the peninsula, Rue Victor Hugo, Rue de la République and Rue de l'Hôtel de Ville, since 1958 renamed Rue Président Herriot, which carry much of the business traffic, were constructed in the latter half of the 19th century. To the north is the hill of Croix Rousse with the tall houses of the silk weavers. and at its summit the baroque church of St Bruno-des-Chartreux. The 17th-century group of buildings around the Place des Terreaux is particularly beautiful, especially the *hôtel* de *ville*, begun in 1646 by the Lyonnais Simon Maupin, one of the masterpieces of French civic architecture, and the palace of St. Pierre, formerly a Benedictine abbey, built between 1659 and 1685 in the Italian baroque style. In front of the *hôtel* de *ville* is a fountain designed by the 19th-century sculptor, F. A. Bartholdi. The churches of St. Nizier and St. Bonaventure are Gothic buildings of little interest. The opera house, the Bourse and the Théâtre des Célestins, built in the 19th century, are also in this district. Facing the RhBne between the Wilson bridge and the La Guillotikre bridge is the 17th-century Hôtel Dieu for which Soufflot designed the façade in the following century. The Bellecour quarter is characterized by elegant 18th-century hotels and buildings. From the Place de Bellecour, with its equestrian statue of Louis XIV, the Rue Victor Hugo leads via the Place Carnot to the Perrache quarter with its docks, hostels and warehouses. This district, at the southern tip of the peninsula, was named after the most famous of the 18th-century engineers who worked to extend the confluence farther south.

East of the RhBne are the new districts of Lyons with busy streets and broad shady embankments. There are the university and the prefecture, and also the wealthy residential quarter built around the large park of La Tête d'Or, in which are a lake, a zoological collection and fine botanical gardens. Farther east are the manufacturing suburbs of Villeurbanne and Montchat where the industrial outskirts are constantly extending into the plain of Dauphiné. The university which, although the newest in France, is the most important after Paris, has a veterinary school founded by C. Bourgelat in 1762 (the oldest in the world). Mention should also be made of the Central School of Lyons (1857), the dental school, the Institute of Industrial Chemistry (1883), the Military Medical school and the National Institute of Applied Science, which was opened in 1957. In addition to the university library, there is the municipal library possessing a fine collection of books, manuscripts, incunabula, prints and engravings. The most important of the city's 21 museums are: the museum of fine arts in the Palais St. Pierre, where Perugino's altarpiece, works of the 19th-century Lyonnais school and a fine picture of the Tahiti period by Paul Gaugin are among the chief treasures; the museum of textiles and the museum of decorative arts in the 18th-century houses of the Rue de la Charité, where the history of the weaving industry is illustrated; the historical museum in the old Hôtel de Gadagne, a hich contains an international collection of marionettes; the Guimet museum (natural history); and the museum of printing in the former medieval town hall.

Transport and Communications.— Situated on the banks of two rivers and guarded by the surrounding hills, Lyons naturally commands a number of routes: to Paris by the valley of the SaBne, across Burgundy to the Rhine, to Switzerland and Italy by the upper RhBne, westward through the valley of St. Étienne and to the Mediterranean by the corridor of the lower RhBne. Since the beginning of its history, Lyons has owed much of its prosperity to river traffic. In spite of the junction of road and rail routes, three harbours are in use, and shipping in these doubled between 1926 and 1955. In the latter year shipping on the Saône (connected by canal with the basins of the Loire, Seine and RhBne) amounted to 3,000,000 tons, while cargo carried by the RhBne barges is annually 1,000,000 tons. Roads from east to west across the dividing peninsula are connected by no fewer than 27 bridges. The problem of traffic in this direction has been made easier by the tunnel of the Croix Rousse, the longest road tunnel in France (5,748 ft.), connecting the Delattre de Tassigny bridge on the RhBne to the Clemenceau bridge on the SaBne. Trunk roads to Paris and Marseilles were planned in the 1950s.

The first railway in France to use a steam engine was built between St. Étienne and Lyons (1826–33), and the great Paris-

Lyons-Mediterranean line was built in 1850. Since the electrification of the line. some of the fastest trains in the world run between Paris and Lyons, which is also a main-line station for Switzerland and Italy. Other lines connect Lyons with Brittany, Alsace and Languedoc.

Air services operate from the aerodrome of Bron, the first to be built in France (1929). It was destroyed in World War II, but was later reconstructed and steadily improved. Apart from daily services with Paris. most flights are to North Africa.

Industries. — Since the 15th century, Lyons has been the centre of a silk industry originally derived from Italy. The monopoly was granted to the city in 1450 by Charles VII and under succeeding royal patronage the industry developed rapidly. The "Grande Fabrique" was the most important source of the city's prosperity until the 19th century. The designs were made by artists such as Philippe de la Salle but the work was done by the local weavers in the town and surrounding countryside. The invention of the weaving loom by J. M. Jacquard (1752–1834) gave a new impetus to the industry. In the mid-19th century more and more silk-weaving factories were established in the southeast, but, nevertheless, Lyons remained the controlling centre for the silk trade of the world. The manufacture of chemicals, dyes and synthetic fibres has developed largely to meet the silk industry's requirements. and Lyons' chemical industries are second only in importance in France to those of the Paris region. Industries allied to that of silk produce mineral and vegetable colouring matters, gelatin, glue. fertilizers and pharmaceutical and plastic products.

The metal industry is the most important, however, employing in the Rhône *département* 70,000 workers (late 1950s) in mechanical construction and motor and electrical engineering. The electric cables of Lyons are world famous and there are sheet-iron works. foundries and wire mills. In 19j6 the output of Lyons represented 4.5% of the total output of the country and 8% excluding Paris.

History. — The earliest Gallic people who occupied the territory at the river confluence were Segusians. In Oct. 43 B.C. Lucius Munatius Plancus, Julius Caesar's lieutenant, founded a colony, Copia Lugdunum, on the hill above the confluence. The importance of the site as a node of communications had turned Lyons into a political centre by the 2nd century. Five great roads radiated from it, toward Aquitaine, the Atlantic. the Rhine, Italy and the Mediterranean; three towns surrounded it, the Roman Fourvière. the Gallic Condate on the slopes of the Croix Rousse, and the settlement of boatmen and merchants on the Isle of Ainay.

Augustus and Caligula lived at Lugdunum and the emperors Claudius. who gave Roman citizenship to the Lyonnese, and Caracalla were born there. In the 2nd century Christianity reached Lyons. In 177 its Christian community was persecuted by hlarcus Aurelius and in 197 the city was burned and ravaged by Septimus Severus. so that by the jth century it was no more than the chief town of a province of Gaul.

The barbarian invasions preceded the coming of the peace-loving Burgundians who made Lyons their capital in 470. Under the Franks. churches and monasteries were built by the bishops. In 1032 Lyons was incorporated into the Holy Roman empire under Conrad II. having previously been the chief town of the kingdom of Provence and then of part of Burgundy. The real power lay with the archbishops and under their authority two ecumenical councils were held there, one in 1245 when Innocent IV deposed the emperor Frederick II. and one in 1274 when Gregory X proclaimed the reunion of the Greek and Latin churches. In 1305 Clement V. the first pope of Xvignon, and in 1316 John XXII. both Frenchmen. were crowned popes at Lyons. The Lyonnese. having revolted against their prince-archbishop, appealed to Philip the Fair who. in 1312, annexed the town to the French crown. From then on it was administered by 12 elected consuls.

Lyons remained faithful to the king during the Hundred Years' War. Louis XI granted it the privilege of four annual fairs in 1463 and in the 16th century it entered into its most prosperous period. During the wars with Italy Lyons was the seat of the court and the government. the wealth of its merchants. bankers and printers, and the work of its writers and poets. such as Louise Labé and Maurice Scève (*q.v.*), made it, in fact, the political and literary capital of France and the biggest commercial and financial centre. This prosperity was lost during the wars of religion. the Protestant occupation of 1j62 and the Lyonnese massacres of St. Bartholomew of 1jjz. Held in check by the absolute monarchy, Lyons once again became no more than the chief town of the united province of Lyons. Beaujolais and Forez.

At the time of the Revolution the town was suffering from an economic crisis. It was besieged by the army under Gen. F. C. Kellermann from Aug. 8 to Oct. 9, 1793, and was forced to surrender to the republicans. It was condemned to partial destruction and to the loss of its name for that of "*commune-affranchie*," and 2.000 of its citizens were guillotined or shot. Under the first empire its prosperity returned. The wretched condition of the working classes provoked the risings of 1831. 1834 and 1849.

The 20th century saw the steady urban and industrial expansion of the city. An annual international sample fair was first staged in 1916 by Édouard Herriot. the city's most illustrious mayor (from 1905 to 1957), who became prime minister and president of the national assembly. Under German occupation (1940–44) in World War II, Lyons was the headquarters of the French resistance movement and, in its region alone, 5,000 people were executed by the Gestapo.

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LYONS, COUNCILS OF. The first Council of Lyons met at the summons of Pope Innocent IV in June and July of 1245 to deliberate on the conflict between Church and emperor, on the assistance to be granted to the Holy Land and the eastern empire, on measures of protection against the Tatars and on the suppression of heresy. Among these tasks the most important, in the eyes of the pope, was that the Council should lend him effectual aid in his labours to overthrow the emperor Frederick II. The condemnation of the emperor was a foregone conclusion and the objections of the emperor's representative, Thaddeus of Suessa, that the accused had not been regularly cited, that the pope was plaintiff and judge in one, and that therefore the whole process was anomalous, achieved as little success as his appeal to the future pontiff and to a truly oecumenical council. On July 17 the verdict was pronounced by Innocent IV, excommunicating Frederick and dethroning him on the grounds of perjury, sacrilege, heresy and felony.

All oaths of fealty sworn to him were pronounced. null and void, and the German princes were commanded to proceed with the election of a new sovereign.

See J. D. Mansi, *Collectio conciliorum* (1759, etc.) tom. xxiii; C. G. Hefele, *Conciliengeschichte,* and ed., vol. v, pp. 1,105–26 (1886); Fr. W. Schirrmacher, *Kaiser Friederich der Zweite* (Gottingen, 1859–65); A. Folz, *Kaiser Friedrich II. u. Papst Innocenz IV.* (Strasbourg, 1905).

The second Council of Lyons met from May 7 to July 17, 1274, under the presidency of Pope Gregory X. Its chief result was the regulation that future elections to the papacy should be held by the college of cardinals in conclave (*q.v.*). It is also important through the appearance of representatives of the eastern emperor Michael VIII. who acknowledged the supremacy of the pope over the eastern Church.

See J. D. Mansi, op. *cit.*, tom. xxiv; C. G. Hefele, *op. cit.*, vol. vi p. 119 *seq.*

LYOT, BERNARD FERDINAND (1897–1952), French astronomer, famous for his invention of the solar coronagraph, who started his researches in the 1920s with measurement of polarization of light from the moon and planets, using a new sensitive polarimeter constructed by himself, was born in Paris on Feb. 27, 1897. He showed that the moon's surface behaves as though covered with a layer of dust, that Mercury can have at most a very tenuous atmosphere, that polarization from Mars is sometimes affected by haze or dust and that there are irregularities over the Martian south polar cap, attributable to the formation of clouds. Venus was found to be covered by a continuous cloud layer composed of droplets of diameter about 2μ and of refractive index near that of water.

In 1931 Lyot successfully observed the solar corona in broad daylight, an achievement at that time generally regarded as impossible, using a new form of telescope, much of which he carried to the summit of the Pic du Midi himself, on skis. Two years later he perfected a polarizing filter, of the type now known by his name, permitting single exposure monochromatic photography of the whole sun in a band width about one Angstrom. During the 1930s he measured day-to-day changes in the solar corona, particularly in the light of the 5,303 and 6,374& lines, and also added much to our knowledge of the coronal spectrum. His pioneer cinematograph films, showing movement in solar prominences in the light of the red hydrogen Hα line, were unsurpassed in quality for many years and added new and unexpected knowledge in this field. At the Pic du Midi he also made some of the finest planetary photographs obtained until that time. He showed that if the moon has an atmosphere the density cannot exceed one hundred millionth of that of the earth's atmosphere.

Lyot relied greatly on apparatus with virtually flawless optical surfaces and therefore invented new and sensitive methods of examining very small defects of glass structure or of surface polish. He designed a large new spectrograph for examining the light of the night sky. One of his last achievements was the construction of electronic apparatus allowing observations of the solar corona from places near sea level.

Lyot's work. consistently of the finest quality, was characterized by great originality and elegance He was awarded the gold medal of the Royal Astronomical society in 1939 and the Bruce medal of the Astronomical Society of the Pacific in 1946. He died on a train between Cairo and Helwan, Egy., April 2, 1952.

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LYRA ("the Harp"), in astronomy, a constellation in the northern hemisphere. It contains Vega, the brightest star in the northern hemisphere and the fourth brightest star in the sky. The name Vega is a remnant of an Arabic phrase meaning "falling eagle"; Altair (in Aquila) is a similar remnant of "flying eagle." The star β Lyrae is an eclipsing variable with a period of 12.92 days; the system presents some abnormal features, perhaps owing to the very low densities of the two components.

ϵ Lyrae is a double double; a binocular or even the unaided eye shows two stars which can only be loosely connected. and a small telescope resolves each of these into two components. The Ring nebula in Lyra (Messier 57) is the brightest example of this class of nebula.

LYRE, a type of stringed musical instrument that was widespread in the ancient Mediterranean world and near east and is still used in Arabia and parts of Africa. It is characterized by a sound box from which project two arms joined by a yoke: the shape of the sound box varies between instruments. The strings run from the sound box over a bridge to the yoke, where they are tuned by means of twisted thongs or pegs; they are plucked with the fingers or with a plectrum.

The lyre is known in Mesopotamia from the Sumerian period onward; it was introduced into Egypt not later than the 19th century B.C. Size, construction and the number of strings vary greatly. Splendid specimens have survived from Ur (25th century B.C.). These are about 3 ft. 6 in. high. Giant lyres that stand on the ground and are played by a seated player are seen on Mesopotamian reliefs from the 3rd millennium and later in Egypt (Amarna period). Smaller, portable instruments (Babylonia, Egypt. Syria, Assyria) were held horizontally or lying in the arms; their construction was often asymmetrical. The Hebrew *kinnor* was probably a lyre.

In Greek lands there is evidence of lyre-type instruments with seven or more strings—probably related to Asiatic types—during the Minoan-Mycenaean civilizations. Vase paintings of the 8th century B.C. show a simple variety with from three to five strings that can be identified with the phorminx of Homer. From the 7th century B.C., probably under renewed Asiatic influence, the main classical varieties became established, with seven strings at first.

The lyra had a sound box made of tortoise shell (later wood) and slender curved arms. This was the instrument of the schoolboy and the amateur; players are generally shown seated with the lyre resting on the left hip. The barbiton, a subtype of the lyra. had longer strings and lower pitch.

FROM M. WEGNER, "DAS MUSIKLEBEN DER GRIECHEN" (W. DE GRUYTER AND CO., BERLIN. 1949)

INSTRUCTOR AND PUPIL PLAYING THE LYRE BENEATH HANGING CITHARA AS DEPICTED IN SCHOOL SCENE ON ATHENIAN VASE. 5TH CENTURY B.C.

The instrument of the professional was the cithara. which was larger and more solidly built, the hollow arms forming a substantial prolongation of the sound box. The citharoedus (singer to the cithara) stood on a small platform, his decorative instrument resting against his body and supported in position by a band attached to his left wrist.

There were two main varieties of cithara: the first, an elaborately constructed instrument with a flat base; the second, a much simpler instrument with a rounded base that was favoured by less pretentious players.

With both the lyra and the cithara, the left hand was spread over the strings, while the right hand held a plectrum. The precise function of the two hands is still uncertain. Though strings numbering up to 12 mere added to the cithara by virtuosos of the Iate 5th century B C., the number 7 was canonical in the classical period. It is debated whether each string provided one note only or whether it was possible to obtain notes of higher pitch by stopping.

During the Roman period new varieties of cithara emerged. The lyre of medieval Europe (rote) tended to depart from the type by the addition of a finger board and the use of a bow; e g., the Welsh *crwth* (*q.v.*), which was still played in the early 19th century. A similar instrument, the kantele, is still played in Finland and Estonia.

In Africa, *e.g.,* Sudan, Ethiopia, Uganda, the lyre survives in a form not unlike that of the ancient world and is used, as in Homer's day, to provide an accompaniment for the professional singer.

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LYREBIRD, the name for Australian birds of the genus *Menura,* allied to the scrubbirds (*q.v.*). Somewhat smaller than a pheasant, the common species (*M. superba*) is remarkable for the three kinds of feathers composing the tail of the cock, giving the latter the appearance of an ancient lyre. It is shy, inhabiting the thickest bush. The cock displays on small hillocks, which he scratches up, and has a fine song. The food consists of insects, myriapods and snails.

The lyrebird's nest is on or near the ground, closely woven of roots and fibres and lined with feathers. A single purplish-gray egg; blotched with purplish-'brown, is laid. The young bird is clad in dark down.

M. superba inhabits New South Wales, south Queensland and Victoria. There are two other species, M. *victoriae,* having much the same range as the last, and M. *alberti,* which is more northerly. The plumage of all three is brown.

LYRICAL POETRY, a general term for all poetry which is, or can be supposed to be, susceptible of being sung to the accompaniment of a musical instrument. In the earliest times it may be said that all poetry was of its essence lyrical. The primaeval oracles were chanted in verse, and the Orphic and Bacchic Mysteries, which were celebrated at Eleusis and elsewhere, combined, it is certain, metre with music. Homer and Hesiod are each of them represented with a lyre, yet, if any poetry can be described as non-lyrical, it is surely the archaic hexameter of the *Iliad* and the *Erga.* These poems were styled epic, in direct contra-distinction to the lyric of Pindar and Bacchylides, but inexactly, since it is plain that they were recited, with a plain accompaniment on a stringed instrument. However, the distinction between epical and lyrical, between what was said and what was sung, is accepted, and neither Homer nor Hesiod is among the lyrists. It is, however, as Hegel insists, the personal thought, or passion, or inspiration, which gives its character to lyrical poetry, while the metrical form is also to be taken into consideration. Since, as a rule, the lyric is short, its lines attain unusual speed and direction. It may be said that the lyric is a direct, arrow-like flight, a spontaneous flash of emotion which makes its own music.

There was an early distinction, soon accentuated in Greece, between the poetry chanted by a choir of singers, and the song which expressed the sentiments of a single poet. The latter, the *μέλος* or song proper, had reached a height of technical perfection in "the Isles of Greece, where burning Sappho loved and sung," as early as the 7th century B.C. That poetess, and her contemporary Alcaeus, divide the laurels of the pure Greek song of Dorian inspiration. By their side, and later, flourished the great poets who set words to music for choirs, Alcman, Arion, Stesichorus, Simonides and Ibycus, who lead us at the close of the 5th century to Bacchylides and Pindar, in whom the tradition of the dithyrambic odes reached its highest splendour of development. The practice of Pindar and Sappho, we may say, has directed the course of lyrical poetry ever since, and will, unquestionably, continue to do so. They discovered how, with the maximum of art, to pour forth strains of personal magic and music, whether in a public or a private way. The ecstasy, the uplifted magnificence, of lyrical poetry could go no higher than it did in the unmatched harmonies of these old Greek poets, but it could fill a much wider field and be expressed with vastly greater variety. This was proved even in their own age. The gnomic verses of Theognis were certainly sung; so were the satires of Archilochus and the romantic reveries of Mimnermus.

At the Renaissance, when the traditions of ancient life were taken up eagerly, and hastily comprehended, it was thought proper to divide poetry into a diversity of classes. The earliest English critic who enters into a discussion of the laws of prosody, William Webbe, lays it down, in 1586, that in verse "the most usual kinds are four, the heroic, elegiac, iambic and lyric." Similar confusion of terms was common among the critics of the 15th and 16th centuries, and led to considerable error. It is plain that a border ballad is heroic, and may yet be lyrical; here the word "heroic" stands for "epic." It is plain that whether a poem is lyrical or not had nothing to do with the question whether it is composed in an "iambic" measure. Finally, it is undoubted that the early Greek "elegies" were sung to an accompaniment on the flute. Thus a poem may be heroic, iambic, or elegiac, and at the same time, in all senses of the word, lyrical.

More difficulty is met with in the case of the sonnet, for although no piece of verse, when it is inspired by subjective passion, fits more closely with Hegel's definition of what lyrical poetry should be, yet the rhythmical complication of the sonnet, and its rigorous uniformity, seem particularly ill-fitted to interpretation on a lyre. When F. M. degli Azzi put the book of Genesis (1 joo) into sonnets, and Isaac de Benserade the *Metamorphoses* of Ovid (1676) into rondeaux, these eccentric and laborious versifiers produced what was epical rather than lyrical poetry, if poetry it was at all. But the sonnet as Shakespeare, Wordsworth and even Petrarch used it was a cry from the heart, a subjective confession, and although there is perhaps no evidence that a sonnet was ever set to music with success, yet there is no reason why that might not be done without destroying its sonnet-character.

Jouffroy was perhaps the first aesthetician to see quite clearly that lyrical poetry is, really, nothing more than another name for poetry itself, that it includes all the personal and enthusiastic part of what lives and breathes in the art of verse, so that the divisions of pedantic criticism are of no real avail to us in its consideration. We recognize a narrative or epical poetry; we recognize drama; in both of these, when the individual inspiration is strong, there is much that trembles on the verge of the lyrical. But outside what is pure epic and pure drama, all, or almost all, is lyrical. Complexity of form, rhythmical and stanzaic, takes in most lyrics much of the place which was taken in antiquity by such music as Terpander is supposed to have supplied. In a perfect lyric by a modern writer the instrument is the metrical form, to which the words have to adapt themselves. There is perhaps no writer who has ever lived in whose work this phenomenon may be more fruitfully studied than it may be in the songs and lyrics of Shelley. The temper of such pieces as "Arethusa" and "The Cloud" is indicated by a form hardly more ambitious than a guitar; "Hellas" is full of passages which suggest the harp; in his songs Shelley touches the lute or viola da gamba, while in the great odes to the "West Wind" and to "Liberty" we listen to a verse-form which reminds us by its volume of the organ itself. On the whole subject of the nature of lyric poetry no commentary can be more useful to the student than an examination of the lyrics of Shelley in relation to those of the song-writers of ancient Greece.

See Hegel, *Die Phänomenologie des Geistes* (1807); T. S. Jouffroy, *Cours d'esthétique* (1843); W. Christ, *Metrik der Griechen und Römer* (2nd ed. 1879); John Drinkwater, *The Lyric* (1916).

LYS, BATTLE OF THE. In the general scheme of the great German offensive of 1918, the idea of breaking through the British-Portuguese front in French Flanders was considered by the German High Command. Although this scheme became secondary to the great offensive further south, the preparations for it were carried out, firstly in order to mislead the British and Allied headquarters, and secondly that the Germans might be able to revert quickly to it in case the Somme offensive should come to a standstill.

When on March 30 it became obvious that no further progress was possible in the southern battle area, the German Supreme Command decided to put into effect the Flanders attack, the preparations for which were nearly complete. Although they did not anticipate that they would be able to force a decision in this area, there were certain definite advantages to be obtained from a successful blow in the direction of St. Omer-Hazebrouck and the local situation favoured, in their opinion, the prospect of success. This was to be the second blow struck against the British army, a great proportion of which had already been employed on the southern front.

The abnormally dry weather gave good grounds for hope that the Lys valley would be practicable, a state of affairs which was not the case till much later in the spring in a normal year. The only lateral lines of communication in this sector of the British zone, other than the coast railway, ran through St. Pol-Lillers-Hazebrouck, and if the use of this could be denied to the British, problems of supply and reinforcement would be immeasurably complicated. It was above all important, in the view of the German Supreme Command, to retain the initiative, and to strike a second blow before the French could organize a counter-attack against the somewhat vulnerable southern flank of the salient which had been created by the success of the Somme offensive.

Plan of Attack.—The general plan of attack was that the main blow should be struck by Quast's VI. Army on the front between Armentières and the La Bassée canal, in the direction of Hazebrouck. If the VI. Army's attack met with sufficient success, the IV. Army under Arnim was to advance north of Armentières, which was to be made to fall by envelopment, with the eventual object of securing the heights stretching from Kemmel to Mt. des Cats, south of the Ypres-Poperinghe road. If this were achieved the British and Belgian positions in the Ypres salient and on the Yser would be threatened from the rear. The extension of the attack southwards was a secondary consideration, but it was hoped that at least the destruction of the important mining area south of Bethune might be achieved.

The forces available for the operation of the German VI. Army were four corps, from north to south, the Bavarian II. and German XIX., LV. and IV., to which were allotted nine divisions in the first line and five in corps reserve. Three more divisions were retained in army reserve. The subsidiary attack of the German IV. Army was to be delivered by the X. and XVIII. Res. Corps, with three divisions in the first and one in the second line.

The initial blow fell on the left of the I. and right of the II. British Armies, under Sir Henry Home and Sir Herbert Plumer, the point of junction between which was, on April g, the Lys, east of Armentikres. The XI. Corps (British jjth and Portuguese 2nd Divs.) and the XV. Corps (40th and 34th Divs.) held the front from the La Bassée canal to the Lys, while the IX. Corps (25th, 19th and 9th Divs.) continued the line from the Lys to the Ypres-Comines canal. With the exception of the 55th, all these British divisions had already taken part in the southern battle and had been rapidly made up with reinforcements from home. Three more battle-worn divisions were in corps reserve. The 1st Portuguese division had been withdrawn from the line on April 5 and the 2nd was also to be relieved on April 9, but, pending their relief, it had taken over the whole corps sector.

The Battle Opens.—At about 4 A.M. on April 9 the battle opened with an intense bombardment of the whole front from Lens to Armentikres, with both gas and high-explosive shell. The front trenches were subjected to a rain of high explosive, while battery positions, cross roads, headquarters and railheads far in rear were treated with both gas and high explosive. Armentières itself and the British position south of the La Bassée canal were deluged with mustard gas. The foggy morning made observation difficult, and, according to German accounts, the counter-bombardment was ineffective. Between 8 and 9 A.M. nine German divisions were launched against the two British and one Portuguese divisions. In the centre the weight of the attack of the German XIX. and LV. Corps overwhelmed the Portuguese 2nd Div., and both corps advanced steadily towards their objectives. The right of the Bavarian II. Corps was held firmly by the 40th Div., but the left of the Bavarians succeeded in advancing past the right flank of that division. On the British right the 55th Div. held stoutly on to Givenchy and north of that place withdrew slowly from the outpost position to the main line of resistance which ran just east of Festubert.

All available British reserves were hurried up; the reserve brigade of the 55th Div. was employed to form a defensive flank facing north, from Festubert to the Lawe. The 11th Cyclist Bn. and King Edward's Horse were rushed up to Lacouture and Vieille-Chapelle, and by their heroic resistance effectually prevented any extension of the break through to the south. The 51st and 50th Divs. were moved up from the back areas to the river Lawe and the neighbourhood of Estaires respectively. Meanwhile the 55th Div continued to hold its position at Givenchy and Festubert throughout the day and in counter-attacks against elements of the enemy, which had penetrated into their position, captured over 750 prisoners. The magnificent fight put up by this division completely broke the attack of the Prussian IV. Corps.

On the northern flank of the battle, the Bavarian II. Corps succeeded eventually in occupying the forward posts of the right battalion of the 40th Div , and gradually worked their way northwards By noon the division was forced back by pressure in front and flank to a position facing south from Bois Grenier through Fleurbaix to Sailly-sur-Lys. Owing to the rapid advance of the German centre the 50th Div. was unable to gain touch with the 40th, the right flank of which withdrew across the Lys at Bac St. Maur early in the afternoon. The remainder of this division, reinforced by troops of the 34th Div., successfully maintained their line covering the approaches to Erquinghem and Armentières from the south, till the evening.

The Saxon XIX. Corps had rapidly followed up the right of the 40th Div. and about 3 P.M. succeeded in passing small bodies of troops across the Lys at Bac St. Maur. During the night the Germans established themselves firmly on the north bank, in the gap between the 40th and 50th British Divisions.

On April 10 the attacks were renewed all along the line. Practically no progress was made by the IV. Corps on the left. It was only just before nightfall that the LV. Corps succeeded in gaining a footing on the west bank of the Lawe between Lestrem and Vieille-Chapelle. At Estaires the 50th Div. defended itself with great gallantry and inflicted very heavy casualties on the enemy in the street fighting which continued all day. It was only at nightfall that this division was forced to withdraw to a prepared position north and west of the town. East of Estaires the German Corps, which had now got up artillery in support of its infantry and machine guns, pushed back the thin British line to a position north of Steenwerck, where the arrival of reinforcements for a time effectually held up the German advance.

Extension of the Attack.—Meanwhile, after an intense preliminary bombardment of the British positions between Frélinghien and Hill 60 north of the Ypres-Comines canal, the German IV. Army about 5.30 A.M. attacked the British VIII. Corps. The outposts of the 25th and 19th Divs. were driven in and under cover of mist the German X. and XVIII. Res. Corps worked their way up the valleys of the Warnave and Douve rivers on the flanks of the British positions in Ploegsteert Wood 'and Messines. By midday the village of Ploegsteert, the south-east corner of the wood and Messines had been captured. During the afternoon the German attack succeeded in capturing the outpost position as far north as the Ypres-Comines canal, but was held up on the crest of the Wytschaete ridge and in front of Hollebeke by the 9th Division. The South African brigade of the same division retook Messines during the afternoon. This further success of the Germans, combined with the progress made by the right flank of the German VI. Army, gravely imperilled the situation of the 34th Div. which was holding the original line east of Armentikres and had not been attacked. A withdrawal to the north bank of the Lys was therefore decided on, and was completed by 9:30 P.M. when the Lys bridges were destroyed.

On April 11 the attack was continued. The German IV. Corps again failed to make any progress between Givenchy and the Lawe river. North of Locon the British 51st and 50th Divs., weakened by continuous fighting, were slowly pushed back by the German LV. and XIX. Corps. The British divisions fought with the greatest gallantry, but bodies of German infantry worked their way through gaps in the attenuated line and by nightfall they had reached Neuf-Berquin and were in occupation of Merville. Further east progress was checked by a counter-attack of the 31st Div., which had arrived from the southern battlefield, but the Bavarian II. Corps pushed forward through Nieppe to Steenwerck. Slight progress was made by the German IV. Army between Nieppe and Messines.

Renewed Attacks.—During April 12 the arrival of reinforcements, mostly from the southern battle front, began to have its effect. The right flank of the British still held firm, but the German LV. Corps, attacking before dawn in the mist, broke through the left centre of the 51st Div., and reached Riez du Vinage, where their progress was checked by two batteries of artillery. The British 3rd Div. had come into action about Locon, which village was lost to the German LV. Corps, but the German advance was checked. The right flank of the same German Corps was checked in Calonne by the 61st Div., which, like the 3rd, had arrived from the Somme battle area.

Meantime the Bavarian II. and German XIX. Corps attacked between Vieux Berquin and Steenwerck. In spite of the gallant defence put up by the 29th and 31st Divs. they succeeded in forming a gap south-west of Bailleul, which enabled them to penetrate to and seize Merris. This gap was eventually blocked by a brigade of the 33rd Div. reinforced by a party of cyclists, a pioneer battalion and every available man from the local schools and reinforcement camps. Further north the 25th, 34th and 49th Divs. maintained their positions against all attacks.

During April 12 headquarters of Prince Rupert's group of armies issued orders for the continuance of the attack by the inner wings of the two armies, with the dual objectives of Hazebrouck and the range of hills north of Bailleul. The VI. Army was also to prepare to continue the pressure of their left wing towards Bethune. On April 13 the German attacks north of the Lys were continued with great vigour. On the left, elements of the LV. Corps, which had penetrated into the outskirts of the Nieppe forest, were driven back by the British 5th Div., which finally checked the German advance in this area. In the centre the German XIX. Corps continued to attack the 29th and 31st British Divs., now greatly diminished in strength by continuous fighting. Except at Vieux Berquin, which was captured by the Germans, who brought up guns to point blank range, those divisions carried out their instructions to hold their positions at all costs and cover the detrainment of the Australian 1st Division. The arrival of the Australians in the evening definitely closed the approach to Hazebrouck. Further north a succession of heavy attacks was repulsed.

Early on the morning of April 14 the British troops withdrew without interference to a new line in front of the Ravelsburg heights between Bailleul and Neuve Eglise. The latter village, after intense fighting all day, was finally captured by the Germans by midnight. Elsewhere all attacks were repulsed, and the British 4th Div., coming up, recaptured Riez Du Vinage. On April 15 the German attacks were renewed. By this time their troops had been reinforced by the Guard Res. Corps on the left wing of the IV. Army. The IX. Res. Corps had come in on the right of the IV. Corps, and the Bavarian III. Corps had replaced the Bavarian II. Corps Heavy attacks developed during the day culminated in the capture of Bailleul and the Ravelsburg Ridge.

British Withdrawal. — On the night of April 15–16 a withdrawal of the British troops from the Ypres salient to a line east of Ypres through St. Julien and along the Westhoek and Wytschaete ridges was completed without interference. This move had been commenced on the night of the 12–13 by direction of British G.H.Q. in order to set free additional troops, and to forestall any plans the Germans might be entertaining for the extension of the battle front to the north. The withdrawal was well timed, as the Germans were preparing an offensive from the Houthulst forest, and the preparations were almost complete when the British withdrawal took place.

On April 16 strong local attacks were made at various points on the Meteren-Wytschaete front, all of which were repulsed by the 25th, 34th and 49th Divs., except on the extreme flanks, where both villages, after intense fighting, eventually fell into German hands. On the following day determined efforts to take Mt. Kemmel and to advance on the Meteren-Merris front were repulsed, and the Belgian army achieved a notable success in defeating a powerful assault against their right flank about the Ypres-Staden railway.

Meantime the Germans had been preparing to renew the attack on the British right flank, and on the 18th, after a very intense bombardment, the IV. and IX. Res. Corps advanced to the assault of the British positions about Givenchy-Festubert and Mt Bernenchon-Hinges. On the British right they penetrated at certain points, but were thrown back by the 1st Div. which had relieved the 55th. Everywhere else they failed to obtain even an initial success. For nearly a week the battle died down. In the left centre of the British front French troops, which had been brought up from the south, relieved some of the wearied British divisions, and by the morning of the 21st had taken over the sector between Meteren and Spanbroekmolen.

New German Plan. — During this pause the German Higher Command readjusted their plan. On the 18th the Army Group suggested that the main operations should be abandoned, and it was finally decided on the 20th that further operations should be limited to the capture of Mt. Kemmel on the north, and the villages of Givenchy and Festubert on the south. No success whatever was obtained on the southern flank, but the attacks about Mt. Kemmel led to further bitter fighting.

At 3.30 A.M. on April 25 an intense bombardment was opened on the French and British positions extending from Bailleul to the Ypres-Comines canal. The main object of the attack was the capture of Kemmel hill by direct assault on the French, combined with an attack on the British right south of Wytschaete, intended to separate it from the French. The attack was entrusted to the XVIII. Res., Alpine and X. Res. Corps, to which were allotted nine divisions, five of which were fresh. Between 6 and 7 A.M. the German infantry advanced, supported by large numbers of squadrons of battle planes and bombers. After intense fighting they succeeded by 10 A.M. in wresting Kemmel hill and village from the French, detachments of whom, however, though surrounded, held out till late in the day. The weight of the initial attack on the British front fell on the 9th Div, who inflicted very heavy casualties on their enemy but by midday were forced back to Vierstraat. Further north the 21st Div., after a gallant resistance, was in the afternoon compelled to withdraw to a line Hill 60-Vormezeele.

On April 26, 27 and 28 local fighting continued without substantial alteration in the situation. During the night of April 26–27 the salient east of Ypres was further reduced by a withdrawal without interference to the line Pilkem-Zillebeke-Lake-Voormezeele.

The German final effort took place on April 29. The action started with a bombardment of exceptional intensity at 3.10 A M. At 5 A.M. powerful attacks commenced against the French and British troops from west of Dranoutre to Voormezeele After very heavy fighting the Germans gained a temporary success north of Locre, but were driven back by the French troops holding the sector. On the British front the positions held by the 21st, 49th and 25th Divs. were again and again attacked unavailingly by German infantry.

Results of the Battle. — Thus ended the battle of the Lys. The second great German offensive had succeeded in penetrating the British front on a front of about 20 m. to an extreme depth of about 12 miles. A large number of towns and villages had been taken and nearly 30.000 Allied prisoners and 450 guns had been captured. But the attack had failed to gain its main objects The lateral railway communication between St. Pol and Hazebrouck was still intact. Except for the detached hill of Remmel, the high ground dominating the Poperinghe-Ypres road still remained in Allied hands. A pronounced salient had been formed in the German front which was to cost them dear in the succeeding months. On the other hand, the British had been forced to abandon the almost equally pronounced salient east of Ypres, and with it all the ground which had been gained at so great a cost in the battle of Passchendaele the previous year. The losses on both sides had been very heavy. To achieve these results the Germans had employed 42 divisions, of which 33 were fresh; 25 British divisions were employed, of which only eight had not been engaged in the battle of the Somme.

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LYSANDER (Gr. Λύσανδρος), son of Aristocritus, Spartan admiral and diplomatist. Aelian (*Var. Hist.* xii. 43) and Phylarchus (*ap.* Athen. vi. 271 e) say that he was a *mothax, i.e.*, the son of a helot mother (*see* HELOTS), but this tradition is at least doubtful; according to Plutarch he was a Heraclid, though not of either royal family. He first appears as admiral of the Spartan navy in 407 B C. The story of his influence with Cyrus the younger, his naval victory off Notium, his quarrel with his successor Callicratidas in 406, his appointment as ἐπιστολεύς in 405, his decisive victory at Aegospotami, and his share in the siege and capitulation of Athens belong to the history of the Peloponnesian War (*q.v.*). By 404 he was the most powerful man in the Greek world and set about completing the task of building up a Spartan empire in which he should be supreme in fact if not in name. Everywhere democracies were replaced by oligarchies, directed by bodies of ten men (δεκαρχίαι) under the control of Spartan governors (harmosts, ἁρμοσταί).

But Lysander's boundless influence and ambition, and the superhuman honours paid him, roused the jealousy of the kings and the ephors, and, on being accused by the Persian satrap Pharnabazus, he was recalled to Sparta. Soon afterwards he was sent to Athens with an army to aid the oligarchs and established the Council of Thirty on the same model as the other oligarchies he had set up throughout Greece; but Pausanias, one of the kings, followed him and brought about a restoration of democracy. On the death of Agis II., Lysander secured the succession of Agesilaus (*q.v.*), whom he hoped to find amenable to his influence. But in this he was disappointed. Though chosen to accompany the king to Asia as one of his 30 advisers (σύμβουλοι), he was kept inactive and his influence was broken by studied affronts, and finally he was sent at his own request as envoy to the Hellespont. He soon returned to Sparta to mature plans for overthrowing the hereditary kingship and substituting an elective monarchy open to all Heraclids, or even, according to another version, to all Spartiates. But his alleged attempts to bribe the oracles were fruitless, and his schemes were cut short by the outbreak of war with Thebes in 395. Lysander invaded Boeotia from the west, receiving the submission of Orchomenus and sacking Lebadea, but the enemy intercepted his despatch to Pausanias, who had meanwhile entered Boeotia from the south, containing plans for a joint attack upon Haliartus. The town was at once strongly garrisoned, and when Lysander marched against it he was defeated and slain. He was buried in the territory of Panopeus, the nearest Phocian city.

An able commander and an adroit diplomatist, Lysander was fired by the ambition to make Sparta supreme in Greece and himself in Sparta. To this end he shrank from no treachery or cruelty; yet, like Agesilaus, he was totally free from the characteristic Spartan vice of avarice, and died, as he had lived, a poor man.

See the biographies *by* Plutarch and Nepos; Xen. *Hellenica*, i. 5–iii. 5; Diod Sic. xiii. 70 sqq., 104 sqq, xiv. 3, 10, 13, 81; Lysias xii. 60 *sqq.;* Justin v. 5–7; Polyaenus i. 45, vii. 19; Pausanias iii., ix. 32, 5–10, x. 9, 7–11; C. A. Gehlert, *Vita Lysandri* (Bautzen, 1874); *W.* Vischer, *Alkibiades und Lysandros* (Basel, 1845); O. H. J. Nitzsch, De *Lysandro* (Bonn, 1847); and the Greek histories in general.

LYSANIAS, the tetrarch of Abilene in the time of John the Baptist (Luke iii, 1). The only Lysanias who was mentioned in profane history as exercising authority in this district was executed in 36 B C. by Mark Antony. He was the son of Ptolemy Mennaeus, the ruler of an independent state, of which Abilene formed only a small portion. According to Josephus (Ant. xix. 5, 1) the emperor Claudius in A.D. 42 confirmed Agrippa I. in the possession of "Abila of Lysanias" already bestowed upon him by Caligula. It is argued that this cannot refer to the Lysanias executed by Mark Antony, since his paternal inheritance must have been of far greater extent. It is therefore assumed by some authorities that the Lysanias in Luke (A.D. 28–29) is a younger Lysanias, tetrarch of Abilene only, one of the districts into which the original kingdom was split up after the death of Lysanias I. This younger Lysanias may have been a son of the latter, and identical with, or the father of, the Claudian Lysanias. On the other hand, Josephus knows nothing of a younger Lysanias, and it is suggested by others that he really does refer to Lysanias I.

LYSIAS (459?–380? B.C.), Attic orator, was born, according to Dionysius of Halicarnassus and the author of the life ascribed to Plutarch, in 459 B.C., a date obtained from the founding of Thurii in 444 B.C.; tradition says that Lysias went there at the age of 15. Cephalus, his father, was a native of Syracuse, and on the invitation of Pericles had settled at Athens. The opening scene of Plato's Republic is laid at the house of his eldest son, Polemarchus, in Peiraeus. The family were obviously well known to Plato.

At Thurii, a new foundation on the Tarentine gulf, Lysias began his studies in rhetoric under Tisias, according to tradition. The destruction of the Athenian expedition in 413 led to an anti-Athenian outburst, and the expulsion of Lysias and Polemarchus, who returned to Athens. There they settled as favoured aliens (ἰσοτελεῖς), Polemarchus in Athens itself and Lysias in Peiraeus, near their shield factory, a large concern employing 120 slaves. The attack of the Thirty Tyrants on the resident aliens in 404 was fatal to Polemarchus, and Lysias only just escaped from imprisonment by a large bribe. He took refuge in Megara; from there he gave assistance to the exiles, and in the restoration in 403 Thrasybulus moved to bestow the citizenship on him, a measure defeated on a technical objection. The recent disturbances had probably reduced Lysias to comparative poverty, and the rest of his life was spent in composing speeches for the law courts. Little is known of his personal life. He made his only personal appearance in 403, when he indicted Eratosthenes, one of the Tyrants. There is a tradition that he delivered his own *Olympiacus* at the festival of 388, to which Dionysius of Syracuse had sent a magnificent embassy. The speech is an appeal to Greece to deliver Sicily from Dionysius' tyranny. The latest speech we can date (For *Pherenicus*) belongs to 381 or 380. Lysias probably died in or soon after 380 B.C.

Lysias was a man of kindly and genial nature, warm in friendship, loyal to country, with a keen perception of character, and a fine though strictly controlled sense of humour. The literary tact which is so remarkable in the extant speeches is that of a singularly flexible intelligence, always obedient to an instinct of gracefulness. He owes his distinctive place to the power of concealing his art. It was obviously desirable that a speech written for delivery by a client should be suitable to his age, station and circumstances. Lysias was the first to make this adaptation really artistic. His skill can be best appreciated if we turn from the easy flow of his graceful language to the majestic emphasis of Antiphon, or to the self-revealing art of Isaeus. Translated into terms of ancient criticism, he became the model of the "plain style" (ἰσχνὸς χαρακτήρ, genus *tenue*). Greek rhetoric began in the "grand" style; then Lysias set an exquisite pattern of the "plain"; and Demosthenes might be considered as having effected an almost ideal compromise.

The vocabulary of Lysias is pure and simple. Most of the rhetorical "figures" are sparingly used—except such as consist in the parallelism or opposition of clauses, due to the still surviving influence of the Sicilian school. Lysias excels in vivid description; he has also a happy knack of marking the speaker's character by light touches. He has equal command over the "periodic" style (κατεστραμμένη λέξις) and the non-periodic or "continuous" (εἰρομένη, διαλελυμένη). His disposition of his subject-matter is always simple. The speech has usually four parts—introduction (προοίμιον), narrative of facts (διήγησις), proofs (πίστεις) and conclusion (ἐπίλογος). It is in the introduction and the narrative that Lysias is seen at his best. In his greatest extant speech —that Against Eratosthenes—and also in the fragmentary *Olympiacus,* he has pathos and fire; but these were not characteristic qualities of his work. In Cicero's estimate of the various Greek orators (De *Orat.* iii. 7, 28) the quality in which Lysias is supreme is subtilitas (refinement). Nor was it oratory alone to which Lysias rendered service; his work had an important effect on all subsequent Greek prose, by showing how perfect elegance could be joined to plainness. And his style has an additional charm for modern readers, because it is employed in describing scenes from the everyday life of Athens.

In literary and historical interest, the first place among his extant speeches belongs to that Against Eratosthenes (403 B.C.), one of the Thirty Tyrants, whom Lysias arraigns as the murderer of his brother Polemarchus. The speech is an eloquent and vivid picture of the reign of terror which the Thirty established at Athens; the concluding appeal, to both parties among the citizens, is specially powerful. Next in importance is the speech *Against Agoratus* (399 B.C.), one of our chief authorities for the internal history of Athens during the months which immediately followed the defeat at Aegospotami. The *Olympiacus* (388 B.C.) is a brilliant fragment, expressing the spirit of the festival at Olympia, and exhorting Greeks to unite against their common foes. The Plea *for* the Constitution (403 B.C.) is interesting for the manner in which it argues that the wellbeing of Athens—now stripped of empire—is bound up with the maintenance of democratic principles. The speech *For Mantitheus* (392 B.C.) is a graceful and animated portrait of a young Athenian ἱππεύς, making a spirited defence of his honour against the charge of disloyalty. The defence *For the Invalid* is a humorous character-sketch. The speech *Against Pancleon* illustrates the intimate relations between Athens and Plataea, while it gives us some picturesque glimpses of Athenian town life. The defence of the person who had been charged with destroying a *moria,* or sacred olive, places us amidst the country life of Attica. And the speech *Against Theomnestus* deserves attention for its curious evidence of the way in which the ordinary vocabulary of Athens had changed between 600 and 400 B.C.

Thirty-four speeches (three fragmentary) have come down under the name of Lysias; 127 more, now lost, are known from smaller fragments or from titles. The ἐρωτικός in Plato's *Phaedrus,* pp. 230 E-234 has generally been regarded as Plato's own work; however, the certainty of this conclusion will be doubted by those who observe (1) the elaborate preparations made in the dialogue for a recital of the ἐρωτικός which shall be *verbally exact* and (2) the closeness of the criticism made upon it. If the satirist were merely analysing his own composition, such criticism would have little point. Lysias is the earliest writer who is known to have composed ἐρωτικοί; it is as representing both rhetoric and a false *Epws* that he is the object of attack in the *Phaedrus.*

All mss. of Lysias yet collated have been derived, as H. Sauppe first showed, from the Codex Palatinus X. (Heidelberg). The next most valuable ms. is the Laurentianus C (15th century), which I. Bekker chiefly followed. Speaking generally, we may say that these two mss. are the only two which carry much weight where the text is seriously corrupt. In *Oratt.* i.–ix. Bekker occasionally consulted 11 other mss., most of which contain only the above nine speeches: viz., Marciani F, G, I, K (Venice); Laurentiani D, E (Florence); Vaticani M, N; Parisini U, V; Urbinas O.

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LYSIMACHUS (c. 355–281 B.C.), Macedonian general, son of Agathocles, was a citizen of Pella in Macedonia. During Alexander's Persian campaigns he was one of his immediate bodyguard and distinguished himself in India. After Alexander's death he was appointed to the government of Thrace and the Chersonese. For a long time he was chiefly occupied with fighting against the Odrysian king Seuthes. In 315 he joined Cassander, Ptolemy and Seleucus against Antigonus, who, however, diverted his attention by stirring up Thracian and Scythian tribes against him. In 309, he founded Lysimachia in a commanding situation on the neck connecting the Chersonese with the mainland. He followed the example of Antigonus in taking the title of king. In 302 when the second alliance between Cassander, Ptolemy and Seleucus was made, Lysimachus, reinforced by troops from Cassander, entered Asia Minor, where he met with little resistance. On the approach of Antigonus he retired into winter quarters near Heraclea, marrying its widowed queen Amastris, a Persian princess. Seleucus joined him in 301, and at the battle of Ipsus Antigonus was slain. His dominions were divided among the victors, Lysimachus receiving the greater part of Asia Minor.

Feeling that Seleucus was becoming dangerously great, he now allied himself with Ptolemy, marrying his daughter Arsinoë. Amastris, who had divorced herself from him, returned to Heraclea. When Antigonus's son Demetrius renewed hostilities (297), during his absence in Greece, Lysimachus seized his towns in Asia Minor, but in 294 concluded a peace whereby Demetrius was recognized as ruler of Macedonia. He tried to carry his power beyond the Danube, but was defeated and taken prisoner by the Getae, who, however, set him free on amicable terms. In 288 Lysimachus and Pyrrhus invaded Macedonia, and drove Demetrius out of the country. Pyrrhus was at first allowed to remain in possession of Macedonia with the title of king. but in 285 he was expelled by Lysimachus.

Domestic troubles embittered the last years of Lysimachus's life. Amastris had been murdered by her two sons; Lysimachus treacherously put them to death. On his return Arsinoe asked the gift of Heraclea, and he granted her request, though he had promised to free the city. In 284 Arsinoë, desirous of gaining the succession for her sons in preference to Agathocles (the eldest son of Lysimachus), intrigued against him with the help of her brother Ptolemy Ceraunus; they accused him of conspiring with Seleucus to seize the throne, and he was put to death. This atrocious deed of Lysimachus aroused great indignation. Many of the cities of Asia revolted, and his most trusted friends deserted him. The widow of Agathocles fled to Seleucus, who at once invaded the territory of Lysimachus in Asia. Lysimachus crossed the Hellespont, and in 281 a decisive battle took place at the plain of Corus (Corupedion) in Lydia. Lysimachus was killed; after some days his body, watched by a faithful dog, was found on the field, and given up to his son Alexander, by whom it was interred at Lysimachia.

See Arrian, *Anab.* v. 13, vi. 28, Justin xv. 3, 4, xvii. 1; Quintus Curtius v. 3, x. 30; Diod. Sic. xviii. 3; Polybius v. 67; Plutarch, *Demetrius,* 31. 52, *Pyrrhus,* 12; Appian, *Syriaca,* 62; Thirlwall, *History of Greece,* vol. viii. (1847); J. P. Mahaffy, *Story of Alexander's Empire;* Droysen, *Hellenismus* (2nd ed., 1877); A. Holm, *Griechische Geschichte,* vol. iv. (1894); B. Niese, *Gesch. d. griech.* u. *maked. Staaten,* vols. i. and ii. (1893, 1899); J. Beloch, *Griech. Gesch.* vol. iii. (1904); Hiinerwadel, *Forschungen zur Gesch. des Konigs Lysimachus* (1900); Possenti, *Il Re Lisimaco di Tracia* (1901); Ghione, *Note sul regno dz Lisimaco* (*Atti d. real. Accad. di Torino,* xxxix.); and MACEDONIAN EMPIRE. (E. R. B.)

LYSIPPUS (fl. late 4th century B.C.), Greek sculptor, was head of the school of Argos and Sicyon in the time of Philip and Alexander of Macedon. He worked in bronze and was said to have produced some 1,500 works, several of them colossal. He modified the canon of Polyclitus toward a more slender type, and introduced an element of impressionism. Lysippus represented the acme of lifelike naturalism. Pliny and other writers mentioned many of his statues. Among the gods he seems to have produced new and striking types of Zeus, Poseidon, the sun-god Helios and others. He made several statues of Hercules, stressing the motif of weariness exemplified in the later Farnese Hercules.

Lysippus made many portraits of Alexander the Great and became the court sculptor of the king, from whom and from whose generals he received many commissions. The extant portraits of Alexander vary greatly and it is impossible to determine which among them go back to Lysippus.

As head of the great athletic school of the Peloponnese, Lysippus sculptured many athletes; a figure by him of a man scraping himself with a strigil (skin scraper) was a great favourite of the Romans in the time of Tiberius; and this has been usually regarded as the original copied in the Apoxyomenus of the Vatican. More than 40 ancient copies of his "Eros" exist. His "Kairos," a personification of opportunity, has often been imitated. He also did drunken flute players, and satyrs dancing.

See F. P. Johnson, *Lysippos* (1928); *M.* Bieber, *The Sculpture of the Hellenistic Age,* pp. 38–39 (1955). (P. G.; D. M. R.)

LYSIS OF TARENTUM (fl. *c.* 400 B.C.), Greek philosopher, a member of the Pythagorean community in southern Italy, is said to have escaped from a massacre there to Thebes, where he became the teacher of Epaminondas. A letter of his, whose genuineness is doubtful, is given in Iamblichus, *Life of Pythagoras,* 75–78.

LYSISTRATUS, a Greek sculptor of the 4th century B.C., brother of Lysippus of Sicyon. Pliny relates in his *Natural History* that he followed a strongly realistic line, being the first sculptor to take impressions of human faces in plaster.

LYTE, HENRY FRANCIS (1793–1847), English clergyman and hymn writer, was born near Kelso on June 1, 1793, and was educated at Enniskillen school and at Trinity college, Dublin. He took orders in 1815, and eventually settled, in 1823, in the parish of Brixham. He died at Nice on Nov. 20, 1847.

Lyte is remembered for his *Poems, chiefly Religious* (1833) and

The Spirit of the Psalms (1834). His best known hymns are "Abide with me!"; "Jesus, I my cross have taken"; "Praise, my soul, the King of Heaven." See his *Remains* (1850) with memoir.

LYTHAM ST. ANNE'S, a municipal borough (1922) and seaside town in the South Fylde parliamentary division of Lancashire, Eng., on the north side of the Ribble estuary, about 12 mi. W. of Preston and 8 mi. S.E. of Blackpool by road. Pop. (1951) 30,343. Area 9.1 sq.mi. There are five public parks and an extensive promenade; there are sands at low tide. A Benedictine cell was founded at Lytham in the 12th century by Richard Fitz-Roger, lord of the manor.

LYTHRACEAE, the loosestrife family consisting of about 23 genera and 475 species of dicotyledonous herbs, shrubs or trees, widely distributed but abundant in the American tropics. They have mostly opposite entire leaves, stipules minute or wanting, flowers bisexual, mostly axillary, solitary or in cymes or panicles, generally actinomorphic, calyx free from the 1-4-locular many-seeded ovary, and petals sometimes wanting. Among the best-known ornamental members are crape myrtle (Lagerstroemiu), spiked or purple loosestrife (Lythrum), cigar flower (*Cuphea*) and henna (*Lawsonia*). See LOOSESTRIFE; HENNA. (J. M. BL.)

LYTTELTON, ALFRED (1857–1913), British politician, mas born Feb. 7, 1857, the youngest child and eighth son of the 4th Lord Lyttelton. His mother, daughter of Sir Stephen Glynne and sister of Mrs. W. E. Gladstone, died six months after his birth. All the eight boys were brought up to be keen cricketers, the cricket ground at Hagley, Worcs., their home, being close to the house; all went to Eton, and six were in the Eton eleven.

Alfred was the most famous cricketer of them all. Indeed for nearly all ball games he had an extraordinary aptitude. He excelled in football of three kinds, and in fives, racquets and especially tennis — holding the amateur championship for tennis from 1882 to 1896. At cricket he was equally good as a bat and as a wicket keeper. He went to Trinity college, Cambridge, and was called to the bar in 1881. In 1895 he became M.P. for Warwick and Leamington as a Liberal Unionist, retaining the seat until 1906, when he was defeated. After a few months' interval, he was returned for a London constituency, St. George's, Hanover Square.

He was appointed, in 1900, chairman of a commission to inquire into the various concessions which Pres. Stephanus Rruger and the Volksraad had granted in the Transvaal. In pursuance of the investigation he spent the autumn of 1900 in South Africa, and Lord Milner hoped to secure him as his successor. But it was as colonial secretary, in the Conservative government of Balfour in 1903, that his South African experience was utilized. He incurred much odium by sanctioning the scheme for importing Chinese coolies into South Africa in order to remedy the shortage of native labour and to restart the mines and thereby the whole economic machinery of South Africa.

Lyttelton died on July 5, 1913, after an injury in a local cricket match.

See E. S. Lyttelton, Alfred Lyttelton (1923).

LYTTELTON, GEORGE LYTTELTON, 1ST BARON (1709–1773), English statesman and man of letters, born at Hagley, Worcestershire, was a descendant of the great jurist Sir Thomas Littleton (*q.v.*). He was the eldest son of Sir Thomas Lyttelton, 4th bart., (d. 1751). Lyttelton was educated at Eton and Oxford, and in 1728 set out on the grand tour, spending considerable periods at Paris and Rome. On his return to England he sat in parliament for Okehampton, Devonshire. From 1744 to 1754 he held the office of a lord commissioner of the treasury. In 1755 he succeeded Legge as chancellor of the exchequer, but in 1756 he quitted office, being raised to the peerage as Baron Lyttelton, of Frankley, in the county of Worcester. In the political crisis of 1765, before the formation of the Rockingham administration, it was suggested that he might be placed at the head of the treasury, but he declined. The closing years of his life were devoted chiefly to literary pursuits. He died on Aug. 22, 1773.

His Works were published by his nephew, G. E. Ayscough, in 1774. See Sir R. Phillimore's *Memoirs* and *Correspondence of* Lord Lyttelton (2 vols., 1845).

LYTTELTON, a borough of New Zealand, the port of Christchurch on the east coast of South Island, on an inlet on the northwestern side of Banks peninsula. Pop. (1956) 3,589. It is surrounded by abrupt hills rising to 1.600 ft., through which a railway communicates with Christchurch (8 mi. northwest) by a tunnel $1\frac{3}{4}$ mi. long. Great breakwaters protect the inner harbour, which has an area of 105 ac., with a low-tide depth of 20 to 33 ft. There is a graving dock accessible for vessels of 462 ft.×54 ft. beam. The produce of the rich agricultural district of Canterbury is exported, frozen or preserved. Lyttelton was the original settlement in this district (1850).

LYTTON, EDWARD GEORGE EARLE LYTTON, BULWER-LYTTON, 1ST BARON (1803–1873), English novelist and politician, the youngest son of Gen. William Earle Bulwer of Heydon Hall and Wood Dalling, Norfolk, was born at London on May 25, 1803. He had two brothers, William (1799–1877) and Henry (1801–72), afterward Lord Dalling (*q.v.*). Bulwer's father died when the boy was four years old. His mother, Elizabeth Barbara, daughter of Richard Warburton Lytton of Knebworth, Hertfordshire, after her husband's death settled in London. Bulwer was educated at private schools and at Trinity college and Trinity hall, Cambridge. Before he went to Cambridge he had published a volume of verse: and had fallen in love. The lady married another, to Bulwer's lasting grief. After leaving Cambridge he published some volumes of juvenilia which he afterward ignored.

Meanwhile he had begun to take his place in society, being already known as a dandy of considerable pretensions, who had acted as second in a duel and experienced the fashionable round of firtation and intrigue. He purchased a commission in the army, only to sell it again without undergoing any service, and in Aug. 1827 married, in opposition to his mother's wishes, Rosina Doyle Wheeler (1802–82), an Irish beauty, niece and adopted daughter of Gen. Sir John Doyle. Upon his marriage with her, Bulwer's mother withdrew the allowance she had hitherto made him. In the year of his marriage he published *Falkland,* and in 1828 *Pelham,* a novel for which he had gathered material during a visit to Paris in 1825. This intimate study of the dandyism of the age was immediately popular, and gossip was busy in identifying the characters of the romance with the leading men of the time. In the same year he published The Disowned, following it up with *Devereux* (1829), *Paul* Clifford (1830), *Eugene Aram* (1832) and Godolphin (1833). All these novels were designed with a didactic purpose, somewhat upon the German model. To embody the leading features of a period, to show how a criminal may be reformed by the development of his own character, to explain the secrets of failure and success in life, these were the avowed objects of his art. Meanwhile he became a follower of Bentham, and in 1831 was elected member for St. Ives, Huntingdon. In 1836 he and his wife were legally separated. Three years later his wife published a novel called *Cheveley,* or *the Man* of Honour, in which Bulwer was bitterly caricatured, and in June 1858, when her husband was standing as parliamentary candidate for Hertfordshire, she appeared at the hustings and indignantly denounced him. She was placed under restraint as insane, but liberated a few weeks later. For years she continued her attacks upon her husband's character, and outlived him by nine years, dying at Cpper Sydenham in March 1882.

After representing St. Ives, Bulwer was returned for Lincoln in 1832, and sat in parliament for that city for nine years. He spoke in favour of the reform bill, and secured the reduction of the newspaper stamp duties. His pamphlet, issued when the Whigs were dismissed from office in 1834, entitled "A Letter to a Late Cabinet Minister on the Crisis." led to an offer from Lord Melbourne of a lordship of the admiralty, which he declined. He continued to write indefatigably. Godolphin was followed by *The Pilgrims* of the Rhine (1834), The Last Duys of *Pompeii* (1834), and *Rienzi* (1835). These books were received with enthusiasm, and Ernest *Maltravers* (1837) and Alice, or *the* Mysteries (1838) were hardly less successful. In 1831 he became editor of the *New Monthly,* but resigned in the following year. In 1841, the year in which he published Sight and *Morning,* he started the *Monthly* Chronicle, a semiscientific magazine, for which he wrote *Zicci,* an unfinished first draft afterward expanded into *Zanoni* (1842). Simultaneously he was writing plays. In 1838 he produced *The Lady of Lyons*, a play which Macready made a great success at Covent Garden: in 1839 *Richelieu* and *The Sen Captain*, and in 1840 *Money*. All, except *The Sea Captain*, were successful. and this solitary failure he revived in 1869 under the title of *The Rightful Heir*. Of the others it may be said that, though they abound in examples of strained sentiment and false taste, they have nevertheless a certain theatrical *flair*, which enabled them to survive a whole library of stage literature of greater sincerity and truer feeling. *The Lady of Lyons* and *Money* long held the stage, and the latter provided a good part for many comedians.

In 1838 Bulwer was created a baronet, and on succeeding to the Knebworth estate in 1843 added Lytton to his surname, under the terms of his mother's will. From 1841 to 1852 he had no seat in parliament, and spent much of his time in continental travel. His later historical romances are *The Last of the Barons* (1843), *Lucretia, or the Children of the Night* (1847), and *Harold, the last of the Saxon Kings* (1838). In the intervals between these he had produced a volume of poems in 1842, another of translations from Schiller in 1844, and a satire called *The Sew Timon* in 1846, in which Tennyson. who had just received a civil list pension. was bitterly lampooned. His most ambitious work in metre, a romantic epic entitled *King Arthur*, had no success. His best work in the novel was still to come. His historical novels are much better than it has been the fashion to think. In *The Caxtons* (1849) he turned to English society, and in *My Novel* (1853) and *Kenelm Chillingly* (1873) he gave an unrivalled picture of English society in the mid-Victorian era. Other late works are A *Strange Story* (1862). *The Coming Race* (1871) and *The Parisians* (1873).

In 1852 he entered the political field anew, and in the Conservative interest. He had differed from the policy of Lord John Russell over the corn laws. and now separated finally from the Liberals. He stood for Hertfordshire and was elected, holding the seat until 1866. when he was raised to the peerage as Baron Lytton of Knebworth. His eloquence gave him the ear of the house of commons. and he often spoke with influence and authority. In 1858 he was appointed secretary for the colonies. In the house of lords he was comparatively inactive.

See T. H. S. Escott, *Edward Bulwer, 1st Baron Lytton of Knebworth* (1910).

LYTTON, EDWARD ROBERT BULWER-LYTTON, 1ST EARL OF (1831–1891), English diplomat and poet, a notable viceroy of India from 18; 5 to 1880, was the only son of the first Lord Lytton (*q.v.*), and was born at London on Nov. 8, 1831, and educated at Harrow and Bonn. In 1850 he entered the diplomatic service as unpaid attache to his uncle, Sir Henry Bulwer, then minister at Washington, D.C. He rose fast in the service through several European capitals, and by 1865 was minister at Lisbon, Port. In 1864 he married Edith Villiers, niece of the earl of Clarendon, and in 1873 he succeeded to the barony.

In Nov. 187j Disraeli chose him to succeed Lord Northbrook as governor-general of India. Relations with Afghanistan were in a particularly delicate state; Russian influence there was growing, and Lytton took with him orders either to counteract it, or to secure a stronger frontier by force. Eleven months of negotiations had produced no result when he abruptly suspended them in March 1878; and he forced on a war in November. His government quickly won it; the amir. Shere Ali Khan, fled; a son, Yakub Khan, was installed in his place, and granted by the treaty of Gandamak (May 26. 1879) a more defensible "scientific" frontier with India, and a British residency at Kabul to control Afghan foreign policy. But on Sept. 3 the resident, Sir Louis Cavagnari, and his staff were murdered. and war began again. Lytton immediately dispatched Gen. Sir Frederick Roberts on a successful campaign: which was still being pursued when the governor-general resigned, with the Conservative government, in the spring of 1880. Lytton received an earldom on resignation. His successor, Lord Ripon, disapproved and revised his "forward" Afghan policy. Though Afghanistan received most attention in Great Britain during Lytton's viceroyalty, and his conduct there was sharply criticized, he had done much for Indian administration: he supervised effective measures for famine relief, abolished internal customs barriers, decentralized the whole financial system. proclaimed the queen empress of India at a splendid durbar at Delhi (Jan. 1, 1877), and reserved one-sixth of the civil service vacancies for Indians.

After seven years at home without a post, he was appointed late in 1887 to be ambassador at Paris, where his winning personality did much to improve Anglo-French relations. He died there, very suddenly. on Nov. 24, 1891. His elder surviving son (b. 1876) succeeded him.

Lytton is known as a poet under the pen name of Owen Meredith. *Selections* from his poems were published, with an introduction by his daughter, Lady Betty Balfour, in 1894. Besides many volumes of verse, Lytton published a biography of his father (1883).

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(M. R. D. F.)

M THE letter M corresponds to the Semitic (mem) and to the Greek (mu). The Semitic form may derive from an earlier sign representing waves of water. Early Greek forms from Thera, Attica and Corinth closely resemble the early North Semitic , . The Lydian alphabet also had the form . These forms differ only in the direction of the writing. The Etruscan form was similar, but with an additional stroke, . The Ionic alphabet had the form . Since this form is rare in Etruscan, the Latin form M may have been borrowed directly from the Chalcidian.

Curious forms occurred in the various Italic alphabets. Umbrian had or . Oscan , Faliscan . The rounded form appeared in the uncial writing of the 5th or 6th centuries, . The cursive hands of the 6th century showed m and on this was based the Carolingian . The modern minuscule does not differ essentially from the majuscule letter. The sound represented by

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

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

the letter has been from the beginning the labial nasal. The nasals of all sounds are least liable to change, a fact that is reflected in the consistent history of the letter. See also ALPHABET. (B. F. C. A.; J. W. P.)

MAAS, NICOLAS: see MAES, NICOLAES.

MAASDORP, SIR ANDRIES FERDINAND STOCKENSTROM (1847–1931), was born at Malmesbury, Cape Colony, on Jan. 14. 1847, and educated at Graaff Reinet college, Cape Colony, and University college, London. He was called to the bar in 1871. He returned to Cape Colony. and from 1874 to 1878 was a member of the legislative assembly of Cape Colony, and from 1878 to 1897 solicitor-general. From 1900 he was a member of the Special Treason court, until 1902, when he was appointed chief justice of the Orange River colony (Orange Free State province) division of the supreme court of South Africa. He resigned in 1919.

MAASTRICHT, a frontier town and the capital of the province of Limburg, Netherlands, on the left bank of the Maas at the influx of the Geer, 19 mi. by rail N.N.E. of Liége in Belgium, is the seat of a court. Pop. (1957 est.) mun., 86,665. Maastricht was originally the *traiectus* superior (upper ford) of the Romans, and was the seat of a bishop from 382 to 721. Having formed part of the Frankish realm, it was ruled after 1204 jointly by the dukes of Brabant and the prince-bishops of Liége. In 1579 it was besieged, taken and plundered by the Spaniards under the duke of Parma. It was taken by the French in 1673, 1748 and 1794. A small portion of the town, known as Wyk, lies on the right bank of the river.

A stone bridge connecting the two sections replaced a wooden structure as early as 1280, and was rebuilt in 1683. Formerly a strong fortress, its ramparts were dismantled in 1871–78. The town hall, completed in 1683, contains pictures and tapestry. The old town hall (Oud Stadhuis), a Gothic building of the 15th century, is a museum of antiquities. The church of St. Servatius, founded by Bishop Monulphus in the 6th century, is the oldest church in Holland; according to one account it was rebuilt and enlarged as early as the time of Charlemagne. The late Romanesque church of Our Lady has two ancient crypts and a 13th-century choir, but the nave suffered severely from a restoration in 1764. The original church of St. Martin (in Wyk) occupied the supposed site of an old heathen temple.

The Protestant St. Janskerk church, a Gothic building of the 13th and 15th centuries, with a fine tower, was formerly the baptistery of the cathedral. The town did not reap the full advantages of its situation till the opening of the railways between 1853 and 1865. At first a trade was carried on in wine, colonial wares, alcoholic liquors and salt; there are now manufactures of china. glass and crystal, also breweries, tobacco and cigar factories, and a trade in corn and butter.

A short distance south of Maastricht are the great sandstone quarries of Pietersberg, which were worked from the time of the Romans till the end of the 19th century, resulting in subterranean labyrinths covering an area of 15 mi. by 9 mi. In the time of the Spanish wars these underground passages served to hide the peasants and their cattle. Five miles distant are the medieval castles of Amstenrade, Neubourg and Mheer. Maastricht was assaulted by the Germans, May 11, 1940—the second day of the invasion of the Low Countries.

MABILLON, JEAN (1632–1707), Benedictine monk and scholar of the Congregation of St. Maur, was born on Nov. 23, 1632, the son of a peasant living near Reims. In 1653 he entered the abbey of St. Remi at Reims and in 1664 was placed at St. Germain-des-Prés in Paris, the great literary workshop of the Maurists. There he lived and worked for 20 years, at first under Luc d'Achéry, with whom he edited the nine folio volumes of *Acta* of the Benedictine saints (1668–1701). In Mabillon's prefaces (reprinted separately) these lives were for the first time made to illustrate the ecclesiastical and civil history of the early middle ages.

Several journeys—in Flanders, Lorraine, Burgundy, southern Germany and Switzerland—proved exceptionally fruitful. Many of Mabillon's discoveries were promptly published in his *Vetera Analecta* (4 vol., 1675–85). Prompted by the excessive skepticism of the Jesuit Daniel Papebroch, who in his *Propylaeum antiquarium* circa veri ac *falsi* discrimen in *vetustis membranis* (1675) had declared that nearly all Merovingian documents were spurious and that no authentic charters existed for the period before 700, Mabillon with the help of several of his confrères produced a classic work, his *De re diplomatica* (1681; supplement, 1704), in which were first laid down the principles for determining the authenticity and date of medieval charters and manuscripts. It practically created the science of Latin paleography. Work on the Lectionary of Luxeuil. discovered in the early days of the *Iter Germanicum* (1683), stimulated him to write the *De liturgia Gallicana* (1685), and the most profitable journey of all. that in Italy, led to the publication of the *Museum Italicum* (1687–89), which included not only the famous Missal of Bobbio but also the precious *Ordines Romani*. These important texts have been splendidly re-edited since, but for more than two centuries they were the only resource available to scholars. On his return to Paris from Italy Mabillon was called upon to defend against the Trappist abbot A. J. le B. de Rancé, the legitimacy for monks of the kind of studies to which the Maurists devoted themselves. This called forth hlabillon's *Traité des études monastiques* and his *Réflexions sur la réponse de M. l'abbé de la Trappe* (1691–92), works embodying the ideas and program of the hlaurists for ecclesiastical studies.

Mabillon produced in all about 20 folio volumes and as many of lesser size, nearly all works of monumental erudition. He died in Paris on Dec. 27, 1707, in the midst of the production of the colossal Benedictine *Annales* (4 vol., 1703–07; vol. 5, posthumously. 1713; vol. 6, the work of other authors, 1739).

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(E. C. B.; AM. S.)

MABINOGION, THE, the title of a collection of 11 medieval Welsh tales. *Thr White Book of Rhydderch* (*c.* 1300–25) is the first manuscript extant to contain any considerable number of them; *The Red Book of Hergest* (*c.* 1375–1425) the first to contain them all. The form *mabinogion* was long regarded incorrectly as a plural of *mabinogi,* which meant, first "youth." then "a tale of youth" and, lastly "a tale." The stories of the *Mabinogion* are (1) "The Four Branches of the *Mabinogi,*" consisting of "Pwyll Prince of Dyfed." "Branwen daughter of Llŷr," "Manawydan son of Llŷr" and "Math son of Mathonwy"; (2) the native Arthurian tales "Culhwch and Olwen" and "The Dream of Rhonabwy"; (3) "The Dream of Macsen Wledig" and "The Adventure of Lludd and Llefelys" and (4) the French Arthurian romances "Owain and Luned" (or "The Lady of the Fountain"), "Geraint and Enid" and "Peredur son of Efrawg." These anonymous tales, taken from oral stories. are based on mythology. folklore. heroic traditions and etiological elements and range from the second half of the 11th century to the close of the 13th century.

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(T. Js.)

MABUSE (MALBODIUS), **JAN** (JAN GOSSAERT or JENNI GOSSART) (*c.* 1478–1532), was the name adopted (from Maubeuge in northern France. where he or his family originally came from) by the Flemish painter Jan Gossaert. He is most likely to be identified with the Jennyn van Hennegouwe who registered as master in the guild of St. Luke at Antwerp in 1503. His most important early work extant is the "Adoration of the Kings" in the National gallery, London. which is signed by him. There he throws together some 30 figures on an architectural background. carefully elaborated and Romanesque in style. He surprises us by pompous costume. His figures, like pieces on a chessboard, are often rigid and conventional. The landscape which shows through the ruined architecture is adorned with towers and steeples in minute fashion. This picture, probably painted for the abbey of St. Adrian, Grammont, is the work of a man trained in the old Flemish traditions.

That he was an admirer of Jan van Eyck is shown by his picture in Madrid of "Jesus, the Virgin and the Baptist," in Gothic framework One of hlabuse's most distinguished works, the little triptych at Palermo was probably also painted at this early period. Jean Carondelet, who was Mabuse's patron, was archbishop of Palermo and chancellor of Flanders, and he probably transferred the picture to Sicily. It is a wonderful piece of pictorial elaboration. containing features taken from Dürer. 'Another early mork is the moonlight scene representing "The Agony in the Garden," in the Berlin museum.

After living for a few years at Antwerp, Mabuse took service with Philip. bastard of Philip the Good, at that time lord of Somerdyk and admiral of Zeeland One of his pictures had already become celebrated—a "Descent From the Cross" uith 50 figures, ordered by Philip of Burgundy for the high altar of the church of Middelburg; and the value which was then set on the picture is apparent from the fact that in 1521 Diirer came expressly to Middelburg to see it, noting in his diary that it was not so good in design as in execution. In 1j68 the altarpiece perished by fire A smaller "Descent From the Cross," seen by Van Mander at Delft, is probably the one now in the Hermitage at Leningrad. In 1508 Mabuse accompanied Philip of Burgundy on his Italian mission, and this led to an important revolution in the art of the Netherlands. Mabuse not only brought home a new style. but also introduced the fashion of traveling to Italy; and from that time until the age of Rubens and Van Dyck it was considered proper that all Flemish painters should visit the peninsula.

In the summer of 1509 Philip returned to the Ketherlands, and, retiring to his seat of Suytburg in Zeeland, surrendered himself to the pleasures of planning decorations for his castle and ordering pictures from Mabuse and Jacopo de Barbari. Being in constant communication nith the court of Margaret of Austria at Malines, he gave the artists in his employ fair chances of promotion Barbari nas made court painter to the regent. while Mabuse received less important commissions. Records prove that Mabuse painted a portrait of Leonora of Portugal, and other small pieces, for Charles V in 1516. But his only signed pictures of this period are the "Neptune and Amphitrite" of 1j16 at Berlin. the composition of which is taken from Durer's famous engraving, and the Madonna, with a portrait of Carondelet of 1517, at the Louvre. In these last two we clearly discern that Giorgio Vasari only spoke by hearsay of the progress made by Mabuse in "the true method of producing pictures full of nude figures and poesies," for the types are ugly, though drann delicately and modeled elaborately. Of similar type is the "Hercules and Deianira," dated 1517, in the Barber institute, Birmingham. In later forms of the same subject—the "Adam and Eve" at Hampton court, or the other version at Berlin—we observe more nudity. combined nith realism.

Mabuse's "St. Luke Painting the Portrait of the Virgin" in the Narodni Galerie at Prague, and a variety of the same subject in the Vienna museum, prove that travel had left many of Mabuse's fundamental peculiarities unaltered. His figures still retain the character of stone; his architecture, now in Italian Renaissance style. is as rich and varied; his tones are as strong as ever. But bright contrasts of gaudy tints are replaced by soberer grays, and a cold haze pervades the surfaces. In this form the Madonnas of Munich (1527) and Vienna. in the collections of Max Wassermann in Paris. and E. Simon in Berlin, are fair specimens of his skill.

As early as 1523, when Christian II of Denmark came to Belgium, he asked Mabuse to paint the likenesses of his dwarfs. In 1528 he requested the artist to suppress the design for his Queen Isabella's tomb and epitaph in the Abbey of St. Pierre near Ghent. It was no doubt at this time that Mabuse completed the portraits of John. Dorothy and Christine, children of Christian II. of which replicas are at Hampton court, at Wilton house and at Longford castle, Wiltshire. It is as a portrait painter that Mabuse can be seen to the best advantage. His portraits of Carondelet in the collection of M von Guttmann in Vienna and L. Hirsch in London; of Marquise de Vere in the Gardner museum at Boston, Mass., and others in the galleries of Copenhagen, London, Paris, Berlin, and in the Pratt collection, New York city, are remarkable for their strength and plasticity. In his later portraits the rendering of the hands becomes remarkably expressive of the sitter's personality. Carondelet's portrait in Vienna formed part of a diptych. The opposite wing is now in the Tournay museum and carries a half-length of St. Donatian. This diptych is one of the most powerful works of Mabuse.

When Philip of Burgundy became bishop of Utrecht, and settled at Duerstede, near Wyck, in 1517, he was accompanied by Mabuse, who helped to decorate the new palace of his master. At Philip's death. in 1524, Mabuse retired to Middelburg, where he took service with Philip's nephew, Adolph, lord of Veeren. He died at Breda in 1532.

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MAC, a Gaelic word meaning "son," and the distinguishing prefix in a large number of Scots and Irish personal names; frequently contracted to Mc and M' in the written form. Its use in forming Celtic patronymics is ancient in both Scots and Irish records, and may be compared with Welsh Xp (originally *mab* or map, the Brythonic equivalent of *mac*), Irish O' in such names as O'Donnell (Scots MacDonald and MacDonnell) and Anglo-Norman Fitz, etc. In the 8th century the Pictish king Angus MacFergus (Aonghas MacFhearghuis) prepared the way for the union of Picts and Scots, and in the following century Kenneth MacAlpin became the founder of the first dynasty to rule over a united Scotland; Shakespeare's *Macbeth* has rendered familiar the name of MacAlpin's descendant two centuries later on the Scottish throne. The advent of the Norsemen, and their colonization of the outer isles from the Shetlands to the Isle of Man and Northern Ireland, accounts for a number of Celticized names of old Norse origin which now also make their appearance, such as the Gaelic *mac Amhlaibh, mac Mhanuis, mac Iamhair,* etc., from old Norse Olaf or Olave, Magnus or Manus, Ivar or Ingvar, Thorketill, Lochlann. from which the more familiar forms of Macaulay. MacManus, MacIvor, MacCorquodale, Maclachan are derived. Association of the prefix with English names, such as M'Ritchie, M'Dicken, M'Cutcheon, M'Watt (*i.e.,* Richardson, Dickinson, Hutchinson, Walter's son) is uncommon and always late in origin.

The Celtic names so formed are both fewer in number and more regular in structure than the wide diversity of forms and spellings that have been derived from them. Ferguson. Farquharson, Duncanson are more correctly rendered in the original "Fergus' son," or Fergusson, etc. (though using a prefix in place of a suffix). From *mac* Aonghais, son of Angus, come M'Ainsh, M'Innes. M'Quinness (Ir M'Guinness), M'Neish; from *mac* Coinneach, son of Kenneth, M'Kinnie, M'Kenzie, M'Kenna, M'Whinnie; from *mac* Eachainn, son of Hector, come M'Kechnie, M'Geachie, M'Kichan; while Meikleham from M'Ilquham shows a still further process of change by ellipsis. (Cf. Welsh Map-Richard and Map-Rhys, which became Ap-Ritchard, Ap-Rhys, and finally Pritchard, Price and Bryce.) The conversion of the Gaelic inflected *mh* and bh into its equivalent sound of v is also common, as M'Vanish son of Manus, from MacMhanuis; M'Tavish. son of Thomas, from MacTamhais, etc. (Cf. Scott's Vic Ian Vor in *Waverley,* i.e., *Mhic* lain *Mhór,* Son of Big John.)

Among the elements that enter into these name processes, besides the simple personal names, such as MacGregor, MacFarlane, MacAlister, from Gregory, Bartholomew (Gael. Parlain), Alexander (Gael Alasdair), are names of crafts, rank, personal description, etc.. such as Macduff from Gaelic dubh, dark. whence also M'Duffie. M'Phee, M'Fie; M'Dougall and M'Dowall from dubh ghal or Dugald. the dark stranger, MacFarquhar from *fhear* char, the dear man; MacKinnon, the fair born, and MacIntyre (*Mac* nn t-snoir), son of the carpenter, besides a number of names of religious origin. such as M'Kellar, M'Nab. M'Gillespie, M'Taggart (*Mac* an t-sagaart). son of the prior abbot, bishop, priest (another form of which is M'Millan, the bald or

Names incorporating initial Gil, Il, Le, etc.. are derivatives from *gille* or *ghill',* a lad or servant, which is common to names of religious origin and in naming after saints, as M'Gilchrist (*Mac gille* Chriosd), M'Ilhose or Maclehose, M'Gillivray or M'Ilwraith. M'Lean, M'Clure, son of the servant of Christ, of Jesus, of judgment (bhràith), of John, and of the Book (Leabhair) or Bible. MacIntosh (*Mac* an tdisclz), son of the chief, is an instance of a name of rank. In Celtic Scotland the *tòiseach* was the head of a district under the *maormaers* or stewards of the great provinces. who later became earls, while tdiseach is frequently translated thane in English, though without the English sense. Under the clan system which reached its greatest development later, it may be more exactly rendered the chief of the clan in a particular district. It is also owing to this community system that the use of the patronymic to decide relationship. at first of father and son, and by extension all children or descendants. became part of the social heritage and structure of the Scots, and took the place of the feudal relationships which spread elsewhere.

Bibliography.—A. MacBain, *Outlines of Gaelic Etymology* (1909); *Etymology of the Principal National Nanzes, Personal Names and Surnames* (1911); J. B. Johnston, *The Scottish Macs* (1922); *W.* J. Watson, *The History of the Place Names of Scotland* (1926). *See* also under Clan; Tartan, etc.

MACABEBE, a municipality (with administrative centre and 18 barrios or districts) of the province of Pampanga, Luzon, Philippine Islands, on the Pampanga river, about 10 mi. above its mouth and about 25 mi. N.W. from Manila. Pop. (1948) 17,637. Macabebe was long a recruiting ground for the Spanish *guardia* civil and later for the Philippine scouts which formed an adjunct of the United States army in the archipelago. The inhabitants are traders who travel. Agriculture is also a leading industry, the principal crops being palay (rice) and sugar. Alcohol is distilled from the nipa palm and abaci (Manila hemp) and cotton fabrics are woven into cloth. Pampango is the vernacular.

MACABRE: see Dance of Death.

McADAM, JOHN LOUDON (1756–1836), Scottish inventor, who gave his name to the system of road making known as "macadamizing," was born at Ayr. Scot., on Sept. 21, 1756. In 1770 he went to New York city, entering the countinghouse of a merchant uncle. He returned to Scotland with a considerable fortune in 1783, and purchased an estate at Sauhrie, Ayrshire. The highways of Great Britain were at this time in a very bad condition, and McAdam, who was a road trustee in his district, at once began to consider how to effect reforms. At his own expense he began at Sauhrie, despite much opposition, a series of experiments in road making.

In 1798 McAdam moved to Falmouth, where he had received a government appointment, and continued his experiments there. His general conclusion was that roads should be constructed of broken stone (see Roads and Streets). In 1815. having been appointed surveyor general of the Bristol roads, he was able to put his theories into practice. In 1819 he published a Practical Essay on the *Scientific* Repair and Preservation of Roads, followed, in 1820, by the Present State of Road-making. In 182; he mas appointed by the government general surveyor of roads.

He died at Moffat. Dumfriesshire, on Nov. 26, 1836.

See M. R. *R.* Pember-Devereux, *The Colossus of Roads: a Life of John Loudon McAdam* (1936).

McADOO, WILLIAM GIBBS (1863–1941), U.S. lawyer and politician. was born near Marietta: Ga., Oct. 31, 1863. He entered the University of Tennessee but did not finish his course. In 1882 he became clerk in the U.S. circuit court of Chattanooga: read law and three years later was admitted to the bar. He began practice in Chattanooga, but in 1892 removed to New York city. There he became interested in the problem of passenger transportation. In 1902 he formed the New York and New Jersey Railroad company. which took over the abandoned Hudson river tunnel from Hoboken to New York, and in March 1904 this tunnel was completed. In 1909 the tunnel under the Hudson river to downtown New York also was finished. He was a strong supporter of Woodrow Wilson for president. and on the latter's election he was appointed, in 1913, secretary of the treasury. In this position he contributed largely to the working out of the new federal reserve banks system.

After C.S. entrance into World War I he was called upon to raise very large sums of money He was successiul in floating four Liberty Loans betneen May 1917 and Oct. 1918. amounting in all to more than $18,000,000,000. He also secured the creation of a bureau of war risk insurance for shipping, later extended to include life insurance for soldiers and sailors in World War I. When the railways were taken over by the federal government in 1917 he was appointed director-general He favoured the League of Nations, woman suffrage and the prohibition amendment. He resigned the secretaryship of the treasury in Dec. 1918, and the directorship of railways the following January. He then resumed the practice of law, first in New York and later at Los Angeles, Calif. McAdoo emerged from public service as the acknonledged leader of a large segment of the Democratic party. He made a strong showing as a candidate at the nominating convention in San Francisco in 1920. On the first ballot he received the highest number of votes, but the nomination finally went to James M. Cox. McAdoo's candidacy for the nomination in 1924 at New York, where a near majority of the delegates supported him, precipitated the famous deadlocked convention nhich. after 16 days, nominated John W. Davis on the 103rd ballot. McAdoo was elect'ed United States senator from California for the term 1933–39, and supported the New Deal policies of Pres. Franklin D. Roosevelt, whom he had helped to nominate in 1932. McAdoo died in Washington, D.C., on Feb. 1. 1941. His career is well-documented by the large collection of his personal papers in the Library of Congress. An autobiography, *Crowded Years,* was published in 1931.

MACAIRE, a French *chanson de geste. Macaire* (12th century) and *La Reine Sibille* (14th century) are two versions of the story of the false accusation brought against the queen of Charlemagne, called Blanchefleur in *Macaire* and Sibille in the later poem. *Macaire* is preserved only in the Franco-Venetian *geste* of Charlemagne (Bibl. St. Mark ms. fr. xiii). *La Reine Sibille* exists only in fragments. but the tale is given in the chronicle of Alberic Trium Fontium and in a prose version. *Macaire* combines two legends: that of the unjustly repudiated wife and that of the dog who detects the murderer of his master. (For the former motive *see* GENEVIÈVE OF BRABANT.) The second is found in Plutarch, *Script. moral.,* where a dog, like Aubri's hound. stayed three days without food by the body of its master, and subsequently attacked the murderers. thus leading to their discovery. The duel between Macaire and the dog is paralleled by an interpolation by Giraldus Cambrensis in a manuscript of the *Hexameron* of St. Ambrose. Aubri's hound received the name of the "dog of Montargis," because a representation of the story was painted on a chimney piece in the château of Jlontargis in the 15th century. The tale was early divorced from Carolingian tradition. and Jean de la Taille. in his *Discours notable des duels* (1607). places the incident under Charles V.

See *Macaire* (1866). ed. *by* Guessard in the series of *Anc. poètes de la France; P.* Paris in *Hist. litt. de la France,* vol. xxiii (1873) ; L. Gautier, *Épopées françaises,* vol. iii, 2nd ed. (1880) ; G. Paris, *Hist. poét. de Charlemagne* (1865) ; M. J. G. Isola. *Storie nerbonesi,* vol. i (1877) ; F. Wolf. *Über die beiden . . . Volksbücher von der K. Sibille u. Huon de Bordeaux* (1857), *Über die neuesten Leistungen der Franzosen* (1833).

McALESTER, city and seat of Pittsburg county. Okla.. U.S., 120 mi. S.E. of Oklahoma City. was developed in 1870 from a Choctaw and Chickasaw Indian territory trading post built by a pioneer settler. J. J. McAlester. for whom it was named. at the crossroads of the well-traveled California trail and Texas road. Its early settlement resulted from coal mining and the construction of the Jlissouri-Kansas-Texas railroad, later crossed by the Rock Island railroad. Thereafter it became a trade centre for a diversified farming area (cotton, corn, oats, dairy products). When coal and cotton production diminished in the 1920s. livestock, meat packing and clothing manufacture became significant. In 1906 the city of South McAlester (incorporated in 1899) and McAlester were amalgamated. and in 1919 the commission-manager form of municipal government was adopted.

Long a centre of Freemasonry, McAlester is known for its temple. Indian-Scottish Rite consistory, and as the birthplace and headquarters of the Order of the Rainbow for girls. It is the site of the Oklahoma state penitentiary, and a large U.S. naval ammunition depot is nearby. For comparative population figures *see* table in OKLAHOMA: *Population.* (J. D. Mo.)

McALLEN, a city of Hidalgo county, in southeastern Texas, U.S., about 50 mi. W.N.W. of Brownsville and 7 mi. from the International bridge over the Rio Grande at Reynosa, Mex. It was founded in 1905, incorporated in 1911 and named for John McAllen, a Scottish settler from whose ranch the townsite was carved. McAllen is a leading winter resort. It is the centre of oil-field operations in the Lower Rio Grande valley. McAllen is also a packing and shipping centre for an irrigated district devoted to citrus culture and vegetables, and a port of entry for trade with Mexico. hlanufactures include clothing, food processing and petroleum products For comparative population figures *see* table in TEXAS: *Population.* (O. Mo.)

MACALPINE (MACCABEUS), **JOHN** (d. 1557), Scottish reformer and theologian, was from 1532 to 1534 prior of the Dominican convent of Perth; but having in the latter year been summoned with Alexander Ales and others to answer for heresy before the bishop of Ross. he fled to England. where he was granted letters of denization on April 7, 1537, and married Agnes Macheson, a fellow exile for religion; her sister Elizabeth became the wife of Miles Coverdale. The reaction of 1539 made England a doubtful refuge and on Nov. 25, 1540, Macalpine matriculated at the University of Wittenberg, Ger. In 1542, having assumed the name of Maccabeus or Machabeus. he became professor of theology at the University of Copenhagen. There he took a prominent part in building up the Lutheran Church of Denmark. A joint exposure by Peter Plade and Macalpine of Andreas Osiander's errors was published in 1552 and reprinted at Leipzig and Copenhagen in 1768; and Macalpine was one of the four translators of Luther's German Bible into Danish. He died at Copenhagen on Dec. 6, 1557.

MACAO, a Portuguese colony on the coast of South China, on the west side of the entrance to the Canton river, opposite to and about 35 mi. distant from Hong Kong Island. It comprises the peninsula of Macao and the small islands of Taipa and Colôane: the area of the whole colony being about six square miles. On the peninsula, which is about three miles long and a mile broad, is situated the picturesque city of Macao, extending up a hillside to overlook a fine bay. Its multicoloured buildings reveal a quaint combination of oriental and European features. The mean monthly temperature reaches 84° F. in July, but in no month falls below 60° F. Its tropical climate. with an annual rainfall of 60 in.. is relieved by southwest sea breezes This, with the 124 good schools. as well as the unrestricted gaiety, has attracted many well-to-do Chinese and European residents.

Direct trade by sea between Europe and China began through Portuguese enterprise as early as 1516. Macao was established in 1557 and is the oldest European outpost in the trade with China It was an early centre of Jesuit missionary activity and in 1580 the bishopric of Macao, which includes also Timor (East Indies) and the Christians of Malacca and Singapore, was created; in 1680 the first governor was appointed, but the Portuguese remained largely under the control of the Chinese nith nhom there nere constant disputes concerning the extent of Portuguese jurisdiction. A rental was paid for the peninsula until 1849, when the Portuguese abolished the Chinese customs house and declared the independence of the port. It was not. however, until 1887 that China formally recognized Portuguese sovereign rights in a treaty whereby China confirmed the perpetual occupation and government of Macao and its dependencies by Portugal, which in turn undertook never to alienate Macao and its dependencies without the consent of China, and to co-operate in the work of the opium revenue at Macao on the same lines as Great Britain at Hong Kong. This did not put an end to disputes, and the delimitation of the colonial boundaries is still an unsettled question.

During the 18th century Macao was the chief centre in the

Sino-European trade, but the rapid development of Hong Kong (ceded to Great Britain in 1842) was responsible for its decline, as also was the rapid silting of Macao harbour. As a free port it remained a distribution centre for rice, fish, lumber, silk, piece goods and oil; but it also had an unenviable reputation for opium smuggling and gambling. The League of Nations' efforts reduced its opium trade value from $1,500,000 (U.S.) to about $200,000 (U.S.) before 1939. In 1939, after the capture of Canton and the closure of the Hong Kong-Kowloon border, Macao enjoyed briefly the available import and export trade of South China. The Lappa Customs figures are: Imports, 1938, $784,359 (U.S.), 1939, $3,184,288 (U.S.); Exports, 1938, $1,503,074 (U.S.), 1939 $2,384,425 (U.S.). In 1938, 6,406 vessels cleared the port, a total of more than 3,100,000 tons. Its fishing industry employed about 1,800 junks and 40,000 people, and distributed annually more than $750,000 (U.S.) worth of fish to neighbouring cities of the Canton delta. The great bulk of the fish exported is salted. and Macao's position as the second fish port in China is in large measure due to the imports of foreign salt, which is much cheaper than Chinese government-taxed salt. The chief manufactures are those of cement, preserves, fire-crackers, vegetable oil, and also metalworking.

In 1920 a definite scheme for harbour improvement was launched and a contract placed with the Netherlands Harbour Works. The construction of an artificial deepwater harbour began in 1923; and this entailed the dredging of a four-mile channel to the open sea. These harbour works were completed in 1926, having cost $10,000,000, and have led to the reclamation of 130 acres of land surface.

Pop. (1940) 374,737; (1950) 187,772 (2,942 Portuguese); (1960) 169,299. The so-called Macanese are descended from the original 1,000 Portuguese families, now with a dominance of Chinese blood through intermarriage. Revenue is derived from ground rents, industrial taxes, gambling and opium monopolies, and the 1942 budget was 46,798,761 escudos. The city, with its famous 1½-mi. long Praia Grande, comprises a Chinese and a non-Chinese ward under separate administration. In March 1940, the Japanese army demanded Portuguese recognition of the near-by "puppet" government at Chungshan, the evacuation of Portuguese troops from the islands of Lappa and Wantsai, and the right of house-to-house search in Macao, etc. In Aug. 1943 Japanese troops seized the British steamer *Sian* in Macao, killing some 20 guards. In September they demanded the installation of Japanese "advisers" under the alternative of military occupation.

MACAQUE, a name for the monkeys of the mainly Asiatic genus *Macaca,* of which one species, the Barbary ape, inhabits North Africa and the rock of Gibraltar. Displaying great variation in the length of the tail, macaques are heavily built monkeys, with longer muzzles than their compatriots the langurs *(see* PRIMATES), and large naked callosities on the buttocks. They range over India and Ceylon, thence northward to Tibet. and eastwards to China, Japan, Formosa, and the Malay region. Mention of the more important species is made in the article PRIMATES. Like most monkeys, macaques go about in troops, each headed by an old male. They feed on seeds, fruits, insects, lizards, etc.; and several of the species are mainly terrestrial.

MACARA, SIR CHARLES WRIGHT (1845–1929), 1st Bart. (cr. 1911), English business man, was born on Jan. 11, 1845, at Strathmiglo, Fifeshire, and educated privately and at Edinburgh. From 1892 for 34 years he acted as chairman of the Manchester and district cotton employers' association, and was partly responsible for the Brooklands agreement which ended the strike of 1892. He acted as president of various associations connected with the cotton trade, taking an active part in their work. and the establishment of the Industrial Council by the government in 1911 was largely due to his efforts. From 1912 to 1916 he was president of the Employers' Parliamentary Association, and in September 1922 was appointed chairman of the provisional emergency cotton committee, set up to consider the action to be taken in view of the state of the cotton trade. He died Jan. 2, 1929.

His many publications on social and industrial questions include: *Social and Industrial Reform* (1918); *Recollections* (1921); *Getting the World to Work* (1922); *Trade Stability and how to obtain it* (1925); *Modern Industrial Tendencies* (1926).

MACARONI, a preparation of a glutinous wheat originally peculiar to Italy, where it is an article of food of national importance (from dialectic Ital. *maccare,* to bruise or crush). The same substance in different forms is also known as *vermicelli, pasta* or Italian pastes, *spaghetti, taglioni, fanti,* etc. These substances are prepared from the hard, semi-translucent varieties of wheat which are largely cultivated in the south of Europe, Algeria and other warm regions, and distinguished by the Italians as *grano duro* or *grano da semolino.* These wheats are much richer in gluten and other nitrogenous compounds than the soft or tender wheats of more northern regions, and their preparations are more easily preserved. The various preparations are met with as fine thin threads (vermicelli), thin sticks and pipes (spaghetti, macaroni), small lozenges, stars, discs, ellipses, etc. (pastes). These various forms are prepared in a uniform manner from a granular product of hard wheat, which, under the name of semolina or middlings, is a commercial article.

The semolina is thoroughly mixed with boiling water and incorporated in a kneading machine, such as is used in bakeries, into a stiff paste or dough. It is then further kneaded by passing frequently between rollers or under edge runners, till a homogeneous mass has been produced which is placed in a strong steam-jacketed cylinder, the lower end of which is closed with a thick disc pierced with openings corresponding with the diameter or section of the article to be made. Into this cylinder an accurately fitting plunger or piston is introduced and subjected to very great pressure, which causes the stiff dough to squeeze out through the openings in the disc in continuous threads, sticks or pipes, as the case may be. Vermicelli is cut off in short bundles and laid on trays to dry, while macaroni is dried by hanging it in longer lengths over wooden rods in stoves or heated apartments through which currents of air are driven. It is only genuine macaroni, rich in gluten, which can be dried in this manner; spurious fabrications will not bear their own weight, and must, therefore, be laid out flat to be dried. In making pastes the cylinder is closed with a disc pierced with holes having the sectional form of the pastes, and set of knives revolving close against the external surface of the disc cuts off the paste in thin sections as it exudes from each opening.

True macaroni can be distinguished by observing the flattened mark of the rod over which it has been dried within the bend of the tubes; it has a soft yellowish colour, is rough in texture, elastic and hard, and breaks with a smooth glassy fracture. In boiling it swells up to double its original size without becoming pasty or adhesive. It can be kept any length of time without alteration or deterioration.

MACARONICS, burlesque poetry, in which modern words with Latin endings are introduced into Latin verse, so as to produce a ridiculous effect. Sometimes Greek is used instead of Latin. The founder of the practice was Teofilo Folengo (1491–1544), whose mock-heroic *Liber Macaronicus* appeared in 1517. Folengo (*q.v.*) was a Benedictine monk, who escaped from his monastery and lived a dissolute life, supporting himself by his absurd verses, which he described as an attempt to produce in literature something like macaroni, a gross, rude and rustic mixture of flour, cheese and butter. His poem is a burlesque epic, containing an extraordinary medley of chivalrous feats, ridiculous and squalid adventures and satirical allegory. Its effect upon Rabelais was so extraordinary that no examination of *Pantagruel* can be complete without a reference to it. It was imitated in Italy by a number of minor poets; and in France Antonius de Arena published at Avignon in 1573 a burlesque account of Charles V.'s disastrous campaign in Provence. Folengo in Italy and Arena in France are regarded as the macaronic classics. Great popularity was achieved later by an anonymous macaronic, *Funestissimus trespassus Micheli Morini,* who died by falling off the bianch of an elmtree:—

De branche in brancham degringolat, et faciens pouf
Ex ormo cadit, et clunes obvertit Olympo.

Molière employed macaronic verse in the ceremonial scene with the doctors in Le *Malade imaginaire.* Works in macaronic prose are rarer. An Anti-Clopinus by Antony Hotman may be mentioned and the *Epistolae obscurorum virorum* (1515).

The use of true macaronics has never been frequent in Great Britain, where the only prominent example of it is the *Polemo-Middinia* ascribed to William Drummond (*q.v*). This describes a quarrel between two villages on the Firth of Forth.

MacARTHUR, ARTHUR (1845–1912), U.S. army officer, was born at Chicopee Falls, Mass, June 2, 1845. He served throughout the American Civil War in the 24th Wisconsin volunteer infantry, being advanced through the ranks from lieutenant to colonel of the regiment when but 20 years of age. His regiment gained fame in Gen. Philip Sheridan's division of the Army of the Cumberland nhere he was affectionately known as the "Boy Colonel of the West." He was wounded three times, brevetted four times, and cited for "gallant and meritorious service" in the battles of Perryville, Stone River. Missionary Ridge, Resaca, Dalton, Jonesboro, Kenesaw Mountain, Atlanta and Franklin. He mas anarded the Medal of Honor for seizing the colours of his regiment at a critical moment and planting them on the captured works on the crest of Missionary Ridge. At the close of the nar he entered the regular army and from 1866 to 1886 participated in Indian campaigns in the southwest. At the outbreak of the Spanish-American War (1898) he was appointed a brigadier general and assigned to the Philippine command. His brigade captured the town of Malate and thus prepared the way for the taking of Manila. He was cited by Gen. Wesley Merritt for gallantry and conspicuous service and appointed a major general to command the 2nd division. When the insurrection under Gen. Emilio Aguinaldo broke out in February of 1899 he commanded the main column which defeated the insurgents. He succeeded Gen. E. S. Otis in command of the 8th corps, the army of the Philippines, and as the military governor. In the latter capacity (1900–01) he helped to lay the foundations for a free and independent Philippine republic, introducing the nrit of habeas corpus, revising the Spanish law and establishing the free public school system and other democratic concepts. During the Russo-Japanese War he was detailed as a special observer with the Japanese army. In 1906 he was appointed a lieutenant general and became the senior ranking officer of the U.S. army. He retired from the army in 1909 and died Sept. 5, 1912, at Milnaukee, Wis. (D. MacA.)

MacARTHUR, DOUGLAS (1880–), U.S. army officer who commanded Allied forces in the Pacific during World War II, served as supreme commander of occupation forces in Japan and of United Nations forces during the first nine months of the Korean war, was born on Jan. 26, 1880, at Little Rock barracks, Ark., the son of Arthur MacArthur (*q.v.*). In 1903 he graduated from the G.S. Military academy, West Point. first in his class and senior officer in the corps of cadets. He served with the military survey in the Philippines and on a study of colonial lands in the far east, including Korea (1905). He took part in the Veracruz (Mexico) expedition (1914), and in World War I rose to command the 42nd (Rainbow) division. After the mar he was put in charge of the U S. occupation sector along the Rhine. He served as superintendent of the G.S. Military academy (1919–22) and in 1925 was a member of the court-martial which tried aviation advocate Col. William ("Billy") Mitchell (*q.v.*). Although MacArthur is popularly believed to have voted for acquittal at this famous trial, the actual voting of the court members was, according to standard army procedure, not revealed. He served as department commander in the Philippines (1928–30) and as US. army chief of staff (1930–35). In preparation for Philippine independence. MacArthur, in 1935, was appointed military adviser to organize the islands' defenses. He was made a field marshal in the Philippine commonnealth army the folloning year, and continued to serve in the islands after his retirement from the G.S. army on Dec. 31, 1937.

World War **II.**—With tension mounting in the Pacific, MacArthur was recalled to active duty on July 26, 1941, to command U.S. and Philippine troops. When the Japanese attack came in December, his outnumbered forces made a heroic stand on Luzon, falling back to the Bataan peninsula and the island of Corregidor where they were forced to capitulate during April and May 1942. For this gallant defense MacArthur was awarded the medal of honor, the same decoration his father had received more than 50 years before. Ordered by Pres. Franklin D. Roosevelt to leave the Philippines before the surrender, MacArthur arrived in Australia on March 17, 1942, after a daring 3.000-mi. dash through enemy-controlled seas. He opened his offensive campaign in the fall of 1942 with the invasion of New Guinea, and began to retake the areas conquered by Japan in the war's initial stages. Approaching the Philippines in 1944, he was ordered to by-pass and neutralize them as he had many other Japanese strong points during the preceding two years. His arguments in favour of a Philippine invasion, however, persuaded President Roosevelt to allow him to retake the islands. Landings were made at Leyte in Oct. 1944 and by the following July the Philippines were again in Allied hands. Two months later, on Sept. 2, 1945, MacArthur, who had been appointed to the newly created rank of general of the army, accepted the Japanese surrender on board the *U.S.S. Missouri* in Tokyo bay. During the next five years, as supreme commander allied poners he supervised the reconstruction of Japan and the establishment there of a democratic form of government.

Korean **War.**—When North Korean Communist troops crossed the 38th parallel and invaded South Korea in June 1950, MacArthur was put in charge of UN forces. Despite heavy odds against him, he was finally able to stop the Communist advance near the port of Pusan and, with the arrival of fresh UN units, plan his offensive, a surprise landing by amphibious troops at Inchon. far to the enemy rear. Subordinates and other high military officials at first opposed the plan but MacArthur was able to convince them of its feasibility and on Sept. 15, 1950, U.S. marine and army units landed at Inchon. At the same time UN forces to the south broke out of the Pusan perimeter and rolled north to effect a juncture with the amphibious forces. During the next two months the North Korean army was routed and all but destroyed. The intervention of the Chinese Communists late in November precipitated what MacArthur called a "new war" and UN forces were forced to withdraw south of the 38th parallel. By March 1951 MacArthur, having stopped the Chinese advance, was able to resume the offensive. Contrary to the policy of Pres. Harry S. Truman (*q.v.*), with whom he had conferred in Oct. 1950 at Wake Island, MacArthur urged the bombing of Communist bases in Manchuria, the blockade of the Chinese coast and the employment of Chinese nationalist forces based on Formosa. This conflict of viens led to his being relieved of his command on April 11, 1951.

Returning to the U.S., MacArthur addressed both houses of congress in a memorable speech, outlining; explaining and defending his policies in the far east. Thereafter, having been placed on the active list for life as general of the army, he retired to private life. The folloning year he delivered the keynote address at the Republican national convention.

See World War II; Korean War; see also index references under "MacArthur, Douglas" in the Index volume.

MACASSAR (Makasar), the chief port in the island of Celebes, Indon., and capital of the government of Celebes and its dependencies. (Also spelled Makassar; native *M*angkasar.) The first Dutch settlement there was in 1607; it was known then as Vlaardingen. In 1618 the colonists were massacred, but in 1667 the power of the sultan of Macassar was shattered by the Dutch, who established themselves very firmly at Macassar, which served as a useful base in the Dutch operations against the sultans of states in Celebes. It had aluays been retarded by lack of harbour and wharf facilities, but after 1925 Macassar became a first-class port. The main commodities exported are copra, gums and resins, coffee and rattan; minor ones are kapok, ebony, maize, spices. hides and skins. It is normally the great centre for distribution of imports from Europe, America, India and the far east and destined for Celebes, the Moluccas, Lesser Sundas and New Guinea.

Macassar tonn, pop. (1956 est.) 346,085, is picturesque, seen from the sea. Parallel roads run from the harbour along by the sea. through old Macassar and China-town, to the old Fort Rotterdam, facing which there is a large green square containing a monument in memory of the officers and men who fell in the last expedition to south Celebes. Near the town's newer part is the grave of Dipa Negoro, leader of the Java rebellion of 1825, who was exiled and died there. The port was invaded and occupied by the Japanese from Feb. 1942 to the end of World War II. In 1949 it became part of the Republic of Indonesia.

The natives, the Mangkassaras, are a branch of the Malay race similar to if not identical with the Bugis (*q.v.*) of Sumatra.

(E. E. L.; X.)

MACAULAY, THOMAS BABINGTON MACAULAY, Baron (1800–1859), English historian, essayist and politician, was born at Rothley Temple, Leicestershire, on Oct. 25, 1800. His father Zachary Macaulay (1768–1838), had been governor of Sierra Leone, and was in 1800 secretary to the chartered company which had founded that colony; an ardent philanthropist, he was one of the group who worked for the abolition of the slave trade, and he edited the abolitionist organ, the *Christian Observer*, for many years. Before Thomas was eight years of age he had written a *Compendium of Universal History*, and a romance in the style of Scott, in three cantos, called *The Battle of Cheviot*. A little later he composed a long poem on the history of Olaus Magnus, and a vast pile of blank verse entitled *Fingal, a Poem in Twelve Books*. Young Macaulay was sent to a private school, then, in October 1818, he went to Trinity college, Cambridge, where he afterwards became a fellow. He gained in 1824 a college prize for an essay on the character of William III. He also won a prize for Latin declamation and a Craven scholarship, and wrote the prize poems of 1819 and 1821.

In 1826 Macaulay was called to the bar and joined the northern circuit. But he spent many more hours under the gallery of the house of commons than in the court. His first public speech, made at an anti-slavery meeting in 1824, was described by the *Edinburgh Review* as "a display of eloquence of rare and matured excellence." In Aug. 1825 began Macaulay's connection with the *Edinburgh Review*, which was at this time an organ of the growing opinion which leant towards reform, and a literary tribunal from which there was no appeal. His essay on Milton (Aug. 1825), so crude that the author afterwards said that "it contained scarcely a paragraph such as his matured judgment approved," established at once his great literary reputation. The sudden blaze of popularity kindled by this single essay, is partly to be explained by the dearth of literary criticism in England at that epoch. For, though a higher note had already been sounded by Hazlitt and Coleridge, the public mind was still satisfied with the feeble appreciations of the *Retrospective Review*, or the dashing and damnatory improvisation of Wilson in *Blackwood* or Jeffrey in the *Edinburgh*. Still it seems surprising that a social success so signal should have been the consequence of a single article. The explanation is that the writer of the article on Milton was also a brilliant talker. At the university Macaulay had been pre-eminent for inexhaustible talk and genial companionship among a circle of such brilliant young men as Charles Austin, Romilly, Praed and Villiers. He now displayed these gifts on a wider stage. He was courted and admired by the most distinguished personages of the day. He was admitted at Holland House, where Lady Holland listened to him with deference, and scolded him with a circumspection which was in itself a compliment. Samuel Rogers spoke of him with friendliness and to him with affection.

Macaulay now began to aspire to a political career. But commercial disaster fell on the house of Babington and Macaulay, and the son saw himself compelled to work for his livelihood. His Trinity fellowship of £300 a year expired in 1831; he could make at most £200 a year by writing; and a commissionership of bankruptcy, which was given him by Lord Lyndhurst in 1828 was swept away in 1830. Macaulay was reduced to such straits that he had to sell his Cambridge gold medal In Feb. 1830 he entered the House of Commons for the "pocket borough" of Calne, offered to him by Lord Lansdowne. The offer was accompanied by the express assurance that the patron had no wish to interfere with Macaulay's freedom of voting. Macaulay made his maiden speech on April 5, 1830, on the second reading of the bill for the Removal of Jewish Disabilities. In June the king died and parliament was dissolved; the revolution took place in Paris. Macaulay, who was again returned for Calne, visited Paris, eagerly enjoying a first taste of foreign travel. On March 1, 1831 the Reform Bill was introduced, and on the second night of the debate Macaulay made the first of his reform speeches, of which Sir Robert Peel said that "portions were as beautiful as anything I have ever heard or read." On the triumph of Earl Grey's cabinet, and the passing of the Reform Act in June 1832, Macaulay, whose eloquence had signalized every stage of the conflict, became one of the commissioners of the board of control, and applied himself to the study of Indian affairs. Giving his days to India and his nights to the House of Commons, he could only devote a few hours to literary composition by rising at five in the morning. Between Sept. 1831 and Dec. 1833 he furnished the *Edinburgh Review* with eight important articles, besides writing his ballad on the Armada.

In the first Reform parliament, Jan. 1833, Macaulay took his seat as one of the two members for the new borough of Leeds. He replied to O'Connell in the debate on the address, meeting the great agitator with high, but not intemperate, defiance. In July he defended the Government of India bill in a speech of great power, and he was instrumental in getting the bill through committee without unnecessary friction. When the abolition of slavery came before the house as a practical question, Macaulay had the prospect of having to surrender office or to vote for a modified abolition, *viz.*, twelve years' apprenticeship, which was proposed by the ministry, but condemned by the abolitionists. He placed his resignation in Lord Althorp's hands, and spoke against the ministerial proposal. But the sense of the house was so strongly expressed as unfavourable that, finding they would be beaten if they persisted, the ministry gave way and reduced apprenticeship to seven years, a compromise which the abolition party accepted; and Macaulay remained at the board of control. He then (1834) accepted a seat in the supreme council of India, created by the new India act. The salary of the office was fixed at £10,000, out of which he calculated to be able to save £30,000 in five years.

Macaulay's appointment to India occurred at the critical moment when the government of the company was being superseded by government by the crown. At this juncture there was more need of statesmanship directed by general liberal principles than of a practical knowledge of the details of Indian administration. The part he took in India has been described as "the application of sound liberal principles to a government which had till then been jealous, close and repressive." He vindicated the liberty of the press; he maintained the equality of Europeans and natives before the law; and as president of the committee of public instruction he inaugurated the system of national education. Macaulay was appointed president of a commission to inquire into Indian jurisprudence. The draft of a penal code which he submitted became the basis of the Indian criminal code.

In 1838 Macaulay and his sister Hannah, who had married Charles Trevelyan in 1834, returned to England. He at once entered parliament as member for Edinburgh. In 1839 he became secretary for war, with a seat in the cabinet in Lord Melbourne's ministry. His acceptance of office diverted him for a time from prosecuting the plan he had already formed of a great historical work. But in less than two years the Melbourne ministry fell. In 1842 appeared his *Lays of Ancient Rome*, and in the next year he collected and published his *Essays*. He returned to office in 1846, in Lord John Russell's administration, as paymaster general. In the sessions of 1846–47 he spoke only five times, and at the general election of July 1847 he lost his seat for Edinburgh. The balance of Macaulay's faculties had now passed to the side of literature. At an earlier date he had relished crowds and the excitement of ever new faces; as years went forward, and absorption in the work of composition took off the edge of his spirits, he recoiled from publicity.

He retired into private life with a sense of relief. He gradually withdrew from general society, but he still enjoyed close and constant intercourse with a circle of the most eminent men that London then contained. At that time social breakfasts were in vogue. Macaulay himself preferred this to any other form of entertainment. Of these brilliant reunions nothing has been preserved beyond the names of the men who formed them—Samuel Rogers, Henry Hallam, Sydney Smith, Lord Carlisle, Lord Stanhope, Nassau Senior, Charles Greville, Henry Hart Milman, Sir Anthony Panizzi, G. C. Lewis, Van de Weyer. His biographer thus describes Macaulay's appearance and bearing in conversation: "Sitting bolt upright, his hands resting on the arms of his chair, or folded over the handle of his walking-stick, knitting his eyebrows if the subject was one which had to be thought out as he went along, or brightening from the forehead downwards when a burst of humour was coming, his massive features and honest glance suited well with the manly sagacious sentiments which he set forth in his sonorous voice and in his racy and intelligible language. To get at his meaning people had never the need to think twice, and they certainly had seldom the time."

In these years he was working with unflagging industry at the composition of his *History*. His composition was slow, his corrections both of matter and style endless; he spared no pains to ascertain the facts. He sacrificed to the prosecution of his task a political career, house of commons fame, the allurements of society. The first two volumes of the *History of England* appeared in Dec. 1848. The success was in every way complete beyond expectation. The sale of edition after edition, both in England and the United States, was enormous.

In 1852, when his party returned to office, he refused a seat in the cabinet, but the city of Edinburgh returned him at the head of the poll at the general election in July of that year. He had hardly accepted the summons to return to parliamentary life before fatal weakness betrayed itself in deranged action of the heart; from this time forward till his death his strength continued steadily to sink. He was oppressed by the thought that the great work to which he had devoted himself would remain a fragment. Once again, in June 1853, he spoke in parliament, and with effect, against the exclusion of the master of the rolls from the house of commons, and at a later date in defense of competition for the Indian civil service. But he was aware that he made these efforts at the cost of more valuable work.

In Nov. 1855 volumes iii and iv of the *History* appeared and obtained a vast circulation. Within a generation of its first appearance more than 140,000 copies of the *History* were printed and sold in the United Kingdom alone; and in the United States the sales were on a correspondingly large scale. The *History* was translated into German, Polish, Danish, Swedish, Hungarian, Russian, Bohemian, Italian, French, Dutch and Spanish. Flattering marks of respect were heaped upon the author by foreign academies. His pecuniary profits were (for that time) on a scale commensurate with the reputation of the book: the cheque he received for £20,000 has become a landmark in literary history.

In May 1856 he quitted the Albany, in which he had passed 15 happy years, and went to live at Holly Lodge, Campden Hill,·then, before it was enlarged, a tiny bachelor's dwelling, but with a lawn whose unbroken slope of verdure gave it the air of a considerable country house. In the following year (1857) he was raised to the peerage by the title of Baron Macaulay of Rothley. But his health was every year visibly failing. In the house of lords he never spoke. Gradually he had to acquiesce in the conviction that his physical energies would not carry him through the reign of Anne; and, though he brought down the narrative to the death of William III, the last half volume wants the finish and completeness of the earlier portions. He died on Dec. 28, 1859. On Jan. 9, 1860, he was buried in Westminster abbey.

Lord Macaulay never married. A man of warm domestic affections, he found their satisfaction in the attachment and close sympathy of his sister Hannah, the wife of Sir Charles Trevelyan, Her children were to him as his own. Macaulay was a steadfast friend, and no act inconsistent with the strictest honour and integrity was ever imputed to him. When a poor man, and when salary was of consequence to him, he twice resigned office rather than make compliances for which he would not have been severely blamed. In 1847, when his seat in parliament was at stake, he would not be persuaded to humour, to temporize, even to conciliate. He had a keen relish for the good things of life. and desired fortune as the means of obtaining them; but there was nothing mercenary or selfish in his nature. When he had raised himself to opulence, he gave away with an open hand, not seldom rashly. His last act was to write a letter to a poor curate enclosing a cheque for £25. The purity of his morals was not associated with any tendency to cant.

The life of Macaulay was eminently happy. Till the closing years (1857–59), he enjoyed life with the full zest of healthy faculty, happy in social intercourse, happy in the solitude of his study, and equally divided between the two. For the last 15 years of his life he lived for literature. His writings were remunerative to him far beyond the ordinary measure, yet he never wrote for money. He lived in his historical researches; his whole heart and interest were unreservedly given to the men and the times of whom he read and wrote. His command of literature was imperial. Beginning with a good classical foundation, he made himself familiar with the imaginative, and then with the historical, remains of Greece and Rome. He went on to add the literature of his own country, of France, of Italy, of Spain. He learned Dutch enough for the purposes of his history. He read German, but for literature of the northern nations he had no taste, and of the erudite labours of the Germans he had little knowledge and formed an inadequate estimate. The range of his survey of human things had other limitations more considerable still. All philosophical speculation was alien to his mind; nor did he seem aware of the degree in which such speculation had influenced the progress of humanity. A large—the largest—part of ecclesiastical history lay outside his historical view. Of art he confessed himself ignorant and even refused a request to furnish a critique on Swift's poetry to the *Edinburgh* ***Review.*** He declared that Lessing's *Laocoon*, or Goethe's criticism on Hamlet, "filled" him "with wonder and despair."

Of the marvellous discoveries of science which were succeeding each other day by day he took no note; his pages contain no reference to them. It has been told already how he recoiled from the mathematical studies of his university. These deductions made, the circuit of his knowledge still remains very wide—as extensive perhaps as any human brain is competent to embrace. His literary outfit was as complete as has ever been possessed by any English writer; and, if it wants the illumination of philosophy, it has an equivalent resource in a practical acquaintance with affairs, with administration, with the interior of cabinets, and the humour of popular assemblies. Nor was the knowledge merely stored in his memory; it was always at his command. Whatever his subject, he pours over it his stream of illustration, drawn from the records of all ages and countries. His *Essays* are not merely instructive as history; they are, like Milton's blank verse, freighted with the spoils of all the ages. As an historian Macaulay has not escaped the charge of partisanship. He was a Whig; and in writing the history of the rise and triumph of Whig principles in the latter half of the 17th century he identified himself with the cause. But the charge of partiality, as urged against hfacaulay, means more than that he wrote the history of the Whig revolution from the point of view of those who made it. When he is describing the merits of friends and the faults of enemies his pen knows no moderation. He has a constant tendency to glaring colours, to strong effects, and will always be striking violent blows. He is not merely exuberant but excessive. There is an overweening confidence about his tone; he expresses himself in trenchant phrases, which are like challenges to an opponent to stand up and deny them. His propositions have no qualifications. Uninstructed readers like this assurance, as they like a physician who has no doubt about their case. But a sense of distrust grows upon the more circumspect reader as he follows page after page of Macaulay's categorical affirmations about matters which our own experience of life teaches us to be of a contingent nature. We inevitably think of a saying attributed to Lord Melbourne: "I wish I were as cocksure of any one thing as Macaulay is of everything" Macaulay's was the mind of the advocate, not of the philosopher; it was the mind of Bossuet, which admits no doubts or reserves itself and tolerates none in others, and as such was disqualified from that equitable balancing of evidence which is the primary function of the historian. (M. PA.; X.)

Macaulay's whale works were collected in 1866 by his sister, Lady Trevelyan, in 8 vols. The first four volumes are occupied by the *History;* the next three contain the *Essays,* and the *Lives* which he contributed to the *Encyclopædia Britannica.* In vol. viii are collected his *Speeches,* the *Lays of Ancient Ronze,* and some miscellaneous pieces. The "life" by Dean Milman, printed in vol. viii of the edition of 1858–1862, is prefixed to the "Peopleis Edition," 4 vol. (1863–1864). Longmans, Green & Co. published a complete edition, the "Albany," in 12 vol., in 1898. There are numerous editions of the *Critical and Historical Essays,* separately and collectively; they were edited in 1903 by F. C. Montagu.

The Life and Letters of Lord Macaulay, 2 vol. (1876), by his nephew, Sir George Otto Trevelpan, is one of the best biographies in the English language. His long correspondence with T. F. Ellis, which was utilized by Trevelyan in preparing the life, but only in part, was presented by Ellis's grandson to Trinity college, Cambridge, together with some unpublished poems and translations. The life (1882) in the "English Men of Letters" series was written by J. Cotter Morison. For further criticism, *see* Hepworth Dixon, in his *Life of Penn* (1841); John Paget, *The New Examen: Inquiry into Macaulay's History* (1861) and *Paradoxes and Puzzles* (1874); Walter Bagehot, in the *National Review* (Jan. 1856), reprinted in his *Literary Studies* (1879); James Spedding, *Evenings with a Reviewer* (1881), discussing his essay on Bacon; Sir L. Stephen, *Hours in a Library,* vol. ii (1892); Lord Morley, *Critical Miscellanies* (1877), vol. ii; Lord Avebury, *Essays and Addresses* (1903); Thum, *Anmerkungen zu Macaulay's History of England* (1882). A bibliography of German criticism of Macaulay is given in G. Korting's *Grd. der engl. Literatur,* 4th ed. (1905).

McAULEY, CATHERINE ELIZABETH (1787–1841), foundress of the Sisters of Mercy: was born in County Dublin, Ire., Sept. 29, 1787. The McAuley children, orphaned at an early age, were entirely dcpcndent on Protestant relatives, but Catherine could not be induced to join in Protestant worship. Left a small fortune, she invested it in a large building on Lower Baggot street, Dublin. and on Sept. 24, 1827, opened it as an institution for destitute women, orphans and the poor in need of schools.

At first there was no intention of forming a religious institute, but the work and way of life of Catherine McAuley's group soon led authorities to desire that they join the newly formed Irish Sisters of Charity. This situation was solved by the founding of a new congregation which was to combine the silence and prayer of the Carmelites with the active labours of the Sisters of Charity. The first novices were invested with the habit of the Sisters of Mercy on Dec. 12, 1831. At this same time Catherine McAuley was named superior, an .office she held for the remainder of her life. She died in Dublin on Nov. 11, 1841. Her cause for beatification has been handicapped by the lack of authenticated miracles and primary documents.

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McAULIFFE, ANTHONY CLEMENT (1898–), U.S. army officer in the European theatre during World War II, was born in Washington, D.C., July 2, 1898. He graduated from the United States Military academy at West Point in 1919 and was commissioned in the field artillery. After routine service and school appointments during peacetime, McAuliffe served with air-borne troops in World War II. He was acting commander of the 101st air-borne division in Dec. 1944 during the "battle of the bulge," and in this post his stout defense of Bastogne checked the German drive in the Ardennes and contributed to the ultimate German defeat. His terse reply to a German summons to surrender Bastogne—"Nuts!"—became a classic of World War II. During the postwar period, McAuliffe held various command and staff' appointments, ending his military career as commanding general of the 7th army in Germany in 1953–55 and as U.S. army commander in Europe in 1955–56. He retired from the army as a full general on May 31, 1956, to enter industry. (W. R. E.)

MACAW, any of about 18 species of very large, long-tailed, magnificent parrots (*q.v.*) confined to Central and South America, and having brilliant, contrasted colours, naked space around the eye and a powerful hooked beak used to crack very hard palm nuts.

Macaws are named for eating the violet-perfumed oil nuts of the macaw palm (*Acrocomia*) of Brazil. They fly well, have loud, harsh, screaming voices and are popular in zoological gardens. They are gregarious but monogamous. They lay two white eggs in hollow trees. They constitute two genera in the subfamily Psittacinae.

Most species belong to the genus Ara, with naked lores, the important species taking their names from their principal colours. The blue and yellow macaw (*A. ararauna*), eastern Panama to east-central Brazil and northern Paraguay, is blue with yellow-orange underparts; the red, blue and yellow macaw (*A. macao*), 33 in., tropical Mexico to tropical Brazil, is scarlet with blue and yellow on the wings; the red, blue and green macaw (*A. chloroptera*), eastern Panama to the Argentine Chaco and Misiones, is darker red with green instead of yellow on the wing; the green macaw (A. *militaris*), 27 in., tropical Mexico to tropical Bolivia, has blue back, rump, wings and tail. Several species, all extinct, once inhabited Cuba and the Isle of Pines, Martinique, Guadalupe and Jamaica. The little light-green *A. severa,* 17.5 in., lives in northern South America; A. *spixii,* 22 in., of eastern Brazil, is nearly uniform blue. Several other species, nearly uniform cobalt, hyacinthine or greenish blue, belong to the genus *Anodorhynchus,* with feathered lores. The hyacinthine macaw (A. *hyacinthinus*), nearly 3 ft., about ponds in dense forests of interior Brazil, lays its two eggs in a hole excavated in a bank; the green-blue macaw (*A. glaucus*) is found in Paraguay, Uruguay and southeastern Brazil, but the home of the rare Lear's macaw (*A. leari*) of Brazil has not been located. (G. F. Ss.)

MACBETH, king of Scotland (d. 1057), was the son of Findlaech, *mormaer* or hereditary ruler of Moreb (Moray and Ross), who had been murdered by his nephews in 1020. He probably became mormaer on the death of Malcolm, one of the murderers, in 1029, and he may have been one of the chiefs (the Maclbaethe of the Saxon Chronicle) who submitted to Canute in 1031.

Marianus records that in 1040 Duncan, the grandson and successor of Malcolm king of Scotland, was slain by Macbeth. Duncan had shortly before been defeated by Thorfinn, the Norwegian earl of Orkney and Caithness, and it was perhaps this event which tempted Macheth to seize the throne. As far as is known he had no claim to the crown except through his wife Gruach. who appears to have been a member of the royal family. Macbeth was a generous benefactor to the church, and according to S. Berchan, his reign was a time of prosperity. More thnn one attempt was made by members of the Scottish royal family to recover the throne; in 1045 by Crinan, the lay abbot of Dunkeld, son-in-law of Jfalcolm II, and in 1054 by Duncan's son Malcolm with the assistance of Siward, earl of Northumbria, himself a connection of the ousted dynasty. In 1057 Malcolm and Siward again invaded Scotland and defeated Macbeth, who was slain at Lumphanan. Macbeth is chiefly famous as the central figure of Shakespeare's great tragedy.

Sre W. F. Skme, *Chronicles of the Picts and Scots* (1867) and *Celtic Scotland* (1876); Sir J. Rhys, *Celtic Britain* (1904).

MACBETH, ROBERT WALKER (1848–1910), British painter, was born at Glasgow on Sept. 30, 1848. He studied art at the Royal Scottish Academy, and in 1871 came to London where he was for some time on the staff of the *Graphic.* Both as painter and etcher he was very popular. He died at Golders Green on Nov. 1, 1910. Among his best-known works are "Dunster Castle" (1895); "The End of a Good Day" (1897); and "Naval Manoeuvres" (1899).

McBRIDE, SIR RICHARD, K.C.M.G., 1912 (1870–1917), Canadian politician, was born at New Westminster on Dec. 15, 1870, and was educated first in that city and later at Dalhousie university. Halifax, Nova Scoria. He was called to the Canadian bar in 1892, and entered the British Columhian parliament as member for Dewdney in 1898. In 1900 he became minister of mines and in 1902 leader of the Opposition. In June 1903 he became prime minister for the province and retained that position until 1915, when he became agent-general for British Columbia in London. He died in London on Aug. 6, 1917.

MACCABEES, the name (in the plural) of a distinguished Jewish family dominant in Jerusalem in the 2nd century B.C., effective in preventing the destruction of Judaism by Hellenism. According to I Macc. ii, 4, the name Maccabee, or Maccabaeus, was originally the distinctive surname of Judas, third son of the Jewish priest Mattathias, who struck the first blow for religious liberty during the persecution under Antiochus IV Epiphanes. Subsequently, however, it obtained a wider significance, having been applied first to the kinsmen of Judas, then to his adherents, and ultimately to all champions of 'religion in the Greek period. It is now customary to apply it only to the sons and descendants of Illattathias. As, however. according to Josephus, this brave priest's great-great-grandfather was called Hasmon. the family is more correctly designated by the name of HASMONAEANS or ASMONEANS. If Maccabee is the original form of the name, it is derived from a Hebrew word which is generally believed to be *maqqabi*, "the hammerer"; hence Judas Maccabee is "Judas the Hammerer," with reference to his beating down the enemies of the Jewish nation. But as Judas was surnamed "the Maccabee" before his military exploits, it is perhaps more probable that the name is derived from the verb *maqab,* "to designate," "to appoint"; hence. "the one appointed [by Yahweh]" (A. Bevan in the Journal of Theological *Studies*, 30:191–193 [1929]).

The Maccabaean revolt was caused by the attempt of Antiochus IV, king of Syria, to force Hellenism upon Judaea (see SELEUCID DYNASTY; ANTIOCHUS). In Dec. 168 sacrifice was offered to Zeus upon an idol altar erected over the great altar of burnt offering. The issue of an edict ordaining the erection of heathen altars in every township of Palestine, and the appointment of officers to deal with recusants, brought matters to a crisis. At Modin, Mattathias, an aged priest, not only refused to offer the first 'sacrifice, but slew an apostate Jew who was about to step into the breach. Having thus given the signal for rebellion, he then with his five sons took to the mountains. Many, including the Hasidim ("the pious"). who had constituted themselves champions of the Law, flocked to his standard. and set themselves to revive Jewish rites and to uproot paganism. In 166 Mattathias died, after nominating Judas as their leader.

The military genius of Judas made this the most stirring chapter in Israelite history. In quick succession he overthrew the Syrian generals Apollonius, Seron and Gogias, and after the regent Lysias had shared the same fate at his hands he restored the Temple worship (165). These exploits dismayed his opponents and kindled the enthusiasm of his friends. When, however, Lysias returned in force to renew the contest. Judas had to fall back upon the Temple mount, and escaped defeat only because the Syrian leader was obliged to hasten back to Antioch in order to prevent a rival from seizing the regency. Under these circumstances Lysias unexpectedly guaranteed to the Jews their religious freedom (162). But though they had thus gained their end, the struggle did not cease. The Hasidim indeed were satisfied, and declined to fight longer, but the Maccabees determined not to desist until their nation was politically as well as religiously free.

In 161 Judas defeated Nicanor at Adasa, but within a few weeks thereafter, in a heroic struggle against superior numbers under Bacchides at Elasa, he was himself cut off. If in his brother Jonathan the cause which Judas had espoused did not possess so brilliant a soldier, it had in him an astute diplomatist who knew how to exploit the internal troubles of Syria. With all his cunning, Jonathan walked into a trap at Ptolemais, was made prisoner and ultimately slain (143). The leadership now devolved upon Simon, the last survivor of the sons of Mattathias, who succeeded in negotiating a treaty whereby the political independence of Judaea was at length secured in May 142. In the following year he was by popular decree invested with absolute powers, being appointed leader, high priest and ethnarch. As these offices were declared hereditary in his family, he became the founder of the Hasmonaean dynasty. The first year of his reign (143–142 B.C.) was made the beginning of a new era; issue of a Jewish coinage betokened the independence of his sovereignty. Under Simon's administration the country enjoyed prosperity! but in 13j he and two of his sons were murdered by Ptolemy, his son-in-law, who had an eye on the supreme power. Simon's third son, John Hyrcanus, warned in time. asserted his rights as hereditary head of the state.

After the death of Antiochus VII Sidetes in 128 left him a free hand. Hyrcanus (135–105) soon carved out for himself a large and prosperous kingdom, which, however, was rent by internal discord owing to the antagonism developed between the rival parties of the Pharisees and Sadducees. Hyrcanus was succeeded by his son Aristobulus, whose reign of but one year was followed by that of his brother, the warlike Alexander Jannaeus (104–78). The new king's Sadducean proclivities rendered him odious to the populace. which rose in revolt, but only to bring upon itself a savage revenge. The accession of his widow, Salome Alexandra (78–69), witnessed a complete reversal of the policy pursued by Jannaeus, for she chose to rule in accordance with the ideals of the Pharisees. Her elder son, Hyrcanus II, a pliable weakling, was appointed high priest; her younger son, the energetic Aristobulus, aho chafed at his exclusion from office, seized 20 strongholds and with an army bore down on Jerusalem. At this crisis Alexandra died, and Hyrcanus agreed to retire in favour of his brother.

A new and disturbing element now entered into Jewish politics in the person of the Idumaean Antipater, who for selfish ends deliberately made mischief between the brothers. An appeal to M. Aemilius Scaurus, who in 65 came into Syria as the legate of Pompey. led to the interference of the Romans, the siege of Jerusalem by Pompey and the vassalage of the Jews. Repeated but fruitless attempts were made by the Hasmonaeans and their patriotic supporters to throw off the Roman yoke. At length, in 40, the Parthians set up as king Antigonus, sole surviving son of Aristobulus. Through the execution of Antigonus by Mark Antony in 37 B.C. the Hasmonaean dynasty became extinct. *See* also JEWS: Greek and *Roman* Conquests; SELEUCID DYNASTY.

Another set of brothers, also called Maccabees (though not so named in II Macc. vii, where their story is given), who were executed because they refused to break the commands of the Jewish Law. were regarded as examples of martyrdom in the early Christian period and are celebrated as saints on Aug. 1 in both the eastern and western churches.

BIBLIOGRAPHY.—I and II Macc. and Josephus are the main sources for the Maccabaean history. *See* also Madden, *Coins of the Jews* (1881); *E.* Beurlier in F. Vigouroux (ed.), *Dictionnaire de la Bible,* vol. iv, cols. 479–488 (1908); C. C. Torrey in T. K. Cheyne and J. S. Black (eds.), *Encyclopaedia Biblica,* vol. iii, cols. 2850–58 (1902); H. Weiss, *Judas Makkabaeus* (1897); *A.* W. Streane, *The Age of the Maccabees* (1898); *E.* Schiirer, *Geschichte des jüdischen Volkes im Zeitalter Jesu Christi,* 4th ed., vol. i (1901); E. Bickermann, *The Maccabees,* trans. *by M.* Hadas (1947). (W. F.; X.)

MACCABEES, BOOKS OF, the name given to several Apocryphal books of the Old Testament. The Vulgate contains two books of Maccabees declared canonical by the council of Trent (1546) and found among the Apocrypha of the English Bible. Three other books of this name are extant. Book iii. is included in the Septuagint but not in the Vulgate. Book iv. is embraced in the Alexandrian, Sinaitic and other manuscripts of the Septuagint, as well as in some manuscripts of Josephus. A fifth book is contained in the Ambrosian Peshitta, but it seems to be merely a Syriac reproduction of the sixth book of Josephus's history of the *Jewish War*. None of the books of Maccabees are contained in the Vatican (B); all are found in a Syriac recension.

1 *Maccabees* was originally written in Hebrew, but is preserved only in a Greek translation. It probably dates from about the beginning of the 1st century B.C. As it supplies a detailed and accurate record of the 40 years from the accession of Antiochus Epiphanes to the death of Simon (175–13j B.C.), without doubt the most stirring chapter in Jewish history, the book is one of the most precious historical sources we possess. In its careful chronology, based upon the Seleucid era, in the minuteness of its geographical knowledge, in the frankness with which it records defeat as well as victory. in the restraint with which it speaks of the enemies of the Jews, in its command of details, it bears on its face the stamp of genuineness. Although written in the style of the historical books of the Old Testament the work is characterized by a religious reticence which avoids even the use of the divine name, and by the virtual absence of the Messianic hope. The observance of

the law is strongly urged, and the cessation of prophecy deplored (iv. 46; xiv. 41). There is no allusion either to the immortality of the soul or to the resurrection of the dead. Many scholars are of opinion that the unknown author was a Sadducee, but all that can be said with certainty is that he was a Palestinian Jew devotedly attached to the national cause.

2 Maccabees, the epitome of a larger work in five books by one Jason of Cyrene, deals with the same history as its predecessor, except that it begins at a point one year earlier (176 B.C.), and stops short at the death of Nicanor (161 B.C.), thus covering a period of only 15 years. Originally written in excellent Greek, from a pronouncedly Pharisaic standpoint, it was possibly directed against the Hasmonaean dynasty. It shows no sympathy with the priestly class. Both in trustworthiness and in style it is inferior to 1 Maccabees. In spite of its obvious defects, however, it forms a useful supplement to the first book. The writer's interests are religious rather than historical. The eschatology of 2 Maccabees is singularly advanced, for it combines the doctrine of a resurrection with that of immortality. It is worthy of note that the Roman Church finds support in this book for its teaching with reference to prayers for the dead and purgatory (xii. 43 *seq.*). An allusion to Jeremiah as "he who prayeth much for the people and the holy city" (xv. 14) it likewise appeals to as favouring its views respecting the intercession of the saints. Neither of Jason's work nor of the epitomizer's can the precise date be determined. The changed relations with Rome (viii. 10, 36) prove, however, that the latter was written later than 1 Maccabees, and it is equally clear that it was composed before the destruction of Jerusalem A.D. 70.

3 Maccabees, although purporting to be an historical narrative, is really an animated, if somewhat vapid, piece of fiction written in Greek somewhere between 100 B.C. and A.D. 70, and apparently preserved only in part. It has no connection with the Hasmonaeans, but is a story of the deliverance experienced by the Egyptian Jews from impending martyrdom at the hands of Ptolemy IV. Philopator, who reigned in the century previous to the Maccabaean rising (222–205 B.C.). The title is of later origin and rendered possible only by the generalization of the name Maccabees so as to embrace all who suffered for the ancestral faith. The purpose of the writer was evidently to cheer his Egyptian brethren during some persecution at Alexandria. Although the book was favourably regarded in the Syrian it was apparently unknown to the Latin Church. Among the Jews it was virtually ignored.

4 Maccabees differs essentially from the other books of this name. While it does not itself aim at being a history, it makes striking use of Jewish history for purposes of edification. It bears, moreover, a distinctly philosophical character, and takes the form of a "tractate" or discourse, addressed to Jews only, upon "the supremacy of pious reason over the passions." The material is well arranged and systematically handled.

The book is written in a cultured, if somewhat rhetorical, Greek style, and unmistakably coloured by the Stoic philosophy. The four cardinal virtues are represented as forms of wisdom, which again is inseparable from the Mosaic law. That the writer owes no slavish adherence to any philosophical system is plain from his independent treatment of the affections. Although influenced by Hellenism, he is a loyal Jew, earnestly desirous that all who profess the same faith should adhere to it in spite of either Greek allurements or barbaric persecution. It is not to reason as such, but only to *pious* reason (*i.e.,* to reason enlightened and controlled by the divine law), that he attributes lordship over the passions. While in his zeal for legalism he virtually adopts the standpoint of Pharisaism, he is at one with Jewish Hellenism in substituting belief in the soul's immortality for the doctrine of a bodily resurrection. The name of the author is unknown. He was, however, clearly a Hellenistic Jew, probably resident in Alexandria or Asia Minor. The date of composition cannot be definitely fixed. Most likely it is a product of the Herodian period.

5 Maccabees. On this *see* above.

BIBLIOGRAPHY.—C. J. Ball's *Variorum Apocrypha* will be found specially useful by those who cannot conveniently consult the original Greek. Among commentaries see those of C. L. W. Grimm (1853–1857), E. C. Bissell on 1, 2 and 3 Macc. in Lange-Schaff's commentary, 1880 (the whole Apocrypha being embraced in one volume, and much of the material being transferred from Grimm); G. Rawlinson on 1 and 2 Macc. in the *Speaker's Commentary* (1888; much useful matter, but marred by too frequent inaccuracy); Zöckler, on 1, 2 and 3 Macc. (1891; slight and unsatisfactory); W. Fairweather and J. S. Black on 1 Macc., in the *Cambridge Bible for Schools* (1897); E. Kautzsch on 1 and 3 Macc., Kamphausen on 2 Macc., Deissmann on 4 Macc. in *Die Apok. u. Pseudepigr. des Alt. Test.* (1898 ed. by E. Kautzsch, a most serviceable work for the student of apocryphal literature) and Oesterley (1M.), Moffatt (2M.) and Emmet (3M.) in *Apocrypha and Pseudepigrapha* (ed. Charles). Brief but useful introductions to all the four books of Maccabees are given in E. Schurer's *Geschichte des Judischen Volkes im Zeitalter Jesu Christi* (Eng. tr. of earlier edition, 1886–1890).

See also R. H. Charles, *Between the Old and New Testaments,* pp. 198–202, 218 seq. (1914), and A. A. Bevan in *Journ. Theol. Stud.,* Jan. 1929. (W. F.)

MacCARTHY, DENIS FLORENCE (1817–1882), Irish poet, was born in Dublin on May 26, 1817, and educated there and at Maynooth. His earlier verses appeared in *The Dublin Satirist,* and in 1843 he became a regular contributor of political verse to the recently founded *Nation.* He also took an active part in the Irish political associations. In 1846 he edited *The Poets and Dramatists of Ireland* and the *Book of Irish Ballads.* His collected *Ballads, Poems and Lyrics* (1850), including translations from nearly all the modern languages, took immensely with his countrymen on account of their patriotic ring. In 1853 he began a number of translations from the Spanish of Calderon's dramas, which won him a medal from the Royal Spanish Academy. He was granted a civil list pension for his literary services. He died in Ireland on April 7, 1882. His works include *The Bellfounder* (1857); *Under-glimpses* (1857); and *The Early Life of Shelley* (1871).

M'CARTHY, JUSTIN (1830–1912), Irish politician, historian and novelist, was born in Cork on Nov. 22, 1830, and was educated there. He worked on the staff of the *Northern Daily Times* (1853–59); the *Morning Star* (1860–68), being its editor for four years; and the *Daily News* (1870, etc.). He represented Co. Longford in parliament as a Liberal and Home Ruler from 1879 to 1885; North Longford, 1885–86; Londonderry, 1886–92; and North Longford from 1892 to 1900. He was chairman of the Anti-Parnellites from the fall of C. S. Parnell in 1890 until Jan. 1896; but his nationalism was of a temperate and orderly kind, and though his personal distinction singled him out for the chairmanship during the party dissensions of this period, he was in no active sense the political leader. His real bent was towards literature. His earliest publications were novels, some of which, such as *A Fair Saxon* (1873), *Dear Lady Disdain* (1875), *Miss Misanthrope* (1878), *Donna Quixote* (1879), were excellent. His most important work is his *History of Our Own Times* (vols. i.–iv., 1879–80; vol. v., 1897), which treats of the period between Queen Victoria's accession and her diamond jubilee. He also began a *History of the Four Georges* (1884–1901), of which the latter half was written by his son, Justin Huntly M'Carthy (1860–1936), the author of various clever novels, plays, poetical pieces and short histories. Justin M'Carthy died at Folkestone on April 24, 1912. His publications include biographies of Sir Robert Peel (1891), Pope Leo XIII. (1896) and W. E. Gladstone (1898); *Modern England* (1898); *The Reign of Queen Anne* (1902) and *Reminiscences* (2 vols., 1899).

McCLELLAN, GEORGE BRINTON (1826–1885), American soldier, was born at Philadelphia, Pa., on Dec. 3, 1826. He was educated at the University of Pennsylvania Preparatory school, and in July, 1846, graduated from West Point with such high rank that he was attached to the corps of engineers. In September of that year he was despatched to Mexico, where he served under Gen. Winfield Scott and was breveted for gallantry. At the close of the Mexican War he was assigned to West Point as instructor in practical engineering, and in 1851 superintended the construction of Ft. Delaware. In 1852 he served in the Red river expedition, and in 1853–54 was on duty in Washington Territory and Oregon as an engineer officer.

In the spring of 1855 he was directed to visit Europe, with two other officers, and to report upon the art of war. The commission witnessed the siege of Sevastopol, in the Crimea, and visited many countries and military establishments. Upon its return, McClellan not only furnished an able report under the title *Armies of Europe* (republished 1862), but also designed (1856) a saddle which was adopted by the army, and afterwards known as "the McClellan." In Jan. 1857, when captain in the 1st cavalry, he resigned his commission and accepted the position of chief engineer of the Illinois Central railroad. He was later made vice president, and subsequently president, of the Ohio and Mississippi Railroad Company. In May 1860 he married Ellen Mary Marcy, and established his residence at Cincinnati, O., where he was living at the outbreak of the Civil War. Offering his services to the Union, he was commissioned major-general of Ohio Volunteers on April 23, 1861, and on May 4, was made major-general in the army of the United States. He was placed in command of the department of the Ohio, and acting upon his own initiative, on May 26, despatched a small force across the Ohio river at Philippi. He dispersed the Confederates early in June, and, following this success by a rapid advance, secured control of so much territory for the Union cause, that the State of Sliest Virginia was separated from the Old Dominion, of which it had been a component part. This was the first successful campaign in the war between the States, and gave him such immediate popularity that he was dubbed "Little Mac: the Young Napoleon."

On July 22, McClellan was directed to turn over his command to the next in rank and to proceed to Washington, where he arrived July 26, 1861. He was there informed by President Lincoln that he had been placed in charge of the troops at the capital, and was directed speedily to bring order out of chaos. This he did, and the spirit of demoralization which obsessed the Federals after the disastrous defeat at First Bull Run quickly disappeared. With the assistance of his engineers, he soon had a ring of earthen fortifications and redoubts thrown about the city, and by drill and disciplinary measures whipped the raw levies into excellent shape before the spring of 1862. Then the so-called army of the Potomac was transported to Fortress Monroe by steamer, and began an advance upon Richmond by way of the peninsula which lies between the York and James rivers.

The Confederates delayed the march at Big Bethel, Yorktown, and Williamsburg, and although, by May 31, McClellan's forces were within seven miles of the Confederate capital, they were in a very bad strategical position, because the Chickahominy river—with its treacherous swamp land-divided the two wings of the army. To McClellan's great disappointment, the President had detained Gen. McDowell with 40,000 men to cover Washington, which made his numbers about equal to those of the Confederates. Gen. Banks in the Shenandoah valley was watching "Stonewall" Jackson's remarkable "foot cavalry," but by defeating Banks and threatening Washington, Jackson kept McDowell's division from re-enforcing McClellan. Jackson himself joined the Confederates defending their capital. Meanwhile, President Lincoln called Maj.-Gen. John Pope from the West, placing him in command of the combined armies of Banks and Frémont in the valley, and McDowell at Fredericksburg. These forces were advanced towards the Rappahannock.

McClellan was checked at the battle of Seven Pines, or Fair Oaks, where Gen. Johnston, who directed the Confederates, was wounded, and Gen. Robert E. Lee took command of the army. Seeing the advantage of attacking a portion of McClellan's divided detachments, the new commander (with the assistance of Jackson's corps) precipitated a furious assault upon the Union right wing. Then followed the terrible "Seven Days" fighting, in which McClellan was compelled to retreat (June 26 to July 1) to the James river; ending the backward movement and change of base (from White House on the Pamunkey to Harrison's Landing on the James) at hlalvern Hill, under the protection of the Union gunboats. By a petulant telegram (June 28) the defeated commander incurred the everlasting displeasure of the secretary of War, and by an ill-advised letter to the president from Harrison's Bar, engendered a similar feeling among the members of the cabinet. Yet, after his army had been transported to Alexandria and sent to the aid of Pope, who was signally defeated at Cedar mountain and Second Bull Run, so great was the need of his assistance that be was called to Washington by Gen. Halleck (military adviser of the President) and verbally ordered to take charge of all the troops retreating to the city. In this President Lincoln concurred.

The Federals were soon well in hand, but there was immediate work for them to do, as Lee had crossed the Potomac, invaded Maryland and seized Hagerstown and Fredericksburg. McClellan put the Union forces in motion towards the invaders, and on Sept. 13, 1862, had the good fortune to come into possession of an order issued by the Confederate chieftain which had been found by a private of the 27th Indiana Voluntezrs, wrapped securely around three cigars. This fully disclosed his plans. An immediate and rapid advance was ordered; the Confederates were driven through the Blue Ridge at Turner's and Fox's gaps and pursued to Antietam creek, near Sharpsburg, Md., where they offered battle. Although the Confederate army consisted of but 41,500 men, and the Union force was approximately 81,176, McClellan not only fought the battle in detail, engaging not more than two of his six corps simultaneously, but he even held two corps out of the battle almost entirely. On the 18th the Union troops were not permitted to attack, and on the next day Lee safely retreated across the Potomac at Shepherdstown. McClellan's unwillingness to risk battle in spite of superior numbers, coupled with his great delay in following the retreating Confederates so exasperated the authorities in Washington with his conduct of the campaign that he was subsequently removed from the position of commander-in-chief of the army of the Potomac (Nov. 5 1862). Major-Gen. Burnside was appointed to succeed him, and he was never afterwards tendered a command.

In 1864, McClellan became the Democratic presidential candidate upon a platform which denounced the war as a failure and proposed negotiations with the South for peace, but, as a patriotic soldier, he repudiated the platform although accepting the nomination. At the polls Abraham Lincoln was overwhelmingly re-elected president, as a result of which McClellan soon sailed for Europe, after resigning his commission in the army. Upon his return, the former leader took up his residence in New York city, where (1868–69) he was engaged in superintending the construction of an experimental floating battery. In 1871–72 he was engineer-in-chief of the City of New York's department of docks. Removing to Orange, N.J. (1877–81), he was elected governor of New Jersey upon the Democratic ticket. Although offered a second nomination, he refused it, and spent his later years in travelling abroad and preparing his memoirs. He died suddenly of heart disease, on Oct. 29, 1885, at Mayfield, Orange, New Jersey. Bronze equestrian statues at Philadelphia and Washington have been erected to this popular but unfortunate general, who always held the affectionate regard of the enlisted men.

BIBLIOGRAPHY.—Besides *McClellan's Own Story*, published posthumously by W. C. Prime in 1887, Gen. McClellan was the author of *Exploration of the Red River of Louisiana in the year 1852* (1853); *Report on the Several Pacific Railroad Explorations* (1855); *European Cavalry* (1861); *Regulations and Instructions for the Field Service of the U.S. Cavalry in time of war* (1861); *Armies of Europe* (1862); *Manual of Bayonet Exercise* (1862); *Letter to President Lincoln* (1862); *Letter to the Secretary of War* (1862); *Complete Report of the Organization and Campaigns of the Army of the Potomac* (1864); *Letter of Acceptance and West Point Oration* (1864); and *McClellan's Mexican War Diary*, not published until 1917. He wrote also a series of articles on the Russo-Turkish War for *The North American Review*. *See* memoir in the preface of *McClellan's Own Story;* Wakenfield Addey, *Little Mac and How he became a Great General* (1864); P. S. Michie, *General McClellan* in the "Great Commanders" series (1901); J. H. Campbell, *A Vindication of the Military Career of General McClellan* (1916); Capt. T. G. Frothingham, "The Peninsula Campaign" and "The Crisis of the Civil War: Antietam," in *Proceedings of the Massachusetts Historical Society*, vol. lvi. and lvii.

(C. H. L. J.)

McCLERNAND, JOHN ALEXANDER (1812–1900), American soldier and lawyer, was born in Breckinridge county, Ky., on May 30, 1812. He was admitted to the bar in Shawneetown, Ill., in 1832; in the same year served as a volunteer in the Black Hawk War, and in 1835 founded the *Shawneetown Democrat*, which he thereafter edited. As a Democrat he served in 1843–51 and in 1859–61 as a representative in Congress, where in his first term he vigorously opposed the Wilmot Proviso, but in his second term was a strong unionist. He resigned from Congress, raised in Illinois the "McClernand brigade," and was commissioned (May 17, 1861) brigadier-general of volunteers. He was second in command at the battle of Belmont (Missouri) in Nov. 1861, and commanded the right wing at Ft. Donelson. In March 1862 he became a major-general of volunteers. and at Shiloh he commanded a division. Early in January. 1863, at Milliken's Bend. McClernand, who had been placed in command of one of the four corps of Grant's army, superseded Sherman as the leader of the force that was to move down the Mississippi against Vicksburg. On Jan. 11 he took Arkansas Post. During the rest of the Vicksburg campaign there was much friction between McClernand and his colleagues: he undoubtedly intrigued for the removal of Grant: it was Grant's opinion that at Champion's Hill (May 16) he was dilatory; and on June 18 he was relieved of his command. President Lincoln, who saw the importance of conciliating a leader of the Illinois War-Democrats, restored him to his command in 1864. but McClernand resigned in November of that year. He died in Springfield. Ill., on Sept. 20, 1900.

MACCLESFIELD, EARLS OF. CHARLES GERARD. 1st earl of Macclesfield (c. 1618–94). Royalist. of an old Lancashire family. commanded a brigade at Edgehill, and, distinguishing himself at Newbury (1643) and Newark (1644). he was given chief command in Wales. His severity made him unpopular and he was removed. but was retained in command of the king's guard during the march from Wales to Oxford. and thence to Hereford and Chester. In 1645 he was created Baron Gerard of Brandon. Suffolk. but soon after was dismissed for his protest against the supersession of Sir Richard Willis. After the capitulation of Oxford (1646) he went abroad. where he remained until the Restoration. In 1660 he returned at the head of the life guards: his estates were restored and he received a pension. Gerard was created earl of Macclesfield and Viscount Brandon in 1679. but his relations with the duke of Monmouth led to an order for his arrest in 168j. He escaped abroad, but returned with William III in 1688 as commander of his bodyguard. He was made a privy councillor and president of the council of the Welsh marches. 1689. He died on Jan. 7, 1694.

His eldest son. CHARLES. 2nd earl of Macclesfield. (*c.* 1659–1701), born in Paris, was naturalized in England. He was concerned in the intrigues of Monmouth, and in 168j was sentenced to death for complicity in the Rye House plot. but was pardoned. In 1698 hlacclesfield was divorced from his wife Anne. daughter of Sir Richard Mason of Sutton, by act of parliament, the first occasion on which a divorce was so granted without a previous decree of an ecclesiastical court. The countess was the mother of two children. known by the name of Savage. whose reputed father was Richard Savage, 4th Earl Rivers (d. 1712). The poet Richard Savage (*q.v.*), claimed that he was the younger of these children. The 2nd earl was succeeded by his brother, on whose death in 1702 the title became extinct.

In 1721 the title of earl of hfacclesfield was revived in favour of THOMAS PARKER (1667–1732). He became a barrister in 1691, took part in the proceedings against Henry Sacheverell and was appointed lord chief justice in 1710, and in 1718 became lord chancellor. In 1725 he was impeached for corruption, found guilty and heavily fined. He died in 1732.

Macclesfield's only son, George (c. 1697–1764), was celebrated as an astronomer and prominent in introducing the new style of dates (1752). He was president of the Royal society and died on March 17, 1764.

See G. E. C(okayne), *Complete Peerage,* vol. viii, rev. ed. (London, 1932).

MACCLESFIELD, a municipal borough and market and manufacturing town in the Macclesfield parliamentary division of Cheshire, Eng.. 18 mi. south-southeast of hfanchester by road. Pop. (1951) 35,999. Area 7.25 sq.mi. It stands on the Bollin river in a deep gorge with heights up to 1,600 ft. on the east where the bleak upland country retains its ancient name of Macclesfield forest. Steps and terraces connect the low lying Waters Green near the river, where the Barnaby and May fairs are held, with the upper part of the town with its many steep, cobbled streets. The church and town hall crown the hill where gardens are now laid out. St. Michael's church was founded in 1278 by Queen Eleanor and was once connected with the two private chapels of the Savage and Legh families. The Savage chapel belonged to a college of secular priests founded in 1508 by Thomas Savage. A Unitarian chapel. built in 1689. stands behind a lovely wrought iron gate. The King's school was founded in 1502, as a free grammar school, and refounded in 1552. There are also a technical school and a school of art. The museum was built in 1898. The most important industry is silk manufacture; others include cork, paper, shirts, shoes and electrical appliances. Stone is quarried locally.

Before 1066 hlacclesfield was held by Edwin. earl of Mercia; in Domesday Book it is in the lands of the earl of Chester where it remained until 1244 when it lapsed to the crown. The forest remained a royal forest until after the Restoration, but by the 18th century it had been enclosed and cultivated. In 1389 John de Macclesfield obtained permission to fortify his mansion: it was later owned by the duke of Buckingham and then by the earl of Derby: it was destroyed in the Civil War when the town walls also were demolished. The names Jordangate. Chestergate and Wallgate bear witness to the ancient fortifications. The earliest of many charters was granted by Ranulf (or Randulph). earl of Chester. in 1220; in 1261 another, granted by Edward, prince of Wales. constituted Macclesfield a free borough with a merchant guild. In 1684 Charles II issued the last charter which continued until 183j. The markets. first mentioned in 1617. are still flourishing. The charter of Elizabeth I (1564) granted an annual fair in June. and Charles II granted fairs in April and September. The present fairs are held in May and October. hlacclesfield first sent two members to parliament in 1832; in 1880 it was disfranchised and in 1885 it was merged in the county division of hfacclesfield.

The manufacture of silk-covered buttons began in the 16th century and flourished until the early 18th. Charles Roe, who came to hlacclesfield in 1740, introduced silk throwing in 1756, when the first silk mill was erected. and fostered the silk and metal-working industries. By 1790 silk manufacture was being carried on on a large scale and in 1831 the Macclesfield canal. between the Trent and Mersey canal and the Peak Forest canal, was opened. In 184j the railway connected hlacclesfield with Stockport.

McCLINTOCK, SIR FRANCIS LEOPOLD (1819–1907), British naval officer and arctic explorer. who made known the fate of Sir John Franklin's expedition, was born at Dundalk. Ire.. on July 8, 1819. He went to sea at the age of 12 and served in several ships of the Royal Navy before joining the Franklin search expedition of 1848–49 under Sir James Clark Ross. as second lieutenant of the "Enterprise." During his second arctic season (1850–51) as first lieutenant of the "Assistance." and during his third (1852–54) when he commanded the ".Intrepid." he improved on Ross's sledging methods and equipment, and initiated a system of depot laying which resulted in some great man hauling journeys. McClintock's party in the spring of 1853 traveled 1,328 mi. in 105 days. and sledge journeys of comparable length were made in 1854, and during his last searching expedition of 1857–59. Much new coast line was explored, but no traces found of Sir John Franklin (*q.v.*). After many fruitless expeditions. news of the fate of the lost party was obtained in 1854 by John Rae from the Eskimo of Boothia peninsula. The government refused to equip another expedition, so Lady Franklin sent McClintock in the "Fox" to King William Island, off which Franklin's ships, the "Erebus" and "Terror." had been beset. Through him the fate of the expedition was made known and many relics discovered. including a record left on the island. These relics and McClintock's own papers are in the National Maritime museum. He died on Nov. 17, 1907.

BIBLIOGRAPHY.—Sir C. R. Markham, *Life of Admiral Sir Leopold M'Clintock* (1909); and his own *Voyage of the "Fox" in the Arctic Seas* (1859) and "Reminiscences of Arctic Ice-Travel." *Journal of the Royal Dublin Society* (Feb. 1857); R. J. Cyriax, *Sir John Franklin's Last Arctic Expedition* (1939). (A. M. Ss.)

McCLINTOCK, JOHN (1814–1870), U.S. Methodist Episcopal theologian and educator! an able preacher, orator and teacher. and a versatile scholar. was born in Philadelphia. Pa.. on Oct. 27, 1814. After his graduation from the University of Pennsylvania in 183j he taught in Dickinson college for 12 years. He edited the *Methodist Quarterly Review* (1848–56), and in 1867, at the wish of Daniel Drew, became president of the newly established Drew Theological seminary at Madison, N.J., where he died on March 4. 1870.

McClintock by his editorial and educational work probably did more than any other man to raise the intellectual level of American Methodism. He put into practice the scholarly methods of the new German theology of the day, not alone by his translation with Charles E. Blumenthal of Neander's *Life of Christ* (1847), and of Bungener's *History of the Council of Trent* (1855), but by his own noteworthy project, McClintock and Strong's *Cyclopaedia oj Biblical Theological and Ecclesiastical Literature* (1867–81; supplement, 1885–87). Among McClintock's other publications are *Sketches of Eminent Methodist Ministers* (1853). *Living Words* (1871) and *Lectures on Theological Encyclopaedia and Methodology* (1873).

See G. R. Crooks, *Life and Letters of the Rev. Dr. John McClintock* (1876)

McCLOSKEY, JOHN (1810–1885), U.S. Roman Catholic archbishop of New York, the first C.S. cardinal, was born in Brooklyn, N.Y.. March 10, 1810. Educated at Mount St. Mary's college, Emmitsburg. Md., he was ordained a priest in 1834, spent two years in graduate study at the Gregorian university in Rome. and returned to New York city in 1837 as rector of St. Joseph's church. In 1841 he organized and became first president of St. John's college (later Fordham university). After serving from 1844 to 1847 as bishop coadjutor to Bishop John Hughes of New York, he became first ordinary of the newly created see of Albany, N.Y. Succeeding to the archbishopric of New York in 1864, he renewed construction of St. Patrick's cathedral, suspended during the Civil War. and dedicated the edifice on May 25. 1879 Elevated to the cardinalate in 1875, he journeyed to Rome in 1878 but arrived too late to attend the conclave that elected Pope Leo XIII. He died in New York on Oct. 10, 1885.

See J. M. Farley, *The Life of John Cardinal McCloskey* (1918). (J. A. Rs.)

McCLURE, SIR ROBERT JOHN LE MESURIER (1807–1873), British arctic explorer who commanded the first expedition to complete the Northwest passage, though Sir John Franklin was later credited with its discovery, was born at Wexford. Ire., on Jan. 28, 1807. He joined Sir George Back's arctic expedition of 1836–37, and the Franklin search expedition of 1848–49 under Sir James Clark Ross. In 1850, McClure. commanding H.M.S. "Investigator," accompanied Sir R. Collinson, in H.M.S. "Enterprise," to search again for Franklin's lost expedition. "Investigator" preceded "Enterprise" through Bering strait and discovered a northwest passage, finding one route through Prince of Wales strait and another round Banks Island. Having abandoned ship off Banks Island, the expedition joined the "Resolute" and "Intrepid" of the search expedition commanded by Horatio Austin, at Melville Island. These ships were in turn abandoned, and McClure's party went on foot to Beechey Island and thence home by ship in 1854. *(See* also ARCTIC, *THE.)* McClure died in London on Oct. 17, 1873.

BIBLIOGRAPHY.—George Back, *Narrative* . . . (1838); Sherard Osborn, *The Discovery of a Northwest Passage* (1856); Alexander Armstrong, *A Personal Narrative of the Discovery of the North-West Passage* (1857); *R.* McClure, *Voyages* . . . , 2 vol. (1884). (A. M. Ss.)

McCONNELL, FRANCIS JOHN (1871–1953), U.S. Methodist bishop, was born at Trinway, Ohio, Aug. 18, 1871. He graduated at Ohio Wesleyan university and later studied at Boston university. In 1894 he entered the Methodist ministry and was pastor successively at Chelmsford, Newton Upper Falls, Ipswich and Cambridge, all in Massachusetts, and in 1903–09 at the New York Avenue Methodist church in Brooklyn. From 1909 to 1912 he was president of De Pauw university. He was elected bishop in 1912 and served for a number of years in Mexico and afterward in the Pittsburgh district. In the latter region he entered actively into a study of industrial conditions and problems. As chairman of the Commission of Inquiry appointed by the Interchurch World Movement organization he pushed the investigation resulting in the *Report on the Steel Strike of 1919* which was influential in abolishing the 12-hour day and seven-day week in the steel industry He wrote many books, among which are *Personal Christianity* (1914); *Christianity and Coercion* (1933); *John Wesley* (1939); and *Evangelicals, Revolutionists and Idealists* (1942). Bishop McConnell retired in 1944 and died at Lucasville. Ohio. on Aug. 18. 1953

McCOOK, ALEXANDER McDOWELL (1831–1903), U.S. soldier, was born in Columbiana county. O.. on April 22, 1831. He graduated at the U.S. military academy in 1852, served against the Apaches and Utes in New Mexico in 1853–57, and in April 1861 became colonel of Ohio volunteers. He served in the first battle of Bull Run; commanded a brigade in Kentucky in the winter of 1861, a division in Tennessee and Mississippi early in 1862. and the 1st corps in Kentucky in October of the same year; was in command of Nashville in November and December of that year: and was then engaged in Tennessee until after the battle of Chickamauga. He retired in 1895, a major-general.

His father, DANIEL MCCOOK (1798–1863), killed at Buffington's island during Gen. John H. Morgan's raid in Ohio, and seven of his eight brothers (three of whom were killed in battle) all served in the Civil War; this family and that of John McCook (1806–1865). Daniel's brother. who served as a volunteer surgeon in the Civil War, are known as the "fighting McCooks"—four of John's sons served in the army and one in the navy.

McCORD, LOUISE SUSANNA CHEVES (1810–1879), U.S. author, daughter of Langdon Cheves and Mary Elizabeth Dulles Cheves, was born Dec. 3, 1810, in Charleston, S.C. A member of a colonial family, her ancestry was Scotch, Irish and Huguenot. In her early years in South Carolina Louise McCord studied French and music for young girls. Her education was continued at Grimshaw's school in Philadelphia Before her formal presentation to society in Philadelphia and Washington, D.C., native linguists were employed to perfect her in the languages. Later, under tutors selected for her brothers, she studied mathematics and kindred branches.

In association with her father and his intimate circle of public men of the state, Miss Cheves became deeply interested in the history of the U.S. Her attitude toward slavery was that the Negro was being civilized in his contact with the white Christian races of the United States. She contributed political and other essays to the *Southern Quarterly Review* in 1853 and, in 1848, published a translation of Frederic Bastiat's *Sophismes Economiques*, which influenced all of her views. Other literary efforts included a volume of poems, My *Dream*, and a five-act, blank verse drama, *Gaius Gracchus.* In 1840 Louise Cheves was married to David James McCord, a lawyer of distinction. After his death she spent two years abroad and, on her return, made her home in Columbia, S.C. During the Civil War Mrs. McCord was active in relief work; on the death of her son, Capt. Langdon Cheves McCord, in the 2nd battle of Manassas. she gave much of her time to nursing sick soldiers and other hospital work. After the Civil War Mrs. McCord removed to Charleston, S.C., where she died in Nov. 1879. She was buried with honours in Magnolia cemetery of that city.

See C. A. Mauchope, *The Writers of South Carolina* (1910); *Library of Southern Literature* (vol. viii, 1907); *Dictionary of Anzerican Biography* (vol. xi). (*E.* Row)

MacCORMAC, SIR WILLIAM, BART. (1836–1901), Irish surgeon. was born at Belfast on Jan. 17, 1836. He studied at Belfast, Dublin and Paris. After practice in Belfast and war service in France (1870) and Serbia (1876) he became (1881) assistant surgeon at St. Thomas's hospital, London. He was one of the first to apply Listerian methods in surgery and was a pioneer in operating for intraperitoneal rupture of the bladder (1886). He was president of the Royal College of Surgeons no less than five times. In 1897 he was surgeon-in-ordinary to the prince of Wales. In 1899 he was Hunterian orator. He died at Bath on Dec. 4, 1901.

McCORMACK, JOHN (1884–1945), tenor, was born at Athlone, Eire, on June 14, 1884. At the age of nine he faced his first audience when he sang at the Marists Brothers school. He was educated at Summerhill college, Co. Sligo. He won the prize at the Irish music festival, *Feis* Ceoil, and went to the U.S. on a short singing tour, returning to Dublin to sing before going to Italy where he studied under Sabatini. At his second attempt Cleofonte Campanini gave him his opportunity at Covent Garden, where he made his début in *Cavalleria Rusticana,* Oct. 15, 1907, his success the following year leading to presentation to King Edward and Queen Alexandra. Oscar Hammerstein engaged him for the Manhattan Opera house where he made his New York début in *Traviata,* Nov. 10, 1909. He afterward sang with the Chicago-Philadelphia Opera company, the Chicago Grand Opera company and the Metropolitan Opera company. In 1911 he toured Australia with Melba in Italian opera. After two further operatic seasons in the U.S., 1912, and Australia, 1913, he turned to the concert stage where he achieved extraordinary popularity as a ballad singer. He became a citizen of the United States in 1919. In 1921 he was made Knight commander of the orders of St. Gregory the Great and of the Holy Sepulchre by Pope Benedict XV, and in 1928 he was made a count in the papal peerage. McCormack died Sept. 16, 1945, in Dublin.

McCORMICK, CYRUS HALL (1809–1884), U.S. inventor of grain-harvesting machinery, was born in Rockbridge Co. (Va.), U.S.A., on Feb. 15, 1809. His father was a farmer who had invented numerous labour-saving devices for farm-work, but after repeated efforts had failed in his attempts to construct a successful grain-cutting machine. In 1831, Cyrus, then 22 years old; took up the problem, and after careful study constructed a machine which was successfully employed in the late harvest of 1831 and patented in 1834. The McCormick reaper, after further improvements, proved a complete success; and in 1847 the inventor removed to Chicago, where he manufactured his machines. He died in Chicago on May 13, 1884.

BIBLIOGRAPHY.—Herbert N. Casson, *Cyrus Hall McCormick: His Life and Work* (1909); W. T. Hutchinson, *Cyrus Hall McCormick,* vol. i, *Seed-Time 1809–1856* (1930), vol. ii, *Harvest 1856–1884* (1935); Cyrus McCormick, *The Century of the Reaper* (1931).

McCORMICK, ROBERT RUTHERFORD (1880–1955), G.S. publisher, editor and soldier, was born in Chicago, Ill., July 30, 1880. His father was a U.S. diplomat, his mother a daughter of Joseph Medill, editor and proprietor of *The Chicago Tribune.*

A graduate of Yale university (1903) and Northwestern university law school, Chicago (1906), McCormick was admitted to the bar in 1908. He served as a Chicago alderman, 1904, and president of the Sanitary District board, 1905–1910. As a staff and combat officer with the American expeditionary force (1917–18) McCormick was awarded the U.S. distinguished service medal.

McCormick was named president of the Tribune company in 1911, and with his cousin, Joseph Medill Patterson (*q.v.*), shared the functions of publisher and editor of *The Chicago Tribune* from 1914 until 1925 when he became sole editor and publisher. Under his direction the *Tribune* came to lead the U.S. in standard-size newspaper circulation and the world in newspaper advertising revenue. He built Tribune enterprises to include forest lands. paper mills, hydroelectric installations and shipping companies as well as major publishing, radio and television facilities. Tribune editorial policies voiced outspoken opposition to Prohibition, the Roosevelt and Truman administrations and U.S. political involvement in overseas conflicts. From 1925 until his death April 1, 1955, at Wheaton, Ill., McCormick was among the most powerful and controversial figures in U.S. journalism. A staunch advocate of constitutional liberties, McCormick was the author of historical works, numerous pamphlets, and public and radio addresses.

(F. C. CN.)

McCOSH, JAMES (1811–1894), Scottish minister and philosophical writer, born in Ayrshire. on April 1, 1811. He was president of the College of New Jersey, Princeton (1868–88). He died on Nov. 16, 1894.

His chief works are: *Method of Divine Government, Physical and Moral* (1850); *The Typical Forms and Special Ends in Creation* (1855); *Intuitions of the Mind Inductively Investigated* (1860); *An Examination of Mr. J. S. Mill's Philosophy* (1866).

McCOY, SIR FREDERICK (1823–99), British paleontologist, the son of Simon McCoy, was born in Dublin in 1823, and was educated for the medical profession. In collaboration with A. Sedgwick he prepared *A Synopsis of the Classification of the British Palaeozoic Rocks, With a Systematic Description of the British Palaeosoic Fossils in the Geological Museum of the University of Cambridge* (1855). After four years in Belfast he became professor of natural science in the University of Melbourne, where he lectured for more than 30 years. He established the National Museum of Natural History and Geology in Melbourne, of which he was director; and becoming associated with the geological survey of Victoria as paleontologist, he issued a series of decades entitled *Prodromus* of *the Palaeontology of Victoria.* He also issued the *Prodromus of the Zoology of Victoria.* He was elected a fellow of the Royal society in 1880 and created companion of the Order of St. Michael and St. George in 1886 and knight commander of the Order of St. Michael and St. George in 1891. He died in Melbourne on May 16, 1899.

MACCULLOCH, HORATIO (1805–1867), Scottish landscape painter, was born in Glasgow. He studied for a year under John Knox, a Glasgow landscape-painter, was then engaged at Cumnock to paint the ornamental lids of snuff-boxes, and afterwards went to Edinburgh where Lizars, the engraver, employed him to colour book illustrations. At Glasgow he was employed to paint several large pictures for the decoration of a public hall in St. George's place. MacCulloch's works form an interesting link between the old world of Scottish landscape and the new. From 1829 he exhibited regularly in the Royal Scottish academy's exhibition till his death on June 24, 1867.

A volume of photographs from his landscapes, with a biographical notice by Alexander Fraser was published in Edinburgh in 1872.

McCULLOCH, HUGH (1808–1895), U.S. financier, was born at Kennebunk (Me.) Dec. 7, 1808. He was educated at Bowdoin college, studied law in Boston, and in 1833 began practice at Ft. Wayne (Indiana). He was cashier and manager of the Ft. Wayne branch of the old state bank of Indiana from 1835 to 1857, and president of the new state bank from 1857 to 1863. He was selected by Secretary Chase as comptroller of the currency in 1863 to put the new National Banking act of 1862 into operation. He was appointed secretary of the treasury by President Lincoln in 1865, and was continued in office by President Johnson until the close of his administration in 1869. In accordance with his suggestion, an act was passed (March 12, 1866), authorizing the withdrawal from circulation of greenbacks as a preliminary to the resumption of specie payments, but it met with strong opposition and was repealed on Feb. 4, 1868, after only $48,000,000 had been withdrawn. McCulloch went to England, and spent six years (1870–76) as a member of the banking firm of Jay Cooke, McCulloch and Co. From Oct. 1884 until the close of President Arthur's term of office in March 1885 he was again secretary of the treasury.

He died at his home near Washington (D.C.) May 24, 1895.

M'CULLOCH, SIR JAMES (1819–1893), Australian statesman, was born in Glasgow. He went to Melbourne to open a branch of Dennistoun Brothers. In 1854 he was nominated to the legislative council, and was returned for Wimmera in the legislative assembly. In 1857–58 he was minister of trade and customs, and in 1859–60, treasurer. On the defeat of the third O'Shanassy ministry in June 1862 he became premier and chief secretary. M'Culloch's ministry was involved in a struggle with the council, over the ministerial policy of protection. A tariff was tacked to an appropriation bill, which the council rejected three times. M'Culloch had the support of Australia, and of the governor, Sir Charles Darling, who was recalled by the home government for partisanship. A long and bitter struggle between the two chambers over a grant of £20.000 to Lady Darling, which was also tacked to an appropriation bill, ended in 1868 when M'Culloch, who had resigned, resumed office with different colleagues. He resigned in 1869, when he was knighted, but formed a third ministry in 1870. In June 1871 he resigned again and held the office of agent-general for Victoria in London until 1873, was created K.C.M.G. in 1874 and, returning to the colony, formed his fourth ministry in 1875. After his defeat in 1877 he returned to England, where he died at Ewell, Surrey, on Jan. 30, 1893.

MACCULLOCH, JOHN (1773–1835), Scottish geologist, was born in Guernsey. Graduating at Edinburgh in 1793 as M.D. he became chemist to the Board of Ordnance in 1803, and in 1814 was appointed geologist to the trigonometrical survey. Two years later he became president of the Geological society, and in 1820 was elected F.R S. His chief work was carried out in Scotland, where he examined the structure of the range of western islands. His geological map of Scotland was published soon after his death on Aug. 21, 1835.

M'CULLOCH, JOHN RAMSAY (1789–1864), British economist and statistician, was born at Whithorn, Wigtownshire, on March 1, 1789. In 1818–19 he edited the *Scotsman.* His articles on economic questions in that paper and in various reviews, and the publication of his *Principles of Political Economy* (1825) led to his appointment in 1828 as professor of political economy at London university. He held this office until 1832, and in 1838 became comptroller of H.M. Stationery Office, where he introduced useful reforms. M'Culloch died in London on Nov. 11, 1864. He was intimate with John Stuart Mill and his circle, but remained a Whig pure and simple. His *Dictionary of Commerce and Commercial Navigation* (1832) and his *Statistical Account of the British Empire* (1837) are monumental.

McCULLOUGH, JOHN EDWARD (1837–1885), American actor, was born in Coleraine, Ireland, on Nov. 2. 1837. He went to America at the age of 16, and made his first appearance on the stage at the Arch street theatre, Philadelphia, in 1857. In support of Edwin Forrest and Edwin Booth he played second rôles in Shakespearian and other tragedies, and Forrest left him by will all his prompt books. Virginius was his greatest success, although even in this part and as Othello he was coldly received in England (1881). In 1884 he broke down physically and mentally, and he died in an asylum at Philadelphia on Nov. 8, 1885

MACCUNN, HAMISH (1868–1916), Scottish musical composer, was born at Greenock, the son of a shipowner, and was educated at the Royal College of Music. His first success was with the overture *Land of the Mountain and Flood* in 1887 at the Crystal Palace, and this was followed by other compositions, with a characteristic Scottish colouring. From 1888 to 1894 he was a professor at the Royal College of Music. His opera *Jeanie Deans* was produced at Edinburgh in 1894. He was for some years conductor to the Carl Rosa Opera company, and subsequently to other companies. His opera *Diarmid* was produced at Covent Garden in 1897, and his other music includes cantatas, overtures, part-songs, instrumental pieces and songs, all markedly Scottish in type. He died in London on Aug. 2, 1916.

MACDONALD, ALEXANDRE (1765–1840), duke of Taranto and marshal of France, was born at Sedan on Xov. 17, 1765, of an old Jacobite family, and was related to Flora Macdonald. In 1785 he joined the legion supporting the revolutionary party in Holland against the Prussians, and then received a commission in the French army. He supported the Revolution, and was appointed aide-de-camp to General Dumouriez. He refused to desert to the Austrians with Dumouriez, and was rewarded with the rank of general of brigade. He took part in Pichegru's invasion of Holland (1795), served as general of division on the Rhine and in Italy (1797), became first French governor of Rome, and later reconstituted the kingdom of Naples as the Parthenopaean Republic. His resistance against Suvarov's attack in northern Italy gained him the position of governor of Versailles, where he acquiesced in the events of the 18th Brumaire. In 1800 he received the command of the army in Switzerland, and his march (1800–01) over the Splugen Pass, is as noteworthy as Bonaparte's famous passage of the St. Bernard before Marengo. After some years as French plenipotentiary in Denmark, he became (1809) military adviser to Eugène Beauharnais, viceroy of Italy. For his share in the victory over the Austrians at Wagram Napoleon made him marshal of France and duke of Taranto. After serving in Spain (1810) and Russia (1812), he invaded Silesia in 1813, and was defeated by Blücher at Katzbach *(see* NAPOLEONIC CAMPAIGNS). Napoleon presented him with the sabre of Murad Bey for his fidelity, and directed him to submit to the new régime. At the Restoration he was made a peer of France, and became chancellor of the Legion of Honour (1815–31) and major-general of the royal bodyguard (1816). From 1830 his life was spent in retirement at Courcelles-le-Roi (Seine-et-Oise), where, greatly respected, he died on Sept. 7, 1840.

See Mathieu Dumas *Evènements militaires;* Ségur, *Lettre sur la campagne du Général Macdonald dans les Grisons en 1800 et 1801* (1802), and *Eloge* (1842); his memoirs were published in 1892 (Eng. trans. *Recollections of Marshal Macdonald).*

MACDONALD, SIR CLAUDE MAXWELL (1852–1915), British soldier and diplomatist, was born on June 12, 1852; the son of Major-General J. D. Macdonald. He was educated at Uppingham and Sandhurst, and in 1872 entered the army (74th Highlanders). He took part in the Egyptian campaign of 1882, and was appointed military attache to Sir Evelyn Baring (afterwards earl of Cromer). serving in the Suakin expedition of 1884–85. He left the post of military attaché in 1887, and after a year as consul-general at Zanzibar went to the Niger Territories for the Foreign Office. In 1891 he became first commissioner and consul-general in the Oil Rivers Protectorate, where he successfully established a stable government, and was responsible for many administrative reforms. Macdonald retired from the army in 1896, and was appointed British minister at Peking, and during the critical period which followed secured for England the leases of Wei-Hai-Wei and of the Hong-Kong extension. He also obtained many other useful concessions, including the opening of the West river to trade, and the non-alienation of the Yangtze region. During the Boxer rising of 1900 he organized the defence of the legations. In Oct. 1900 Macdonald was appointed the first British ambassador to Tokyo, and gave valuable service to the British government during the Russo-Japanese War He was admitted to the privy council in 1906 in recognition of his work in connection with the Anglo-Japanese agreement of Xug. 1905 (ended in 1921). He died in London on Sept. 10, 1915.

MACDONALD, FLORA (1722–1790), Jacobite heroine, was the daughter of Ranald Macdonald of Milton, in the island of South Uist (Hebrides). In June 1746 Prince Charles Edward (*q.v.*) took refuge, after the battle of Culloden, in Benbecula in the Hebrides, where she was living, and his companion, Captain O'Neill, sought her help. She obtained a pass to the mainland for herself, a manservant, an Irish spinning maid, Betty Burke, and a boat's crew of six men. The prince was disguised as Betty Burke. The party landed at Portree and escaped. The boatmen's talk afterwards brought suspicion on Flora and she was arrested and imprisoned in the Tower. She was afterwards allowed to live outside under the guard of a gaoler, and when the Act of Indemnity was passed in 1747 she was left at liberty. In 1750 she married Allen Macdonald of Ringsburgh and they emigrated to America (1773). He served the British government in the War of Independence, and was taken prisoner. His wife returned home in 1779, and died on March 5, 1790.

See A. C. Ewald, *Life and Times of Prince Charles Edward* (1886) ; A. MacGregor, *The Life of Flora Macdonald* (1882, later ed. 1901) ; W. Foly, *Flora Macdonald in Uist* (1886). The so-called *Autobiography* of Flora Macdonald (1870) is not authentic.

MACDONALD, GEORGE (1824–1905), Scottish novelist and poet, was born at Huntly, Aberdeenshire, the son of a farmer, and a direct descendant of a family that suffered in the massacre of Glencoe. Macdonald's youth was passed in Huntly, in an atmosphere strongly impregnated with Calvinism. He took his degree at Aberdeen university, and then studied at Highbury college, in London, for the Congregational ministry After some years in the Congregational ministry at Arundel and in Manchester, and a short visit to Algiers. he settled in London and adopted the profession of literature. He wrote: *Within and Without* (1856), a dramatic poem; *Poems* (18jj), and the "faerie romance" *Phantastes* (1858). His first conspicuous success was achieved in 1862 with *David Elginbrod,* the forerunner of a number of popular novels, which include *Alec Forbes of Howglen* (186j), *Annals of a Quiet Neighbourhood* (1866), *Robert Falconer* (1868), *Malcolm* (187j), *The Marquis of Lossie* (1877) and *Donal Grant* (1883). He also wrote some stories for the young and several volumes of sermons. In 1877 he was given a civil list pension, He died on Sept. 18. 1905. His verse is homely and direct. and marked by religious fervour. As a portrayer of Scottish peasant life he was the precursor of a large school.

MACDONALD, SIR HECTOR ARCHIBALD (1852–1903), British soldier, was born of humble parentage at Muir of Allan-Grange, Ross-shire, Scotland. In 1870 he enlisted in the 92nd (Gordon) Highlanders, and distinguished himself in the Afghan War of 1879, in the first Boer War of 1880–81, and at Majuba. In 1885 he served under Sir Evelyn Wood in the reorganization of the Egyptian army, and took part in the Nile expedition of that year. In 1889 he received the D.S.O. for his conduct at Toski. Seven years later he commanded a brigade of the Egyptian army in the Dongola expedition, and after his achievements in the final battle of Omdurman (1898) was promoted colonel and made an aide-de-camp to the queen. He became popularly known as "Fighting Mac." In 1899 he was promoted major general. and appointed to a command in India. In Dec. 1899 he was called to South Africa to command the Highland brigade, and in 1901 he was made a K.C.B. In 1902 he commanded the troops in Ceylon, but on March 25, 1903, he committed suicide in Paris.

MACDONALD, JAMES RAMSAY (1866–1937), British prime minister, was born on Oct. 12, at Lossiemouth, a little fishing village on the Moray Firth. His father was a labourer, his first home a "but and a ben." At Drainie board school he received an elementary education and continued as a pupil teacher. Going to London at 18, he worked at 12/6*d.* a week as a clerk. He continued his own education by evening classes, laboratory work and incessant reading. A breakdown in health ended his scientific career and sent him to journalism.

MacDonald's experience and reading made him a convinced socialist. He joined, in 1894, the Independent Labour party, founded by Keir Hardie, and in 1895 stood, unsuccessfully, for Southampton. As a member of the London county council he completed his training for public service and. after his marriage in 1896 with Margaret Ethel Gladstone, niece of Lord Kelvin, made frequent journeys abroad. In 1897 he paid his first visit to Canada and the United States; in 1902 he went to South Africa; in 1906, travelled through the Pacific to Australia and New Zealand; in 1910 visited India, to which he returned in 1913 and 1914 as a member of the royal commission on the civil service. He also attended the (Second) Socialist International.

Three main stages may be noted in his political career: the creation of the Labour party, World War I and the Labour government. In the 1890s, the great trade unions still stood aloof from politics, or were satisfied nith a vague alliance with the Liberal party. The propaganda of the Independent Labour party, with which he was prominently associated, was directed to convincing the unions of the need of a political party for labour; in 1899 the Trades Union congress was induced to set up a committee to consider parliamentary action. Out of this came the Labour Representation committee, of which MacDonald was secretary. Thanks largely to his energy. patience and tenacity, the hostility of some unions and the apathy of others was broken down and a Labour party came into being in 1900. After the return of 29 M P.s, run by the Labour Representation committee in 1906, the battle was won; the party became an effective force. But it was only in 1918 that MacDonald's ideas mere fully realized. The party was reorganized and thrown open to all classes.

Elected as M.P. for Leicester in 1906, by 1911 he was leader of the Labour party in the house of commons. A constructive critic of Sir Edward Grey's foreign policy, he opposed, on Aug. 4, 1914, the view that there was an "obligation of honour" to go to war. The speech mas an agreed one, but the majority of the party broke away. He had already refused suggestions of office; he now resigned his leadership. He was denounced in public and private, and had to face the fact that. his views were not accepted by the nation at war. In 1918 he lost his seat at Leicester, and in 1921 failed to get in for East Woolwich.

Although out of the house of commons till late in 1922, his influence on opinion steadily grew. By 1922, the party took his view of the peace treaties, and resisted the tendencies that split nearly every Labour party abroad. In 1912 he had opposed the demand for the substitution of industrial ("direct") for parliamentary action in his book *Syndicalism;* in 1919, when, under the stimulus of Russian events, this demand reappeared as the Communist doctrine of violent revolution, he wrote *Parliament and Revolution* and *Parliament and Democracy,* in which he gave a definite and logical lead against the tactics of violence and championed parliamentary democracy. The 1922 election registered his moral ascendancy. Labour, with 140 members, was the second party in the state, and he himself, returned for Aberavon, was chosen by his colleagues leader of the opposition.

After the sudden election of 1923, he came back with 192 followers. With the authorization of the National Labour party and the Trades Union congress MacDonald declared that Labour would take office, if given the chance, in order to render national service. On Jan. 21, 1924, he accordingly moved a vote of no confidence in the Unionists, which was carried with Liberal support. Next day the king called upon him to form a government. The first Labour cabinet was announced on Jan. 24, and on Feb. 12 the new prime minister set out its general program in the house of commons. In this, the first item was the settlement of a disturbed Europe; with this supreme object in view, he added the post of foreign secretary to his premiership.

The unsettled state of Europe: aggravated through the occupation of the Ruhr, was a primary cause of distress and unemployment in Britain. British prestige had fallen low: relations between Britain and France were bad, between France and Germany threatening. The reparations question blocked the way. In letters to Raymond Poincaré, published on Feb. 4 and March 3, MacDonald, with finn friendliness, set out the British point of view, and had soon created a new atmosphere, one of confidence and hope. When, on April 13. the experts committee on reparations issued a unanimous report, he at once accepted it on the part of Britain as a basis for settlement. In May, Poincaré was replaced by the Radical Edouard Herriot, who in June came over to London to discuss the European position with MacDonald. Friendship with Italy had been assisted by the handling of Jubaland. On July 16, 1924, an allied conference assembled in London, over which he presided, for the specific purpose of putting the experts' report into operation. Within a fortnight, agreement had been reached and the German delegates called in. On Aug. 16 the London settlement, the first negotiated agreement since the war, was initialled. By mutual consent, the experts' plan was put in effect, and the reparation problem thus lifted out of the political sphere. France, at the same time! agreed to evacuate the Ruhr within a year and certain towns at once. Negotiations for an Anglo-German commercial treaty were initialled. In September MacDonald and Herriot attended the fifth assembly of the League of Nations at Geneva, and there submitted a plan, the Protocol, for the elimination of private war and the submission of all disputes to arbitration, after general mutual disarmament.

In the house of commons, meantime, the difficulties of the government's minority position were growing. Philip Snowden's budget met with general approval, a housing act was passed and the machinery for the relief of unemployment improved. But when MacDonald sought to complete his peace work by making treaties with Russia, whose de *jure* recognition had been an early act as foreign secretary, the Liberals broke away. In October the government was defeated on a motion, calling for a select committee, on their dropping of the prosecution of J. R. Campbell, editor of the Communist *Workers' Weekly.* In the general election, then declared, the press was exceedingly hostile. and Labour was identified with Bolshevism. Polling took place on Oct. 29; as a result the Conservatives came back with a great majority. The Labour vote went up by over a million, but its representation was reduced to 150. On Nov. 4 MacDonald resigned, and resumed his leadership of the opposition. His party, in conference in 1925, confirmed his leadership.

The confidence of the party was justified by the results of the general election of May 1929. The final results gave Labour 290 seats as against 259 Conservative, 57 Liberals and 9 Independents. Baldwin resigned and the King sent for MacDonald. His cabinet included: Sankey (lord chancellor), Parmoor (lord president), J. H. Thomas (Privy seal and deputy leader in House of Commons), P. Snowden (exchequer), A. Henderson (foreign affairs), J. R. Clynes (home office), Sidney Webb (Lord Passfield) (colonies and dominions), Shaw (war), Wedgwood Benn (India), Thomson (air), A. V. Alexander (admiralty), W. Graham (board of trade), C. P. Trevelyan (education), A. Greenwood (health), Noel-Buxton (agriculture), Margaret Bondfield (labour), G. Lansbury (first Comm. of Works), W. Adamson (Scotland) and O. Mosley (Duchy of Lancaster).

A year later, in June 1930, Mr. Thomas was transferred to the Dominions Office which in view of the approaching Imperial Conference was separated from the Colonies: Mr. Hartshorn becoming Lord Privy Seal, and Dr. Addison Minister of Agriculture.

MacDonald at once resumed the peace work begun in 1924. The Optional Clause was signed in Sept. 1929 and the evacuation of the Rhineland secured, while normal relations with Russia were resumed. His visit to the U.S.A. paved the way for the Naval Treaty of April 1930, carrying out limitation of all categories, as between Britain, the U.S. and Japan, and reaching agreement on many points also with France and Italy. Work at home—a new Pensions Act, a new Unemployment Insurance Act, a Coal Mines Bill—was overshadowed by the mounting unemployment figures due to the world-wide slump. To help in dealing with this great issue MacDonald appointed an Economic Advisory Committee, and, in the summer of 1930, invited the "emergency" co-operation of the other parties.

MacDonald's contribution to British political history cannot be measured unless it is noted that he made the Labour Party, which he assisted to create, the vehicle of a new political philosophy. His socialism has modified opinion over a wider range than that of professed adherents

On the formation of the National Government in 1931, when most of his socialistic colleagues resigned, MacDonald remained prime minister, retaining this office after the general election of that year. He presided over the Lausanne Conference, 1932, and the World Economic Conference, 1933. In June 1935, for reasons of health, he resigned the premiership to Stanley Baldwin, but remained in the cabinet as lord president of the council. He died Nov. 9, 1937 in mid-Atlantic enroute to South America for a rest.

MacDonald's views on socialism can best be studied in his books. Among them the more important are: *Socialism and Society* (1905); *Socialism and Government* (1909); *The Awakening of India* (1911); *The Socialist Movement* (1911); *Syndicalism* (1912); *The Social Unrest* (1913); *National Defence* (1917); *Parliament and Revolution* (1919); *Parliament and Democracy* (1919); *The Government of India* (1919); *A Policy for the Labour Party* (1920); and *Socialism, Critical and Constructive* (1921). In addition, his biography of his wife, *Margaret Ethel MacDonald* (1912); and a volume of essays and travel pictures, *Wanderings and Excursions* (1925) may also be mentioned. See C. W. Mullins, *The Patriotism of Ramsay MacDonald and Others* (1916); L. N. Le Roux, *J. Ramsay MacDonald, Sa vie, son oeuvre et sa pensée* (1919); "Iconoclast" (M. A. Hamilton) *The Man of Tomorrow, J. Ramsay MacDonald* (1923); *J. Ramsay MacDonald, 1923–25* (1925); H. Tracey, *From Doughty Street to Downing Street. The Rt. Hon. J. Ramsay MacDonald, M.P.* (1924); J. Bardoux, *J. Ramsay MacDonald* (1924); G. Glasgow, *MacDonald as Diplomatist* (1924); U. D. C. *The Diplomacy of Ramsay MacDonald* (1925). (M. A. H.)

MACDONALD, SIR JOHN ALEXANDER (1815–1891), first premier of the dominion of Canada, was born in Glasgow on Jan. 11, 1815, the third child of Hugh Macdonald (d. 1841), a native of Sutherlandshire. The family emigrated to Canada in 1820, settling first at Kingston, Ontario. At the age of fifteen Macdonald entered a law office; he was called to the bar in 1836, and began practice in Kingston, with immediate success.

In 1844 Macdonald was elected to the provincial assembly as Conservative member for Kingston. A sentence in his first address to the electors strikes the dominant note of his public career: "I therefore need scarcely state my firm belief that the prosperity of Canada depends upon its permanent connection with the mother country, and that I shall resist to the utmost any attempt (from whatever quarter it may come) which may tend to weaken that union." In 1847 he was made receiver-general with a seat in the executive council.

One of the first acts of the Reform government which succeeded that of which Macdonald was a member was to pass the Rebellion Losses Bill. In the controversy on the British connection which followed that event, Macdonald helped to found a British-American league, having for its object the confederation of all the provinces, the strengthening of the connection with the mother country, and the adoption of a national commercial policy. He remained in opposition from 1848 till 1854, holding together under difficult circumstances an unpopular party with which he was not entirely in sympathy. The two great political issues of the time were the secularization of the clergy reserves in Ontario, and the abolition of seigniorial tenure in Quebec. Both of these reforms Macdonald long opposed, but when successive elections had proved that they were supported by public opinion, he brought about a coalition of Conservatives and moderate reformers for the purpose of carrying them. Out of this coalition was gradually developed the Liberal-conservative party, of which until his death Macdonald continued to be the most considerable figure, and which for more than forty years largely moulded the history of Canada. From 1854 to 1857 he was attorney-general of Upper Canada, and then, on the retirement of Colonel Taché, he became prime minister.

At this critical period of Canadian history a proposal was made for a coalition of parties in order to carry out a broad scheme of British-American confederation. Macdonald, at the head of a representative delegation from Ontario and Quebec, met the public men of the maritime provinces in conference at Charlottetown in 1864, and the outline of confederation then agreed upon was filled out in detail at a conference held at Quebec soon afterwards. The actual framing of the British North America Act, into which the resolutions of these two conferences were consolidated, was carried out at the Westminster Palace Hotel in London, during December 1866 and January 1867, by delegates from all the provinces working in co-operation with the law officers of the Crown, under the presidency of Lord Carnarvon, then secretary of state for the colonies. Macdonald took the leading part in all these discussions, and he thus naturally became the first premier of the Dominion. He was made a K.C.B. in recognition of his services to the empire.

The difficulties of organizing the new Dominion, the questions arising from diverse claims and the various conditions of the country, called for infinite tact and resource on the part of the premier. Federal rights were to be safeguarded against the provincial governments, always jealous of their privileges. The pledge made at confederation with regard to the building of the Intercolonial railway to connect the maritime provinces with those of the St. Lawrence was fulfilled. The North-West Territories were secured as a part of confederated Canada by the purchase of the rights of the Hudson's Bay Company, and the establishment of Manitoba as a province in 1870. Canada's interests were protected during the negotiations which ended in the Treaty of Washington in 1871, and in which Macdonald took a leading part as one of the British delegates. In this year British Columbia entered the confederation, one of the provisions of union being that a transcontinental railroad should be built within ten years. This was declared by the opposition to be impossible. It was possible only to a leader of indomitable will. Charges of bribery against the government in connection with the contract for the building of this line led to the resignation of the cabinet in 1874, and for four years Macdonald was in opposition.

During the summer of 1876 he travelled through Ontario addressing the people on the subject of a commercial system looking to the protection of native industries. This was the celebrated "National Policy," which had been in his thoughts as long ago as the formation of the British-American League in 1850. The government of Alexander Mackenzie refused to consider a protection policy, and determined to adhere to Free Trade, with a tariff for revenue only. On these strongly defined issues the two parties appealed to the people in 1878. The Liberal party was almost swept away, and Macdonald, on his return to power, put his policy into effect with a thoroughness that commanded the admiration even of his opponents, who, after long resistance, adopted it on their accession to office in 1896. He also undertook the immediate construction of the Canadian Pacific railway, which had been postponed by the former government. The line was begun in 1880, and finished in November 1885—an achievement which Macdonald ranked among his greatest triumphs.

During the remaining years of his life his efforts at administration were directed mainly towards the organization and development of the great North-West. From 1878 until his death in 1891 Macdonald retained his position as premier of Canada, and his history is practically that of Canada (*q.v.*). For forty-six years of a stormy political life he remained true to the cardinal policy that he had announced to the electors of Kingston in 1844. "A British subject I was born; a British subject I will die," says his last political manifesto to the people of the Dominion. At his advanced age the anxiety and excitement of the contested election of 1891 proved too great. On May 29, he suffered a stroke of paralysis and died on June 6.

A condensed biography by G. R. Parkin forms one of the "Makers of Canada" series (Toronto, 1907; new ed., 1909). *See* also Sir J. Pope, *The Day of Sir John Macdonald* (Toronto, 1915).

MACDONALD, JOHN SANDFIELD (1812–1872), Canadian statesman, was born at St. Raphael, Glengarry county, Ontario, on Dec. 12, 1812. He was admitted to the bar in 1840, and settled in Cornwall. In 1841 he was elected to the Canadian parliament for Glengarry, which seat he held for 16 years. In 1842 he joined the Reformers in the cry for constitutional government, and from 1852 to 1854 was Speaker of the house. He was always uncertain in his party allegiance, and often attacked George Brown, the Liberal leader. In 1862 he was called on by Lord Monck, the governor-general, to form a ministry, which by manifold shifts held office till Feb. 1864. In the debates on federation he opposed the measure, but on its passage was in 1867 entrusted by the Conservatives with the task of organizing the provincial Government of Ontario. He ruled the province with economy and efficiency, but was defeated in Dec. 1871 by the Liberals, resigned the premiership, and died on June 1, 1872.

MACDONELL, SIR JOHN (1846–1921), British jurist, was born at Brechin. Forfarshire, on Aug. 11, 1846, and was educated at the universities of Aberdeen and Edinburgh. In 1901 he was made Quain professor of comparative law in the University of London and he was president of the society of public teachers of law (1912–13), a member of several royal commissions, and editor, for many years, of *The Journal of Comparative Legislation and International Law.* In 1913 he was elected a fellow of the British Academy and in 1914 was created K.C.B. Besides editing the *State Trials* (1887), the *Civil Judicial Statistics* (from 1894) and the *Criminal Judicial Statistics* (from 1900), he published works on the subjects of capture at sea and the law of master and servact, and was the author of many papers on international law. He was also for 40 years a leader writer on *The Times,* London. He died in London on March 17, 1921.

MACDONNELL or **MACDONELL, ALESTAIR** (*i.e.,* ALEXANDER), **RUADH** (*c.* 1725–1761), chief of Glengarry, a Scottish Jacobite. The family was a branch of the clan Macdonald. Alestair ran away when a boy and entered the Royal Scots, a regiment in the French service, being sent to Scotland as a Jacobite agent in 1744. He was in France in Jan. 1745 when Prince Charles Edward landed in Scotland. Later in the year he was captured at sea while bringing help to the prince, and imprisoned for 22 months in the Tower. He then went abroad, but in 1749 he was again in London, and is believed to have acted as spy to the British Government, under the name of Pickle, enabling a close watch to be kept on the prince and on the Jacobite conspiracies. He died on Dec. 23, 1761.

See Andrew Lang, *Pickle the Spy* (1897), and *The Companions of Pickle* (1898).

MacDONNELL, ANTONY PATRICK (1844–1925), Indian and Irish administrator, was born in Co. Mayo on March 7, 1844, and educated at Athlone and at Queen's college, Galway. He entered the Indian Civil Service in 1864, and was sent to Bengal in 1865. His book, *Food Grain Supply and Famine Relief in Bihar and Bengal,* dealt with his experiences during the Bengal famine of 1873. He held successively the posts of secretary to the Bengal Government, home secretary, acting chief commissioner of Burma, chief commissioner of the Central Provinces (1890), member of the Government of India, and lieutenant-governor of the united provinces of Agra and Oudh. His particular interest was in the agrarian policy of India, and he was responsible for many reforms in the legislation affecting native tenants and cultivators. His six years' administration of the Central Provinces proved him to be a capable administrator, but his determined methods led to many misunderstandings with his subordinates. He experienced difficulties with the natives also on his introduction of Nagri (Hindi) script in place of Urdu in the courts, and Muslim political agitation has been traced to this cause. In 1897 MacDonnell personally organized the relief measures during the serious famine, and in 1901, just before the end of his term of office, he was made president of the Famine commission, and drew up the report which has become a standard authority. In Jan. 1903 he became member of the Indian Council, and of the privy council.

MacDonnell was then made under-secretary for Ireland, but with special powers over administration. His tenure of office at first appeared successful, but Wyndham, the chief secretary, was forced to resign on the question of Lord Dunraven's Devolution Act, of which MacDonnell was one of the principal authors. MacDonnell remained in office until 1908, but his special powers were annulled. On his resignation he was raised to the peerage as Lord MacDonnell of Swinford. In the House of Lords he took an active part for many years in the discussion of Irish and Indian problems, and in Aug. 1920 he attended the Irish Peace Conference in Dublin. He died on June g, 1925, the peerage becoming extinct

MACDONNELL, ARTHUR ANTHONY (1854–1930), English Sanskrit scholar, was born on May 11, 1854, and educated at Göttingen and at Corpus Christi college, Oxford. From 1880 to 1900 he was Taylorian teacher of German at Oxford, and from 1888 to 1899 deputy professor of Sanskrit. In 1922 he was appointed Stephanos Nirmalendu Ghosh lecturer on Comparative Religion at Calcutta.

His numerous publications include: critical editions of the *Sarvānukramani* and the *Anuvakānukramanī,* with Shadgurucishya's commentary (1886); *A History of Sanskrit Literature* (1900); the *Brihaddevata,* the first translation and critical edition (2 vols. 1904); Sanskrit and Vedic Grammars, and numerous articles.

MACDONNELL, SORLEY BOY (*c.* 1505–1590), Scoto-Irish chieftain, son of Alexander Macdonnell, lord of Islay and Kintyre (Cantire), was born at Ballycastle, Co. Antrim. From an ancestor who had married Margaret Bisset, heiress of the district on the Antrim coast known as the Glynns (or Glens), he inherited a claim to the lordship of that territory; and he was one of the most powerful of the Scottish settlers in Ulster whom the English Government tried to bring into subjection. He took an active part in the tribal warfare between his own clan and the MacQuillins, and by defeating the latter at Glenshesk in 1558, acquired the lordship of the Route. He was now too powerful to be neglected by Elizabeth and her ministers, who were also being troubled by his great contemporary, Shane O'Neill. Elizabeth aimed at fomenting the rivalry between the two men, and came to terms sometimes with the one and sometimes with the other. Shane O'Neill defeated Sorley Boy near Coleraine in 1564; in 1565 he invaded the Glynns, and at Ballycastle won a decisive victory, in which James Macdonnell and Sorley Boy were taken prisoners. James soon afterwards died, but Sorley Boy remained O'Neill's captive till 1567, when Shane was murdered by the Macdonnells at Cushendun (*see* O'NEILL). After the massacre of his family by the English in 1575, Sorley Boy made a successful raid on Carrickfergus and re-established his power in the Glynns and the Route. His position was further strengthened by an alliance with Turlough Luineach O'Neill, and by a formidable immigration of followers from the Scottish islands. In 1585 he regained possession of Dunluce castle. Sir John Perrot reluctantly opened negotiations with Sorley Boy, who in 1586 made submission to Elizabeth's representative. He obtained a grant to himself and his heirs of all the Route country between the rivers Bann and Bush, with certain other lands to the east, and was made constable of Dunluce castle. For the rest of his life he gave no trouble to the English Government.

See G. Hill, *An Historical Account of the Macdonnells of Antrim* (1873); R. Bagwell, *Ireland under the Tudors* (3 vols., 1885–90); *Calendar of State Papers: Carew MSS.* i., ii. (6 vols., 1867–73); D. Gregory, *History of the Western Highlands and Isles of Scotland 1493–1625* (1881); Sir J. T. Gilbert, *History of the Viceroys of Ireland* (1865).

MACDONOUGH, THOMAS (1783–1825), U.S. naval officer, who commanded the U.S. squadron at the battle of Lake Champlain during the War of 1812, was born in Delaware on Dec. 31, 1783. He entered the U.S. navy in 1800. During long service as a lieutenant, he took part in the bombardment of Tripoli and on a subsequent occasion showed great firmness in resisting the seizure of a seaman as an alleged deserter from the British navy. his ship at the time lying under the guns of Gibraltar. When war with England broke out in 1812, he was ordered to cruise in the lakes between Canada and the United States: with his headquarters on Lake Champlain. He was instrumental in saving New York and Vermont from invasion by his brilliant victory of Lake Champlain, gained on Sept. 11, 1814, with a flotilla of 14 vessels carrying 86 guns, over Capt. George Downie's 16 vessels and 92 guns. *See* WAR OF 1812, THE.

McDOUGALL, WILLIAM (1871–1938), British psychologist, who did more than any other writer at the beginning of the 20th century to establish British psychology on an experimental and physiological basis. He was born in Lancashire on June 22, 1871, and was educated at school at Weimar, Ger., and at the universities of Manchester and Cambridge, at the latter of which he studied medicine. In 1899 he joined the Cambridge anthropological expedition to the Torres straits, where he applied psychological tests to natives. He then went to Gottingen to acquire a fuller knowledge of experimental techniques from G. E. Miiller. McDougall's first important publication described a series of ingenious experiments seeking to reinstate Thomas Young's three-colour theory of vision. He turned next to the study of attention (which he identified with apperception) and its neurological correlates and formulated the hypothesis that the basis of intellectual activities is a hierarchy of neural circuits arranged in four main levels. In his *Physiological Psychology* (1905) and his *Psychology, the Study of Behaviour* (1912) he demonstrated the value of a thoroughgoing biological standpoint in place of the traditional philosophical approach. In 1901 McDougall joined James Sully as assistant in the new experimental laboratory at University college, London; and in 1904 he accepted a readership at Oxford. There he encouraged research students to apply Sir Francis Galton's method of mental testing to determine the innate factors of individual differences.

In his best-known work (*An Introduction to Social Psychology*, 1908), McDougall developed a theory of human behaviour based on the assumption of inherited instincts with their accompanying emotions and an acquired superstructure of sentiments. In 1920 he accepted the chair of psychology at Harvard university, and in 1927 moved to Duke university, Durham, N.C., where, with J. B. Rhine, he continued his earlier studies on extrasensory perception and paranormal psychology. In *Modern Materialism and Emergent Evolution* (1929) and *The Riddle of Life* (1938) he elaborated his hypothesis of interaction between body and soul and drastically criticized the materialistic revival inaugurated by the American behaviourist school and the consequent neglect of purposive factors in human life. He died at Durham, N.C., on Nov. 28, 1938. (CY. B.)

MacDOWELL, EDWARD ALEXANDER (1861–1908), American musical composer, was born in New York city on Dec. 18, 1861. His parents, who were Irish, had emigrated to America from Belfast shortly before the boy's birth. He had a varied education in music, first under Spanish-American teachers, and then in Europe, at Paris (Debussy being a fellow pupil), Stuttgart, Wiesbaden and Weimar, where he was chiefly influenced by Joachim, Raff and Liszt. From 1879 to 1887 he lived in Germany, teaching and studying, and also appearing as solo pianist at important concerts. In 1884 he married Marian Nevins, of New York. He returned to America in 1888, and settled in Boston until 1896 when he was made professor of music at Columbia university, New York. This post he resigned in 1904, and in 1905 overwork and insomnia resulted in a complete cerebral collapse. He died on Jan. 23, 1908. MacDowell's work gives him perhaps the highest place among American composers. Deeply influenced by modern French models and by German romanticism, full of poetry and "atmosphere," and founded on the "programme" idea of composition, it is essentially creative in the spirit of a searcher after delicate truths of artistic expression. His employment of touches of American folk-song, suggested by Indian themes, is characteristic. This is notably the case with his orchestral *Indian Suite* (1896) and *Woodland Sketches* for the piano.

See Lawrence Gilman, *Edward MacDowell* (1906).

MACDUFF, a small burgh and seaport of Banffshire, Scot., on the Deveron, 1 mi. E. of Banff and 46 mi. N.W. of Aberdeen by road. Pop. (1951) 3,322. The site, occupied by the fishing village of Doune (or Down), was purchased by the 1st earl of Fife, about 1732, and the name was later altered to Macduff by the 2nd earl. In honour of its constitution as a burgh in 1783 he rebuilt the market cross in front of the parish church. Behind it is a World War I memorial in the shape of a tower 70-ft. high. The harbour is safer and more accessible than that of Banff. The inhabitants are chiefly employed in the whitefish industry, and in boatbuilding. New Fishmarket buildings were opened in 1955. Grain and fish are exported and coal imported. A stone bridge across the Deveron connects with Banff.

McDUFFIE, GEORGE (c. 1788–1851), an American statesman, of South Carolina, was the son of John and Jane McDuffie, energetic, intelligent and unspoiled Scots who had migrated to Georgia after the Revolution. George was born about 1788 or 1790 (authorities differ) near Augusta. In 1804 Calhoun and Wilson, of Augusta, employed him as a clerk; and in 1810 William Calhoun, brother of James and John C. Calhoun (*q.v.*) took him into his family and sent him to Willington academy. George McDuffie justified the expectations of his patron. He graduated from South Carolina college in 1813, was called to the bar in 1814, and after a brief period of preliminary experience in law and politics entered into a partnership with Col. Eldred Simkins, of Edgefield, who possessed a good library and large practice. He secured election to the State Legislature in 1818, and to Congress in 1821.

In the national House of Representatives he won distinction and served continuously on important committees until 1834. While the Calhoun influence was strong upon him, George McDuffie maintained a vigorous intellectual independence which displayed itself in facile writing, strong debating, and an intense, rapid and fiery but logical oratory; also, in his gradual change from liberal construction to strict construction he was in advance of his contemporaries. In the end he was a free trader after the heart of Thomas Cooper, a believer in the right of revolution like Patrick Henry, supporting nullification on revolutionary rather than on constitutional grounds, and an opponent of internal improvements. But he was the leader of "the bank interest" in the house. In 1834 he denounced the Jackson administration, retired from Congress, and served as governor of South Carolina, 1834–36, with marked effectiveness, giving particular attention to the compilation of the statute laws of the State and to the reorganization of South Carolina college. He did something to promote Southern "direct trade with Europe," and while in England in the spring of 1839 was invited by J. B. Smith to participate in free trade activities of the Anti-Corn Law League, but this he declined.

In Dec. 1842 George McDuffie was elected to the U.S. Senate, where he helped to bring about the annexation of Texas, the "amicable adjustment" of the Oregon question with Great Britain and the passage of the low Walker tariff of 1846, displacing the high Whig tariff of 1842 almost in conjunction with the repeal of the British corn laws. Indeed, his bust was sent with Calhoun's to the Free Trade Hall at Manchester during this period of intimate relations between the free traders of both countries. McDuffie's public services practically ended with these adjustments in Anglo-American relations; for an old wound in the spine received in a duel in 1822 compelled him to resign his seat in the senate, Aug. 17, 1846. He died at Cherry Hill, in the Sumter district of South Carolina, on March 11, 1851. (T. P. MA.)

MACE, originally a weapon of offense. made of iron or steel, capable of breaking through armour. The mace was carried in battle by mediaeval bishops (Odo of Bayeux is represented on the Bayeux tapestry wielding one) instead of the sword. so as to conform to the canonical rule which forbade priests to shed blood. It continued in use as a weapon until the late 16th century, though many of the later examples with elaborately pierced flanges and damascened shafts seem to have been carried as a sign of rank The Turkish mace (*pushkan*), with an almost spherical head of iron sheathed in silver-gilt, was also used in the 17th century in eastern and northern Europe, mainly in those countries under Turkish domination, as a symbol of authority. The earliest ceremonial maces, as they afterward became, though at first intended to protect the king's person, were those borne by the sergeants at arms. a royal bodyguard established in France by Philip II and in England probably by Richard I. The history of the civic mace (carried by the sergeants at mace) begins about the middle of the 13th century, though no examples of that period are in existence today. Ornamented civic maces were considered an infringement of one of the privileges of the king's sergeants, who, according to the commons' petition in 1344, were alone deemed worthy of having maces enriched with costly metals. This privilege was granted, however, to the sergeants of London and later to those of York (in 1396), Norwich (in 1403–04) and Chester (in 1506). Maces covered with silver are known to have been used at Exeter in 1387–88; two were bought at Norwich in 143j and others for Launceston in 1467–68. Several other cities and towns had silver maces in the next century, and in the 16th century they were almost universally used.

The mace was carried as a symbol of royal authority, and for this reason the royal arms was set on the button at the end of the handle. During the 15th century this button was greatly expanded in size, in order to give due prominence to the royal arms. Thereafter it was surrounded by a coronet, which by the 17th century developed into an arched croun. At the same time the flanges of what had been the head dwindled into decorative brackets, and the mace was carried upside down with the crown uppermost, what had started as the head being held in the hand. As the custom of having sergeants' maces ceased, the large maces borne before the mayor or bailiffs came into general use.

In 1649 it was decided that the house of commons should have a mace of approved design; this was furnished by Thomas Maundy, who supplied many others to the same pattern for provincial towns. This pattern remained standard in England thereafter, with the exception that at the Restoration the royal devices were replaced on the head. There are two maces in the house of lords, the earliest dating from the reign of William III. Historic silver maces of the 18th century include the one of 1753 at Norfolk, Va., and that of 1756 of the state of South Carolina.

Among other maces. more correctly described as staves, in use at the present time, are those carried before ecclesiastical dignitaries and clergy in cathedrals and parish churches, and the maces of the universities. The silver mace with crystal globe of the lord high treasurer of Scotland, at Holyrood palace, Edinburgh, was made about 1690. The remarkable mace or sceptre of the lord mayor of London is of crystal and gold and set with pearls; the head dates from the 15th century, while the mounts of the shaft are early mediaeval.

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MACEDO, JOSÉ AGOSTINHO DE (1761–1831), Portuguese didactic poet and a critic and pamphleteer notable for his acerbity. Born at Beja, Sept. 11, 1761, he became professed as an Augustinian in 1778. Because of his turbulent character he spent much time in prison and was constantly transferred from one community to another. In 1792 he was unfrocked but obtained a papal brief which gave him the status of a secular priest. He was soon recognized as the leading pulpit orator of the day and in 1802 was appointed one of the royal preachers.

The best examples of his didactic poetry are *A Meditação* and Newton (1813). In 1814 he produced *O* Oriente, an insipid epic dealing with Vasco da Gama's discovery of the sea route to India. He also founded and wrote for a large number of journals, and the tone and temper of these and of his political pamphlets caused one of his biographers to call him the "chief libeler" of Portugal. His malignity reached its height in a satirical poem in six cantos. *Os* Burros (1812–14), in which he pilloried, by name, men and women of all grades of society, living and dead, with the utmost licence of expression. From *c.* 1823 onward he was the virulent champion of the absolutist reaction. He died at Pedrouços, Oct. 2, 1831.

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MACEDONIA, the central part of the Balkan peninsula. Macedonia was always strategically important as a crossroads: Via Egnatia, the shortest Roman route between the Adriatic coast and Constantinople, passed through places now known as Bitolj (Monastir) and Salonika. The valley of the Vardar (Axios) river was and continues to be the easiest highway from Salonika to the north. Both the Roman and the Ottoman empires based on Constantinople considered it essential to hold Macedonia, through which Serbia, Bosnia, Albania and continental Greece could be reached. This stretch of land had, therefore, a complex history and, as a result, a mixed population. When in the 19th century the national consciousness of the Balkan peoples began to waken, Macedonia became a problem of international magnitude.

Physical Geography.—Macedonia is bounded on the east by the lower Mesta (Nestos) river and the western slopes of the Rhodope (Rodopi) upland. North of the Pirin (Orvilos) massif the boundary turns west, passing south of Kyustendil (Velbuzhd), by the Shiroka Planina, Crna Gora and Shar Planina. Thence it turns southward by the Korab and Yablanitsa range and lakes Ohrid or Ochrida (2,280 ft.) and Prespa (2,798 ft.) to the massif of Grammos (8,033 ft.); then eastward, embracing the whole basin of the Aliakmion (Bistritsa) river and reaching the Gulf of Salonika near Mt. Olympus. Including the Khalkidiki or Chalcidic peninsula, Macedonia covers an area of more than 26,000 sq.mi. It is not, however, a geographical entity.

Aegean Macedonia.—The coastal belt along the Aegean sea, with the wide, flat and treeless *kampania* of Salonika and the plains of the lower Strymon (Struma) river and of Kavalla, has a Mediterranean climate, and its agricultural products are varied. They include grapes, mulberry trees for silk production, and fruit, especially figs, as well as crops such as cotton, tobacco, rice and a great variety of vegetables.

Pirin Macedonia.—Pirin Macedonia lies north of a belt of mountains through which the gorges of the Struma and Mesta rivers are the only highways to the south. While in the valleys climatic conditions are somewhat Mediterranean, the wild Pirin massif lying between them is snowbound in winter. The Belasitsa range, with a peak reaching 6,657 ft. (Radomir), is a natural boundary between Aegean and Pirin Macedonia, and the Malesh and Osogov ranges, with peaks reaching 6,312 ft. (Kadiyitsa) and 7,388 ft. (Ruyen), are the boundary between Pirin and Vardar Macedonia. The only highway leading westward from the former to the latter is the Strumitsa valley, parallel to the Belasitsa range.

Vardar Macedonia.—This lies to the northwest of Aegean Macedonia and is divided from it by the Kozhukh and Nidzhe ranges with Mt. Kajmakcalan as the highest peak (8,271 ft.).

With the exception of the Vardar valley, lower Bregalnitsa valley and lower Tsrna valley, this part of Macedonia is a plateau lying from 2.000 ft. to 3.000 it. above sea level. with mountain massifs re'aching 8,333 ft. (Yakupitsa). The climate approaches the continental type. with summer rains and often copious winter snowfalls. Chief crops are wheat, barley, maize and rye, while extensive pastures support large flocks of sheep and cattle.

HISTORY

From Alexander the Great to the Turkish Conquest.— For a relatively short period in ancient times, more than three centuries before the Christian era, there existed a state called Macedonia. It was consolidated by Philip II of Macedon and it covered the area of what is now the northern part of modern Greece and the southern parts of modern Albania. Yugoslavia and Bulgaria. The ancient Macedonians were either Greeks or superficially Hellenized Illyrians and Thracians (see ILLYRIA; THRACE). The sudden extension of Macedonian power over Asia Minor and the middle east was attributable to a combination of the Greek spirit of adventure, Philip II's military planning and the strategic genius of his successor, Alexander the Great. This empire, however, disintegrated after Alexander's death (*see* MACEDONIAN EMPIRE), and eventually, in 146 B.C., Macedonia was constituted as a Roman province. When in the 4th century the Roman empire was divided, Macedonia was assigned to the eastern half.

At that time the original Thraco-Illyrian population was probably partly Latinized and partly Hellenized. Greek, no doubt, was chiefly spoken along the Aegean coast, and the population was mainly Christian. Invasions of Goths, Vandals, Huns and Avars in the 4th and jth centuries brought devastation but no great changes in the ethnic composition of the population. But when the Slavs entered the Balkans in the 5th century they colonized hlacedonia too, and only a few towns remained Greek. In the 9th century almost the whole of Macedonia, with the exception of Salonika. was included in the first Bulgarian empire. Although themselves a Turanian people, the Bulgars were Slavicized. After the decay of the first Bulgarian empire, Macedonia remained independent under Shishman I, count of Trnovo, who in 963 founded a local dynasty. The third ruler of this dynasty, Samuel, founded an empire which is sometimes described as Western Bulgarian. It comprised Macedonia and extended over much of the Balkan peninsula, but it was destroyed by the Byzantine emperor Basil II Bulgaroctonus. The dynasty was extinguished in 1018 and its lands, including Macedonia, were returned to Byzantium.

Migratory movements and warlike invasions continued. Nomadic Vlachs found in Macedonia a region well suited to their mode of life. Turanian invaders, called Polovtsy by the Slavs and Kumans (Cumans) by the Greeks, were crossing the Danube and entering Byzantine domains; some of them settled in Macedonia and were later known as Vardariotes. While the brothers Peter and Ivan Xsen laid the foundations of the second Bulgarian empire in the 1180s, the Normans under William of Sicily captured and sacked Salonika. After the diversion of the fourth crusade to Constantinople in 1204, a Latin kingdom of Salonika was set up for Boniface of Montferrat. Boniface however mas expelled from there in 1222 by Theodore Angelus, despot of Epirus, a Greek, who styled himself emperor of Salonika and ruled over almost all Rlacedonia. He in turn was defeated in 1230 by Tsar Ivan Asen II, who included northern Macedonia in the second Bulgarian empire while its southern Aegean part was taken by the eastern Roman emperors of Nicaea. Meanwhile the Serbian state was growing strong under the dynasty of Nemanya; Stephen Dushan (1331–55) conquered the western parts of Bulgaria and all Macedonia except Salonika, Epirus and Thessaly and was crowned at Skoplje (1346) as "tsar of the Serbs and Greeks." This state, however, was as short-lived as all others in this area.

Macedonia under the Turks.—Before attacking Constantinople the Turks established themselves in the Balkans. In 1340 they began the conquest of what is now Bulgaria. In 1371 they held most of Macedonia and in 1389 they sealed the fate of the mediaeval Serbian empire by defeating King Lazar at Kossovo. Salonika fell into Turkish hands for the first time in 1387, for the second in 1391 and finally in 1430. The best lands in the plains were distributed among the Turkish chiefs and a system of feudal tenure mas developed. The Christian peasants either were driven to the less fruitful regions or remained on the lands assigned to the Moslem lords, to whom they paid a tithe.

The ethnic conditions of Macedonia were still further complicated. Large colonies of Turks were settled in the plains, while the Moslem Albanians (called Arnauts by the Turks) spread eastward, occupying much land in western Macedonia. The Serbian element, which had been strengthened under Stephen Dushan. was weakened by the great northward emigration of 1691 and 1740. The national consciousness of Serbs and Bulgars alike suffered a heavy blow when the patriarchates of Pech or Ipek (Serbian) and of Ohrid (Bulgarian) were abolished in 1766 and 1777 respectively. From that time the spiritual control of the Christian peoples in the Balkans became vested solely in the Greek Phanar or ecumenical patriarchate of Constantinople. The Greeks continued to live in towns controlling trade, but from the 16th century onward they had to face serious competition among the Sephardic Jews, who, expelled from Spain, founded prosperous communities at Salonika and in other Macedonian towns. There were also, as centuries before, Vlachs (called Kutso-Vlachs by the Greeks and Tsintsars by the Slavs) and a few Armenians.

With the decadence of the central power in the Ottoman empire the condition of the Christian population of Macedonia worsened. The reforms of 1839 and 1856, both of which proclaimed the equality of races and religions, remained unfulfilled. In 1864 Macedonia was divided into three vilayets or provinces: that of Salonika; that of Monastir (Bitolj). which included parts of Albania; and that of Kosovo, with the capital at Uskub (Skopljej. which protruded into "Old Serbia."

The Bulgarian Exarchate.— In the 19th century the Russian empire, in pursuance of its designs on Istanbul and the Turkish straits. presented itself in the Balkans in the guise of a liberator, addressing itself in particular to the Bulgars. Russia started by pressing the Porte to agree to the creation of an autocephalous Orthodox Church for the Bulgarian people. After some resistance, the Porte acquiesced, hoping to strengthen its grip on the Balkans by dividing its Christian subjects. On Feb. 28, 1870, Sultan Abd ul-Aziz issued the firman creating the Bulgarian exarchate; "Christian" and "Greek" were no longer synonymous in European Turkey. The ecumenical patriarch succeeded in postponing for two years the appointment of the first Bulgarian exarch and then excommunicated him and his flock as schismatics.

In 1878. after a victorious campaign, Russia compelled Turkey to recognize the independence of Bulgaria. By the treaty of San Stefano (March 3), the new Bulgarian state was given the whole of Macedonia, except Salonika and Khalkidiki. But Great Britain had also its protégés in the Balkans and immediately and energetically vetoed this treaty as unfair to the Greeks of Macedonia. The treaty of Berlin (July 13), to which all the Great Powers were signatories, created in the northern part of the Danube vilayet. as Bulgaria was then styled, a Bulgarian principality with Sofia as capital under the suzerainty of the sultan; in the southern part was formed an autonomous province of Eastern Rumelia, with Plovdiv (Philippopolis) as capital, under a Christian governor appointed by the Porte, with the assent of the Powers. Russian-sponsored Bulgaria was thus seriously reduced in size, but the Macedonian strongholds of Hellenism remained under Turkey.

The artificial division of Bulgaria into two units did not last long; on Sept. 18, 1885, Bulgarian nationalists deposed the governor and proclaimed the union of Eastern Rumelia with Bulgaria. To the general surprise the coup succeeded, because Turkey abstained from intervening. The Russian tsar, however. was offended because his protégé Alexander of Battenberg, first prince of Bulgaria, with the advice of Stefan Stambulov, then the speaker of the Bulgarian *sobranje*, had dared to proclaim the unification without asking for Russian help. To recover their influence in Sofia, the Russians organized a coup d'état on Aug. 21, 1886, which enforced Alexander's abdication. On July 7, 1887, Ferdinand of Saxe-Coburg was elected second prince of Bulgaria. But clumsy Russian diplomacy only increased the Bulgarian people's spirit of independence. Stambulov, now premier, saw clearly that it was in Bulgaria's interest to establish friendly relations with Turkey; he was thus able to secure exequatur for Bulgarian bishops at Ohrid and Skoplje in 1891 and at Veles and Nevrokop in 1894. In 1894 Ferdinand felt strong enough to dismiss Stambulov and to make his peace with Russia, but he continued to cultivate the good grace of the sultan, his suzerain. In 1898 Bulgarian prelates were appointed bishops of Bitolj, Debar and Strumitsa. In 1900 Bulgaria had 785 schools in Macedonia, Serbia had only 178 and Greece 927.

Komitadzhi, Andartai and **Chetnitsi.**—The Sofia nationalists argued that the Slavs of Macedonia spoke a dialect akin to Bulgarian and therefore should be regarded as Bulgars and that all Macedonia should be incorporated into Bulgaria. The Belgrade nationalists affirmed that, as the Macedonian Slavs retained the custom of *slava* (feast of ancestors), common to all Serbs but not occurring among the Bulgars, they could not be genuine Bulgars, but were at best superficially Bulgarized Serbs, whose land, it was argued, should be incorporated into a greater Serbia. The Greek nationalists maintained that the few hundred thousands of "Slavophones" whom they acknowledged to be in Macedonia were attracted by the superior Greek culture and considered themselves of Greek nationality. The Rumanians had no territorial claims in Macedonia but considered it useful to support the Vlachs. whom they called Arumanians.

The liberation of Macedonia from the Turks was desired by all non-Moslem Macedonians. To prepare it, a group of Macedo-Slavonic leaders, Damian Gruev (1871–1906), Goche Delchev (1872–1903) and others. formed a secret Internal Macedonian Revolutionary organization (Vatreshna hlakedonska Revolutsionna Organizatsia or V.M.R.O.) in Salonika in Nov. 1893, which put forward a slogan of "Macedonia for the Macedonians" and the idea of a Balkan federation. After the fall of Stambulov (who died three days after being attacked by assassins in Sofia in July 1895), the Bulgarian nationalists had reason to believe that the Russian government would attempt to restore the Bulgaria of the San Stefano treaty. In March 1895 a Supreme Committee for Macedonia and Adrianople (Vrkhoven Makedonski Odrinski Komitet) was formed at Sofia; its aim was to prepare the incorporation of the whole of Macedonia and the province of Adrianople into Bulgaria. Ferdinand was not opposed to the idea of maintaining a pro-Bulgarian agitation in Macedonia and Thrace but ordered his war ministry to keep the V.M.R.O. and the Supreme committee under control. This, he thought should be simple, because both were to be supplied with money and arms from Sofia. The first president of the Supreme committee was Traiko Kytanchev, but, as the real power was in the hands of the war ministry, the position of president was nor easy and changes were frequent. From 1899 the president of the committee was Boris Sarafov (1872?–1907). His main task was to send guerrilla bands (hence the name of *komitadzhi* or "committeemen") into Macedonia to coerce the population into declaring itself Bulgarian and to make certain that the V.M.R.O. would follow Sofia's line.

Sofia was not the only Balkan capital from which such irredentist activity was organized in Macedonia. Athens was disconcerted by the progress of Bulgarian propaganda. The Greek religious and educational organizations were well established but fighting a defensive battle. To counteract the Bulgarian activities and also to bring about a war with Turkey, a newly formed Ethniki Hetairia was sending guerrilla bands of *andartai* into Macedonia. These succeeded in provoking the Graeco-Turkish War (*q.v.*) of 1897, which ended in the complete defeat of Greece and thus benefited the Bulgarian movement. By then the Turks were sufficiently informed about the underground activities of the V.M.R.O. and of the Supremists; to counterbalance their influence the Porte inclined to favour other nationalities. Serbia, cut off from expansion in Bosnia-Hercegovina by the Austrian occupation, could look only southward. A nationalist organization controlled by the ministry of war started sending *chety* (companies) of underground fighters into Macedonia to encourage a pro-Serbian movement among the Macedonian Slavs, and a Serbian source mentions the names of Yovan Dovezenski, Djordje Skopljanche, Gligor Sokolovich and Yovan Babunski as the most famous *chetnitsi*. At the same time Belgrade began to agitate for the restoration of the Serbian patriarchate of Pech; a prolonged conflict with the Phanar secured only the appointment of a Serb, Msgr. Firmilian Drazhich, as archbishop of Skoplje in 1902. In 1905 a Rumanian bishop was appointed at Bitolj. At that time there were about 40 Rumanian schools in Macedonia, including a *gynznasium* at Bitolj founded in 1866 by the priest Apostol Margaritis. The Bulgars did not like this Serbian and Rumanian trespassing into a land that they considered their own; but they concentrated their efforts on combating the Greeks and the Grekomans (as they called pro-Greek Macedonian Slavs). At this time it was Lambros Koromylas, the Greek consul-general at Salonika, who directed the whole secret organization of agents and bands upholding Hellenism against the Bulgars.

The terrorist activities of Bulgarian *komitadzhi,* Greek *andartai,* Serbian *chetnitsi* and also of Turkish bashi-bazouks created so serious a situation in Macedonia that on Feb. 21, 1903, the Russian and Austro-Hungarian ambassadors presented identical notes to the Porte demanding the appointment of an inspector-general for the three Macedonian vilayets and the reorganization of the *gendarmerie* with the aid of foreign officers. Sultan Abd ul-Hamid accepted the scheme. and the Sofia government, under Russian pressure. pretended to have dissolved the Supreme committee.

The V.M.R.O., however, was unreachable, and on Aug. 2, on the Ilinden (St. Ilya's day), a general rising started in Macedonia. The rising was no doubt inspired by Sofia. The Supremist agents assured Gruev and Delcliev that, once the insurgents had tied down a sufficient number of Turkish forces, the Bulgarian army would intervene. By the end of September, however, the rising was suppressed and the Bulgarian army, although partly mobilized, did not cross the frontier. Having achieved a complete surprise, the insurgents had some initial successes (especially in the Bitolj area, which for a while they controlled). According to Bulgarian sources, the insurgents numbered 15,000, of whom 948 were killed as compared with 3.087 Turks killed. Turkish repression was ruthless; 105 Macedo-Slavonic villages comprising 9.830 houses were destroyed, 1,778 noncombatant Macedonian Slavs were shot and 60,953 rendered homeless. Thousands fled to Bulgaria, and their leaders, Gruev in particular (Delchev had been killed in the fighting), complained of having been betrayed by Sofia. But Ferdinand was gratified because, he thought: the federalist tendencies of the V.M.R.O. had suffered a decisive blow so that thenceforward it would be easy to control.

On Oct. 9, 1903, the Russian and Austro-Hungarian governments submitted to the Porte a second part of their reform scheme. called, after the place of signature, the Miirzsteg program, which also was accepted by the sultan. Russian and Austrian civil advisers were attached to Hussein Hilmi Pasha, the Turkish inspector-general of Macedonia, and an Italian general was entrusted with the reorganization of the *gendarmerie.*

In 1905 Hilmi carried out in the three vilayets the first census of population since the Turkish conquest, which disclosed the following results: Moslems 1,720,007; Greeks 648,962; Bulgars 557,734; Serbs, 167,601; Jews and others 77,386; total 3,171,690. Under "Moslems" were included Turks and Albanians inhabiting the western part of the Monastir vilayet and the northwestern part of the Kossovo vilayet; under "Greeks," all the "Patriarchists," whether of Greek, Slavonic or Rumanian speech; under "Serbs," only those attending Serbian churches and schools, who were confined to the northern and northwestern districts of the Kossovo vilayet.

A Bulgarian source, dealing with Macedonia proper (*i.e.,* excluding the Albanian and "Old Serbian" sanjaks of the Monastir and Kossovo vilayets), gave the following figures for 1905: in a total population estimated at 2,258,224, there were 1,370,949 Christians, 819,23j Moslems and 68,040 Jews. From the point of view of nationalities. this source stated that there were 1,181,-336 Bulgars, 499,204 'Turks, 218,702 Greeks, 128,711 Albanians, 80,767 Vlachs, 68,040 Jews, 54,557 Gypsies, 700 Serbs and 16,207 others (Armenians, Circassians. etc.).

In June 1908, when King Edward VII paid a visit to Tsar Nicholas II at Reval, an Anglo-Russian program of limited autonomy for Macedonia was prepared; but one month later the bloodless revolution of the Young Turks broke out. The internal conflicts between the various nationalities in Macedonia came temporarily to a standstill, Using this opportunity, Bulgaria proclaimed itself independent and Ferdinand took the title of tsar. The hopes of Macedonian populations that the new Turkish regime would grant them territorial autonomy were disappointed. The policy pursued by the Young Turks, who attempted to transform a multinational Ottoman empire into a national Turkish state, brought about a gradual *rapprochement* between the governments of Bulgaria, Serbia and Greece. This *rapprochement* was converted in the summer of 1912 into a military alliance, and in October the allies, declaring that promises of reform in Macedonia and elsewhere had not been fulfilled, attacked Turkey.

The Balkan Wars and World War I.—Bulgaria and Serbia concluded an agreement stipulating that Bulgaria should annex "the territory east of the Rhodope mountains and the river Struma," while Serbia was to annex the lands lying "north and west of the Shar Planina." But so great was their mutual distrust that no agreement could be reached as to the destiny of the main bulk of Macedonia. The Serbo-Bulgarian treaty of March 13, 1912, stipulated that, if autonomy for the rest of Macedonia were found to be impossible, the two states were to accept a partition along a line running roughly southwestward irom Kriva Palanka through Veles to Ohrid; alternatively, the tsar oi Russia would be asked to arbitrate and fix the Serbo-Bulgarian frontier in Macedonia. Between Greece and Bulgaria the feud was even deeper; and no previous agreement had been reached as to the ultimate distribution of territory to be taken from Turkey. Such a situation was iraught with danger, and, after the Balkan league's victorious campaign against the Turks, the Bulgars, on June 29, 1913, suddenly turned on their allies. Defeated by both Serbs and Greeks, and attacked irom the rear by the Rumanians, the Bulgars had to sue for peace. (*See* BALKAN WARS.) The treaty of Bucharest of Aug. 10, 1913, divided Macedonia as follows Greece took the southern half of it, with a new northern frontier running from Lake Prespa through Kajmakcalan to Lake Doiran, then eastward along the Belasitsa range and the lower Mesta; Bulgaria received the Strumitsa district, with the Pirin massif; and Serbia had the remainder.

When World War I broke out in 1914, Ferdinand thought that destiny had presented him with a chance of revenge and of realizing his territorial ambitions in Macedonia. Bulgaria entered the war in Oct. 1915, on the side of the Central Powers and rapidly occupied not only all Serbian Macedonia but also parts of Serbia proper. The Allies landed at Salonika to help Serbia, but only in 1918 were they able to carry through a successful offensive, which led to the Bulgarian armistice of Sept. 29, 1918. The treaty of Neuilly (Nov. 27, 1919) leit the Graeco-Yugoslav frontier unchanged but transferred the district of Strumitsa to Yugoslavia. Greek or Aegean Macedonia then had 13,361 sq.mi.; Yugoslav or Vardar Macedonia, 10,229 sq.mi; Bulgarian or Pirin Macedonia, 2,621 sq mi.

The 1920s and 1930s.—During the period between the outbreak of the first Balkan War and the end of World War I, certain movements of population had taken place in Macedonia: about 100,000 Turks had fled or been transported to Turkey in 1912–13; many pro-Bulgarian Macedonians had fled to Bulgaria in 1913 and many others in 1918; and in 1913 the Greeks from Melnik, Strumitsa and Bitolj had withdrawn to Greek Macedonia. After the treaty of Neuilly, moreover, about 25,000 Greeks left Bulgaria and 46,878 Bulgars left the eastern half of Greek Macedonia (approximately 80,000 "Slavophones," however, preferred to remain in the western hali). A much more radical exchange of population was that which took place under the Lausanne convention (Jan. 21, 1923), after Greece's deieat in Anatolia: 375,976 Turks leit Greek Macedonia and 638,253 of the 1,222,000 Greek refugees from Turkey were installed in their place.

No exchange of population took place in Yugoslav Macedonia. The Belgrade authorities considered the Macedonians as Southern Serbs and, to make the population thoroughly Serbian, took steps to repress pro-Bulgarian sentiments. This soon led to new tension. In 1920 the V.M R.O. was revived and Todor Aleksandrov (or Alexandrov) became its leader. It started a campaign of terrorism in Yugoslav Macedonia. When in March 1923 Aleksandr Stamboliski (*q.v.*), the Bulgarian premier, attempted to make terms with Yugoslavia, Aleksandrov declared "irrevocable hostility" against his government. Macedonians took an active part in overthrowing Stamboliski and in his assassination (June 1923).

A movement for an autonomous province within a federal Yugoslavia was born with Pero Shandanov as its leader, but the Belgrade government gave it no support. In April 1924, in Vienna, Dimiter Vlahov, a Macedonian Communist (and a former Bulgarian civil servant), persuaded Aleksandrov to fight for an autonomous Macedonia within a Communist Balkan federation. A manifesto along these lines, signed on May 6 and published on July 15, frightened the Sofia government; and on Aug. 31, 1924, Aleksandrov was assassinated in his Pirin hiding place. Gen. Aleksandr Protogherov (Alexander Protogueroff) and Ivan Mikhailov then became the leaders of the V.M.R.O. Mikhailov organized the assassination of many federalist Macedonian leaders and eventually of Protogherov himself, in Sofia on July 7, 1928, because he opposed the policy of assassinating federalists indiscriminately.

Yugoslav security measures made V.M.R.O. activity in Macedonia more difficult; and in the 1930s, as Fascist Italy began to exploit the organization, opposition to its activity increased also among Bulgarian politicians and army officers. On May 19, 1934, when a government headed by Kimon Gheorghiev and Col. Damian Velchev took power in Sofia, the V.M.R.O. was dissolved, its leaders were arrested and its members disarmed. Mikhailov escaped to Turkey, whence he later went to Germany.

World War II and After.—When Yugoslavia was partitioned in 1941 by the Axis powers, Bulgaria again occupied almost all Macedonia; a few northwestern districts, however, were incorporated into Albania and some southwestern ones occupied by the Italians, while Salonika (where only 9,000 of the 50,000 Jews escaped the gas chambers) was occupied by the Germans.

On July 12, 1943, at Petrich, in Bulgarian Macedonia, Dushan Daskalov, on behalf of the Bulgarian Communist party, and Yannis Ionnidis, on behalf of the Communist party of Greece, signed an agreement stipulating that the whole of Macedonia after the war should be an independent republic within the Balkan Communist iederation. By then, however, the importance of Tito (Josip Broz) was growing inside Yugoslavia. In Tito's opinion Balkan iederation should be effected under the leadership of the Communist party of Yugoslavia; and already in Feb. 1943 he had sent Svetozar Vukmanovich (General Tempo) to Skoplje to organize a Macedonian section of the Yugoslav liberation movement. In 1945 Vlahov became chairman of the presidium of the Macedonian national assembly and vice-president of the federal republic of Yugoslavia, while Lazar Kulishevski became premier of the republic of Macedonia (with Skoplje as capital).

Immediately after the war Tito was looking south, toward Salonika. At Skoplje on Oct. 11, 1945, he said: "We shall never renounce the right of the Macedonian people to unite. There are brothers in Aegean Macedonia to whose destiny we are not indifferent." The peace treaty with Bulgaria, signed in Paris on Feb. 10, 1947, nevertheless introduced no changes in the territorial settlement in Macedonia as fixed in 1919, although the Greek government attempted to put in a claim to the Pirin area. But at that time the second Communist rising in Greece was in progress and the future of the country was in the balance. At a meeting at Bled, in Aug. 1947, between Tito and Gheorghi Dimitrov, the Communist premier of Bulgaria, it was agreed that, on the successful conclusion of the Greek Communist rebellion, Greek Macedonia should be incorporated into Yugoslav Macedonia, that Greek Thrace should become part of Bulgaria and that a great South-Slav federation uniting Yugoslavia and Bulgaria should be formed. In Jan. 1948, however, Moscow, already exchanging somewhat cool notes with Tito, rebuked Dimitrov for supporting such a plan; and on June 28, 1948, the breach between Tito and Moscow was made public.

In Nov. 1948 an organization of Macedonians in Bulgaria was allowed to announce that the only correct and democratic solution of the problem was a Macedonian state equal to Yugoslavia and Bulgaria; and in March 1949 the Greek rebel government (which had its seat in the Vitsi massif in Greek Macedonia) sponsored a similar plan. Tito's reply, the closing of the Graeco-Yugoslav frontier (announced on July 10, 1949), contributed much to the crushing of the rebellion in Greece (September).

From 1950 onward Graeco-Yugoslav relations improved steadily. The pact of friendship (Feb. 28, 1953) and the subsequent military alliance (Aug. 9, 1954) between Greece, Yugoslavia and Turkey made a Graeco-Yugoslav dispute over Macedonia most unlikely.

POPULATION

Yugoslav Macedonia had in 1931 a total population of 949,958. The census of 1948 revealed a population of 1,152,986, including 762,120 (66.1%) Macedonians, 197,423 (17 2%) Albanians, 95,987 (8.4%) Turks and 9,508 (0.8%) Vlachs. According to the census of 1961, the republic of Macedonia had a population of 1,404,883.

Greek Macedonia, at the time of the census of 1928, had 1,412,477 inhabitants; by the census of 1940 this total had risen to 1,759,130. The latter figure included 1,487,571 Greek-speaking persons (84.6%) and 80,310 Turkish-speaking hut Christian Greeks (4.6%); there were also 84,751 "Slavophones" (*i.e.,* 66,665 Macedonians and 18,086 Pomaks or Bulgarian-speaking Moslems; together 4.8%), 48,874 Sephardic or Spaniole Jews and 26,750 Vlachs. The census of 1961 revealed a total population of 1,887,650.

In Bulgarian Macedonia the population census of 1934 was 206,814 and that of 1946 was 252,258 (in the districts of Gorna Dzhumaya, Razloe, Petrich, Sveti Vrach [Sandanski] and Nevrokop [Delchev]). In 1956 the population was 281,636. No Macedonian nationality was recognized in Bulgaria. The data oi 1934 showed 84.7% to be Orthodox Christians (2% of whom were Vlachs). If this basis is adopted for 1946, the population might be reckoned to comprise about

209,000 Bulgars or Macedonians or both, 5,000 Vlachs and 38,000 Turks, Pomaks and others

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MACEDONIAN ARMY. The army created by Philip of Macedon, the military instrument used by his son Alexander the Great in the conquest of the Persian empire, though based on the old Doric hoplite phalanx, was so superior to it that the genius of the great Macedonian cannot be appreciated without a comparison with the older organization.

The Early Greek Army.—The phalanx was the natural tactical formation for a military citizen levy, that is, a body of men whose training and tactics had to be of the simplest nature. Battles always took place on level ground, and normally in narrow valleys where the only manoeuvre possible was a forward or backward movement to drive the enemy out of the valley or into his city, or village, situated in it. Generally speaking, sieges were but holding operations carried out in order to enable the valley to be ravaged, for the economic attack was the main object of early Greek warfare. Except in Thessaly and Macedonia, cavalry was practically unknown until after the Persian wars, and though the bow was an old and respected weapon, used on occasion, as in the Plataea campaign (479 B.C.), it was not suited to a raw citizen force, since a bowman required a far more intensive training than a hoplite.

The phalanx formed a compact tactical body of files of men in varying depth. A file of eight men seems to have constituted the normal number, but frequently this was varied according to the personal predilection of the general from two to as many as twenty-five. In a phalanx of eight deep only t o ranks were engaged, the rear ranks constituting a reserve for the replacement of casualties; also their object was to exercise physical and moral pressure on the leading two. The phalanx was based on two principles, producing opposite effects—depth which gave weight, and length which allowed for outflanking. Normally, depth was preferred to length because of the difficulty of moving a long line forward, especially if the ground was rough or at all broken.

The difficulty of harmonizing these two principles is clearly seen in the formation made use of by Miltiades in the battle of Marathon, 490 B.C. He was faced by the Persian army, which not only was numerically superior to his own but which possessed a strong cavalry force. The battlefield was a narrow plain flanked by two streams, but his phalanx if maintained eight ranks deep would have provided too narrow a front for him to rest its flanks on these obstacles. He, therefore, weakened the centre' by thinning it to probably four ranks, leaving the flanks at their normal depth. When the two armies clinched, the Grecian centre was driven in but not broken; the result of this was a double envelopment of the Persians, and their defeat.

All hoplites wore armour, for it was recognized that a man without armour was not equal to one wearing it. This armour consisted of a large oval shield, helmet, breastplate and greaves, weighing 57 lb. The offensive weapons were a strong Doric spear from 6 to 10ft. in length, and a sword. The total weight carried by the hoplite was 72 lb., an impossible load for either long or rapid marches; consequently we find that each hoplite was accompanied by a slave who acted as shield-bearer, and who took part in the engagement as a lightly armed soldier; he was also a forager and a pillager.

The weak points of the phalanx were its flanks. Should the enemy succeed in attacking a flank whilst the front was engaged, the phalanx was lost. The flanking files were not only incapable of resisting an attack, but if forced to halt and face the enemy they immediately compelled the entire phalanx to stand still. When phalanx met phalanx this defect was not serious; but when, as in the Persian wars, the Greeks were confronted by cavalry

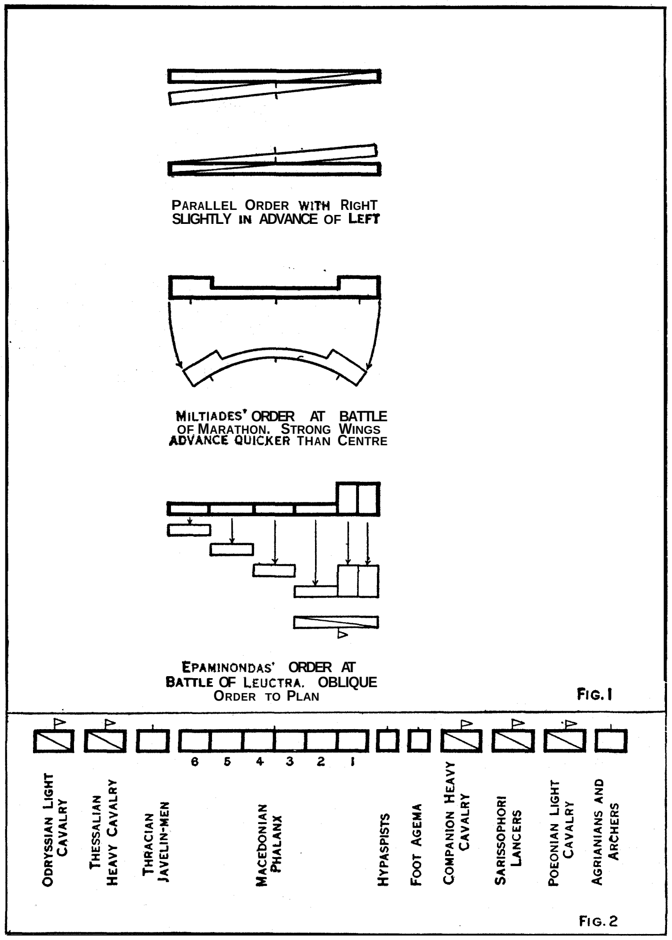


FIG. 1 SHOWS THE BATTLE ORDER OF THE GREEK PHALANXES WHILE FIG. 2 IS THE TYPICAL LINE OF BATTLE ADOPTED BY BOTH PHILIP OF MACEDON AND ALEXANDER

the danger of a charge against an exposed flank became obvious, and the result of this was a slow but noticeable interest taken in the cavalry arm. In the normal battle between hoplites, it generally happened that both sides tended to bear somewhat to their right; since each man felt that his right side was the less protected, consequently he tried to approach the enemy from the right. The tactical consequence of this was the development of an oblique order of attack, the value of which was first fully grasped by Epaminondas, and made use of by him at the battles of Leuctra (371 B.C) and Mantineia (362 B.c.). This famous general was a true artist of war, since he understood how to combine infantry and cavalry according to the value of the ground fought over. So great was his discovery of refusing one wing and concentrating his main blow in the other, that his tactics formed not only the model for Alexander but for Frederick the Great as well.

Organization of the Macedonian Army.—The tactical conception as expounded by Epaminondas was adopted and developed by Philip of Macedon. Macedonia consisted mainly of plains, and had but a small urban population. The majority of the peasants were shepherds and too poor to maintain hoplite armour, consequently their spearmen, or peltasts, were lightly and indifferently equipped; they carried a light round shield, a tunic of leather or quilted linen, several javelins and a sword. These men when required formed the national levy, but the main arm relied upon by the kings of Macedonia was a body of mounted nobles. From these two elements Philip set to work to refashion his army.

Philip, when a hostage in Thebes, the city of Epaminondas, had learnt to appreciate the strength and weakness of trained mercenaries; their discipline was magnificent but they were lacking in patriotism. On his return to his kingdom, he determined to model his troops on what was then a new idea, namely, a highly-trained and disciplined standing army. This force being patriotic and disciplined would possess both the virtue of the old militiaman and the skill of the trained mercenary. As he already possessed the best cavalry in Greece, if he could now raise an efficient force of infantry, and combine these two arms scientifically, he would create for himself an instrument more powerful than that of any city or state in Greece. The system he worked on is not fully known, but much of it can be discovered from an analysis of the army commanded by his son, for it was only towards the close of Alexander's reign that changes in Philip's organization were made. First Philip took the Spartan phalanx as his model, but in place of looking upon it as an offensive force, he organized it as a stable base from which offensive action could be developed by his cavalry, This protective base he armed with a pike called the sarissa, which was in length double, or nearly double, that of the Spartan weapon, which at this time was about $10\frac{1}{2}$ft. long. This lengthening of the pike may be conipared to increasing the range of a modern rifle, for it meant that the enemy armed with the short pike would be outranged. It is true that the sarissa was a clumsy offensive weapon, but, as far as can be gathered, Philip never intended it as such; what, apparently, he aimed at was the establishment on the battlefield of an impenetrable wall of spikes, a mobile fortress upon which his cavalry could pivot and manoeuvre. This protective tactical base was organized into six divisions, each consisting of about 5,000 men. Each of these men, as in the Spartan phalanx, was allowed one or more servants who were lightly armed and could be employed for forays, raids and operations in hilly country.

To the phalanx Philip attached two cavalry wings, mobile arms which could hit out from it; the right wing was in idea offensive, and the left defensive. The main strength of the right lay in the Macedonian cavalry—the Companions—and of the left in the Thessalian cavalry, the second best cavalry in the army. As both these forces of cavalry were mainly for shock action, Philip added to each wing bodies of light cavalry; normally, the Sarissophori, or Lancers, and the Paeonians were allotted to the right wing, and the Odryssian cavalry to the left. Between the cavalry of the right wing and the right of the phalanx Philip inserted a "joint" of highly trained and armoured infantry known as the Hypaspists, of which a picked body constituted the Agema, or Royal Foot Guards, just as a selected regiment of the Companion cavalry, the cavalry Agema, were the Royal Horse Guards. This armoured infantry carried the short pike and were not protective troops like those of the phalanx, the Pezetaeri, but mobile offensive troops which normally, when the cavalry of the right wing charged forward, simultaneously protected the cavalry's left flank and the right flank of the phalanx. Should the charge of the heavy cavalry succeed, the Hypaspists, under cover of the cavalry on their right flank and the phalanx on their left, could take advantage of the enemy's disorder and work into his shattered front. The only point of weakness remaining was the right, or outer, flank of the right wing cavalry, which Philip protected by a body of skilled light infantry, the Agrianians, archers and the Thracian javelin-men.

A comparison between the Macedonian organizations and those of the Spartans and, later on, the Thebans under Epaminondas, shows clearly the genius of Philip. In the Spartan phalanx tactics were little more than push of pike, in which drill and courage generally won the day. In Epaminondas's battle order is seen clearly the idea of concentration of force against a weak point, but the blow is still delivered by infantry and is consequently slow, the Theban cavalry being no more than a protective force to the decisive infantry attack. In Philip's order organization is scientific. First, the moral element is not only based on discipline but on patriotism; secondly, the protective element is fully developed in the armoured and sarissa-armed Pezetaeri and the light infantry; thirdly, the offensive element is represented by the Hypaspists; and fourthly, the mobile element by the cavalry. Nor was this all, for these elements were so combined as to form a single co-operative organization, probably the most wonderful ever devised by a single man, and one much more scientifically perfect than any existing to-day. In the attack, the tactical base is the phalanx, for it can engage the enemy and hold him, and whilst the left wing guards the left flank of the phalanx the right wing can punch out from it with terrific force. The Hypaspists assault, and do not merely hold; the heavy cavalry charge, and do not merely wash round the enemy, and they can do so because their outer flank is well protected by light infantry, who are secured against being ridden over by light cavalry who not only are ever ready to support them, but who, by swarming round the enemy's left wing and rear, pin down his initiative, By means of this superb organization Alexander won victory after victory. Not only was he never defeated, but whether he fought on the plains or in the mountains, his army proved itself equally adaptable to the work it was asked to carry out. That it never failed him is the greatest possible proof of the organizing genius of his father.

The Tactics of Alexander the Great.—The tactics developed from Philip's organization by Alexander were multiform, especially in his lesser campaigns. In his great battles, however, may be discovered two tactical constants which are deserving of careful study The first is the rear attack on the enemy, and the second, the protection of this attack. The rear attack was developed out of the oblique order. The phalanx advancing in echelon with its left refused struck the enemy with its right division. This division held in its grip such of the enemy as confronted it; the rest of the enemy, unopposed, moved forward until they came into contact with the divisions on its left, and when they were also fixed, the enemy's right wing attempted to envelop the left flank of the Macedonian phalanx, but was held off by repeated charges of the left-wing cavalry. Whilst this action mas being fought out the right-wing cavalry smashed through the enemy's left wing, and by wheeling to the left took the enemy's obliqued front in rear. Now as to the protection of the decisive attack which is closely connected with this operation.

If the phalanx were to advance in a solid line parallel to the enemy's front, it could simultaneously fix the enemy's front and protect the left flank of the decisive attack. *(See* fig. 3). But if it advances in echelon (a) *(see* fig. *4)* it can protect not only the inner flank of *(f)* but also its rear should an enemy attack break through (g) the archers and javelin-men *(e).* Similarly (d) and *(e)* advancing in echelon with their left forward, protect the right flank of the decisive attack. The rapid advance of (f) pulls forward the right of the phalanx and the left of *(e)* forming *a* protective funnel for the charge and probably forcing the enemy at *(h)* to *(h')*. Should attack of (f) towards *(i)* succeed, *(f)* can move by *(j)* and attack *(h')* in rear.

The Siege Train and Artillery of the Macedonian Army.—Before the days of Philip of Macedon siege warfare had been little studied by the Greek city states, consequently the defensive remained the stronger form of war. Until fortresses could be stormed there was small likelihood of any centralization of government, and this had been the outstanding curse of Greece. Philip, realizing this, turned his attention to siege warfare, and, though during his reign his siege operations were not uniformly successful, no fortress, even the immensely strong city of Tyre, successfully withstood the engineering ability of his son. In the Macedonian army there was established a special corps of engineers equipped with all the necessary machinery for carrying out sieges, and for crossing rivers. At the siege of Tyre, movable towers, rams and floating battery were used, and in India a pontoon train was added to the army so that the Indus, Jhelum and other rivers could rapidly be crossed. Though siege artillery had long been known in the east, Philip introduced field artillery in the form of wagon-carried catapults and ballistae, of which Alexander made frequent use in his mountain campaigns and in river-crossing operations. It was quite as much due to the Macedonian siege train as to the field army that Alexander was able to overthrow the Persian empire, for all its more important cities were strongly fortified.

Command and Administration of the Macedonian Army. — Though little information is forthcoming on the interior economy of the Macedonian army, it is known that its command rested absolutely in the hands of Philip, and after him in those of Alexander. This was an enormous advantage, since in most of the Greek states generals were elected yearly, and frequently more than one was placed in supreme command. Philip is reported to have said: "I envy the good luck of the Athenians; each year they are able to find ten men fit to command their armies, whilst I have only been able to find Parmenio to lead mine." Lack of unity of command was the ruin of Athens.

When Alexander ascended the throne of Macedon, in every sense, he was commander-in-chief. Under him came two deputy chiefs — Parmenio and Antipater. The first represented the military and the second the civil government, for whilst Parmenio accompanied Alexander to Asia, Antipater was left at home as viceroy. In battle Alexander commanded the right wing and Parmenio the left. For his personal staff Alexander had seven aides-de-camp, or *Somatophylaxes,* who were frequently appointed to command special detachments. Of his administrative directors and officers next to nothing is known, but those services

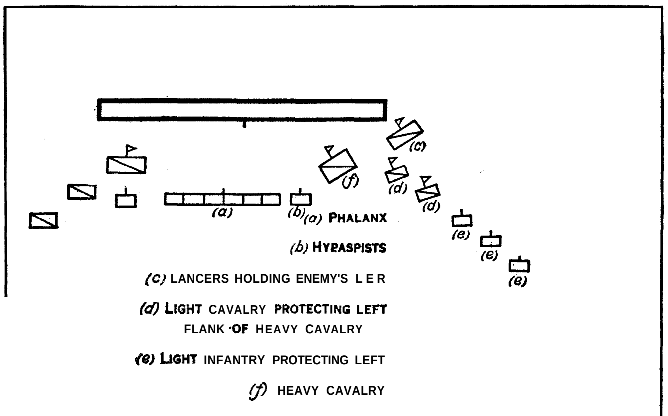


FIG. 3

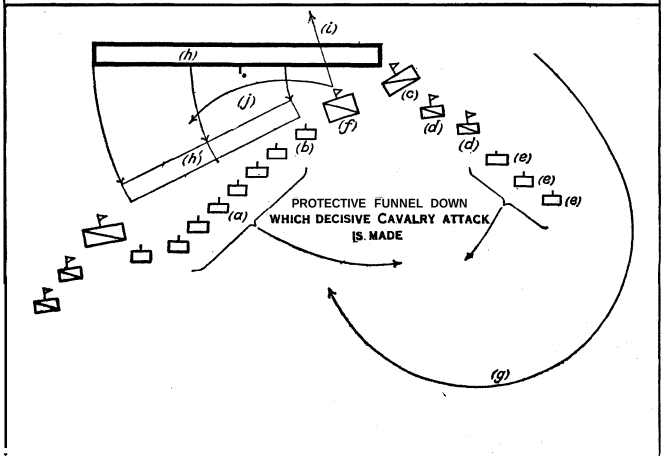


FIG. 4

FIGS. 3 AND 4. — TYPES OF DECISIVE ATTACKS EMPLOYED BY ALEXANDER THE GREAT

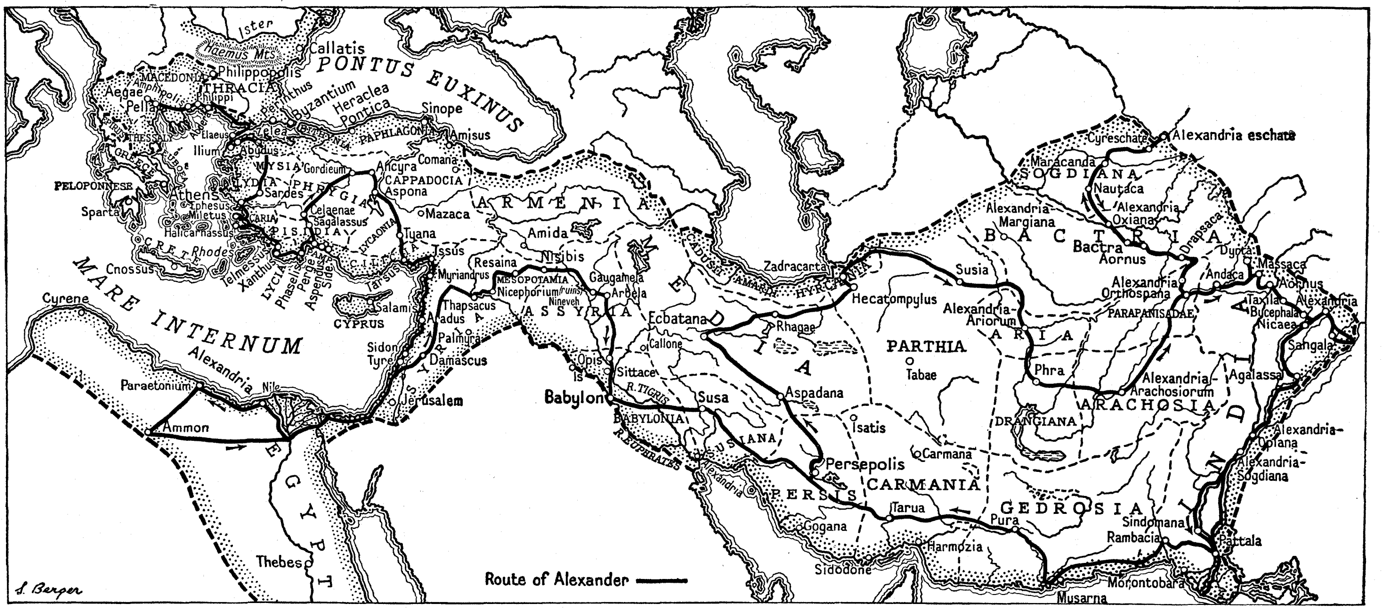
which to-day would fall under the quartermaster-general's and adjutant-general's departments, and the ordnance and medical services, must have been highly organized, otherwise it would have been impossible for him to maintain the army in Asia. To do so demanded most careful supply work and security of the lines of communication, for whilst he was in Babylonia, Persia and India, thousands of recruits were sent out to him as well as great quantities of arms and armour. To despatch reinforcements and stores across land from Greece to the Indus and beyond would require even to-day the highest administrative ability, and without these reinforcements Alexander could not have continued his conquests. Eventually, when he reached the Sutlej, the abandonment of a further advance was probably due as much to the immense time it took to supply and reinforce his army as to any other cause.

The Decline of the Macedonian Army. — The decline of the Macedonian military organization took place during the latter campaigns of Alexander, the main reason being that Greece was unable to supply him with a sufficiency of recruits. He consequently had largely to rely on Asiatics whose tactics were mainly based on projectile weapons — the javelin and the arrow. Arrian informs us that shortly before his death he reorganized his army, creating a phalanx 16 men deep, the first three ranks and the last consisting of Macedonians armed with the sarissa, and the 12 middle ranks of Persians armed with bows and javelins. This organization would appear to be a latter-day invention as are most of the tactics and drill attributed to the Macedonians by Aelian, Arrian and Vegetius.

During the wars of the Diadochi, though generalship was frequently of a high order, and strategical combinations were far more intricate than in the days of Philip and Alexander, the decline, and eventually the decay, of the Macedonian army was rapid and pronounced, until under Ptolemy II. (309–246 B.C.) we find a return to the old horde system, for according to Appian this monarch possessed an army of 200,000 infantry. 40,000 cavalry, 300 elephants and 2,000 war chariots, and a fleet of 1,500 warships and 2,000 transports. Efficiency and organization had once again been replaced by numbers and mass. There were three immediate reasons for this decline. The first was the sudden loss of Alexander's genius; the second, the imitation of his actions without understanding them, and the third the immense influx of gold from Persia. The first two have been patent to military history, the third was exceptional, and is, consequently, of particular interest.

The influence of gold on the art of war of this period was a twofold one: first, it placed mercenary service more than ever on a commercial footing; and, secondly, through the stimulus it gave to science and industry, projectile weapons began to replace shock. From the death of Alexander onwards for some 50 years the money he intended to spend on the reconstruction of his empire was expended on war, in which mercenaries were sold and bought, frequently on the battlefields themselves, as if they were commodities. Though this did not necessarily destroy the discipline of the soldiers, leadership rapidly deteriorated, and the heroism of Alexander, which was the soul of his generalship, was replaced by a more intellectual form of command, the leader of men evolving into the diplomatic commander of armies. When the campaigns of such a man as Eumenes are examined, the change is astonishing. He is as crafty as a fox, in fact is an epitome of his age. Not only does he have to keep his plans secret from his men, but even the enemy they are to battle with. Witness the artfulness of Seleucus at the battle of Ipsus; he rides round his enemy, but he does not charge home; he can charge, but he refrains from doing so until he has won over the deserters. What is seen in all these subtler actions is the replacement of the old physical attack by the moral attack but without changing the physical means. Blows give way to suggestions, and are aimed at the brain rather than the body. It is an occult transformation of military power, but once the clue is found, the change is clearly discernible, and becomes more and more so until, under Hannibal, it is developed to so high a pitch that his presence in any quarter of Italy paralyses Roman action.

The other influence of gold was the founding of great cities such as Alexandria, in which was collected the intellect of the age. Gold-power was transformed into brain-power, and, as these were warring times, warfare became more and more mechanized, muscle being supplemented by machinery. It has often been asserted by historians that the introduction of war engines caused a decadence in the art of war. This is only a half-truth, for the decline of the Macedonian system was due not to the introduction of alephants and artillery, ,but to generalship which took little notice of them, and which attempted to use men against



MAP OF THE MACEDONIAN EMPIRE AND THE ROUTE OF ALEXANDER THE GREAT OF MACEDONIA IN HIS SERIES OF MILITARY VICTORIES (334–323 B.C.)

them in the same manner as before their adoption. Valour was thus destroyed, not by invention but by stupidity. It was because so many generals of this epoch did not understand the influence of new weapons on tactics and *moral* that a decadence set in, and not because these weapons were more powerful than the older ones. Intelligence was the foundation of Philip's military system, and lack of it destroyed it rather than such weapons as the Polybolos of Dionysius, an arrow-throwing "machine-gun," or the cross-bow of Ctesibius, which was geared by pistons working in cylinders filled with compressed air. (J. F. C. F.)

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MACEDONIAN EMPIRE, the name generally given to the empire founded by Alexander the Great of Macedon in the countries now represented by Greece and European Turkey, Asia Minor, Egypt, Syria, Persia and eastwards as far as northern India. The present article falls naturally into two main divisions—I. The reign of Alexander. II. The period of his successors, the "Diadochi" and their dynasties.

I. THE REIGN OF ALEXANDER

At the beginning of the 4th century B.C. two types of political association confronted each other in the lands of the Eastern Mediterranean—the Persian monarchy with its huge agglomeration of subject peoples, and the Greek city-state. Each had a different principle of strength. The Persian monarchy was strong in its size, in the mere amount of men and treasure it could dispose of under a single hand; the Greek state was strong in its *moral,* in the energy and discipline of its soldiery. But the smallness of the single city-states and their unwillingness to combine prevented this superiority in quality from telling destructively upon the bulk of the Persian empire. The future belonged to any power that could combine the advantages of both systems, could make a state larger than the Greek city, and animated by a spirit equal to that of the Greek soldier. This was achieved by the kings of Macedonia. The work, begun by his predecessors, of consolidating the kingdom internally and making its army a fighting-machine of high power was completed by the genius of Philip II. (359–336 B.C.), who at the same time by war and diplomacy brought the Greek states of the Balkan peninsula generally to recognize his single predominance. At the synod of Corinth (337) Philip was solemnly declared the captain-general (*στρατηγὸς αὐτοκράτωρ*) of the Hellenes against the king of Persia, and in 334 his son and successor Alexander delivered his attack at the head of an army composed both of Macedonians and contingents from the allied Greek states. Before this force the Persian monarchy went down, and when Alexander died eleven years later (323) a Macedonian empire which covered all the territory of the old Persian empire, and even more, was a realized fact.

System of Government.—The conquered empire presented Alexander with a system of government ready-made, which it was natural for the new masters to take over. For the Asiatic provinces and Egypt. the old Persian name of *satrapy* (see SATRAP) was still retained. The governors appointed by Alexander were, in the west of the empire, exclusively Macedonians; in the east, members of the old Persian nobility were still among the satraps at Alexander's death

Alexander had at first trusted Persian grandees more freely in this capacity, till the ingrained oriental tradition of misgovernment so declared itself that to three more provinces at least Macedonians had been appointed before his death. In the case of certain provinces, possibly in the empire generally, Alexander established a double control. The financial administration was entrusted to separate officials; we hear of such in Lydia, Babylonia and notably in Egypt. Higher financial controllers seem to have been over groups of provinces, and Harpalus over the whole finances of the empire, with his seat in Babylon. Again, the garrisons in the chief cities, such as Sardis, Babylon, Memphis, Pelusium and Susa, were under commands distinct from those of the provinces. The old Greek cities of the motherland were not formally subjects of the empire, but sovereign states, which assembled at Corinth as members of a great alliance, in which the Macedonian king was included as a member and held the office of captain-general. Of course, in fact, the power of the king was so vastly superior that the Greek cities were in reality subject to his dictation, even in so intimate a matter as the readmission of their exiles, and might be obliged to receive his garrisons. Within the empire itself, the various communities were allowed, subject to the interference of the king or his officials, to manage their own affairs. Alexander is said to have granted the Lydians to be "free" and "to use the laws of the ancient Lydians," whatever exactly these expressions may mean. So too in Egypt, the native monarchs were left as the local authorities. Especially to the gods of the conquered peoples Alexander showed respect. In Egypt and in Babylon he appeared as the restorer of the native religions to honour after the unsympathetic rule of the Persians. The temple of Marduk in Babylon which had fallen began to rise again at his command. It is possible, but not probable, that he offered sacrifice to Yahweh in Jerusalem. In Persia, the native aristocracy retained their power, and the Macedonian governor adopted Persian dress and manners. A new factor introduced by Alexander was the foundation of Greek cities at all critical points of intercourse in the conquered lands. These, no doubt, possessed municipal autonomy with the ordinary organization of the Greek state; to what extent they were formally and regularly controlled by the provincial authorities we do not know. The empire included large tracts of mountain or desert, inhabited by tribes, which the Persian government had never subdued.

Alexander, who set out as king of the Macedonians and captain-general of the Hellenes, assumed after the death of Darius the character of the oriental great king. He adopted the Persian garb, including a head-dress, the *diadema,* which was suggested by that of the Achaemenian king. We hear also of a sceptre as part of his insignia. The pomps and ceremonies which were traditional in the East were to be continued. To the Greeks and Macedonians such a régime was abhorrent, and the opposition roused by Alexander's attempt to introduce among them the practice of *proskunesis* (prostration before the royal presence) was bitter and effectual. The title of *chiliarch,* "commander of a thousand," *i.e.,* of the royal body-guard, was conferred by Alexander upon his friend Hephaestion. The Greek Chares held the position of chief usher. Another Greek. Eumenes of Cardia. was chief secretary. The figure of the eunuch, so long characteristic of the oriental court, was as prominent as ever.

Alexander, however, who impressed his contemporaries by his sexual continence, kept no harem. The number of his wives did not go beyond two, and the second, the daughter of Darius, he did not take till a year before his death. In closest contact with the king's person were the seven, or latterly eight, body-guards, Macedonians of high rank, including Ptolemy and Lysimachus, the future kings of Egypt and Thrace. The institution, which the Macedonian court before Alexander had borrowed from Persia, of a corps of pages composed of the young sons of the nobility, continued to hold an important place in the system of the court and in Alexander's campaigns.

Macedonian Army. — The army of Alexander was an instrument which he inherited from his father Philip. *(See* MACEDONIAN ARMY)

Later modifications in the army system were closely connected with Alexander's general policy, in which the fusion of Greeks and Asiatics held a prominent place. He had himself, as we have seen, assumed to some extent the guise of a Persian king. The most striking declaration of his ideals was the marriage feast at Susa in 324, when a large number of the Macedonian nobles were induced to marry Persian princesses, and the rank and file were encouraged to take Eastern wives. Among the schemes registered in the state papers was one for transplanting large bodies of Asiatics into Europe and Europeans into Asia, for blending the peoples of the empire by intermarriage into a single whole.

Divine Honours. — High above all the medley of kindreds and tongues, untrammelled by national traditions, invested with the glory of achievements in which the old bounds of the possible seemed to fall away, stood in 324 the man Alexander. Was he a man? The question was explicitly suggested by the report that the Egyptian priest in the oasis had hailed him as the son of Ammon. The Egyptians had ascribed deity to their kings, and were ready enough to add Alexander to the list. It is also not unlikely that the Persian kings had received some form of divine worship (L. Taylor, *Journ. Hellenic Studies,* 1927, p. 153, ff.) From the Greeks he certainly received such honours. It has been supposed that in offering such worship the Greeks showed the effect of "Oriental" influence, but certainly we have not to look outside the Greek circle of ideas to explain it. As early as Aeschylus (*Supp.* 991) the proffering of divine honours was a form of expression for intense feelings of reverence or gratitude towards men which naturally suggested itself — as a figure of speech in Aeschylus, but the figure had been translated into action before Alexander not in the well-known case of Lysander only (cf. the case of Dion, Plut. *Dio.* 29). Among educated Greeks rationalistic views of the old mythology had become so current that they could assimilate Alexander to Dionysus without supposing him to be supernatural, and to this temper the divine honours were a mere form, an elaborate sort of flattery. Did Alexander merely receive such honours? Or did he claim them himself? It would seem that he did. We have well-authenticated utterances of Attic orators when the question of the cult of Alexander came up for debate, which seem to prove that an intimation of the king's pleasure had been conveyed to Athens.

Commerce and Discovery. — A new life entered the lands conquered by Alexander. Human intercourse was quickened to a degree not before known. Commercial enterprise now found open roads between the Aegean and India; the new Greek cities made stations in what had been for the earlier Greek traders unknown lands; an immense quantity of precious metal had been put into circulation which the Persian kings had kept locked up in their treasuries. At the same time Alexander himself sought to win fresh geographical knowledge, to open new ways. The voyage of Nearchus from the Indus to the Euphrates was meant to link India by a waterway with the Mediterranean lands. So too Heracleides was sent to explore the Caspian; the survey, and possible circumnavigation of the Arabian coasts was the last enterprise which occupied Alexander. The improvement of waterways in the interior of the empire was not neglected, the Babylonian canal system was repaired, the obstructions in the Tigris removed. The reports of the βηματισταί Baeton and Diognetus, who accompanied Alexander's army, gave a more exact knowledge of the geographical conformation of the empire. Greek natural science was enriched with a mass of new material from the observations of the philosophers who went with Alexander; on the other hand, attempts were made to acclimatize the plants of the motherland in the foreign soil.

The accession of Alexander brought about a change in the monetary system of the kingdom With the conquest of Asia, Alexander conceived the plan of issuing a uniform coinage for the empire. Gold had fallen from the diffusion of the Persian treasure, and Alexander struck coins in both gold and silver on the Attic standard, leaving their relation to adjust itself by the state of the market. This imperial coinage was designed to break down the monetary predominance of Athens.

II. AFTER ALEXANDER

The external fortunes of the Macedonian empire after Alexander's death must be briefly traced before its inner developments be touched upon [1] There was, at first, when Alexander suddenly died in 323, no overt disruption of the empire. The dispute between the Macedonian infantry and the cavalry (*i.e.,* the commonalty and the nobles) was as to the person who should be chosen to be the king, although it is true that either candidate, the half-witted son of Philip II., Philip Arrhidaeus, or the posthumous son of Alexander by Roxana, opened the prospect of a long regency exercised by one or more of the Macedonian lords. The compromise, by which both the candidates should be kings together, was, of course, succeeded by a struggle for power among those who wished to rule in their name. During a period of confused warfare, which lasted, with intervals, for forty years, the family of Alexander was wholly destroyed; the endeavour of Antigonus, satrap of Phrygia, and of his son Demetrius, to establish a new imperial dynasty, was frustrated by the former's defeat and death at the battle of Ipsus (301 B.C.); and a similar and all but successful attempt by Seleucus, governor of Syria, ended in his assassination (280 B.C.)

About 275 B.C. a horde of Celtic warriors from the Danube lands who had crossed over into Asia Minor after a series of devastating forays in Macedonia and Greece, took possession of the central plateau and there formed a federation of tribal kingdoms known as Galatia. In Cappadocia two Persian houses, relics of the old aristocracy of Achaemenian days, had carved out principalities, one of which became the kingdom of Pontus and the other the kingdom of Cappadocia (in the narrower sense); the former regarding Mithradates (281–266) as its founder, the latter being the creation of the second Ariarathes (?302–?281). Ar-

[1] For details see separate articles on *the chief* generals.

menia, never effectively conquered by the Macedonians, was left in the hands of native princes, tributary only when the Seleucid court was strong enough to compel. In India, Seleucus had in 302 ceded large districts on the west of the Indus to Chandragupta, who had arisen to found a native empire which annexed the Macedonian provinces in the Punjab.

Whilst the Antigonid kingdom remained practically whole till the Roman conquest ended it in 168 B.C., and the house of Ptolemy ruled in Egypt till the death of Cleopatra in 30 B.C., the Seleucid empire perished by a slow process of disruption. The eastern provinces of Iran went in 240 or thereabouts, when the Greek Diodotus made himself an independent king of Bactria (*q.v.*) and Sogdiana, and Tiridates, brother of Arsaces, a "Scythian" chieftain, conquered Parthia (so Arrian, but see PARTHIA). Armenia was finally lost in 190, when Artaxias founded a new native dynasty there. Native princes probably ruled in Persia before 166 (see PERSIA). In southern Syria which had been won by the house of Seleucus from the house of Ptolemy in 198, the independent Jewish principality was set up in 143. About the same time Media was totally relinquished to the Parthians. Babylonia was Parthian from 129. In 64 the last shadow of Seleucid rule vanished, when Syria was made a Roman province by Pompey. From this time Rome formally entered upon the heritage of Alexander as far as the Euphrates, but many of the dynasties which had arisen in the days of Macedonian supremacy were allowed to go on for a time as client states.

Restoration of Despotism.—The Macedonians of Alexander were not mistaken in seeing an essential transformation of their national monarchy when Alexander adopted the guise of an oriental great king. Transplanted into this foreign soil, the monarchy became an absolute despotism, unchecked by a proud territorial nobility and a hardy peasantry on familiar terms with their king. The principle which Seleucus is reported to have enunciated, that the king's command was the supreme law, was literally the principle of the new Hellenistic monarchies in the East. But the rights belonging to the Macedonian army as Alexander inherited it did not altogether disappear. Like the old Roman people, the Macedonian people under arms had acted especially in the transference of the royal authority, conferring or confirming the right of the new chief, and in cases of the capital trials of Macedonians. In the latter respect the army came regularly into function under Alexander, and in the wars which followed his death; and in Macedonia, although the power of life and death came de *facto* into the hands of the Antigonid king, the old right of the army to act as judge was not legally abrogated. The right of the army to confer the royal power was still symbolized in the popular acclamation required on the accession of a new king, and at Alexandria in troubled times we hear of "the people" making its will effective in filling the throne, although it is here hard to distinguish mob-rule from the exercise of a legitimate function. Where it is a case of delegating some part of the supreme authority, as when Seleucus I. made his son Antiochus king for the eastern provinces, we find the army convoked to ratify the appointment. So too the people is spoken of as appointing the guardians of a king during his minority. Nor was the power of the army a fiction. The Hellenistic monarchies rested, as all government in the last resort must, upon the loyalty of those who wielded the brute force of the state, and however unlimited the powers of the king might be in theory, he could not alienate the goodwill of the army with impunity. The right of primogeniture in succession was recognized as a general principle; a woman, however, might succeed only so long as there were no male agnates.

The practice by which the king associated a son with himself, as secondary king, dates from the very beginning of the kingdom of the successors; Antigonus on assuming the diadem in 306 caused Demetrius also to bear the title of king. In the Seleucid kingdom the territorial expanse of the realm made the creation of a distinct subordinate government for part of it a measure of practical convenience. The king's government was carried on by officials appointed by him and responsible to him alone. Government at the same time, as an oriental despotism understands it, often has little in view but the gathering in of the tribute and compulsion of the subjects to personal service in the army or in royal works, and if satisfied in these respects will leave much independence to the local authorities. In the loosely-knit Seleucid realm it is plain that a great deal more independence was left to the various communities—cities or native tribes—than in Egypt, where the conditions made a bureaucratic system so easy to carry through. In their outlying possessions the Ptolemies may have suffered as much local independence as the Seleucids; the internal government of Jerusalem, for instance, was left to the high priests. In so far as the older Greek cities fell within their sphere of power, the successors of Alexander were forced to the same ambiguous policy as Alexander had been, between recognizing the cities' unabated claim to sovereign independence and the necessity of attaching them securely. In Asia Minor, the "enslavement" and liberation of cities alternated with the circumstances of the hour, while the kings all through professed themselves the champions of Hellenic freedom, and were ready on occasion to display munificence toward the city temples or in public works, such as might reconcile republicans to a position of dependence. Antiochus III. went so far as to write on one occasion to the subject Greek cities that if any royal mandate clashed with the civic laws it was to be disregarded. How anxious the Pergamene kings, with their ardent Hellenism, were to avoid offence is shown by the elaborate forms by which, in their own capital, they sought to give their real control the appearance of popular freedom. A similar problem confronted the Antigonid dynasty in the cities of Greece itself, for to maintain a predominant influence in Greece was a ground-principle of their policy Demetrius had presented himself in 307 as the liberator, and driven the Macedonian garrison from the Peiraeus; but his own garrisons held Athens thirteen years later, when he was king of Macedonia, and the Antigonid dynasty clung to the points of vantage in Greece, especially Chalcis and Corinth, till their garrisons were finally expelled by the Romans in the name of Hellenic liberty.

Commerce.—The new movement of commerce initiated by the conquest of Alexander continued under his successors, though the break-up of the Macedonian empire in Asia in the 3rd century and the distractions of the Seleucid court must have withheld many advantages from the Greek merchants which a strong central government might have afforded them. It was along the great trade-routes between India and the West that the main stream of riches flowed then as in later centuries. One of these routes was by sea to south-west Arabia (Yemen), and thence up the Red sea to Alexandria. This was the route controlled and developed by the Ptolemaic kings. Between Yemen and India the traffic till Roman times was mainly in the hands of Arabians or Indians; between Alexandria and Yemen it was carried by Greeks. The west coast of the Red sea was dotted with commercial stations of royal foundation from Arsinoe north of Suez to Arsinoe in the south near the straits of Bab-el-Mandeb. From Berenice on the Red sea a land-route struck across to the Nile at Coptos; this route the kings furnished with watering stations. That there might also be a waterway between Alexandria and the Red sea, they cut a canal between the Delta and the northern Arsinoe. It was Alexandria into which this stream of traffic poured and made it the commercial metropolis of the world. We hear of direct diplomatic intercourse between the courts of Alexandria and Pataliputra, *i.e.,* Patna. An alternative route went from the Indian ports to the Persian gulf, and thence found the Mediterranean by caravan across Arabia from the country of Gerrha to Gaza; and to control it was no doubt a motive in the long struggle of the Ptolemaic and Seleucid houses for Palestine, as well as in the attempt of Antiochus III. to subjugate the Gerrheans. Or from the Persian gulf wares might be taken up the Euphrates and carried across to Antioch; this route lay altogether in the Seleucid sphere. With Iran Antioch was connected most directly by the road which crossed the Euphrates at the Zeugma and went through Edessa and Antioch-Nisibis to the Tigris. The trade from India which went down the Oxus and then to the Caspian does not seem to have been considerable. From Antioch to the Aegean the land high-road went across Asia Minor by the Cilician gates and the Phrygian Apamea.

Finance. — Of the financial organization of the Macedonian kingdoms we know practically nothing, except the case of Egypt. Here the papyri and ostraca have put a large material at our disposal; but the circumstances in Egypt[1] were too peculiar for us to generalize upon these data as to the Seleucid and Antigonid realms. That the Seleucid kings drew in a principal part of their revenues from tribute levied upon the various native races, distributed in their village communities as tillers of the soil goes without saying. In districts left in the hands of native chiefs these chiefs would themselves exploit their villages and pay the Seleucid court tribute. To exact tribute from Greek cities was invidious, but Seleucid kings often did so. Sometimes, no doubt, this tribute was demanded under a fairer name, as the contribution of an ally, like the Γαλατικά levied by Antiochus I. The royal domains, again. and royal monopolies, such as salt-mines, were a source of revenue. As to indirect taxes, like customs and harbour dues, while their existence is a matter of course, their scale, nature and amount is quite unknown to us. Whatever the financial system of the Antigonid and Seleucid kingdoms may have been, it is clear that they were far from enjoying the affluence of the Ptolemaic. During the first Seleucid reigns indeed the revenues of Asia may have filled its treasuries, but Antiochus III. already at his accession found them depleted, and from his reign financial embarrassment, coupled with extravagant expenditure, was here the usual condition of things. Perseus, the last of the Antigonid house, amassed a substantial treasure for the expenses of the supreme struggle with Rome, but it was by means of almost miserly economies.

Special officials were naturally attached to the service of the finances. Over the whole department in the Seleucid realm there presided a single chief. How far the financial administration was removed from the competence of the provincial governors, as it seems to have been in Alexander's system, we cannot say. Seleucus at any rate, as satrap of Babylonia, controlled the finances of the province and so, in the Ptolemaic system, did the governor of Cyprus.

With the exception of Ptolemaic Egypt, the Macedonian kingdoms followed in their coinage that of Alexantler. hfoney was for a long while largely struck with Alexander's own image and superscription; the gold and silver coined in the names of Antigonid and Seleucid kings and by the minor principalities of Asia, kept to the Attic standard which Alexander had established. Only in Egypt Ptolemy I. adopted, at first the Rhodian, and afterwards the Phoenician, standard, and on this latter standard the Ptolemaic money was struck during the subsequent centuries. Money was also struck in their own name by the cities in the several dynasties' spheres of power, but in most cases only bronze or small silver for local use.

Court Customs. — In language and manners the courts of Alexander's successors were Greek. Even the Macedonian dialect, which it was considered proper for the kings to use on occasion, was often forgotten. The oriental features which Alexander had introduced were not copied. There was no *proskunesis* (or certainly not in the case of Greeks and Macedonians), and the king did not wear an oriental dress. The symbol of royalty, it is true, the *diadem,* was suggested by the head-band of the old Persian kings but, whereas, that had been an imposing erection, the Hellenistic diadem was a simple riband. The king's state dress was the same in principle as that worn by the Macedonian or Thessalian horsemen, as the uniform of his own cavalry officers. Its features were the broad-rimmed hat, the cloak, and the high-laced boots. There were other traces in the Hellenistic courts of the old Macedonian tradition besides in dress. One was the honour given to prowess in the chase. Another was the fashion for the king to hold wassail with his courtiers, in which he unbent to an extent scandalous to the Greeks, dancing or indulging in routs and practical jokes.

The prominent part taken by the women of the royal house was a Macedonian characteristic. The history of these kingdoms furnishes a long list of queens and princesses who were ambitious and masterful politicians, of which the great Cleopatra is the last and the most famous. The kings after Alexander, with the exception of Demetrius Poliorcetes and Pyrrhus, are not found to have more than one legitimate wife at a time, although they show unstinted freedom in divorce and the number of their mistresses. The custom of marriages between brothers and sisters, agreeable to old Persian as to old Egyptian ethics, was instituted in Egypt by the second Ptolemy when he married his full sister Arsinoe Philadelphus. It was henceforth common, though not invariable, among the Ptolemies. At the Seleucid court there seems to be an instance of it in 195, when the heir-apparent, Antiochus, married his sister Laodice. The style of "sister" was given in both courts to the queen, even when she was not the king's sister in reality. The "friends" of the king are often mentioned. It is usual for him to confer with a council of his "friends" before important decisions, administrative, military or judicial. They form a definite body about the king's person, admission into which depends upon his favour alone, and is accorded, not only to his subjects. but to aliens, such as the Greek refugee politicians (*e.g.*, Hegesianax, Athen. iv. 155b; Hannibal and the Aetolian Thoas take part in the councils of Antiochus III.). The friends (at any rate under the later Seleucid and Ptolemaic reigns) were distinguished by a special dress and badge of gold analogous to the stars and crosses of modern orders. The dress was of crimson; this and the badges were the king's gift, and except by royal grant neither crimson nor gold might, apparently, be worn at court. The order of friends was organized in a hierarchy of ranks, which were multiplied as time went on. As to Macedonia, whatever may have been the constitution of the court, it is implied that it offered in its externals a sober plainness in comparison with the vain display and ceremonious frivolities of Antioch and Alexandria. The position of a friend did not carry with it necessarily any functions; it was in itself purely honorary. The ministers and high officials were, on the other hand. regularly invested with one or other of the ranks specified. The chief of these ministers is denoted ἐπὶ τῶν πραγμάτων and he corresponds to the *vizier* of the later East. All departments of government are under his supervision, and he regularly holds the highest rank of a kinsman. When the king is a minor, he acts as guardian or regent. Over different departments of state we find a state secretary. Under each of these great heads of departments was a host of lower officials, those, for instance, who held to the province a relation analogous to that of the head of the department of the realm. Beside the officials concerned with the work of government we have those of the royal household: (1) the chief-physician; (2) the chief-huntsman; (3) the maître d' hôtel; (4) the lord of the queen's bedchamber. As in the older oriental courts, the high positions were often filled by eunuchs.

It was customary, as in Persia and in old Macedonia, for the great men of the realm to send their children to court to be brought up with the children of the royal house. Those who had been so brought up with the king were styled his σύντροφοι. As under Alexander, so under his successors, we find a corps of βασιλικοὶ παῖδες. They appear as a corps, 600 strong, in a triumphal procession at Antioch.

Hellenism. —,411 the Hellenistic courts felt it a great part of prestige to be filled with the light of Hellenic culture. A distinguished philosopher or man of letters would find them bidding for his presence, and most of the great names are associated with one or other of the contemporary kings. Antigonus Gonatas, bluff soldier-spirit that he was, heard the Stoic philosophers gladly, and, though he failed to induce Zeno to come to Macedonia, persuaded Zeno's disciple, Persaeus of Citium, to enter his service. Nor was it philosophers only who made his court illustrious, but poets like Aratus. The Ptolemaic court, with the museum attached to it, is so prominent in the literary and scientific history of the age that it is unnecessary to give a list of the philosophers, the men of letters and science, who at one time or other ate at King Ptolemy's table. One may notice that the first Ptolemy himself made a contribution of some value to historical literature in his account of Alexander's campaigns; the fourth Ptolemy not only instituted a cult of Homer but himself published tragedies;

[1]For Ptolemaic Egypt, see PTOLEMIES and EGYPT.

and even Ptolemy Euergetes II issued a book of memoirs. The Pergamene court was in no degree behind the Ptolemaic in its literary and artistic zeal. The notable school of sculpture connected with it is treated elsewhere (see GREEK ART); to its literary school we probably owe in great part the preservation of the masterpieces of Attic prose, and two of its kings (Eumenes I and Attalus III) were themselves authors. The Seleucid court did not rival either of the last named in brilliance of culture; and yet some names of distinction were associated with it. Under Antiochus I Aratus carried out a recension of the Odyssey, and Berossus composed a Babylonian history in Greek. Under Antiochus III Euphorion was made keeper of the library at Antioch. Antiochus IV, of course, the enthusiastic Hellenist, filled Antioch with Greek artists and gave a royal welcome to Athenian philosophers. Even in the degenerate days of the dynasty, Antiochus Grypus, who had been brought up at Athens, aspired to shine as a poet. The values recognized in the great Hellenistic courts and the Greek world generally imposed their authority upon the dynasties of barbarian origin. The Cappadocian court admitted the full stream of Hellenistic culture under Ariarathes V. One of the kings called Nicomedes in Bithynia offered immense sums to acquire the Aphrodite of Praxiteles from the Cnidians, and to a king Nicomedes the geographical poem of the Pseudo-Scymnus is dedicated. Even Iranian kings in the last century B.C. found pleasure in composing, or listening to, Greek tragedies, and Herod the Great kept Greek men of letters beside him and had spasmodic ambitions to make his mark as an orator or author.

Deification. — The offering of divine honours to the king which was begun under Alexander, became stereotyped in the institutions of the succeeding Hellenistic kingdoms. Alexander himself nas after his death the object of various local cults, like that which centred in the shrine near Erythrae. His successors in the first years after his death recognized him officially as a divinity, except Xntipater, and coins began to be issued nirh his image. At Alexandria the state cult of him seems to have been instituted by the second Ptolemy, when his body mas laid in the *Sema.* The successors themselves received divine honours. Such worship might be the spontaneous homage of a particular Greek community, like that offered to Antigonus by Scepsis in 311, to Antigonus and Demetrius by Athens in 307, to Ptolemy I by the Rhodians in 304, or by Cassandreia to Cassander, as the city's founder; or it might be organized and maintained by royal authority. The first proved instance of a cult of the latter kind is that instituted at Alexandria by the second Ptolemy for his father soon after the latter's death in 283–282, in which later 279–278, he associated his mother Berenice also, the two being worshipped together as θεοὶ σωτῆρες. Antiochus I followed the Ptolemaic precedent by instituting at Seleucia-in-Pieria a cult for his father as Seleucus Zeus Nicator. So far we can point to no instance of a cult of the living sovereign (though the cities might institute such locally) being established by the court for the realm. This step was taken in Egypt after the death of Xrsinoe Philadelphus (271), when she and her still-living brother-husband, Ptolemy II began to be norshipped together as θεοὶ ἀδελφοί. After this the cult of the reigning king and queen was regularly maintained in Greek Egypt, side by side with that of the dead Ptolemies. Under Antiochus II (261–246) a document shows a cult of the reigning king in full working for the Seleucid realm, with a high priest in each province, appointed by the king himself; the document declares that the Queen Laodice is now to be associated with the king. The official surname of Antiochus II, *Theos,* suggests that he himself had here been the innovator. Thencefornard, in the Hellenistic kingdoms of the east the worship of the living sovereign became the rule, although it appears to have been regarded as given in anticipation of an apotheosis which did not become actual till death. In the Pergamene kingdom at any rate, though the living king mas worshipped with sacrifice, the title θεός was only given to those who mere dead. The Antigonid dynasty, simpler and saner in its manners, had no official cult of this sort. The divine honours offered on occasion by the Greek cities were the independent acts of the cities.

Army. — The armies of Alexander's successors were still in the main principles of their organization similar to the army with which Alexander had conquered Asia. During the years immediately after Alexander the very Macedonians who had fought under Alexander were ranged against each other under the banners of the several chiefs. The most noted corps of veterans, Argyraspides, played a great part in the first wars of the successors, and covered themselves with infamy by their betrayal of Eumenes. As the soldiers of Alexander died off. fresh levies of home-born Macedonians could be raised only by the chief who held the motherland. The other chiefs had to supply themselves with Macedonians from the numerous colonies planted before the breakup of the empire in Asia or Egypt, and from such Macedonians they continued for the next two centuries to form their phalanx. The breed — at least if the statement which Livy puts into the mouth of a Roman general can be relied on — degenerated greatly under Asiatic and Egyptian skies; but still old names like that of *pezetairoi* attached to the phalangites, and they still wielded the national *sarissa.* The latter weapon in the interval between Alexander and the time of Polybius had been increased to a length of 21 ft., a proportion inconsistent with any degree of mobility; once more indeed the phalanx of the 2nd century seems to have become a body effective by sheer weight only and disordered by unevenness of ground. The Antigonid kings were never able from Jlacedonian levies to put in the field a phalanx of more than 20,000 at the utmost; Antigonus Doson took with him to Greece (in 222) one of 10.000 only. The phalanx of Antiochus III at Raphia numbered 20,000, and Ptolemy Philopator was able at the same time to form one of 25,000 men. The royal footguards were still described in Macedonia in 171 as the *agema.* So too the old name of "Companions" was kept up in the Seleucid kingdom for the Macedonian cavalry, and divisions of rank in it were still indicated by the terms *agema* and royal squadron. The Antigonid and Seleucid courts had much valuable material at hand for their armies in the barbarian races under their sway. The Balkan hill-peoples of Illyrian or Thracian stock, the hill-peoples of Asia Minor and Iran, the chivalry of Media and Bactria, the mounted bowmen of the Caspian steppes, the camel-riders of the Arabian desert, could all be turned to account. Iranian troops seem to have been employed on a large scale by the earlier Seleucids. At Raphia, Antiochus III had 10.000 men drawn from the provinces, armed and drilled as Macedonians, and another corps of Iranians numbering 5,000 under a native commander. The experiment of arming the native Egyptians on a large scale does not seem to have been made before the campaign of 217, when Ptolemy IV formed corps of the Macedonian pattern from Egyptians and Libyans. From this time native rebellions in Egypt were recurrent. To the troops drawn from their own dominions the mercenaries which the kings procured from abroad mere an important supplement. These were mainly the bands of Greek *condottieri,* and even for their home-born troops Greek officers of renown were often engaged. The other class of mercenaries were Gauls, and from the time of the Gallic invasion of Asia Minor in 279 Gauls or Galatians were a regular constituent in all armies. They mere a weapon apt to be dangerous to the employer. but the terror they inspired was such that every potentate sought to get hold of them. The elephants which Xlexander brought back from India mere used in the armies of his successors, and in 302 Seleucus procured a new supply. Thenceforward elephants, either brought fresh from India or bred in the royal stables at Apamea, regularly figured in the Seleucid armies. The Ptolemies supplied themselves with this arm from the southern coasts of the Red sea, where they established stations for the capture and shipping of elephants. Scythed chariots such as had figured in the old Persian armies were still used by the Greek masters of Asia, at any rate till the battle of Magnesia. The Hellenistic armies were distinguished by their external magnificence. They made a greater display of brilliant metal and gorgeous colour than the Roman armies, for instance. The description given by Justin of the army which Antiochus Sidetes took to the east in 130 B.C., boot-nails and bridles of gold, gives an idea of their standard of splendour.

During the 3rd century B.C. Egypt was the greatest sea power of the eastern Mediterranean, and maintained a large fleet. Its control of the Aegean was, however, contested not without success by the Antigonids, who won the two great sea-fights of Cos (*c.* 256) and Andros (227), and wrested the overlordship of the Cyclades from the Ptolemies. Of the numbers and constitution of the Antigonid fleet we know nothing. At the Seleucid court in 222 the admiral appears as a person of high consideration; in his war with Rome Antiochus III had 107 decked battleships on the sea at one time.

Macedonian* Rule.**—To their native subjects the Seleucid and Ptolemaic kings were always foreigners. It was considered wonderful in the last Cleopatra that she learned to speak Egyptian. Natives were employed, as we have seen, in the army, and Iranians are found under the Seleucids holding high commands. Native cults the Hellenistic kings thought it good policy to patronize. Antiochus I began rebuilding the temple of Nebo at Borsippa. Antiochus III bestowed favours on the temple at Jerusalem. Even if the documents in Joseph ***Arch. xii, §§138 *et seq.* are spurious, their general views of the relation of Antiochus III and Jerusalem is probably true.

The Macedonian kingdoms, strained by continual wars, increasingly divided against themselves, falling often under the sway of prodigals and debauchees, were far from realizing the Hellenic idea of sound government as against the crude barbaric despotisms of the older east. Yet, in spite of all corruption, ideas of the intelligent development of the subject lands, visions of the Hellenic king, as the Greek thinkers had come to picture him, haunted the Macedonian rulers, and perhaps fitfully, in the intervals of war or carousal, prompted some degree of action. Treatises "concerning kingship" were produced as a regular thing by philosophers, and kings who claimed the fine flower of Hellenism could not but peruse them. Strabo regards the loss of the eastern provinces to the Parthians as their passage under a government of lower type, beyond the sphere of Hellenic ἐπιμέλεια.

In the organization of the administrative machinery of these kingdoms, the higher power of the Hellene to adapt and combine had been operative; they mere organisms of a richer, more complex type than the east had hitherto known. It was thus that when Rome became a world empire, it found to some extent the forms of government ready made, and took over from the Hellenistic monarchies a tradition which it handed on to the later world.

For the events which brought the Macedonian empire into being *see* ALEXANDER III, THE GREAT. For detailed accounts of the separate dynasties into which it was divided after Alexander's death, see SELEUCID DYNASTY, ANTIGONUS I, PERGAMUM, etc., and for its effect on the spread of Hellenic culture see HELLENISM.

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MACEDONIUS, (1) bishop of Constantinople in succession to Eusebius of Nicomedia, was elected by the Arian bishops in 341, while the orthodox party elected Paul, whom Eusebius had superseded. Paul was banished; and Macedonius was recognized as patriarch in 342. Compelled by the intervention of Constans in 348 to resign the patriarchate in favour of his former opponent, he was reinstalled in 350. He then took vengeance on his opponents by a general persecution of the adherents of the Nicene Creed. In 359, on the division of the Arian party into Acacians (or pure Arians) and semi-Arians or Homoiousians, Macedonius adhered to the latter, and in consequence was expelled from his see by the council of Constantinople in 360. He now became avowed leader of the sect of Pneumatomachi, Macedonians or Marathonians, whose distinctive tenet was that the Holy Spirit is but a being similar to the angels, subordinate to and in the service of the Father and the Son. the relation between whom did not admit of a third. He did not long survive his deposition.

See the Church Histories of Socrates and Sozomen; Art. in ***Dict. Chr. Biog.;*** F. Loofs in Herzog-Hauck's ***Realencyk.;*** H. M. Gwatkin, *Arianism.*

MACEDONIUS, (2) bishop of Constantinople (*fl.* 510), a strict Chalcedonian who vainly opposed the fanaticism of the monophysite Severus and was deposed in 513.

MACEIÓ or MACAYÓ, a city and port of Brazil and capital of the state of Alagoas, about 125 mi. S.S.W. of Pernambuco, in lat. 9° 39′ 35″ S., long. 35° 44′ 36″ W. of Greenwich. Population (1960) of the city 153,305 and of the total municipal area 170,134. The city stands at the foot of low bluffs, about a mile from the shore line. The waterside village of Jaraguá, the port of Maceió, is practically a suburb of the city. South of the port is the shallow entrance to the Lagoa do Norte or Lagoa Mundau, a salt-water lake extending inland for several miles. Maceio is attractively situated in the midst of large plantations of coconut and *dendk* palms, though the broad sandy beach in front and the open sunburned plain behind give a barren character to its surroundings. The heat is moderated by the southeast trade winds, and the city is considered healthful. The public buildings are mostly constructed of broken stone and mortar, plastered outside and covered with red tiles, but the common dwellings are generally constructed of tapia—rough trelliswork walls filled in with mud. The lighthouse, situated on a small hill near the middle of the town, is a conspicuous landmark. A streetcar line connects the city and port; the Great Western railway connects the two with various interior towns and with Pernambuco. The port is formed by a stone reef running parallel with and a half mile from the shore line, within which vessels of light draft find a safe anchorage. except from southerly gales. Ocean-going steamers anchor outside the reef. The exports consist principally of sugar, cotton and rum (*aguardente*). Maceio dates from. 1815 when a small settlement there was created a "villa." In 1839 it became the provincial capital and was made a city by the provincial assembly.

McENTEE, JERVIS (1828–1891), U.S. landscape painter of the Hudson River school. was born at Rondout. N.Y., July 14, 1828, and was a pupil of Frederick E. Church. He was made an associate of the Sational Academy of Design, New York city, in 1860, and a full academician in 1861.

In 1869 McEntee visited Europe, painting much in Italy. He excelled in pictures of autumn scenery, as in "Edge of a Wood, November" and "Yellow Autumn Woods."

McEntee died at Rondout. Jan. 27, 1891.

MACERATA, city of the Marche region, Italy, chief town of the province of hlacerata and a bishop's see, 44 mi. by rail south of Ancona. Pop. (1957 est.) 35,064 (commune). Crowning a hill 1,020 ft. above sea level, with a picturesque mass of buildings enclosed by walls and towers: Macerata looks out over the Adriatic. Besides the university (1290) with about 125 students in 1939, Macerata has a communal library founded by Leo XII, containing a small but choice collection of early pictures, and in the municipal buildings, a collection of antiquities from Helvia Ricina. Close by is the elegant Loggia dei Mercanti, by Giuliano da Maiano (1485–91). There is an enormous amphitheatre for *pallone,* a favourite ball game.

The first mention of the *castellum* of Macerata is in a document of 1022; and in 1138 it was formed into a commune. Sicholas IV (1287–1292) made it the seat of the governors of the Marches. It was enclosed in the 13th century by a line of walls more than $2\frac{1}{2}$ mi. in circuit. It remained faithful to the popes and was rewarded by many privileges. Though in 1797 the inhabitants opened their gates to the French. two years afterward the city was stormed and pillaged. The bishopric of Macerata dates from the suppression of the see of Recanati (1320).

MACEWEN, SIR WILLIAM (1848–1924), Scottish surgeon. was born on June 22, 1848, at Rothesay, and educated at Glasgow university. In 1892 he was made regius professor of surgery in the university. In 1922 he was president of the British Medical association. Macewen was a firm supporter of the methods of Joseph Lister, and experimented on the sterilization of instruments and dressings and the preparation of catgut for surgical use. He advanced the practice of bone grafting and became famous for his operative treatment of knock-knee. His paper on surgery of the brain and spinal cord marked him as a pioneer of modern cerebral surgery. He died on March 22, 1924. His best-known works are *Osteotomy* (1880); *Atlas of Head Sections* (1893); *On Pyogenic Infective Disease of the Brain and Spinal Cord* (1893); *On the Growth of Bone* (1912); and "Brain Surgery," in *Brit. Med. Journal* (1922).

See obituary notices in the *Lancet* and *British Medical Journal* for March 29, 1924.

MACFARREN, SIR GEORGE ALEXANDER (1813–1887), English composer. mas born in London on March 2, 1813, and entered the Royal Academy of Music in 1829. His *Chevy Chase* overture was written as early as 1836 and in a single night. In 1837 Macfarren was appointed a professor at the academy, and wrote his *Romeo and Juliet* overture. In 1838 he brought out *The Devil's Opera*, one of his best works. In 1845 he became conductor at Covent Garden. A gradual failure of his eyesight led to total blindness in 1860. He became principal of the Royal Academy of Music in Feb. 1875, and in March became professor of music in Cambridge university. His theoretical works. such as the *Rudiments of Harmony*, and the treatise on counterpoint, will probably be remembered longer than many of his compositions. He was knighted in 1883, and died in London on Oct 31.1887.

An excellent memoir by H C Banister appeared in 1891.

McGEE, THOMAS D'ARCY (1825–1868), Irish-Canadian politician and writer. second son of James McGee, a coastguard, was born at Carlingford. County Louth, on April 13, 1825. He early showed a remarkable aptitude for oratory. At the age of 17 he emigrated to the United States, and by his writing and public speaking in Boston, Mass., attracted the attention of O'Connell. Before he was 20 he returned to London to become parliamentary correspondent of the *Freeman's Journal*, and shortly afterward London correspondent of the *Nation*, to which he also contributed a number of poems. In 1846 he became one of the moving spirits in the "Young Ireland" party. and contributed two volumes to the "Library of Ireland." On the failure of the movement in 1848 McGee escaped in the disguise of a priest to the United States where between 1848 and 1853 he established two newspapers, the *New York Nation* and the *American Celt*.

In 1857 McGee, driven from the Cnited States by the scurrilous attacks of the extreme Irish revolutionaries, took up his abode in Canada, and was admitted to the bar of the province of Lower Canada in 1861. At the general election in 1858 he mas returned to parliament as the member for Montreal, and for four years he was regarded as a powerful factor in the house. On the formation of the Sandfield-Macdonald-Sicotte administration in 1862, he accepted the office of president of the council. When the cabinet was reconstructed a year later the Irish were left without representation, and McGee sought re-election as a member of the opposite party. In 1864 he was appointed minister of agriculture in the administration of Sir E. P. Taché, and he served the country in that capacity until his death. He actively supported the policy of federation and was elected a member of the first Dominion parliament in 1867. On April 7, 1868, he was shot by an assassin as he was about to enter his house at Ottawa. His utterances against the Fenian invasion are believed to have been the cause of the crime for which P. J. Whelan was executed.

McGee's principal works are: *A Popular History of Ireland*, 3 vol. (1862–69); *Irish Writers of the Seventeenth Century* (1846); *Historical Sketches of O'Connell and His Friends* (1844); *Memoirs of the Life and Conquests of Art McMurrogh, King of Leinster* (1847); *Memoir of C. G. Duffy* (1849); *A History of the Irish Settlers in North Anzerica* (1851); *History of the Attempts to Establish the Protestant Reformation in Ireland* (1853); *Life of Edward Maginn, Coadjutor Bishop of Dervy* (1857); *Catholic History of North America* (1854); *Canadian Ballads and Occasional Pieces* (1858); *Notes on Federal Governments Past and Present* (1865); *Speeches and Addresses, Chiefly on the Subject of the British American Union* (1865).

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McGILLIVRAY, ALEXANDER (*c.* 1739–1793). American Indian chief. was born near the site of the present Wetumpka, in Alabama. His father was a Scottish merchant and his mother the daughter of a French officer and an Indian princess. Through his father's relatives in South Carolina. McGillivray received a good education, but at the age of 17 he returned to the Muscogee Indians, who elected him chief. During the Revolutionary War, as a colonel in the British army, he incited his followers to attack the western frontiers of Georgia and the Carolinas. Georgia confiscated some of his property, and after the peace of 1783 McGillivray remained hostile. Though still retaining his British commission. he accepted one from Spain. and during the remainder of his life used his influence to prevent American settlement in the southmest. So important was he considered that in 1790 President Washington sent an agent who induced him to visit New York. There he was persuaded to make peace in consideration of a brigadier general's commission and payment for the property confiscated by Georgia; and with the warriors who accompanied him he signed a formal treaty of peace and friendship. He then went back to the Indian country, but remained hostile to the settlers until his death. He mas one of the ablest Indian leaders of America and at one time wielded great power —having 5,000 to 10,000 armed followers. Before he died he saw that he was fighting in a losing cause and, changing his policy, endeavoured to provide for the training of the Muscogees in the white man's civilization. McGillivray was polished in manners, of cultivated intellect, was a shrewd merchant and a successful speculator; but he had many savage traits, being noted for his treachery, craftiness and love of barbaric display.

See Harry Lincoln Sayler, *American Romance in the South* (1908).

McGILL UNIVERSITY: *see* UNIVERSITIES.

MacGOWAN, KENNETH (1888–). U.S. writer, motion-picture producer and educator. was born in Winthrop, Mass., on Nov. 30, 1888. He graduated from Harvard in 1911 and between 1910 and 1924 urote dramatic criticism for various newspapers and magazines, afterward directing plays. He joined RKO-Radio Pictures in 1932, working as associate producer from 1933 to 1935, and served in the same capacity for Twentieth Century-Fox Film Corp., 1935–41 and 1942–44. MacGowan then acted as a producer at Paramount Pictures until 1946. He became professor and chairman of the theatre arts department, University of California, Berkeley, in 1947. His published works include *The Theatre of Tomorrow* (1921); *Footlights Across America* (1929); *The Old Stone Age in the New World* (1948); and *Early Man in the New World* (1950).

McGUFFEY, WILLIAM HOLMES (1800–1873), U.S. educator, who is remembered chiefly for his elementary school readers, was born in western Pennsylvania on Sept. 23, 1800, of Scotch-Irish parents. In 1802 they moved into the forests of the Ohio Territory four miles north of the present city of Youngstown. With little home or school instruction, McGuffey mastered the school arts and began teaching in the subscription rural schools of Ohio when he was 13 years of age. During spare time and vacations, through his 11 years of teaching in Ohio and Kentucky, he continued his own education intermittently under private tutors, in Greersburg academy and in Washington college. receiving his A.B. degree with honours in 1826.

McGuffey went to Miami university. Oxford, O., as instructor in ancient languages in Nov. 1825, became professor of languages in 1826, and during 11 years there took great interest in public education. He assisted the teachers of the elementary schools of the community and established in his own home a model school of the neighbourhood children.

In 1835 he contracted with Truman and Smith, publishers, of Cincinnati to compile four school readers, the first and second of which were published in 1836 and the third and fourth in 1837. A fifth was published in 1844, a spelling book by McGuffey's brother, Alexander Hamilton McGuffey, came out in 1846, and a sixth reader was added in 1857. These textbooks became virtually the universal readers in the expanding common schools of the great empire of the Mississippi and the south. They went through many editions and sold 122,000,000 copies.

From 1836 to 1839 McGuffey was president of Cincinnati college and from 1839 to 1843 president of Ohio university, Athens. He was one of the three founders of the common school system of Ohio. In 1845 he was elected to the chair of mental and moral philosophy in the University of Virginia, Charlottesville, which position he eminently filled until his death on May 4, 1873.

MACH, ERNST (1838–1916), Austrian physicist and philosopher. whose work, both in physics and in philosophy, had a great influence on 20th-century thought. was born on Feb. 18, 1838, at Turas in Moravia and educated in Vienna. He was professor of physics at Graz from 1864 to 186; and at Prague from 1867 to 1895, and professor of inductive philosophy at Vienna from 1895 to 1901. He was made a member of the Austrian house of peers in 1901 and died at Haar, near Munich, on Feb. 19, 1916.

Mach was a thoroughgoing positivist and took the view. which most scientists now share, that no statement is admissible in natural science unless it is empirically verifiable. His criteria, of verifiability were, however, exceptionally rigorous: they led him not only to reject such metaphysical conceptions as that of the ether and that of absolute space and time but also to oppose the introduction of atoms and molecules into physical theory. Nevertheless it was his criticism along these lines of Sir Isaac Newton's system that made the way clear for Albert Einstein's theory of relativity. As a positivist, he regarded scientific laws as purely descriptive; and he held that the choice between alternative hypotheses covering the same facts was to be made on the grounds of economy.

Mach's philosophical position was phenomenalistic. He maintained that all empirical statements, including those that occur in scientific theories, were in the end reducible to statements about sensations. He tried to lay the basis for the phenomenalist reduction in his book *Analysis of Sensations,* but neither he nor any other philosopher has yet succeeded in carrying it through. Though it would be incorrect to call him an idealist. Mach's views have a certain resemblance to those of Berkeley, and for this reason he was sharply attacked by Lenin in *Materialism and Empirio-Criticism.* His philosophy survived to become one of the sources of inspiration of the Vienna circle of the 1920s (*see* LOGICAL POSITIVISM), the members of which mostly came to reject Mach's phenomenalism but continued to support him in his hostility to metaphysics, in his positivist conception of scientific method and in his insistence upon the unity of science.

Mach's name is popularly associated with the Mach number (*q.v.*), which expresses the air speed of an aircraft in terms of its relation to the local speed of sound.

Mach's works include: *Die Mechanik in ihrer Entwicklung historisch-kritisch dargestellt* (1883; rev. ed., 1908; Eng. trans. by T. J. McCormack, *The Science of Mechanics,* 4th ed., 1919); *Beiträge zur Analyse der Empfindungen* (1886; 5th ed. *Die Analyse der Empfindungen und das Verhältnis des Physischen zum Psychischen,* 1906; Eng. trans. by C. M. Williams. *Contributions to the Analysis of Sensations,* 1897); *Leitfaden der Physik für Studierende* (1881), in collaboration with others; *Populärwissenschaftliche Vorlesungen* (1896; 3rd ed., 1903); *Die Prinzipien der Wärmelehre* (1896); *Erkenntnis und Irrtum* (1905; Fr. trans. by M. Dufour, *La Connaissance et l'erreur,* 1908). (AD. J. A.; X.)

MÁCHA, KAREL HYNEK (1810–1836) Czech romantic poet of great power and individuality. Born at Prague on Nov. 16, 1810. of poor parents, Mácha was influenced as a student by the Czech national revival and by English and Polish romantic literature. Other sources of inspiration were his wanderings amid ruined castles in the Bohemian countryside and a journey to northern Italy (1834). In 1836 he took up a legal post in Litomerice but died there, of pneumonia, on Nov. 5, 1836.

After schoolboy attempts in German he began to write poems, sketches and novels in Czech. Practically all his prose works remained unfinished but their style shows a mastery not previously attained by writers in the newly revived Czech literary language. His lyrics express a characteristic but highly individual romantic pessimism. His best work is the lyrical epic *Máj* ("May"; 1836). Strongly Byronic in subject, this poem is yet personal in treatment and style. and stands comparison with the work of such Slavonic contemporaries as Adam Mickiewicz and Lermontov. Coldly received at the time, it has exercised an almost magical fascination on poets and critics of the 20th century. The subtle melody and rhythms of Macha's verse defied the efforts of his numerous translators.

His letters and diaries, *Dilo Karla Hynka Máchy,* ed. by K. Janský, 3 vol. (1948–50), in vivid colloquial prose, are an essential supplement and background to his poetry. (R. AY.)

MACHADO, BERNADINO (1851–1944), Portuguese statesman, was born at Rio de Janeiro on July 28, 1851. An ardent patriot, a man of unfailing courtesy, unchallenged character and courage, he became a professor at Coimbra university and entered parliament in 1882. In 1893 he held office for a few months as minister of public works. Four years later he espoused openly the cause of republicanism, and his election in March 1906 as Republican deputy for Lisbon was made the occasion of a Republican demonstration which resulted in the downfall of the government. After the revolution in Oct. 1910, Machado became minister of foreign affairs in the provisional government of the republic. He became premier on Feb. 4, 1914, and held office until Dec. 13. Under his guidance and despite German intrigue Portugal proclaimed on Aug. 7 her loyalty to the British Alliance, and on Nov. 23, committed herself to participation in military operations. On Aug. 6, 1915, Machado succeeded Dr. Theophilo Braga as president. On Dec. 15, 1917, he was banished by the insurgents. On March 2, 1921, he became premier of a coalition ministry, but in consequence of a military coup d'état he resigned on May 20. He served as president again from Dec. 1925–June 1926 when a revolution removed him from power. On Feb. 25, 1927, charged with complicity in an abortive insurrection, he was ordered to leave Portugal. He returned after an amnesty was granted to him and other political exiles in May 1936 and died in Oporto, April 29, 1944. (J. SW.; X.)

MACHAULT D'ARNOUVILLE, JEAN BAPTISTE DE (1701–1794), French statesman, was the son of a lieutenant of police. After two years as intendant of Hainaut, he succeeded Orry de Fulvy as controller-general of the finances in Dec. 1745. In order to reorganize the finances after the War of the Austrian Succession, he proposed to replace the old tax of a tenth, which was evaded by many of the clergy and nobility, by a universal tax of a twentieth, but failed to carry the measure in face of opposition though retaining his office until July 1754, when he became minister of marine. He gained the ill-will of Madame de Pompadour by opposing the alliance with Austria, and she obtained his disgrace on Feb. 1, 1757. In 1794 he was arrested as a suspect, and died in prison at the age of 93.

MACHAUT or **MACHAULT, GUILLAUME DE** (*c.* 1300–1377), French poet and musician, was born in the village of Machault near Réthel in Champagne, and died at Reims in April 1377. Machaut tells us that he served for 30 years as secretary to the adventurous John of Luxembourg, king of Bohemia, while holding, at the same time, various ecclesiastical positions at Verdun (1332), Arras (1333) and Reims. He followed John of Bohemia to Russia and Poland, and, though of peaceful tastes himself, saw 20 battles and 100 tourneys. When John was killed at Crecy in 1346 Machaut was received at the court of Normandy, and on the accession of John the Good to the throne of France (1350) he received an office which enabled him to devote himself thenceforth to music and poetry. Machaut wrote about 1348 in honour of Charles III., king of Navarre, a long poem much admired by contemporaries, *Le Jugement du roi de Navarre.* When Charles was thrown into prison by his father-in-law, King John, Machaut addressed him a *Confort d'ami* to console him for his enforced separation from his young wife, then aged 15. This was followed about 1370 by a poem of 9,000 lines entitled *La Prise d'Alexandrie,* one of the last chronicles cast in this form. Its hero was Pierre de Lusignan, king of Cyprus. Machaut is best known for the strange book telling of the love affair of his old age with a young and noble lady long supposed to be Agnes of Navarre, sister of Charles the Bad; Paulin Paris in his edition of the *Voir dit* (*Historie vraie*) identified her as Perronne d'Armentières, a noble lady of Champagne. In 1362, when Machaut must have been at least 62 years of age, he received a rondeau from Perronne, who was then 18, and wished to play Laura to his Petrarch. The romance ended with Perronne's marriage and Machaut's desire to remain her *doux ami*. Its subject and length are deterrent to modern readers. Machaut with Deschamps marks a distinct transition. The *trouvères* had been impersonal. It is difficult to gather any details of their personal history from their work. Machaut and Deschamps wrote of their own affairs, and the next step in development was to be the self-analysis of Villon.

Machaut was also a musician. He composed a number of motets, songs and ballads, also a mass supposed to have been sung at the coronation of Charles V. This was translated into modern notation by Perne, who read a notice on it before the Institute of France in 1817.

E. Hoepffner, in editing hlachaut's works. rightly says that they exercised a powerful and lasting influence on the literary development of the 14th century. As a lyric poet. if he did not actually create the fixed forms, such as the ballade, chant-royal, virelai. rondeau and lay. which prevailed up to the 16th century. it was he who ensured their triumph. And he inaugurated the new lyrical art. It is true that he was profoundly influenced by the *Roman de la Rose,* but he introduced a personal, individual note hitherto lacking. He was undoubtedly the master of a new school. Froissart and Deschamps. Christine de Pisan, Oton de Cranson, even Chaucer, all studied and imitated him. In the second half of the 15th century. he was forgotten, and was not rediscovered till the 18th century, by Lebeuf and the abbé Rive.

Machaut's *Oeuvres choisies* were edited *by* P. Tarbé (Reims and Paris, 1849). There are good modern editions of his longer poems in his *Oeuvres* (edit. E. Hoepffner, 3 vols., 1908, 1911, 1321) ; and of his *Poésies lyriques* (edit. V. Chichmaref! 1909). *See* also *F. G.* Fétis, ***Biog.*** *universelle des musiciens . . .* (1862), and E. Travers, *Instruments de musique au XIV^e siècle d'après Guillaume de Machaut* (1882).

MACHEN, JOHN GRESHAM (1881–1937), **U.S.** Presbyterian theologian and churchman, one of the most eloquent spokesmen for the conservative position in the theological controversies of the 1920s and 1930s, was born at Baltimore, Md., on July 28, 1881. Educated at Johns Hopkins and Princeton universities, Princeton Theological seminary and the Universities of Marburg and Gottingen. he taught at Princeton seminary from 1906 until its reorganization in 1929. Thereupon he left to help found Westminster Theological seminary in Philadelphia, where he served as professor of New Testament until his death on Jan. 1. 1937.

Machen's leading contributions to the conservative cause in the Fundamentalist-Modernist controversy was perhaps his book *Christianity and Liberalism* (1923), which contended that theological liberalism was not really Christian in the biblical and historic sense.

Machen's most scholarly books were *The Origin of Paul's Religion* (1921) and *The Virgin Birth of Christ* (1930; 2nd ed.. 1932). His publications also included numerous pamphlets and articles, in addition to several other books, many of a popular nature. Refusing to resign from the Independent Board for Presbyterian Foreign Missions on the ground that the mandate of the general assembly of the Presbyterian Church, U.S.A., ordering its members to do so was unconstitutional, Machen was suspended from the ministry. When his appeal was not sustained, he left in 1936 to join in forming the Presbyterian Church in America, later known as the Orthodox Presbyterian Church.

Machen also enjoyed a world-wide reputation as a Greek scholar and learned Christian apologist. His theological position, he was wont to emphasize. was not fundamentalist, but the Reformed Faith of the Westminster Confession of Faith. *See* also PRESBYTERIAN.

See autobiographical sketch in V. Ferm (ed.), *Contemporary American Theology* (1932); Ned *B.* Stonehouse, *J. Gresham Machen: a Biographical Memoir* (1954). (N. B. S.)

MACHIAVELLI, NICCOLO (1469–1527), Italian statesman and writer, was born at Florence on May 3. 1469 His ancestry claimed blood relationship with the lords of Montespertoli, a fief situated between Val di Pesa and Val d'Elsa, at no great distance from the city. Niccolb's father, Bernardo (b. 1428), followed the profession of a jurist. He held landed property worth something like £250 a year in English money. His son, though not wealthy, was never wholly dependent upon official income.

Of Niccolò's early years and education little is known. His works show wide reading in the Latin and Italian classics, but it is almost certain that he had not mastered the Greek language. To the defects of Machiavelli's education we may, in part at least, ascribe the peculiar vigour of his style and his speculative originality. He is free from the scholastic trifling and learned frivolity which tainted the rhetorical culture of his century. He made the world of men and things his study, learned to write his mother-tongue with idiomatic conciseness, and nourished his imagination on the masterpieces of the Romans.

Official Life.—The year of Charles VIII.'s invasion and of the Medici's expulsion from Florence (1494) saw Machiavelli's first entrance into public life. He was appointed clerk in the second chancery of the commune under his old master. the grammarian, Marcello Virgilio Adriani. Early in 1498 Adriani became chancellor of the republic. and Machiavelli succeeded as second chancellor and secretary. This post he retained for 14 years—until 1512. The masters he had to serve were the *dieci di libertà e pace,* who, though subordinate to the *signorza,* exercised a separate control over the departments of war and the interior. They sent their own ambassadors to foreign powers. transacted business with the cities of the Florentine domain, and controlled the military establishment of the commonwealth. hlachiavelli was fully occupied in the correspondence of his bureau, in diplomatic missions, and in the organization of a Florentine militia. The first of his many missions to petty courts of Italy was in 1499, when he negotiated the continuance of a loan to Catherine Sforza, countess of Forlì and Imola. In 1500 Machiavelli travelled into France, to deal with Louis XII. about the affairs of Pisa. These embassies were the school in which Machiavelli formed his political opinions. and gathered views regarding the state of Europe and the relative strength of nations. They introduced him to the subtleties of Italian diplomacy, and extended his observation over races very different from the Italians. He acquired principles and settled ways of thinking which later he expressed in writing.

In 1502 Machiavelli married Marietta Corsini, with whom, in spite of his own infidelities, he lived on good terms; she bore him several children, and survived him twenty-six years. In the same year Piero Soderini was chosen gonfalonier for life, in accordance with certain changes in the constitution of the state, which were intended to bring Florence closer to the Venetian type of government. Machiavelli suggested military reforms which Soderini adopted, and finally was involved in ruin by his fall.

In October 1502 he was sent, much against his will, as envoy to the camp of Cesare Borgia, in Romagna, and it was Machiavelli's duty to wait upon and watch him. He witnessed the intrigues which culminated in Cesare's murder of his disaffected captains. From Machiavelli's official letters, and from his tract upon the *Modo che tenne il duca Valentino per ammazzar Vitellozzo Vitelli,* we are able to appreciate the relations between the two men, and the growth in Machiavelli's mind of a political ideal based upon his study of the duke's character. Machiavelli conceived the strongest admiration for Cesare's combination of audacity with diplomatic prudence, for his adroit use of cruelty and fraud, for his self-reliance, avoidance of half-measures, employment of native troops, and firm administration in conquered provinces. More than once, in letters to his friend Vettori, no less than in the pages of the *Principe,* Machiavelli expressed his belief that Cesare Borgia's methods of conquest, the cementing of a new state out of scattered elements, and the dealing with false friends or doubtful allies, was worthy of commendation and imitation. Cesare Borgia became idealized in his reflective but imaginative mind. That Machiavelli separated the actual Cesare Borgia, whom he afterwards saw ruined and contemptible at Rome, from his radiant Duca Valentino, is probable.

Military Studies.--On his return to Florence early in January 1503, Machiavelli turned his mind to the existing conditions of military service in Italy. He was familiar with the disadvantages of the use of professional captains of adventure and mercenary troops. The bad faith of the condottiere Paolo Vitelli (beheaded at Florence in 1499) had deeply impressed him. In the war with Pisa he had observed the insubordination and untrustworthiness of soldiers gathered from the dregs of different districts, serving under irresponsible commanders. From Livy he, learned to admire the Roman system of employing armies raised from the body of the citizens; and Cesare Borgia's method of gradually substituting the troops of his own duchy for aliens and mercenaries showed him that the plan was feasible. He now determined, with the support of Soderini, to furnish Florence with a national militia. Early in 1503 Machiavelli drew up for Soderini a speech, *Discorso sulla provisione del danaro,* in which the necessity of liberal expenditure on defence was expounded upon principles of sound political philosophy. Between this date and the last month of 1506 Machiavelli worked out memorials on the subject for his office, and suggested the outlines of a new military organization. On Dec. 6, 1506, his plan was approved by the *signoria*, and a special ministry, called the *nove di ordinanza e milizia,* was appointed with Machiavelli as secretary. The country districts of the Florentine dominion were now divided into departments, and levies of foot soldiers were made in order to secure a standing militia. A commander-in-chief was found in Don Micheletto, Cesare Borgia's cut-throat and assassin. The appointment illustrates a radical infirmity in Machiavelli's genius. His scheme in itself was inspired by principles of political wisdom and by the purest patriotism. But he failed to perceive that such a ruffian as Micheletto could not inspire the troops of Florence with patriotism and a healthy moral tone. Here, as elsewhere, he was insensible to ethical considerations.

Meanwhile Alexander VI. had died suddenly of fever, and Julius II. had ascended the papal chair. The duke of Valentinois had been checked in mid-career of conquest. The collapse of the Borgias threw Central Italy into confusion; and hlachiavelli had, in 1505, to visit the Baglioni at Perugia and the Petrucci at Siena. In the following year he accompanied Julius upon his march through Perugia into the province of Emilia, to subdue the rebellious cities of the Church. Upon these embassies Machiavelli represented the Florentine *dieci.* Meanwhile the war for the recovery of Pisa dragged on. Machiavelli had to attend the camp and provide for levies amid his many other occupations. Yet in the autumn of 1504 he began his *Decennali,* or *Annals of Italy,* a poem composed in rough terza rima. About the same time he composed a comedy *Le Maschere*, now lost, on the model of Aristophanes.

At the end of 1507 European affairs diverted Machiavelli from his duties in organizing the new militia. Maximilian was arranging for his coronation in Rome, and was levying subsidies from the imperial burghs. The Florentines thought his demands excessive, and Machiavelli was sent to his court in December. He travelled by Geneva, through Switzerland, to Bozen (Bolzano), where he found the emperor. This journey enabled him to study the Swiss and the Germans in their homes; his report on it is among his most effective political studies. remarkable for his concentrated effort to realize the exact political weight of the German nation, and to penetrate the causes of its strength and weakness. He attempts to grasp the national character as a whole, and to deduce practical conclusions. The same qualities are noticeable in his *Ritratti delle cose di Francia,* which he drew up after an embassy to Louis XII. at Blois in 1510. These French notes are more scattered than the German report. But they reveal the same imaginative penetration into the very essence of national existence.

Machiavelli returned from Germany in June 1508. Chiefly through his exertions the Pisan war was terminated by the surrender of Pisa in June 1509. Meanwhile the league of Cambrai had disturbed the peace of Italy, and Florence found herself in a perilous position between Spain and France. Soderini's government grew weaker. The Medicean party lifted up its head. To the league of Cambrai succeeded the Holy League. The battle of Ravenna was fought, and the French retired from Italy The cardinal Giovanni de' Medici, who was present at the battle of Ravenna, brought a Spanish army into Tuscany. Prato was sacked in the August of 1512. Florence, in extreme terror, deposed the gonfalonier Soderini, and opened her gates to the Medici.

Fall **of Machiavelli.**—The government on which Machiavelli depended had fallen, never to rise again. The national militia in which he placed unbounded confidence had proved inefficient to protect Florence. His political and personal enemies regarded him with jealousy as the ex-gonfalonier's right-hand man. He showed no repugnance to a change of masters, and began to make overtures to the Medici. The *nooe della milizia* were, however, dissolved; and on Nov. 7, 1512, Machiavelli was deprived of his appointments. He was exiled from Florence and confined to the dominion for one year, and on Nov. 17 was prohibited from setting foot in the Palazzo Pubblico. He was implicated in the conspiracy of Pier Paolo Boscoli in February 1513, though he had no share in it, because his name was found upon a memorandum dropped by Boscoli. He was racked, and only released upon Giovanni de' Medici's election to the papacy in March 1513. When he left his dungeon he retired to a farm near San Casciano. His political career, now at an end, left him with only disappointment and annoyance. Losing his emoluments, he could barely support his family.

He had lived a continuously active life. Much as he enjoyed the study of the Latin and Italian classics, literature was not his business; nor had he looked on writing as more than an occasional amusement. He was now driven in upon his books for the employment of a restless temperament; and to this irksomeness of enforced leisure may be ascribed the production of the *Principe,* the *Discorsi,* the *Arte della guerra,* the comedies, and the *Historie fiorentine* His letters to Vettori paint a man of vigorous intellect and feverish activity, dividing his time between studies and vulgar dissipation It is very difficult to understand the spirit in which the author of the *Principe* sat down to exchange obscenities with the author of the *Sommario della storia d'Italia.* This coarseness of taste did not blunt his intellectual sagacity. His letters on public affairs in Italy and Europe, especially those which he meant Vettori to communicate to the Medici at Rome, are marked by extrdordinary fineness of perception, and philosophical breadth.

Il Principe.—In retirement at his villa near Percussina, a hamlet of San Casciano, Machiavelli completed the *Principe* before the end of 1513. This famous book is an analysis of the methods whereby an ambitious man may rise to sovereign power It appears to have grown out of the *Discorsi sopra la prima deca di Tito Livio,* begun at an earlier date, but only finished later.

Cast in the form of comments on the history of Livy, the *Discorsi* are really an inquiry into the genesis and maintenance of states. The *Principe* is an offshoot from the main theme of the *Discorsi,* setting forth Machiavelli's views at large and in detail upon the nature of principalities, the method of cementing them, and the qualities of a successful autocrat. Being more limited in subject and more independent as a work of literary art, this essay detaches itself from the main body of the *Discorsi,* and has attracted far more attention. In the *Principe* its author had more than a speculative aim in view, and brought it forth to serve a special crisis. Machiavelli judged the case of Italy so desperate that salvation could only be expected from the intervention of a powerful despot. The unification of Italy in a state protected by a national army was the cherished dream of his life; and the peroration of the *Principe* shows that he meant this treatise to have a direct bearing on the problem, though the book was by no means exclusively directed to that end. Together with the *Discorsi,* the *Principe* contains the speculative fruits of his experience and observation combined with his deductions from Roman history. The two works form a coherent body of opinion, not systematically expressed, it is true, but based on the same principles, involving the same conclusions, and directed to the same philosophical end That end is the analysis of the conception of the state, studied under two main types. republican and monarchical. Up to the date of Machiavelli, modern political philosophy had always presupposed an ideal. Mediaeval speculation took the Church and the Empire for granted, as divinely appointed institutions Thinkers differed only as Guelfs and Ghibellines, as leaning on the one side to papal, on the other to imperial supremacy. No new substantial philosophy of any kind had emerged from humanism: the political lucubrations of the scholars of the Renaissance were, like their ethical treatises, for the most part rhetorical. Still the humanists created a new medium for the speculative faculty. Simultaneously with the revival, Italy had passed into the "age of despots." The yoke of the Empire had been shaken off. The Church had taken rank among Italian tyrannies. Principalities and sovereign cities claimed autocratic jurisdiction. These separate despotisms owned no common social tie, were founded on no common *ius* or right, but were connected in a network of conflicting interests and changeful diplomatic combinations. A keen and positive political intelligence emerged in the Italian race. The reports of Venetian and Florentine ambassadors at this epoch contain the first germs of an attempt to study politics from the point of view of science.

At this moment Machiavelli intervenes. He was aware that the strongholds of mediaeval thought must be abandoned, and that the ruins of mediaeval institutions furnished no basis for solid political edifices. His originality consists in having extended the positive intelligence of his century from the sphere of contemporary politics and special interests to man at large regarded as a political being. He founded the science of politics for the modern world, by concentrating thought upon its fundamental principles. He began to study men, not in the isolation of one century, but as a whole in history. He drew his conclusions from the nature of mankind itself, "ascribing all things to natural causes or to fortune." In this way he restored a method which had been neglected since the days of Aristotle. Machiavelli's conception of the modern state marked the close of the middle ages, and anticipated the next phase of European development. His prince prefigured the monarchs of the 16th and 17th centuries, the monarchs whose motto was *L'état c'est moi!* His doctrine of a national militia foreshadowed conscription. The remedies which he suggested for Italian decadence, in the perorations of the *Principe* and the *Arte della guerra*, have since been applied in the unification of Italy. Machiavelli saw clearly the ruin of his country, and burned to save Italy and set her in her place among the powerful nations; his very limitations and mistakes were due to an absorbing passion for the state of which he dreamed. Concentrating his attention on the one necessity for organizing a powerful coherent nation, Machiavelli forgot that men are more than political being;. He neglected religion, or regarded it as part of the state machinery. He judged private virtue to be the basis of all healthy national existence; but in the realm of politics he subordinated morals to political expediency. He held that the people, as distinguished from the nobles and the clergy, were the pith and fibre of nations; yet this same people had to become wax in the hands of the politician —their commerce and their comforts, the arts which give a dignity to life and the pleasures which make life liveable, neglected—their very liberty subordinated to the one tyrannical conception. To this point the segregation of politics from every other factor which goes to constitute humanity had brought him; and this makes us feel his world a wilderness. Yet isolation of the subject matter of this science was essential at the outset, just as the science of economics had first to make a rigid severance of wealth from other units. Only gradually have we recognized that political economy has unavoidable points of contact with ethics.

Machiavelli thought of dedicating the *Principe* to one of the Medicean princes, but without result. The Medici, as yet at all events, could not employ Machiavelli, and had not in themselves the stuff to found Italian kingdoms.

Other Works.—Machiavelli, meanwhile, was reading his *Discorsi* to a select audience in the Rucellai gardens. Towards the year 1519 both Leo X. and his cousin, the cardinal Giulio de' Medici, thought it necessary to give Florence at least a semblance of self-government. They applied to several politicians, among others to Machiavelli, for advice in the emergency. The result was a treatise in which he deduced practical conclusions from the past history and present temper of the city, blending these with his favourite principles of government in general. He earnestly admonished Leo, for his own sake and for Florence, to found a permanent and free state system for the republic. The year 1520 yielded the *Arte della guerra* and the *Vita di Castruccio*.

The first of these is a methodical treatise, setting forth Machiavelli's views on military matters, digesting his theories respecting the superiority of national troops, the inefficiency of fortresses, the necessity of relying upon infantry in war, and the comparative insignificance of artillery. The peroration contains a noble appeal to the Italian liberator of his dreams, and a parallel from Macedonian history, which, read by the light of this century, sounds like a prophecy of Piedmont.

The *Vita di Castruccio* was composed at Lucca, whither Machiavelli had been sent on a mission. Dealing freely with the outline of Castruccio's career, as he had previously dealt with Cesare Borgia, he sketched his own ideal of the successful prince. Cesare Borgia had entered into the *Principe* as a representative figure rather than an actual personage; so now conversely the theories of the *Principe* assumed the outward form of Castruccio.

In the same year, 1520, Machiavelli received a commission from the officers of the *Studio pubblico* to write a history of Florence. He left a portion of it finished, with a dedication to Clement VII., when he died in 1527. The *Historie fiorentine* is not so much a chronicle of Florentine affairs, from the commencement of modern history to the death of Lorenzo de' Medici in 1492, as a critique of that chronicle from the point of view adopted by hlachiavelli in his former writings. But the *History of Florence* is not a mere political pamphlet. It is the first attempt in any literature to trace the vicissitudes of a people's life in their logical sequence, deducing each successive phase from passions or necessities inherent in preceding circumstances, reasoning upon them from general principles, and inferring corollaries for the conduct of the future. In form it is modelled upon Livy. The style of the whole book is nervous, vivid, free from artifice and rhetoric. Machiavelli had formed for himself a prose style, equalled by no one but by Guicciardini in his minor works; it is an athlete's style, all bone and sinew, without superfluous flesh or ornament.

It would seem that from the date of Machiavelli's discourse to Leo on the government of Florence the Medici had taken him into consideration and he was employed on one or two missions of little importance. But his public career was virtually closed. A translation of the *Andria* and three original comedies from his pen are extant, the precise dates of which are uncertain, though the greatest of them, *Mandragola*, was first printed at Rome in 1524. It is the ripest and most powerful play in the Italian language.

The plot is improbable and unpleasing. But the wit, humour, vivacity and satire of the piece bring before us the old life of Florence in a succession of brilliant scenes. If Machiavelli had any moral object when he composed the *Mandragola*, it was to paint in glaring colours the corruption of Italian society. It shows how a bold adventurer, aided by the profligacy of a parasite, the avarice and hypocrisy of a confessor, and a mother's complaisant familiarity with vice, achieves the triumph of making a gulled husband bring his own unwilling but too yielding wife to shame. The whole comedy is a study of stupidity and baseness acted on by roguery. The force of healthy instincts is underestimated.

He composed a second comedy, *Clizia*, which is even homelier and closer to the life of Florence than its predecessor. It contains incomparable studies of the Florentine housewife and her husband, a grave business-like citizen, who falls into the senile folly of a base intrigue. There remains a short piece without title, the *Commedia in prosa*, which, if it be Machiavelli's, as internal evidence of style sufficiently argues, might be accepted as a study for both the *Clizia* and the *Mandragola*.

The little novel of *Belfagor* is a good-humoured satire upon marriage, the devil being forced to admit that hell itself is preferable to his wife's company. The story has a mediaeval origin, and it was almost simultaneously treated in Italian by Machiavelli, Straparola and Giovanni Brevio.

Last Years.—In the spring of 1526 Machiavelli was employed by Clement VII. to inspect the fortifications of Florence. In the summer of the same year he received orders to attend Francesco Guicciardini, the pope's commissary of war in Lombardy. Guicciardini sent him in August to Cremona, to transact business with the Venetian *Provveditori*. Later on in the autumn we find him once more with Guicciardini at Bologna. Thus the two great Italian historians of the 16th century, who had been friends for several years, were brought into intimacy.

After another visit to Guicciardini in the spring of 1527, Machiavelli was sent by him to Civita Vecchia. But what seemed like a new diplomatic opportunity ended. He died in Florence on June 20, 1527, receiving the last offices of the Church.

In person Machiavelli was of middle height, black-haired, with rather a small head, very bright eyes and slightly aquiline nose. His thin, close lips often broke into a smile of sarcasm. His activity was almost feverish. When unemployed in work or study he was not averse to the society of boon companions, gave himself readily to transient amours, and corresponded in a tone of cynical bad taste. At the same time he lived on terms of intimacy with worthy men. Varchi says that "in his conversation he was pleasant, obliging to his intimates, the friend of virtuous persons." The contradictions of which such a character was capable are seen in his 'correspondence with Vettori. It would be unfair to charge what is repulsive in their letters wholly on the habits of the times, for the published correspondence of similar men at the same epoch offers little that is so disagreeable.

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MACHINE. A machine may be defined as a combination of resistant parts so connected as to have constrained motion and to be capable of transmitting or transforming energy. Although modern machines with their complex controls appear to be extremely complicated, every one is merely a combination of one or more of three basic elements: the wheel (*q.v.*) and axle, the lever (*q.v.*) and the inclined plane. Machines composed of combinations of these three basic machines may be classified according to two general functions: (1) generation and transformation of power; (2) transmission of power and performance of work, accomplished by means of such types of machinery as the pump, compressor, fan, crane, elevator and pulley (*qq.v.*) and the different types of vehicles. *See* also MACHINE TOOLS; MATERIAL HANDLING; and POWER TRANSMISSION. For specific machines not listed above, consult the index.

MACHINE GUN, a military firearm of small calibre capable of rapid, sustained fire. The modern machine gun is an automatic, belt-fed weapon that, barring a malfunction, will continue to fire as long as the trigger is held back, or until the supply of ammunition is exhausted.

The first machine guns, such as the famous Gatling gun described below, were manually operated by turning a hand crank, though they could be powered by a motor. The U.S. patent office described such weapons as being "capable of sustained fire from energy derived from an outside source." Later machine guns, such as the Maxim gun of the 1880s, required no outside source of power; they used the energy released by the burning propellant to feed, load, lock and fire each round, and eject the empty cartridge case. They were thus truly automatic machine guns.

The term automatic gun came into use after World War I to describe automatic aircraft weapons larger than the calibre .30 or calibre .50 machine guns. Such weapons were merely large machine guns (from 20 mm. to 57 mm.) and, as a rule, operated from energy released by the burning propellant. Beginning about 1945, some automatic guns reverted to the original external drive principle of the Gatling gun and employed either an electric motor or a gas turbine as a source of power. (For submachine guns, see SMALL ARMS, MILITARY: 20th-Century *Small Arms.*)

EVOLUTION OF THE MACHINE GUN

Soon after the advent of the first primitive firearms inventors began to contrive means for firing more than one shot before reloading. The first of these devices, known as ribaulds or ribaudequins, were simply bundles or rows of barrels, fired either all at once or in sequence. Many rather ingenious methods were used to control the firing, such as sliding locks that fired several superimposed charges in succession but required that the trigger be pulled for each shot. The idea of a multibore cylinder started in the matchlock period and has been used throughout the age of firearms, culminating in the most modern aircraft automatic guns. Before the invention of metallic cartridges, machine guns did not provide reliable, controlled ignition. They either suffered from stoppages or, even worse, permitted several charges to go off at once, with disastrous results.

The first soundly conceived manually operated machine gun was that patented in London, May 15, 1718, by James Puckle. The patent drawing of the Puckle gun has been widely published, but it is not generally known that the gun was actually produced, tested and found operable. Fig. 1 shows one of the production models in the Tower of London armouries. Puckle called his invention "a portable machine that discharges so often and so many bullets . . . as renders it next to impossible to carry any ship by boarding." The flintlock ignition was a limiting factor in its design, but other features were strikingly similar to those used in the Gatling and other systems of a century and a half later.

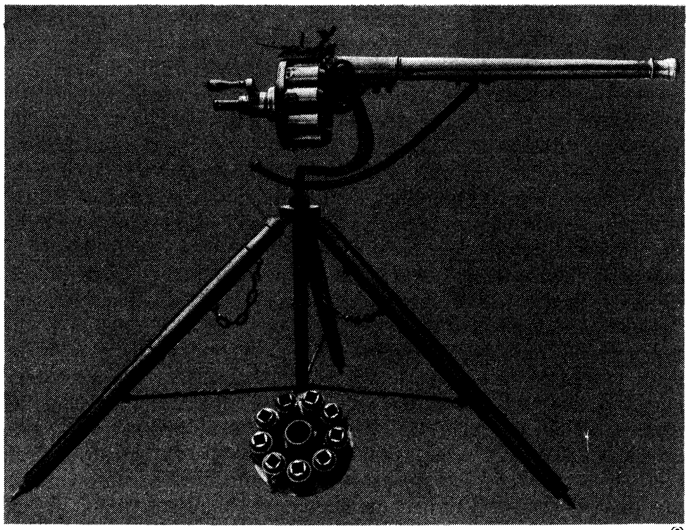


FIG. 1.— PUCKLE MACHINE GUN, 1718, WITH REVOLVING BLOCK FOR FIRING SQUARE BULLETS SHOWN IN THE FOREGROUND

The Percussion Cap.—The many problems arising from inability to ignite all charges at the same time, or with a high degree of reliability, regardless of how close the barrels were grouped, held further development almost at a standstill until 1807, when Alexander John Forsyth (1769–1843), a Scottish Presbyterian minister, patented an "application of the detonating principle to exploding gunpowder firearms." Forsyth utilized mercury fulminate, rolled into "pills" or small pellets which were placed in a nipple at the breech end of the barrel and detonated by the impact of a falling hammer.

Joshua E. Shaw (1776–1860), a U.S. sea captain, perfected a method whereby Forsyth's principle could be given a practical application—use of the percussion cap. Shaw developed a cup, made first of pewter and later of copper (about 1816), in which the mercury fulminate was placed so that the detonating mixture would be protected from the weather. would grip the sides of the nipple and could be used as a unit to transmit fire to the propellent charge. This invention opened the field for numerous weapons that were officially defined by the U.S. patent office as machine guns.

One of the earliest of the devices so classified was invented by Charles Emerson Barnes on July 8, 1856. Although there is no record of even a working model being made from the patent issued to the inventor, the illustration showing his toggle-locking action is still considered basically sound. Among other practical mechanisms of this period were the Ripley machine gun, the Ager "coffee mill" gun (commonly called the Union gun, the Claxton machine gun, the Williams machine gun and the Gorgas machine gun. The battle of Fair Oaks (Seven Pines), Va. (May 31, 1862) where the Confederates fired volleys from a battery of Williams guns, marked the first record of the use of the machine gun in warfare. There were, during the American Civil War, 11 hand-operated mechanisms that could be classified as machine guns available for service use. However, it remained for one man to resolve all the serious problems facing designers of manually powered machine guns at the time. That man was Richard Jordan Gatling (*q.v.*).

The **Gatling** Gun. — Gatling's original gun (about 1862) was a single-barrel device with a rotary chamber that combined certain features of the Ager and the Ripley guns. He employed the best ammunition available at the time. It consisted of a paper cartridge placed in a heavy-walled steel cylinder countersunk at the base and equipped with a nipple on which was placed the percussion cap. The first model of a Gatling gun using this type of cartridge was finished in time to see limited use by the Union army in the American Civil War.

Parallel with Gatling's efforts to improve gun mechanisms appeared the deciding factor which would govern the future of all machine gun design. It was first introduced to the sporting world in the form of the lightweight brass cartridge containing in a single unit a means of ignition, the propellant and the bullet. *(See* SMALL ARMS. MILITARY.) Gatling recognized the significance of this great improvement and redesigned his weapon. It consisted of a number of barrels mounted parallel one to mother and equidistantly spaced to rotate about a central shaft. The gun was actuated by a hand crank which could be turned slowly or rapidly at the will of the operator, thus providing control of the rate of fire. The positioning of the incoming cartridge in the chamber of each individual barrel was accomplished by gravity or by the camming action of the cartridge container located directly above the gun. This was done while the chamber being loaded was making a half-revolution about the central shaft. Firing then took place, followed by extraction and ejection during the second half-revolution. The combination of all factors, from the basically sound mechanism to the self-contained metallic cartridge, was vitally necessary in the evolution and perfection of the Gatling machine gun.

The introduction of the self-contained metallic cartridge made possible not only rapid fire but also bursts of long duration aith great reliability since the round could be mechanically controlled throughout the entire gun mechanism and the base of the cartridge could be designed to facilitate chambering, firing, extracting and ejecting.

Other Types. — The Gatling gun was without peer in the manually operated era and, when powered externally, could fire 3,000 rounds per minute. But its multibarreled arrangement placed a serious limitation on its tactical use. This gave other inventors the opportunity to display their genius in devising variations of hand-powered machine guns to meet specific purposes. Among the foremost of these hand-cranked weapons was the Hotchkiss (1878) developed primarily for shipboard use, being chambered almost exclusively for the large artillery type of cartridge. More mobile than the Gatling, the Gardner was another successful mechanism employing conventional military rifle calibre cartridges only. It was adopted by the navies of many world powers because the one- and two-barrel versions could be easily carried ashore by one man. The prevailing military belief that volley fire was more effective than rapid continuous shots led to the development of another type of volley-firing, hand-polyered machine gun, universally knonn as the Nordenfeldt (patented in 1879). Although never officially adopted, many other ingenious hand-manipulated mechanisms were developed between 186j and 1880 in the United States. These guns mere actually constructed and passed exhaustive government tests. Representative types were the Lowell, which mechanically indexed and fed the incoming round at high speed; the Wilder, which combined the revolver system with reciprocating action; and the Bailey, which was the first to employ belt feeding.

During the American Civil War, French observers attached to the Union and Confederate armies recognized the devastating effectiveness of grapeshot fired from light artillery against concentrated attacking personnel. From these observations there was developed in Europe a peculiar multifiring weapon resembling a piece of standard artillery. It was considered an improved method of delivering grapeshot and was called a mitrailleuse, meaning grape shooter or more literally, grapeshot shooter. This marked the beginning of French interest in machine guns and each subsequent hand-powered or automatic firing device manufactured by the French carried the marking mitrailleuse, although the meaning of the word had no connection with the weapon beyond the first effort.

For the second time in machine gun history another completely new concept entered the field and quickly made all previous efforts obsolete. This revolutionary development came through the invention (about 1885) of a new form of propellant, a progressive burning powder. By gelatinizing nitrocellulose, the burning speed of the explosive mixture could be controlled to a high degree. Another important feature of this new powder was that during combustion there was almost no smoke. Quickly acclaimed by both military and civilian observers for its smokeless qualities, it was named smokeless powder. To the machine gun inventor: however, its real significance lay not in its lack of smoke but in its progressive burning qualities. It not only yielded a higher chamber and bore pressure to give increased velocity to the projectile, but also made it possible for a metered amount of gas pressure to be used for operating a weapon. By drilling a small hole or port in the barrel a fraction of the pressure could be brought to bear on a piston or lever that provided complete control during firing.

Still another method for powering the weapon was provided by the recoil force which was also governed solely by the progressive burning qualities of the new propellant. When the weight of the charge was constant it gave the same amount of thrust with each shot. This assured consistency of the distance and speed of the recoil stroke.

Hiram Stevens Maxim (1840–1916), a U.S. engineer and inventor residing in England, conceived the idea of the first fully automatic machine gun. Again, the conception and development of the automatic machine gun was retarded initially because the inventor was forced to employ as ammunition only what was available at the time, in this case the conventional black powder cartridge. In spite of this handicap, by June 1884, Maxim had progressed to the point where he had a workable product. The principle of short recoil was used by Maxim for the complete cycling of his single-barrel weapon. Although Maxim's early experiments were conducted with black powder cartridges, and he had reached a limited degree of success, it was the introduction of the new propellant, smokeless powder, that not only assured the success of the Maxim gun but also brought about the golden era (from 1884 to World War I) of automatic machine gun inventions. His guns, as manufactured by Vickers and known by that name as well as Maxim or Vickers-Maxim, were used by every major power. The Vickers machine gun was adopted by the U.S. army as its model 191j.

Following closely behind Maxim came the prolific U.S. inventor, John M. Bromning (*q.v.*), of Ogden, Utah. His work on automatic gun mechanisms is well known; no design of his ever failed. After his entry into the field the United States used his automatic weapons almost exclusively. Official adoptions by the U.S. include the calibre .30 Browning automatic rifle (B.A.R.), the calibre .30 light Browning machine gun, the calibre .30 heavy Bromning machine gun, the calibre .45 auto-loading pistol, the calibre .50 aircraft and heavy-barrel ground-type Browning machine gun and the 37-mm. aircraft automatic gun.

From 1890 to World War I, the large standing armies prevalent in Europe furnished an impetus and ready market for tremendous activity in machine gun design, and there was an influx of U.S. aurornatic neapon designers to Europe. Among them were Hugo Borchardt. Benjamin Hotchkiss, Laurence V. Benét. Col. Isaac N. Lewis and later Browning. Consequently, both the Allies and the Central Powers during World War I armed their military forces with machine guns designed by persons of U.S. origin. such as the Maxim. Vickers, Lewis, Hotchkiss, Benét-Mercié and Browning.

The Skoda gun was used by Austria and tested by the United States. The Madsen light machine gun, made in Denmark, was used by Russia, Denmark. Norway, Argentina and several other countries. The Bergmann and Dreyse guns were used by Germany. The Schwarzlose was used by several countries. Before and during World War I, the Chauchat. Benét-Mercié, Berthier and Lewis light machine guns were extensively tested and used. During that war, the Lewis gun, in an adaptation for aircraft, became one of the favourite weapons of fighter pilots. Some of them were still in service at the beginning of World War II. A famous gun, the ZB, was developed in Brno. Czech. The British government acquired a licence to manufacture it before World War II and used it extensively. The weapon was manufactured at the Enfield plant and called the Bren gun, the name being derived from Brno and Enfield.

Designers of other nations active during this time, included Germans such as Paul Mauser, Fritz and George Walther, Theodor Bergmann, Louis Schmeisser and Reinhold Becker; the Austrian, Rudolf Frommer; the Italians, Bethel Revelli and Alfredo Scotti; the Frenchman, André Berthier; the Swiss, Marc Birkigt; and the Mexicans, Manuel Mondragon and Rafael Rlendoza. Their designs, then still in experimental stages, were not used extensively during World War I, but they laid the foundations for many subsequent developments.

World War I. often called the machine gun war, brought to the foreground the importance of the machine gun as a deadly military weapon. Lloyd George, in a speech before the British house of commons on Dec. 15, 1915, estimated that over 80% of the British casualties to that date had been inflicted by machine gun fire and it is reasonable to assume that the other participants suffered in the same ratio. This great conflict also introduced a hitherto unproved weapon, the airplane, which was destined to be combined with the machine gun as a weapon of war of vast potentiality.

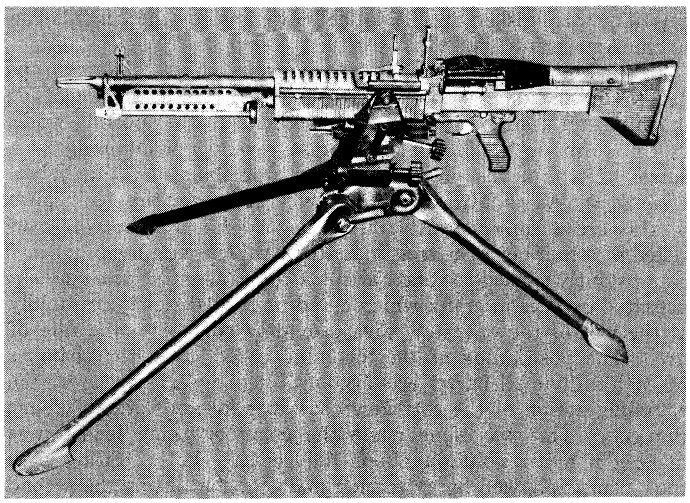
Throughout automatic n-eapon history, new situations that stimulated design always appeared. By World War I, when the ground-type machine gun had reached a stage of near perfection. aviation provided an incentive that opened up fresh concepts in automatic weapons. Certain features, hitherto unforeseen. became immediately critical. Among these were weight, compactness, high rate of fire, amount of ammunition used in comparison with allowable weight to be carried by the airplane, synchronization to fire through the propellers, mounting of weapons and ejection of empty cartridges and links. At first; with the slow flying speed, these problems were easily overcome; in fact, planes originally carried regular ground-type machine guns with slight modifications for mounting purposes.

Machine gun designers managed to stay ahead of aircraft requirements throughout the 1920s, 1930s and the early part of World War 11 However, the advent of jet-powered aircraft in the latter days of World War II introduced a new factor in machine gun design. The problem was to design an extremely light, large-calibre gun shooting an explosive projectile at a very high rate of fire to cope with the supersonic speeds, tremendous stresses and compact design of jet aircraft. However, advances in impact forming had by then developed the art of stamping to such close working tolerances that the forging and machining of receivers, feed mechanisms and internal parts became unnecessary. Metallurgists. successful in the development of new alloys of high tensile strength: found they could replace steel when weight became the important factor. As these things came into being, the weight of the automatic gun was considerably reduced, thus allowing more installations of guns per aircraft and more firepower per pound of weight carried.

To this end scientists and machine gun designers worked constantly to produce reliable, light, compact, rapid-firing automatic guns to keep pace with the ever-advancing aircraft industry. There has been a universal exploitation of systems to take advantage of certain features that are highly adaptable for a specific purpose and to design an automatic firing mechanism having the desired qualities. This resulted in a great advance in aircraft automatic weapon design. In 1957 the U.S. army adopted the M60, a lightweight, general purpose machine gun to replace three older calibre .30 machine guns. The gun could be fired from the shoulder. from the hip, from a bipod or from an aluminum tripod mount. It was chambered for the standard 7.62-mm. NATO (North Atlantic Treaty organization) cartridge.

AUTOMATIC GUNS

When aircraft were first used in combat during World War I they were armed with the types of small arms then used in ground warfare, but machine guns specially designed or adapted for mounting in aircraft were soon developed. Some were mounted in open cockpits while others were installed to fire through the propeller—synchronized so as to miss the blades. Before the end of the war, it was evident that a heavier weapon was needed for firing at



BY CCURTESY OF U.S DEPARTMENT OF ARMY

FIG. 2.—U.S. MACHINE GUN. M60. ADOPTED IN 1957

ground targets such as trucks, locomotives or light tanks. Some of the first attempts at a solution simply placed in the airplane a conventional light fieldpiece with so-called quick-fire breech mechanism. As the recoil energy to be absorbed by the aircraft structure was excessive. it became apparent that specially designed weapons were required. The Puteaux factory in France modified some 37-mm. aircraft cannon designed by Birkigt (of Hispano-Suiza) to fire through the hub of a propeller. But these did not go into service until after World War I. The Germans had placed a 20-mm. Becker gun in a ring mount and found it an effective aircraft weapon. This mas the forerunner of the no-mm. Oerlikon gun of World War II service.

In 1938 the Royal Navy adopted the 20-mm. Oerlikon gun as its standard light antiaircraft weapon on all ships. A short time later the U.S. navy took similar action. During World War II, both Japan and Germany also used the Oerlikon extensively. It was the principal Nazi aircraft gun before and during the battle of Britain.

One of the first automatic aircraft cannon used in World War I was the Revelli (Fiatj which the Italians installed in their large Caproni and Savoia-Pomilio bombers. The calibre of this gun was 25.4-mm. It could fire eight rounds in two seconds from a ring mount. The British Vickers 37-mm. automatic aircrait cannon was installed in British naval aircraft as early as 1915. Its excessive recoil made it unpopular. but during the 1930s, Vickers improved the design and produced some 37-mm. guns which were satisfactory. The size was later increased to 40-mm., and near the end of World War II a few of 57-mm. were produced.

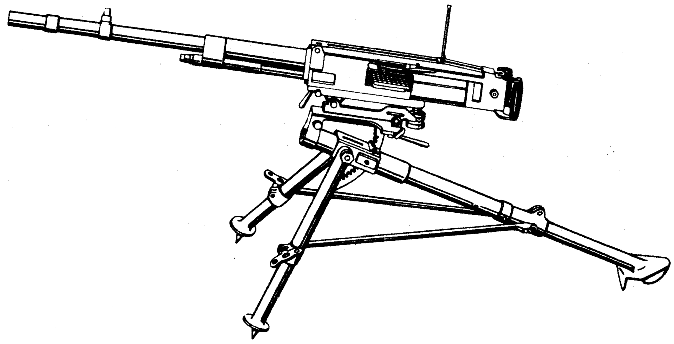


FIG. 3.— TYPICAL GAS-OPERATED AUTOMATIC MACHINE GUN (ITALIAN BREDA)

In the United States, a Browning 37-mm. aircraft cannon was used to some extent during World War II. The U.S. government furnished thousands of these weapons to Russia with Bell Aircobra fighter planes. Most U.S. aircraft carried 20-mm. guns of either Hispano-Suiza or Oerlikon type. The principal gun used by the army air forces was the 20-mm. M1 and AN M2. which operated on a combination gas and blowback principle. It used either a belt-feed mechanism or a 60-round drum magazine. It was mounted as a fixed gun in the wing or fuselage of an airplane, or in a turret. It could also be mounted to fire through the propeller hub. Its rate of fire was 600 to 700 rounds per minute.

The French developed but did not use a 2j-mm. Hotchkiss gun. They did not use it because the plant was captured early in the war. Japan, however, made the gun on a licence agreement and used it extensively. The Italian Scotti gun superficially resembled the Oerlikon, but was not used to any extent. The Danish Madsen guns in 20-mm. and 23-mm. were never very popular. The Nazi forces during World War II used several different aircraft guns, among them the Mauser 20-mm., and the Rheinmetall-Borsig in 20-mm. and 30-mm. sizes. The Swedish Bofors plant also produced aircraft guns in 20-mm. and 57-mm. sizes. Breda made some 20-mm. guns for the Italian government.

Most of the early automatic aircraft guns were mounted on flexible rings. However, some were arranged to fire through the propeller hub, and a few, notably types used in heavy US. bombers during World War II, were placed in remotely controlled turrets. But the weapon most commonly used in such turrets was the calibre .50 Browning machine gun. As first adopted by the U.S. services, this gun was known as the model 1921. It was made with either water-cooled or air-cooled barrels. The former were for antiaircraft use, the latter, either with flexible or fixed mounts, for aircraft installations. The principal type used during World War II was the M2, which is distinguished from earlier models by the fact that it could be fed either from the right or left side. Older guns fed from the left only. The variants of the M2 included aircraft models (fixed and flexible), heavy-barrel models for ground use and water-cooled models for antiaircraft fire. The aircraft guns could be fired mechanically or electrically either by an accessory or by a manual trigger. Their rate of fire was from 7j0 to 850 rounds per minute. The AA version had a rate of from 550 to 700 shots per minute, while the heavy-barrel ground gun fired at from 400 to 500 shots per minute. Late in the war an improved gun, the M3 was introduced. Its main distinction was an increased rate of fire—1,200 shots per minute.

In the Korean war the predominant weapon on planes of the United Nations was the calibre .50 aircraft gun. The Soviet MIG-15 planes were armed with a variety of larger calibre, slower firing weapons ranging in size from the calibre .50 to the 37 mm., including a 23-mm. gun with a cyclic rate of 700–800 rounds per minute. To meet the challenge of supersonic jet planes, aircraft guns firing at the rate of several thousand rounds per minute were under development. One adopted by the U.S. air force was a 20-mm. machine gun operating on the revolver principle, aith a five-chamber cylinder. Another experimental model unveiled by the U.S. army in 1957 was the 20-mm. Vulcan based on the Gatling gun principle. Its six rotating barrels could fire at the rate of about 7,000 rounds per minute. In spite of these developments, aircraft rockets and guided missiles steadily gained ground in competition with conventional machine guns. (See MISSILES; ROCKETS.)

SYSTEMS OF OPERATION

Generally speaking, there are five known practical applications for accomplishing sustained fire as outlined in the definition of an automatic gun: (1) residual pressure remaining in the bore a few milliseconds after the projectile has cleared (blowback); (2) gas pressure in the bore bled off externally through an orifice (gas operation); (3) long recoil; (4) short recoil; and (5) blast energy generated by the expanding gases after being released from the confines of the barrel at the muzzle end (muzzle blast actuation). The last application has had only limited development in automatic weapon design and is not further discussed in this article.

Principles of Blowback.—In some guns, all the energy required for the performance of the automatic cycle is obtained through blowback action while in others only a portion of the required energy is from this source, the remainder being derived from some other system of operation. In any event, the blowback effect is present, at least in part, whenever the bolt of a gun is not locked while there is powder gas pressure in the chamber. When blowback action occurs, the energy derived from the pressure of the powder gases appears in the form of kinetic energy transferred to the bolt mechanism by the empty cartridge case as it is blown from the chamber of the barrel; *i.e.*, it appears in the form of a velocity imparted to the bolt mass. The basic problem involved in blowback operation is in the complete control of this velocity so that the gun will operate as desired. There are several well-defined methods by which the control of the rearward motion of the bolt may be accomplished in guns employing blowback and these various methods are referred to as blowback "systems."

Plain Blowback.—This system is used extensively in the design of lightweight shoulder arms chambered for short-range pistol cartridges. This type of weapon is officially designated as a submachine gun—the Thompson calibre .45 submachine gun, for example. The method is also universally employed in construction of small-bore, auto-loading hand arms; *e.g.*, the calibre .22 Colt Woodsman pistol. In the plain blowback system (see fig. 4), the bolt returns to the firing position with relatively low velocity but with considerable kinetic energy and this energy is absorbed by impact before the next cycle starts. Since the bolt is stationary when the new round is fired, all of the explosive force of the round is effective in accelerating the bolt to the rear. As has been explained, this condition requires the use of an extremely heavy bolt in order to keep the bolt velocity within safe limits.

Delayed Blowback.—This may be defined as a method of operation in which the bolt remains locked until the peak powder gas pressures have passed and a safe operating limit is reached after the projectile clears the muzzle. The bolt is then unlocked by some means so that it can be blown back by the residual pressure with sufficient energy to perform the remainder of the cycle of operation. In this system, the time at which the bolt is unlocked can be controlled in the design so that any desired portion of the residual pressure can be utilized. Of course, the bolt must be unlocked while there is still sufficient impulse available from the residual pressure to produce the required operating energy.

Any gun in which the bolt is unlocked while residual pressure still exists is subject to some blowback and partakes of some of the characteristics of the delayed blowback system. Such guns include certain gas-operated and short-recoil-operated weapons in which the bolt is unlocked almost immediately after the projectile has left the muzzle. However, in guns of this type, the operating energy does not come solely from blowback but is derived also

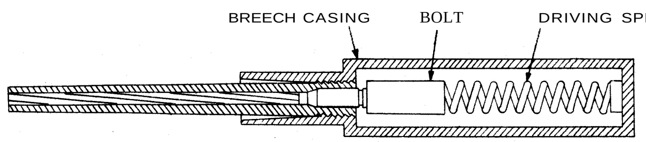


FIG. 4.— SCHEMATIC DRAWING OF PLAIN BLOWBACK SYSTEM

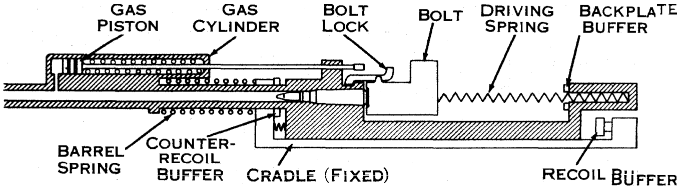


FIG. 5.— SCHEMATIC DRAWING OF GAS-OPERATED SYSTEM

from the action of the gas piston or from a mechanical accelerator actuated by the motion of the recoiling parts. This system is highly adaptable to large calibre automatic guns, such as the Birkigt 404, Hispano-Suiza and Scotti aircraft weapons.

Retarded Blowback.—In this system a special retarding mechanism is operated by the movement of the bolt. The mechanism itself is composed of relatively light parts and the inertia forces which result when these parts are set in motion by the bolt are therefore relatively small. However, the mechanism is arranged so that the bolt must act through a tremendous mechanical disadvantage to overcome the inertia forces and is accordingly subjected to a very high resistance to motion. In other words, although the bolt and the associated mechanism may be quite light, the effective resistance to bolt acceleration can be made just as great as that which would be obtained by the use of an extremely heavy bolt. The mechanism of a retarded blowback gun is similar to that of a plain blowback gun except for the presence of the retarding mechanism. This can take many forms but the basic principle underlying all of these is that the bolt must overcome the inertia forces in the mechanism by acting through a high mechanical disadvantage. Being unadaptable to large bore weapons, this system is used exclusively in design of machine guns employing rifle or pistol cartridges; *e.g.,* the Schwarzlose and Skoda machine guns.

Advanced Primer Ignition.—A substantial saving in bolt weight and other advantages can be realized by making use of the kinetic energy of the returning bolt. Instead of permitting this energy to be dissipated by impact before the next round is fired, it is possible to time the ignition so the new round is fired just before the bolt reaches its fully forward position. In this method, known as advanced primer ignition, the impulse of the propellant explosion must first slow and stop the returning bolt before it can propel the bolt to the rear. With this action, only a portion of the explosive impulse is effective in blowing the bolt back and the interval of time during which the pressure of the powder gases acts to produce a rearward acceleration of the bolt is also reduced. Both of these effects permit the use of a much lighter bolt and produce a condition in which higher bolt velocities are allowable. Thus, not only can the gun be lighter, but it is also possible to achieve a higher rate of fire. This operation is used exclusively in the design of large bore automatic guns; outstanding examples are the Oerlikon and the German MK-108.

Principles of Gas Operetion.—In all machine guns, the fundamental source of operating energy is the high-pressure gas created by the explosion of the propellent charge. This is true, in a general sense, of guns operated by any system of true automatic operation, as defined in this article. In spite of the fact that the ultimate source of operating energy in all machine guns is the pressure of the powder gases, the term gas operation is reserved for a particular type of operating system in which the pressure of the powder gases is employed in a specific way.

In a typical gun which uses the system of gas operation, an opening or port is provided in the side of the barrel. When the projectile has passed this opening, some of the high-pressure gases behind the projectile are tapped off through the hole and pass through an orifice to operate a piston or some similar device for converting the pressure of the powder gases to a thrust. This thrust is then utilized through a suitable mechanism to provide the energy necessary for performing the automatic functions required for sustained fire. These functions include unlocking the bolt, retracting the bolt and operating the other portions of the gun mechanism necessary to perform the complete cycle.

The gas operating mechanism can take many forms. Fig. 5 illustrates a commonly used device, consisting of a simple gas cylinder and a piston which is driven rearward to transfer its energy to the bolt by direct impact. In some cases, the piston may be driven forward instead of rearward, but this does not involve any significant change in the principle of operation. Even the nature of the member which is acted upon by the gas pressure is subject to great variation. Instead of being a conventional piston, this member can be in the form of a sleeve, slide or other device arranged to receive an impulse from the gas pressure.

The methods used for transferring energy from the piston to the gun operating mechanism are also extremely diverse in form and function. Instead of transferring energy directly to the bolt, the piston itself sometimes moves through a very short stroke and transfers its energy by impinging on an intermediate sliding member or lever. A great number of devices have been designed to minimize the shock involved in the energy transfer through the use of levers, links or cams. In certain instances, the shock of transfer is reduced by causing the piston to load intermediate springs which subsequently transfer their stored energy to the mechanism. Existing examples of gas-operated guns (*e.g.,* the Hotchkiss) incorporate many ingenious arrangements for tapping the energy in the powder gases and for handling related problems such as sealing, timing and adjustment.

Principles of Recoil.—These principles can be understood best by considering the forces which result from firing a cartridge in an elementary gun. Such a gun consists of a barrel having a chamber at its rear end for receiving the cartridge and a breech closure in the form of a bolt. The bolt is rigidly locked to the barrel after the cartridge is inserted and provides a firm support for the base of the cartridge case so that the case will not be blown out of the chamber by the explosion of the propellant charge. When the cartridge is fired, the explosion of the propellant results in the rapid generation of extremely high gas pressure in the chamber and the expansion of this high-pressure gas drives the projectile forward through the bore. As the powder gases expand behind the projectile, the centre of mass of the gases also moves forward. While the projectile is in the bore, the same pressure which causes the projectile and powder gases to move forward also acts simultaneously at the breech end of the gun to produce an equal and opposite reaction which tends to drive the entire gun to the rear. The force resulting from this reaction is called the recoil force, and the *magnitude* of this force at any instant depends on the chamber pressure.

The distinguishing characteristic of any recoil system is that energy used for operation is obtained from the recoil movement of the barrel and bolt while these parts are locked together. Any gun in which the bolt is locked to the barrel while there is pressure in the chamber will be subject to some recoil action, but unless the recoil is put to use in actuating the gun mechanism, the weapon is not considered to be recoil operated.

Long Recoil.—This type is defined as an operation in which energy for operating the gun mechanism is obtained from a recoil movement which is greater than the over-all length of the complete cartridge. (*See* fig. 6.) During this entire movement, the bolt remains locked to the barrel. At the end of the rearward movement, the bolt is unlocked from the barrel and is latched in its rear-most position, the barrel moving forward in counterrecoil to pull the chamber off the empty cartridge case and eject the case. When the barrel has moved forward far enough to provide a sufficient opening for feeding, and just before its counterrecoil movement is completed, the bolt is unlatched. The bolt then moves forward for loading and the cycle is completed as the bolt relocks to the barrel (*e.g.,* the Browning 37-mm. aircraft cannon).

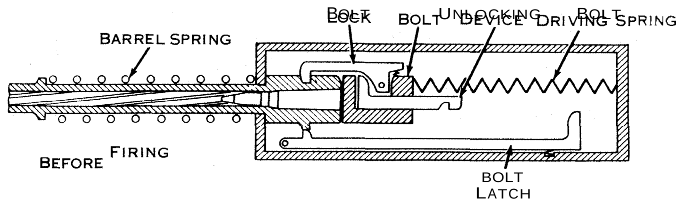


FIG 6 — SCHEMATIC DRAWING OF LONG RECOIL SYSTEM

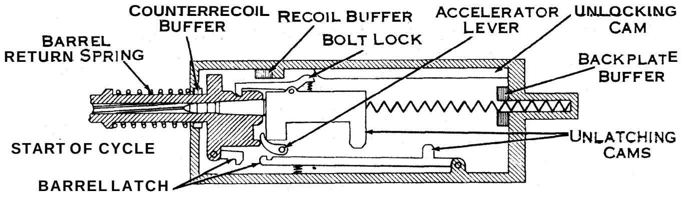


FIG. 7.— SCHEMATIC DRAWING OF SHORT RECOIL SYSTEM

Short Recoil.—In this system, the barrel and bolt remain locked and recoil together for a short distance until the powder gas pressure has dropped to a safe limit. The recoil movement then unlocks the bolt and, after unlocking, the barrel is stopped while the bolt continues to move to the rear until the opening between the barrel and bolt is sufficient to permit feeding. It would be possible for the bolt to complete this movement merely by the momentum it possesses at the instant of unlocking, but in all short recoil weapons. in order to speed up operation, the bolt is given additional momentum by an accelerating device which transfers energy to the bolt from the barrel during the short time that the barrel is still moving to the rear after unlocking. Also, unlocking usually occurs before the residual pressure reaches zero and therefore the bolt receives an additional impulse from blowback action. The basic elements of a short-recoil mechanism are shown in fig. 7. The Browning calibre .30 and calibre .50 machine guns represent this type of action.

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(G. M. CN.; B. R. L.)

MACHINE KNIVES are a large group of cutting tools which operate by a linear or a circular action. Among the smallest are the cutters in woodworking machines to produce moldings, and the largest are shear knives for paper. fabrics and steel plates. The edges are keen and honed up finely! and the knife must be well supported in the machine to cut truly and preserve the edge in good condition. Knives in revolving heads and drums for molding and planing wood require careful balance in order to eliminate vibration and produce good surfaces. A balancing scale is employed to test the uniformity of weight of each of a set of blades. When a knife has linear cutting action it is often set at an angle or "shear." so as to operate gradually instead of all along the edge at once. Paper, leather, tobacco, veneer and metal are among the substances cut with a linear or slicing movement. Some of the wood-planing machines combine high-speed rotary knives and fixed knives in the outfit, the wood being fed through and receiving an extra finish from the fixed knives.

MACHINE TOOLS. Of the many power-driven tools developed by man. machine tools are probably the most important because it is by means of them that other tools such as those for earth working! materials handling. etc.. are made. They are important also because they have made it possible to produce identical parts shaped to sufficiently precise dimensions as to provide complete interchangeability. It is interchangeability of parts that has made possible the assembly of products on a mass-production scale and the quick and inexpensive replacement of worn and broken parts.

Machine tools are often defined as power-driven machines, ordinarily not portable by hand, which cut, shear or press metal into desired forms. They may be classified in various ways. Perhaps the most meaningful way is that which arranges them according to their respective modes of shaping the materials, usually metals, which they are designed to work. (See table below.) Figs. 1–6 show the basic method of operation of various classes of machine tools.

Although evidence indicates that man first used hand tools as long as 35,000 years ago, during the Early Stone Age (35,000 B.C. to 15,000 B.C.), it is interesting to note that the machine tools listed below were themselves originated and developed in the very short span of about 400 years, beginning in the 16th century. Leonardo da Vinci's records show a lathe with a pole drive apparently in use in the 1500s. The basic tools in this list, however, did not assume their present general forms and characteristics until mechanical power became available during the Industrial Revolution beginning in the latter part of the 18th century. In 1794 Henry Maudslay developed his first all-metal lathe with a sliding tool rest. John A'ilkinson improved the lathe for boring purposes in 1776 for James Watt. Maudslay's adaptation of the lead screw to his lathe in 1810 made possible the construction of lathes, planers and milling machines in quantity and really laid the basis for the modern family of machine tools. By 1840 these tools were fairly well established as productive machines for industrial use. Their objective is two-fold?namely: to provide much greater power than man himself can furnish to form and shape certain of his materials of construction; and to give him skill and precision in this work which man alone cannot provide.

Classification of Machine Tools

Classification	Process	Machine tool
Cutting	Turning	Lathe
	Drilling and boring	Drill press, boring machine
	Milling	Milling machine
	Planing	Plane;
	Shaping	Shaper
	Slotting	Slotter
	Sawing	Power hack saw, band saw, circular saw
	Broaching	Broaching machine
	Filing	Filing machine
	Generatina	Hobbing machine, gear generator
Shearing . .	Shearing	Power shear, rotary shear
	Punching	Punch press, nibbler
Abrading .	Grinding	Grinder
	Honing	Honing machine
	Lapping	Lapping machine
	Polishing and buffing	Polishing machine, buffing machine
	Abrasive blasting	Sandblast, shot blast, liquid blast
	Tumbling	Tumbler, tumbling barrel
Forming (impact, bending. squeezing and pressing) . . .	Forging and upsetting	Forging press, drop hammer, forging hammer, forging machine, die-rolling mill, header. upsetter. explosion forging
	Swaging	Swaging machine
	Hammering	Power hammer, hammering machine
	Bending and forming	Roll bender, press brake, roll forming mill
	Stamping and deep drawing (punching, bending, forming, shallow drawing, swaging, coining. shaving and trimming)	Stamping press, punch press, drawing press
	Extrudinr	Extruding press, impact press
Other metal-removing processes . . .	Flame cutting	
	Spark disintegration	
	Ultrasonic grinding	
	Electrochemical disintegration	
	Chemical milling	

The basic machine tools are the lathe (*q.v.*), milling machines, drilling machines, broaching machines, sawing machines, shapers and planers, gear-cutting and metal-forming machines.

Milling Machines.—This class of machines employs a cutting process in which rotary cutters with multiple teeth are used. Flat or formed surfaces usually are produced. Diesinking (*q.v.*) is a milling process involving formed end mills for producing contour surfaces. The cut of each tooth is not continuous but intermittent on the feeding side of the cutter. In general, the cutter, mounted on an arbor fitted into the end of the spindle (a face mill is attached to the end of the spindle), rotates to provide cutting speed, while the work, mounted on the table, is fed into or past the cutter. The commonest operation is plain milling, using a cylindrical or circular section cutter, of the profile or formed type, with teeth on its periphery; side or face milling employs a cutter with teeth

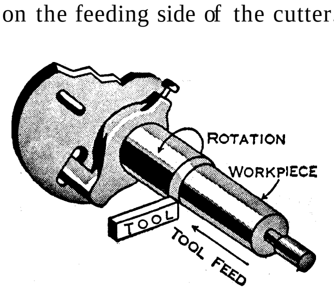


FIG. 1.—BASIC MACHINE-TOOL OPERATIONS: TURNING

projecting from its end, while end milling is a combination of plain and face milling. Milling cutters can be made in a variety of shapes for specific operations.

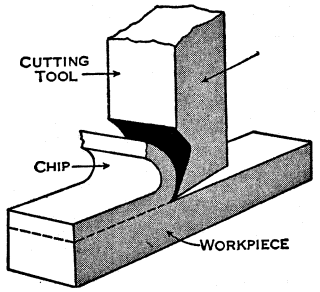


FIG. 2.—BASIC MACHINE-TOOL OPERATIONS: PLANING

Milling machines differ widely in construction and use. A classification may be based on general appearance (column-and-knee or fixed-bed type) or design (plain or universal; bench or floor mounting; horizontal or vertical spindle; hand, mechanical [lead screw] or hydraulic feed) or on the type of work handled (job shop or manufacturing; thread milling and planetary milling; diesinking).

Historically, milling is supposed to have originated in the 16th century; the cutter employed resembled a circular saw or rotary file with a large number of cutting edges spaced about its periphery. The first successful milling machine was built by Eli Whitney prior to 1818. Simeon North also used a plain miller in 1820 in the manufacture of firearms. The first universal knee-type miller is believed to have been built in Windsor, Vt., in 1852. In 1855, a fixed-bed or manufacturing type of miller was built by G. S. Lincoln in Hartford, Conn. This used the screw-and-nut table feed instead of the rack and pinion previously common. In 1862, the first fully universal milling machine, equipped with a universal dividing head, was built by J. R. Brown and used for cutting helical flutes in twist drills.

In 1906 the feed mechanism was driven from the single pulley drive shaft (making it possible to express the feed in inches per minute) rather than from the spindle (which gives inches per revolution of the spindle); in other words, it was possible to achieve constant feed per tooth of the cutter for all spindle speeds. The feed in inches per minute is the product of the feed per tooth, the number of teeth in the cutter and the rotational speed of the cutter.

The column-and-knee milling machine is used for general work in small quantity production. A rigid vise rests on the table for holding the work. In the plain type machine three motions of the table are possible (longitudinal, transverse and vertical), while the universal type, having a swivel table, permits a rotational motion. The spindles fixed in the head of the column, either vertically or horizontally, having only a rotating motion. The spindle of the vertical machine may be fixed in the head of the column or provided with a quill to permit the spindle being fed vertically by hand or power. Hand millers are usually small for light work, of the column-and-knee type. The table is fed longitudinally by hand.

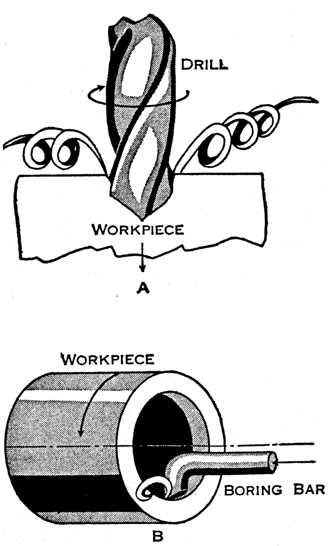


FIG. 3.—BASIC MACHINE-TOOL OPERATIONS: (A) DRILLING AND (B) BORING

The fixed-bed, or manufacturing, millers, offer rigid construction and simple operation for production of relatively small parts. The spindlehead is adjustable vertically on the column, and the table has only longitudinal feed. Large machines of this general type are called planer millers. Rotary millers are usually of the vertical spindle type. Their table is provided with fixtures and they are used for mass production in which the cutting is continuous, that is. there is no idle machine time, as the operator loads the fixture in front of the cutter and removes the finished parts prior to loading the next piece. Thread-milling machines are designed to cut threads and worms using form-milling cutters rather than single-point tools.

The horizontal boring, drilling and milling machine is provided with a horizontal spindle which is adjustable on the column and may be fed both longitudinally and vertically. The table on which the work is clamped may be fed longitudinally and transversely, or the machine may be provided with a rotary table. An almost unlimited variety of operations of boring, drilling, threading and milling may be performed on such a machine.

Drilling Machines.—A drilling machine, or drill press, is designed to hold a drill or other end-cutting tool in a spindle rotated and fed by power. The size of most drill presses is expressed by the diameter in inches of a disk the centre of which can be drilled.

Drilling machines are made in many different types and sizes, each designed to handle a class of work or specific job to the best advantage. The classification is based on design or construction, purpose and application of power. Portable drills are made in many types and sizes, sometimes mounted on a post bracket in garages or small job shops for use as fixed, single-spindle drill presses. Most have a self-contained electric-motor drive but the vertical movement of the drill is done by hand. Upright drilling machines, of the single-spindle type, for floor mounting, are general purpose machines. They are provided with a wide range of spindle speeds and feeds, and a table, vertically adjustable on the column, on which the work is supported. Tools such as drills, reamers, taps, counterbores, in interchangeable quick-change holders, may be used successively to finish holes in a part. In production, upright drilling machines are often mounted in gangs of two to eight, on a common base, so that successive operations may be performed on a part as it is passed from one spindle to the next. A multiple-spindle vertical drilling machine may have a fixed number of spindles, radially adjustable in a head so that all holes in one face of a part produced in small lots may be drilled simultaneously. Other multiple-spindle drill presses for mass production have the spindles built on fixed centres into the head for a given job. If the job is changed the head must be replaced. The radial drilling machine carries a spindle in a head mounted on a horizontal arm, the arm in turn being vertically adjustable on a column about which it swivels. The head may be moved radially on the arm, and the spindle moved vertically in the head, by hand or power feed. Radial drills are employed for general utility work, particularly on large castings and weldments. They are rigidly constructed and are provided with a wide range of speeds and power feeds, and they may be used to drive drills from one-eighth to three or four inches in diameter, as well as large boring tools, taps, etc.

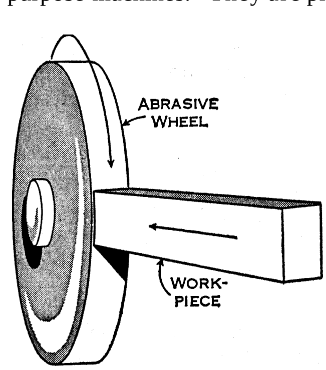
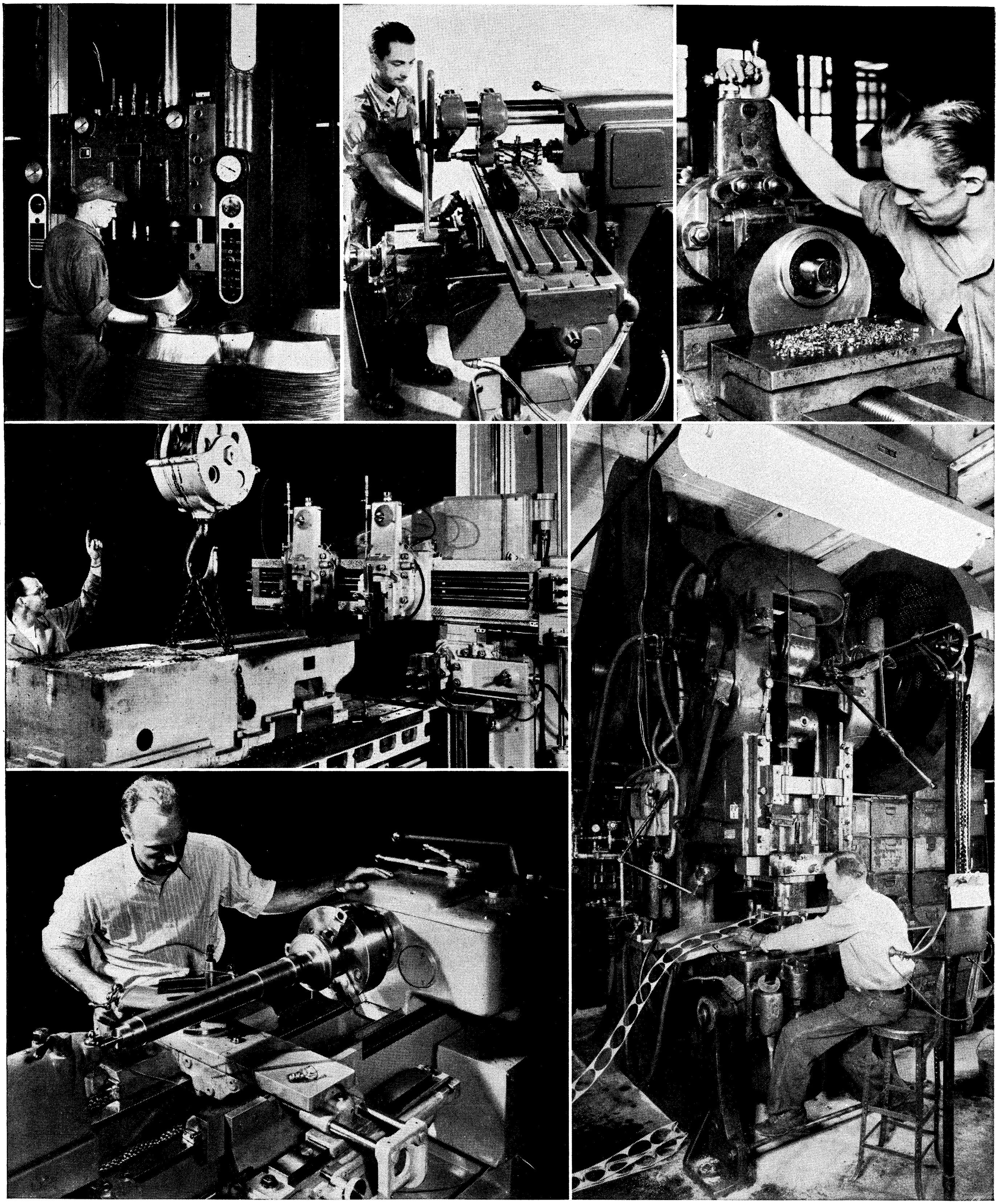


FIG. 4.—BASIC MACHINE-TOOL OPERATIONS: GRINDING

A deep-hole drilling machine, with one or two horizontal spindles, is used for such work as drilling gun barrels. The barrel is rotated at high speed while a single-lipped, sintered-carbide-tipped drill, provided with a high-pressure system for applying cutting oil at the drill point, is fed into the work. For short work, such as drilling oil holes in connecting rods from the crankpin to the wrist-pin hole, vertical, multiple-spindle machines operating on the same principle are used.

Way drilling machines for mass production of parts are built for each job and may consist of several multiple-spindle heads carrying drills, reamers, boring tools and even milling or threading tools operating simultaneously on one or several faces of the work. These are built in horizontal, vertical and a combined form. The transfer machine is an outgrowth of the way drill and represents the ultimate production tool. A complicated part such as a cylinder block is carried on a transfer bar from one machine to the next while it is machined on all surfaces successively and then discharged at the end, finished and inspected. All clamping and transfer is automatic.



BY COURTESY OF NATIONAL MACHINE TOOL BUILDERS' ASSOCIATION

POWER PRESSES, MILLING MACHINE, SHAPER, PLANER AND LATHE

Top left: A 150-ton hydraulic press drawing dishpans, three at a time, from blanked steel

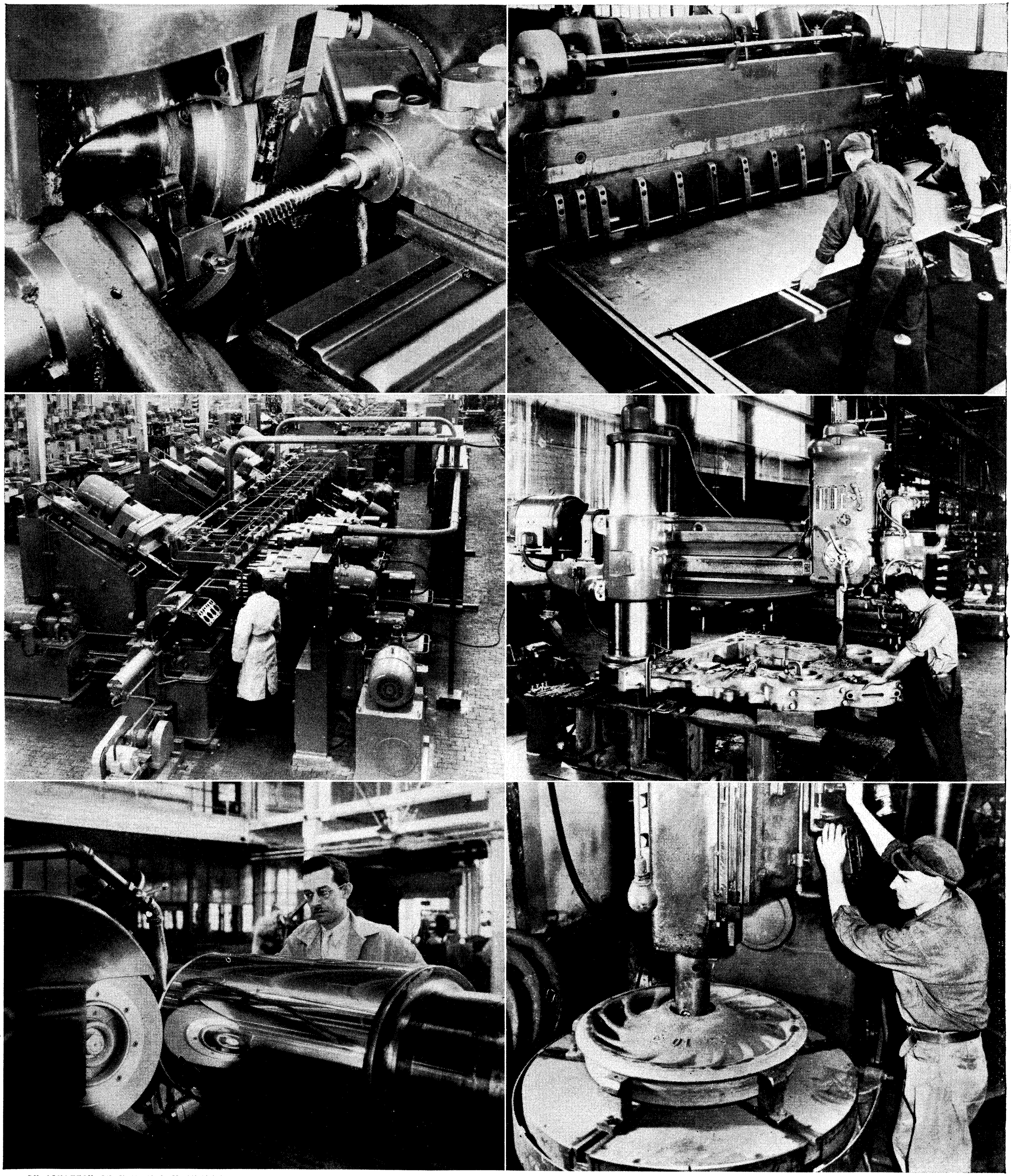
Top centre: Gang milling top, sides and slot in a block of metal on a knee-type miller

Top right: Cutting an internal slot (keyway) on a shaper

Centre left: Operator removing work piece from an openside planer after machining the horizontal surfaces

Right: Mechanical punch press producing circular blanks from strip metal

Bottom left: Geared-head engine lathe machining a spindle



BY COURTESY OF NATIONAL MACHINE TOOL BUILDERS' ASSOCIATION

GRINDERS, SHEAR, TRANSFER MACHINE, RADIAL DRILL PRESS, BORING MILL

Top left: Grinding a worm for a washing machine with a formed wheel on a thread grinder
Top right: Large shear cutting metal sheets
Centre left: Automatic transfer machine performing 19 operations per block on 120 engine blocks per hour
Centre right: Radial drill press drilling holes in a printing press frame
Bottom left: Cylindrical grinder finishing a roll for a rolling mill
Bottom right: Vertical boring mill boring a railway-car wheel

Boring machines, capable of drilling or boring, are made in a variety of types and sizes for specific jobs. Precision boring for mass production of relatively small parts, such as piston-pin holes, employs one or more horizontal spindles which carry single-point tools with diamond or sintered-carbide tips. These tools operate at very high speeds to finish the previously drilled holes in such parts as bushings and aluminum pistons to great accuracy and smooth finish. The jig borer is used to drill, bore or finish holes within very close limits in such work as drilling jigs, multiple drilling-head parts and dies which are accurately spaced. They drill, bore or ream as required.

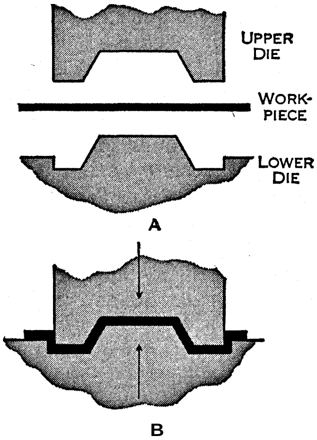


FIG. 5.— BASIC MACHINE-TOOL OPERATIONS: PRESSING

Broaching Machines.— These machines finish surfaces by drawing or pushing one or more cutters, called broaches, entirely past the surface. The broaches have a series of cutting teeth, increasing in height from the leading end. The first teeth are low to permit the broach to enter the hole (in internal broaching), or to pass over the surface (in external broaching), to catch any unforeseen high spots. The first few roughing and intermediate teeth remove most of the metal, the last few, taking lighter cuts, finish the hole or surface to size. Broaching machines may be horizontal or vertical. The broach may be pulled or pushed, or, in some cases, work is held in fixtures on a chain belt which moves past stationary broaches. Most machines are operated hydraulically.

Many broaching operations are completed in the time ordinarily taken to clamp the piece. Broaching is superior to reaming because the broach will hold its size for a much longer time, thus insuring greater accuracy. Other advantages are the good finish, great speed of production, interchangeability of mork and adaptability of the broach to produce irregularly shaped holes or forms,. such as splines. The broach will machine many more pieces before regrinding than any other type of cutter, because of the great number of teeth. Each tooth removes but a few thousandths of an inch of metal because the total depth of cut is proportioned over the total number of teeth.

Sawing Machines.— Saws for parting metals consist of thin disks of metal with cutting teeth on the periphery, or a band of metal with teeth formed on one edge. To eliminate binding between the cut surfaces and the side of the saw, either the teeth are "set'! (bent alternately to each side) or the blade below the edge of the cutting teeth is hollow-ground. The width of the groove cut by the saw blade is called the kerf.

Three types of metal-sawing machines in common use are: the hack saw, band saw and circular saw. The power hack saw has a short, straight blade, which is mounted under tension in a frame and reciprocated over the work in a straight line. The teeth are forced against the work on the cutting stroke by gravity, spring pressure, hydraulic pressure or positive screw feed but lifted on the return stroke to prevent the dragging of the cutting teeth over the work. The reciprocation on small machines is by crank and connecting rod. On some of the larger machines this is done by crank or hydraulically.

The smallest machine of the reciprocating blade type is known as the jig saw. The blade, clamped at its lower end, moves vertically through an opening in a horizontal table. Some machines of this type have holders to support the upper end of a file, used instead of a saw, so as to finish outlines smoothly after sawing. A honing stone, or lap, is also used sometimes for finishing the faces of hardened dies.

The power hack saw has a vise under the saw for clamping the mork. The small machines will take work up to 4 in. square in section and the largest up to 14 in. The small, inexpensive machines have but one reciprocating speed of about 80 strokes per minute. The larger machines usually have three speeds ranging from 50 to 150 strokes per minute. The length of the stroke is six inches in most cases. The small machine uses blades from 12 to 18 in, in length while the largest machine uses blades up to 24 in. Blades have from 4 to 18 teeth per inch, the coarse teeth are used for large, solid work, and the finer teeth for tubes, sheets and small bars.

Band saws employ a long, endless strip of steel with teeth on one edge. carried over two large diameter rotating wheels. This blade passes down through a table on which the work is mounted and fed by hand or screw into the saw. A guide to prevent saw deflection is adjustable just over the work. The machines vary in size with bands from $\frac{1}{4}$ in. to 18 in. in width. Power is applied to the lower wheel and the sawing action is continuous.

Circular saws have disk-shaped blades that may be classified in three groups: cold sawing, abrasive disk and high-speed friction disk. Cold sawing is a milling operation using thin metal-slitting saws of any desired diameter and the correct number of teeth and tooth shape for any metal. Standard milling machines are used with light cuts per tooth and conventional cutting speeds of 50–150 ft. per minute (f.p.m.) with high-speed steel cutters on hard to soft steel, or 400–1,000 f.p.m. for brass and aluminum. For large cold saws, 12–72 in. in diameter, special machines are constructed. These machines may be used to cut a bundle of bars or one large bar at a time, held rigidly in a vise. Abrasive disks made of silicon carbide, for cast iron and nonferrous metals, or aluminum oxide, for steel, are produced in wheels from $\frac{1}{16}$ to $\frac{1}{8}$ in. thick and up to 14 in. in diameter. These wheels are particularly effective on hard, abrasive material, and may be run safely at 12,000–16,000 f.p.m. They are interchangeable with steel-friction saws.

Steel-friction disks are carefully balanced and hollow-ground, usually with teeth hobbed or notched in the edge. These saws range up to 60 in. in diameter and $\frac{3}{8}$ in. in thickness and are run at peripheral speeds of 18,000–20,000 f.p.m. This speed and the pressure against the work melts the metal and carries it away. Hot or cold bars may be parted. Rails, channels, etc., from rolling mills can be cut to length in a matter of seconds.

Shapers and Planers.— The shaper was developed to machine flat surfaces on small work. The tool is held in a holder, supported on a clapper, in the head at the forward end of a ram. The ram reciprocates in a straight line while the table, carrying the vise and nork, feeds transversely on each return stroke. The clapper which carries the tool post is hinged near its top. On the cutting stroke the tool forces the clapper against its rigid seat; on the return stroke it swings outward about its hinge, as the tool is dragged back over the work, thereby relieving the cutting edge of excessive wear and reducing danger of chipping. Automatic tool lifting on the return stroke often is provided to protect the cutting edge of the tool. Tool lifting is accomplished by electromagnets. a flexible linkage or hydraulically. When carbide tools are used, tool lifting is essential to prevent chipping.

Shapers may be classified as horizontal or vertical (slotters), according to whether the ram operates horizontally or vertically; or they may be classed as plain or utility shapers for general light work and standard. heavy-duty and production shapers. Most modern shapers are driven by self-contained motors and the table has both rapid traverse and power feed. horizontally and vertically.

The planer was developed to machine flat surfaces on small or large work, too large for the shaper. The work to be machined is held in a vise or fixture bolted to the table, or may be clamped directly to the table. The table is reciprocated past the cutting tools as the tools are fed horizontally. vertically or at an angle for each stroke. The tools are held in a clapper box on a swiveling head carried on a saddle mounted on a horizontal rail. The head is fed horizontallv on the rail. Sometimes two heads are provided on the rail and a

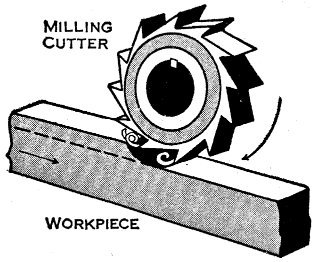


FIG. 6.—BASIC MACHINE-TOOL OPERATIONS: MILLING

third is mounted on the face of the housing. Large planers may take work 6–8 ft. in section and up to 30–40 ft. in length.

The table is driven through a rack on the underside of the table, or hydraulically. The table travel is reversed mechanically when belt drive or nonreversing motor drive is used but frequently the larger planers are driven by reversing motors. The length and position of stroke is adjustable. Cutting speeds up to 100 f.p.m. are obtainable, with table reversing speeds up to 200 f.p.m.

Gear-Cutting Machines.—There are six types of gear-cutting machines. For a composite tooth form a standard knee-type miller with dividing head is used for jobbing work. For large quantities of these gears a special production miller is used which automatically repositions the gear blank after each tooth is cut. The cutter has the approximate shape of the generated space between two teeth. This process is nongenerating and requires eight form cutters for each pitch for all gear teeth. The gear planer uses a cutter in the form of a short rack which cuts on its end as it is reciprocated across the face of the gear blank while the gear blank rolls with it, similar to a gear meshing with a rack. The gear shaper uses a disk-type cutter of the shape of a finished gear. It cuts on its end while reciprocated across the face of the blank as the two are rolled in unison. The gear-hobbing machine uses a cutter or hob consisting of a series of rack teeth arranged in a helix around the periphery of a cylinder. As the hob rotates continuously in unison with the blank to provide the generating action, it is fed across the face of the blank. The teeth of straight-tooth bevel gears are generated but, because of the tapered form, a special type of machine is needed to cause the single-tooth cutters of the rack shape to reciprocate along the cone of the pitch surface. Lastly, the spiral-bevel or hypoid-gear generator uses a cutter with single teeth of rack shape, arranged in a circle on the end of a disk, somewhat like those of a face mill. As the cutter is fed into the proper depth, it is rolled with the bevel-type gear blank to create the generating motion.

For precision gears, tooth profiles may be refinished, particularly after hardening, by special grinding or lapping machines, or by shaving. The gear-shaving machine runs the cutter and work-gear together under pressure with their axes slightly crossed, similar to the arrangement for lapping. The cutter of hardened steel is provided with multiple radial slots to form cutting edges on the tooth face. These have a side-sliding motion on the gear tooth to remove thin chips. (See also GEARS.)

Metal-Forming Machine Tools.—This large class includes machines used to shear, bend, draw, squeeze, coin, upset, swage, circle-cut, flange, forge, press, hammer. horn and wire. In all these machines a movable ram works against an anvil. Power to the ram may be furnished by gravity; mechanically by a crank, cam, toggle or knuckle joint; or through hydraulic or pneumatic systems. The machines may have one, two or three rams on moving slides. The two-ram machine may blank and draw a part, the three-ram may blank with one ram, hold with the second and form with the third. Dies, usually made in mating pairs, are an integral part of the equipment. One member of the pair is mounted on the fixed bed, or platen, of the press, and the other is attached to the lower end of the moving ram.

Flat sheets or plate stock are cut by squaring shears using a shearing action developed between a pair of straight cutting blades. The shearing action, called blanking, is employed also to cut a variety of shapes from a flat sheet. The press brake, similar to the shear, is equipped with either punching dies or bending dies to form edges.

Power presses are made in a large variety of types and sizes. some weighing nearly 1,000,000 lb. The dies used in stamping presses may also be very complicated. Cutting dies are made either plain, for one operation of punching or blanking; progressive, for performing successive operations; compound, to pierce and blank; multiple, and combination, to cut and shape. Shaping dies may be classified as bending, curling, drawing or compression dies.

Presses are made automatic and safe in operation by feeding strip metal from rolls to the dies and removing the scrap from the dies. Some presses are combined to pass the parts automatically from one to another for a series of operations.

Forging machines are also made in several types, some vertical. some horizontal. They range from the small upsetting machine which makes balls, screw blanks, springs, etc., from wire, to the large steam forging hammer for making drop forgings in dies and the large hydraulic presses which forge parts weighing tons.

Metal Removal by Nonmachining Processes.—Chemical milling is a process of shaping metal by dissolving off the unwanted material in an appropriate solution, acid or alkali, controlled to remove metal from unmasked areas at a rate of about 0.001 in. per minute. This method, developed in the aircraft industry, permits over-all reductions on complex shapes and light removals on thin sheet.

Electrical discharge machining consists in directing a series of very high-frequency spark discharges from a soft metal tool, operating as an electrode, to disintegrate hard materials and to form the cavities of dies. Holes of almost any shape can be made to close tolerances. The spark discharge passes through the space between the tool and work, about 0.001 in., which is filled with dielectric liquid, and vaporizes a small portion of the work piece as the electrode advances.

Electrolytic machining is used for sharpening tools, surfacing, forming and diemaking. Metal removal is accomplished by passing a high current of low voltage from an electrode to the work through an electrolyte. As the metal-bonded abrasive wheel. usually faced with diamonds, moves across the work, minute particles of the work are removed by the current in a "reverse-plating" operation.

Ultrasonic machining employs a flat tool of soft metal, vibrating at a frequency of about 20,000 cycles per second, with an amplitude of from .001–.003 in. A liquid carrying a fine abrasive, such as boron carbide, flows between the tool and works and acts as a crushing medium. Impressions may be sunk by this method in glass and very hard metals.

Electron beam cutting employs a very high-voltage beam similar to that of the X-ray. By means of a magnetic field, the beam is focused to produce a series of very small holes to trace out the shape desired. Small sections can be removed from thin stock in this way.

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MACH NUMBER, named for the Austrian scientist Ernst Mach (*q.v.*), is the ratio of a flow velocity to a velocity of sound (see SOUND: *Analysis* of Sound Propagation.) The speed of sound varies with temperature, and thus with altitude, but at sea level is approximately 760 m.p.h. The most commonly used Mach number is the "free-stream Mach number" defined for the flow about a body immersed in a uniform free stream. This number is the ratio of the uniform velocity in the free stream to the sound speed there. It is the same as the "flight Mach number," the ratio of the velocity of a vehicle flying in an atmosphere to the sound speed in the atmosphere. The free-stream Mach number is the most important parameter characterizing the flow field and aerodynamic forces. A flow is termed "incompressible" if this number is negligibly small; "subsonic" if it is not small but significantly less than one, as 0.80; "transonic" if it is approximately one; "supersonic" if it is significantly greater than one, as 1.75; and "hypersonic" if it is much greater than one.

The "local Mach number" is the ratio of the local flow velocity in a steady flow of a gas to the local sound speed. If this number is less than one the partial differential equations governing the flow field are locally of elliptic type. If this number is greater than one the equations are locally of hyperbolic type. If the flow is sufficiently close to a uniform flow, the local Mach number may be approximated at each point by the constant free-stream Mach number, and the differential equations of motion by linear ones. (W. D. Hs.)

MACHYNLLETH, an urban district and market town in the Montgomeryshire parliamentary division of Wales, 10 mi. E.N.E. of Aberdovey and the coast and 40 mi. W.N.W. of Montgomery by road. Pop. (1951) 1,875. Area 1.8 sq.mi. Lying in the Dyfi

(Dovey) valley on the threshold of mountainous country, it is a centre for anglers and for tourists.

In 1291 a charter was obtained which established the Wednesday market and the two annual fairs. Owain Glyndwr (Owen Glendower) held a parliament at Machynlleth in 1403, allegedly in a house (now the town institute) opposite Plas Machynlleth, a manor with a spacious park given to the town by Lord Londonderry. The woollen and tanning industries flourished in the 19th century.

MACÍAS (o NAMORADO) (fl. 1360–1390), Galician *trovador,* represented by five poems in the *Cancionero de Baena.* According to tradition Macias was enamoured of a great lady and murdered by her jealous husband.

His legend became a favourite subject with Spanish writers. inspiring—among others—Lope de Vega in *Porfiar hasta morir* and Larra in *Macías.*

See H. A. Rennert, *Macias, o Namorado; a Galician Trobador* (Philadelphia, 1900).

McINTIRE, SAMUEL (1757–1811), U.S. architect and craftsman, known as "the architect of Salem," was born in Jan. 1757 in Salem, Mass. One of a family of substantial housewrights, he was at 23 already working for his chief patron, the merchant Elias Hasket Derby. The solid foursquare house he created for Jerathmeel Peirce, with details derived from an English handbook, Batty Langley's *Treasury of Designs* (1740), was one of the finest houses of New England in the post-Revolutionary period. His academic style was exemplified in the Salem court house (1785; demolished 1839) and culminated in a competitive design of 1792 for the Capitol in Washington, based on plates in James Gibbs's *Book of Architecture* (1728). Charles Bulfinch meanwhile had introduced to New England the style of Robert Adam, with its attenuated proportions, its classic ornaments often cast in composition and its greater variety of forms of space, with rooms oval and circular. McIntire studied Bulfinch's first houses, and from 1793 he adopted their style and carved many of their chief ornaments. Bulfinch made the first designs and McIntire the final ones: for the lavishly decorated Derby mansion begun in 1794 (destroyed in 1815). In numerous houses McIntire placed his stamp on the town in the prosperous early years of the 19th century.

His carvings included busts, reliefs and the decorations of ships and furniture. Sofas, chairs and other pieces he carved with his typical eagles, baskets of fruit, draperies and pendants of the greatest delicacy. Over 100 pieces survive, constituting the most impressive body of U.S. furniture of the Sheraton style. Works of this modest craftsman and sober citizen: who never traveled more than a few miles from his native town, adorn the leading U.S. art museums.

McIntire died in Salem on Feb. 6, 1811.

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MACINTOSH, CHARLES (1766–1843), F.R.S., 1823, Scottish chemist, was born on Dec. 29, 1766, at Glasgow. His experiments with one of the by-products of tar, naphtha, led to his invention of the waterproof fabrics which bear his name, the essence of his patent being the cementing of two thicknesses of india rubber together by means of naphtha. Macintosh was also responsible for important improvements in the manufacture of dyes, bleaching powder and steel. He died July 5, 1843.

See George Macintosh, *Memoir of C. Macintosh* (1847).

MAÇIP (MASIP), **VICENTE JUAN** (also called JUAN DE JUANES or JOANES) (?1523 or earlier–1579), Spanish artist, one of the chief Valencian painters of the third quarter of the 16th century, was the son of another Valencian painter, Vicente Juan Maçip the elder. Most of his work was done in Valencia, and he died in nearby Bocairente on Dec. 21, 1579. He may have studied in Italy, since his style is largely a provincial adaptation of the manner of Leonardo da Vinci's folloners. with the addition of some Florentine motifs. But his paintings also display strong Flemish influence, and the Italian elements may hare been derived from the works of Italinizing Flemings, which abounded in Spain and which were probably also the source of Maçip's somewhat grotesque realism.

Almost all Maçip pictures are religious; the "Last Supper" and the scenes from the life of St. Stephen, in the Prado museum, Madrid. are among the best known, and he painted many versions of Christ as *Salvator Mundi.* (K. MN)

MACK, CONNIE (CORNELIUS MCGILLICUDDY) (1862–1956), U.S. baseball manager, the "grand old man" of major league baseball in the first half of the 20th century, managed the Philadelphia Xthletics from 1901 to 1950, during which period they non the American league pennant nine times and the world series five times (1910, 1911, 1913, 1929 and 1930). Born in East Brookfield. Mass., on Dec. 23, 1862, and christened Cornelius McGillicuddy, he shortened his name so that it would fit on a scoreboard. A catcher, Mack entered organized baseball nith his home town team in 1883, moving the next year to Meriden, Conn.. then to Hartford, Conn. (1885). With Washington, D.C. (1886–89), Buffalo, N.Y. (1890) and Pittsburgh (1891–96), he played 69j games with a lifetime batting average of .252.

Mack caught in 664 major league games and occasionally played first base or in the outfield. He was catcher-manager of the Milwaukee, Wis., club of the Western association from 1897 to 1901, and in 1901 became manager and part owner of the Xthletics and helped establish the American league *(see* BASEBALL: *Litter History).* He spent 65 years in baseball, retiring in 1951. He died in Philadelphia, Pa., on Feb. 8, 1956. (J. D. McC.)

MACKAY, CHARLES (1814–1889), Scottish writer, mas born at Perth on March 27, 1814. As editor of the Glasgow *Argus,* he made his reputation in 1846 with the publication of *Voices from the Crowd.* He wrote songs, including "Cheer Boys Cheer," some of which were set to music by Henry Russell and Sir Henry Bishop (published 1855). Also, he wrote *Memoirs of Extraordinary Public Delusions* (1841) and edited *A Thousand and One Gems of English Poetry* (186;).

Mackay died in London on Dec. 24, 1889. Marie Corelli (*q.v.*) was his daughter. His son, Eric Mackay (1851–99), wrote *Love Letters of a Violinist* (1886).

MACKAY, CLARENCE HUNGERFORD (1874–1938), U.S. capitalist and philanthropist, who as president of the Mackay system of telegraphs and cables directed the completion of the first trans-Pacific cable between the United States and the Far East in 1904, was born at San Francisco. Calif., on April 17, 1874.

The foundations for his career were laid by his father, John William Mackay (1831–1902), California and Nevada miner, born in Dublin! Ire., Nov. 28, 1531, whose parents brought him to New York in 1840. When he was 21 he sailed for California to try his luck in the gold fields. Working with pick and shovel in the Sierra Nevada mountains, and later in western Nevada, John Mackay learned mining engineering and geology through experience. In 1873, he and his partners, James C. Flood, William O'Brien and James G. Fair, discovered the Big Bonanza of the Comstock lode that yielded approximately $120,000,000 in the next five years. With James Gordon Bennett, Mackay organized the Commercial Cable company in 1883, succeeded in breaking the communications monopoly of the Western Union Telegraph company directed by Jay Gould and established the competing Postal Telegraph company.

In 1907, the company, of which Clarence Mackay had become president after his father's death, placed a cable in service between New York and Cuba and later established cable communication with southern Europe by way of the Azores and with northern Europe through Ireland. He was the first; in 1928, to combine radio, cables and telegraphs under one management.

As a patron of the arts and education: Mackay served as chairman of the board of the Philharmonic Symphony society of New York, trustee of the Metropolitan Museum of Art and director of the Metropolitan Opera company. In memory of his father, he and his mother presented the University of Nevada with the Mackay school of mines. This and a subsequent series of gifts to that university totalled more than $1,500,000.

Mackay was a member of the French Legion of Honour, and in 1931 Pope Pius XI made him a Knight of Malta, the highest

Catholic lay honour. He died in New York city Nov. 13.1938. (W. T. J.)

McKAY, DONALD (1810–1880), U.S. shipbuilder and naval architect. was the outstanding builder of clipper ships, and built the largest and fastest ships of that type.

Born Sept. 4. 1810, in Nova Scotia, he came to New York city, in 1827 and was apprenticed ship carpenter to Isaac Webb. His indenture completed he worked at this trade in New York and Newburyport, Mass. He established his own shipyard at East Boston. Mass., in 1845 and there designed and built the ships which gave him his reputation. His first clipper ship, the "Stag Hound," launched 1850. was followed by many others. His "Lightning" sailed 436 nautical miles in 24 hours. at times reaching a speed of 21 knots. His "Great Republic" registered 4,555 tons when completed and was the largest clipper ship built.

By 1855 the demand for these specialized ships mas over and McKay closed his yard. In 1863 he equipped the yard to build iron ships and built several vessels for the U.S. navy, one. the monitor "Nausett," but was not financially successful in this work. His last sailing ship, the "Glory of the Seas,' built in 1869 lasted until 1923.

McKay died at Hamilton, Mass., on Sept. 20. 1880. (M. R. D.)

MACKAY, HUGH (*c.* 1640–1692), Scottish general, mas born in Scourie. Sutherlandshire. He entered Douglas' (Dumbarton's) regiment of the English army (now the Royal Scots) in 1660,and accompanied it to France when it was lent by Charles II to Louis XIV. In 1669 he was in the Venetian service at Candia, and in 1672 he was back with his old regiment, taking part in the invasion of Holland. Convinced that he was fighting in an unjust cause, he resigned his commission to take a captaincy in a Scottish regiment in the Dutch service. In 16Sj he returned with the Scots brigade to England to assist in the suppression of the hlonmouth rebellion. He went back to Holland, and when the prince of Orange started on his expedition to England Mackay's division led the invading corps. As major general commanding in chief in Scotland. he was called upon to deal with the formidable insurrection headed by Graham of Claverhouse, Viscount Dundee. In the battle of Killiecrankie hlackay was severely defeated, but Dundee was killed, and the English commander subdued the Highlands in one summer. He was killed at the battle of Steinkirk. Mackay invented the ring bavonet.

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MACKAY, a seaport on the northeast coast of Queensland, Austr., 598 mi. north of Brisbane by rail. The city is situated on the Pioneer river, and the district is bounded by the Clarke and Leichhardt ranges. the highest peak is Mt. Dalrymple. 4.190 ft. Pop. (1954) 14,762. The climate, which is moderate generally, is very good during the main tourist season, from April to October. The average annual rainfall is jo in. The chief industry is the manufacture of sugar and others are dairying. sawmilling and the production of power alcohol. industrial methylated spirits and other sugar by-products. Large deposits of coal, so far undeveloped. are known to exist in the hinterland area, and copper mining is undertaken in a small way. Tropical fruits (bananas, pawpaws and pineapples) are grown.

Mackay has a deepwater, artificial harbour, about three miles north of the city. Mackay is serviced by daily air and rail links to north and south.

MacKAYE, PERCY (1875–1956), U.S. poet and dramatist, son of Steele MacKaye (*q.v.*), was born in New York city on March 16, 18;5. After graduating from Harvard in 1897, he traveled and studied abroad (1898–1900).

After his return to the United States, MacKaye lectured in schools and colleges and wrote *The Civic Theatre* (1912), advocating amateur community theatricals. The pageants he wrote encouraged community participation. They included *The Canterbury Pilgrims,* produced at Gloucester, Mass., in 1909, with a cast of 1.500,and *Masque of Saint Louis* (Thomas Wood Stevens, coauthor), performed in 1914 with 7,500 participants. In 1948 MacKaye received the Academy of Xmerican Poets fellowship award for his cycle of four plays. *The Mystery of Hamlet, King of Denmark* (1945). He died at Cornish. N.H.. on Aug. 31. 1956.

MacKaye's many works include, in poetry: *Poems* (collected, 1916). *Dogtown Common* (1921), *My Lady Dear, Arise!* (1940), *Intimations,* (1947): plays: *Jeanne d'Arc* (1906), *This Fine-Pretty World* (1924). *Tlze Sphinx* (1929), *What We Will* (1943); operas: *The Immigrants* (1915); masques: *Saint Louis* (1914), *Caliban* (1916). *Wakefield* (1932); essays: *Tlze Civic Theatre* (1912); folk stories: *The Gobbler of God* (1928). *Kentucky Mountain Fantasies* (1928); biography: *Epoch: the Life of Steele MacKaye* (1927), *William Butler Yeafs, A New Portrait* (1947).

MacKAYE, (JAMES MORRISON) STEELE (1842–1894), U.S. playwright, actor; theatre manager and inventor. a brilliant man of many talents who was. perhaps, the closest approximation to the Renaissance man produced by the United States in the 19th century. He was born in Buffalo. N.Y., June 6, 1842. In his youth he studied painting with Hunt, Inness and Troyon. A pupil of Delsarte and Regnier, he was the first American to act Hamlet in London (1873). At Harvard. Cornell and elsewhere, he lectured on the philosophy of aesthetics. In New York city he founded the St. James, Madison Square and Lyceum theatres.

MacKaye wrote 30 plays, including *Hazel Kirke* (performed many thousands of times). *Paul Kauvar, Money Mad,* etc.. acting in them in 17 different roles. He organizecl the first school of expression (which later became the American Academy of Dramatic Art) and originated "harmonic gymnastics;" initiated overhead lighting (1874); invented the first moving "double stage" (1879); and invented folding theatre seats. In all, he patented over roo theatrical inventions.

At the Chicago World's fair of 1892, MacKaye projected the world's largest theatre. his Spectatorium (seating 12.000, with 2j moving stages), revolutionizing stage production and anticipating motion pictures. Financial difficulties prevented completion of the theatre—the first production was to be *The World Finder,* a saga of Columbus. for which Dvorak composed his *New World Symphony*—but a scale model was later successfully demonstrated.

Though he is best remembered for *Hazel Kirke,* MacKaye's chief importance actually lies in the area of stage production and in his influence toward higher professional standards and ethics in the theatre. He died at Timpas, Colo., Feb. 2j. 1894

See Percy MacKaye, *Epoch: the Life of Steele MacKaye,* 2 vol. (1927). (S. W. H.)

MACKE, AUGUST (1887–1914), German painter. one of the leaders of the Blue Rider school. was born on Jan. 3, 1887, at Meschede. Westphalia. His youth was spent in Cologne and Bonn, and he studied art from 1904, at the Düsseldorf academy and later in Berlin with Lovis Corinth. He was influenced. particularly in his earlier work, by the older Impressionists. Cézanne, Matisse, Picasso and the Cubists. He also visited Paris, Holland and Italy. The period of his independent creation embraces the years 1909–14.

With Kandinsky, Jawlensky and Marc. Macke was one of the most important representatives of the Blue Rider group of painters from which Expressionism in Germany originated (*see* PAINTING: *Expressionism and the German School: Der Blaue Reiter*). His art combines the tradition of French painting, its sense of the grace of movement and atmosphere in landscape painting. with the cosmic sentiment of German art, without losing itself in the subtle and problematical. A journey to Tunis in the spring of 1914 inspired some of his most beautiful pictures.

Macke was killed in World War I at Perthes-les-Hurlus, Champagne. on Sept. 26. 1914.

McKEESPORT, a city in Allegheny county, southwestern Pennsylvania. U.S. Approximately 10 mi. S.E. of Pittsburgh's "golden triangle," the city was founded at the junction of the Monongahela and Youghiogheny rivers. The former has long been an important avenue for the movement of coal and steel, essential elements in the industrial complex of the Pittsburgh (*q.v.*) standard metropolitan statistical area, of which McKeesport is a part In the early 1960s about half of the community's working force was engaged in steel production.

The first settlement was made about 1755 by David McKee, who operated a ferry there, and the town was platted in 1795 by his son John It did not develop appreciably until the basic ingredients of the U.S. steel industry (coal, iron and railroads) had progressed in the late 19th century. Coal mining in the area began about 1830. The G. C Murphy chain of variety stores originated there in 1896. McKeesport was incorporated as a borough in 1842 and chartered as a city in 1890. It was a centre of dissident activity during the Whisky insurrection (*q.v.*) in 1794.

For comparative population figures see table in PENNSYLVANIA: *Population.* (P R J.)

McKEES ROCKS, a borough of Allegheny county. Pa. U S., on the Ohio river, 3 mi from downtown Pittsburgh (*q.v.*). Producing a variety of small iron and steel products, it is an integral part of Pittsburgh's industrial complex. As industry expanded. the population declined slowly from a peak of 18 116 in 1930 Through an extensive rebuilding program launched in 1954. McKees Rocks was among the first suburbs to share in Pittsburgh's renaissance.

The first permanent homes in the area were built near a 100-ft cliff overlooking the Ohio river, shortly after Pontiac's conspiracy of 1763 The cliff. later cut anay for a railroad bed, was the site of an Indian burial mound. The borough, which was incorporated in 1892, was named for the imposing rock formations along the river and for Alexander McKee, a pioneer settler For comparative population figures see table in PENNSYLVANIA: *Population.* (J A KE.)

McKENNA, REGINALD (1863–1943), British politician and financier, was born in London on July 6, 1863, and educated at King's college. He went up to Trinity Hall, Cambridge, as a scholar and graduated as senior optime in 1885. He also gained distinction as an oarsman, rowing in the university boat race in 1887. He was called to the bar in that year, and in 1895 was elected Liberal member for North Monmouthshire. When his party returned to power in Dec. 1905, he became financial secretary to the treasury. In 1907 he was promoted to the presidency of the Board of Education, but was no better able than his predecessor, Birrell, to draft a bill which would satisfy the Nonconformists and yet pass the House of Lords. His tenure of the office was brief, as, on Asquith's succeeding to the premiership in the spring of 1908, he was transferred to the Admiralty.

He entered on his new duties at a time when the country was profoundly stirred by the rapid increase of the German fleet, and was in doubt whether the preparations of the Admiralty aere on a sufficiently extensive scale. McKenna, supported by the prime minister and Edward Grey, persuaded his other colleagues to agree to the building of four battleships of dreadnought type in 1909, and to ask for power, if necessary, to prepare for the construction of four more a year later. This contingent program was also carried.

From the Admiralty McKenna went in the autumn of 1911 to the Home Office, and, as home secretary, had charge of the Welsh Disestablishment bill. In the first Coalition ministry in 1915 he was made chancellor of the exchequer, and a still more difficult task was imposed on him—to find the money to carry on the World War. By a $4\frac{1}{2}\%$ war loan a subscription of nearly £600,000,000 was obtained. In the autumn he introduced a supplementary war budget, providing for over £100,000,000 by new taxation. Income tax was raised 40%, and the abatement and exemption limits lowered; the rates of supertax were seriously heightened; all the old duties on sugar, tea, tobacco, cocoa, coffee, motor spirit and patent medicines were almost doubled; the import of luxuries such as motor cars. cinema films. clocks and musical instruments was restrained by an ad *valorem* duty of $33\frac{1}{3}\%$; and an excess profits tax of 50% was imposed. Other methods of financing the war which he adopted were war savings certificates, which realized over £40,000,000 in their first year; 5% exchequer bonds, replaced after a year for a short time by 6% exchequer bonds. but for current expenses he relied mainly on the sale of treasury bills. In his 1916 budget he raised taxation still further. Income tax was increased to 5s. in the £ and excess profits tax to 60%; there were further increases on sugar, cocoa and coffee; higher duties were imposed on motor vehicles; there were new taxes on amusements, railway tickets, matches and mineral waters.

McKenna went out of office with Asquith in Dec. 1916, and, in 1919, he accepted the chairmanship of the Midland Bank, Limited, a position he retained until his death Sept. 6, 1943, in London. He wrote *Post-War Banking Policy* (1928). (G. E. B.)

MACKENNAL, ALEXANDER (1835–1904), English Nonconformist divine, was born at Truro in Cornwall, on Jan. 14, 1835, the son of Patrick Mackennal, a Scot, who had settled in Cornwall. In 1848 the family removed to London, and at sixteen he went to Glasgow University. He entered the Congregational Ministry in 1856, and from 1877 to his death was pastor of the Congregational Church at Bowdon, Cheshire. In 1886 he was chairman of the Congregational Union. In 1892 Mackennal became associated with a movement for free church federation which grew out of a series of meetings held to discuss the question of home reunion. When the Lambeth articles put forward as a basis of union were discussed, it was evident that all the free churches were agreed in accepting the three articles dealing with the Bible, the Creed and the Sacraments as a basis of discussion, and were also agreed in rejecting the fourth article, which put the historic episcopate on the same level as the other three. Out of this grew the Free Church Federation, which secures a measure of co-operation between the Protestant Evangelical churches throughout England. Mackennal was a lifelong advocate of international peace, and made a remarkable declaration as to the Christian standard of national action when the Free Church Federation met at Leeds during the South African War in 1900. He died at Highgate, London, on June 23, 1904.

See D. Macfadyen, *Life and Letters of Alexander Mackennal* (1905).

MACKENSEN, A. L. F. AUGUST VON (1849–1945), German fieldmarshal, was born in Haus Leiptnitz, Saxony, on Dec. 6, 1849. Educated at Torgau and the University of Halle, he entered the Second Death's Head Hussars as a cadet in 1869. He saw service in the Franco-Prussian War, and in 1882 was promoted to the Great General Staff. He accompanied the German Emperor on his journey to Palestine. In 1908 he was given command of the XVII. Army Corps on the Vistula. At the outbreak of World War I he was placed in charge of the IX. Army on the Eastern Front, where he conducted successful operations against the Russians at Kutno, Łódź and Lowicz. In April 1915 he became leader of the German forces in western Galicia and was largely responsible for the German break-through at Gorlice. On June 20, 1915, he was made a fieldmarshal and in Aug. and Sept. of that year had further successes at Brest-Litovsk and Pinsk. In Oct. and Nov. 1916, as commander of the army sent against Serbia, he practically overran that country; and in 1916, with the composite army which invaded Rumania, he subjugated the Dobruja and by the middle of Jan. 1917 had to all intents and purposes occupied the country. At the Armistice, he was interned by the French at Neusatz, till Dec. 1919. He retired from the army in 1920 and was made a state counsellor in 1933. He died Nov. 8, 1945, at Celle, Germany.

See W. Renner, *Feldmarschall von Mackensen* (1915); M Luyken *Generalfeldmarschall von Mackensen, Von Bukarest bis Salonika* (1920).

MACKENZIE, SIR ALEXANDER (c. 1755–1820) Canadian explorer is believed to have been born nt Inverness. Scot. Emigrating to North America at an early age, he was for several years engaged in the fur trade at Fort Chippewyan, at the head of Lake Athabasca. His first journey (1789) was from Fort Chippewyan along the Great Slave Lake, and down the river which now bears his name to the Arctic Ocean; and his second, made in 1792 and 1793, from Fort Chippewyan across the Rocky Mountains to the Pacific coast near Cape Menzies.

Mackenzie died at Mulinearn, near Pitlochry, on March 11, 1820.

See his *Voyages on the River St. Lawrence and through the Continent of North America to the Frozen and Pacific Ocrans* (1801).

MACKENZIE, ALEXANDER (1822–1892), Canadian statesman, was born in Perthshire, Scotland, on Jan. 28, 1822. He emigrated to Canada in 1842, and later worked in Ontario as a stone-mason, later becoming a builder and contractor at Sarnia with his brother. In 1852 his interest in questions of reform led to his becoming the editor of the *Lambton Shield,* a local Liberal paper. In 1861 he became a member of the Canadian parliament, where he at once made his mark and was closely connected with the liberal leader, George Brown. He was elected for Lambton to the first Dominion house of commons in 1867, and soon became the leader of the liberal opposition; from 1871 to 1872 he also sat in the Ontario provincial assembly, and held the position of provincial treasurer. In 1873 on the defeat of Sir John Macdonald's ministry Mackenzie formed a new Government, taking the portfolio of public works and becoming the first liberal premier of Canada. He remained in power till 1878, when industrial depression enabled Macdonald to return to office on a protectionist programme. In 1875 Mackenzie paid a visit to Great Britain, and was received at Windsor by Queen Victoria; he declined knighthood. In 1880 he resigned the leadership of the opposition owing to failing health, but he retained a seat in parliament till his death at Toronto on April 17, 1892. While perhaps too cautious to be the ideal leader of a young and vigorous community, his grasp of detail, industry, and integrity won him the respect even of his opponents.

See W. Buckingham and the Hon. George W. Ross, *Alexander Mackenzie, His Life and Times* (Toronto, 1892); G. Stewart, *Canada under the Administration of the Earl of Dufferin* (Toronto, 1878).

MACKENZIE, SIR ALEXANDER CAMPBELL (1847–1935), British composer, son of an eminent Edinburgh violinist and conductor, was born on Aug. 22, 1847. Mackenzie studied at the Sondershausen conservatorium under Ulrich and Stein, and in 1861 entered the ducal orchestra as a violinist. At this time he made Liszt's acquaintance. On his return home he spent three years at the Royal Academy of Music. He took part in Chappell's quartette concerts, and started a set of classical concerts. He was appointed precentor of St. George's Church in 1870, and conductor of the Scottish vocal music association in 1873. The most important compositions of this period of Mackenzie's life were the Quartette in E flat for piano and strings, Op. 11, and an overture, *Cervantes,* which owed its first performance to the encouragement and help of von Biilow. On the advice of this great pianist, he settled in Florence in order to compose. The cantatas *The Bride* (Worcester, 1881) and *Jason* (Bristol, 1882) belong to this time, as well as his first opera, *Colomba* (1883), commissioned for the Carl Rosa Company. Mackenzie's second opera, *The Troubadour,* was produced by the same company in 1886; and his third dramatic work was *His Majesty,* an excellent comic opera (Savoy Theatre, 1897). In 1888 he succeeded Macfarren as principal of the Royal Academy of Music. This post he held until 1924, and the importance of his influence over the younger generation of English musicians was very great. From 1892 to 1899 Mackenzie conducted the Philharmonic Concerts, and was knighted in the year 1894. In the two "Scottish Rhapsodies" for orchestra, in the music to *The Little Minister,* and in a beautiful fantasia for pianoforte and orchestra on Scottish themes, he has seized the essential, not the accidental features of his native music.

Mackenzie's works include *The Rose of Sharon* (Norwich festival, 1884); three Scottish Rhapsodies: No. 1 (Glasgow, 1880); No. 2. "Burns" (Glasgow, 1881); No. 3, "Tam O'Shanter" (Int. Music Congress, London, 1911); the Pibroch suite for violin (Leeds, 1889). etc. *See* his *A Musician's Narrative* (1927)

MACKENZIE, EDWARD MONTAGUE COMPTON (1883–), British novelist, son of Edward Compton, was born at West Hartlepool on Jan. 17, 1883, and educated at St. Paul's school, London, and Magdalen college, Oxford. He saw a good deal of stage life before embarking on his literary career which began with *Poems* (1907) and a picturesque "period" novel, *The Passionate Elopement* (1911). *Kensington Rhymes* and the novel *Carnival* followed in 1912, and the long novel *Sinister Street* (2 vols., 1913–14) was characteristic of the quasi-autobiographical novels of childhood and youth which were then attracting some of the younger novelists. War experiences yielded *Extremes Meet* (1928) and other accounts of the secret service. His coloured style included picaresque action and humorous character study, and, in some of his best work, a sympathetic portrayal of religious sensibility. The last appeared in the trilogy *The Altar Steps* (1922), *The Parson's Progress* (1923) and *The Heavenly Ladder* (1924). Other works are *Guy and Pauline* (1915); *Sylvia Scarlett* (1918); *Coral* (1925); *The Windsor Tapestry* (1938); *All over the Place* (1949); and *Indian Epic* (1950).

MACKENZIE, SIR GEORGE (1636–1691), of Rosehaugh, Scottish lawyer, the grandson of Kenneth, first Lord Mackenzie of Kintail. He was born at Dundee in 1635, educated at the grammar school there, at Aberdeen, at St. Andrews and Bourges. He was called to the bar in 1659. He succeeded Sir John Nisbet as king's advocate in August 1677, and in the discharge of this officebecame implicated in all the worst acts of the Scottish administration of Charles II., earning for himself an unenviable distinction as "the bloody Mackenzie." His refusal to concur in the measures for dispensing with the penal laws against Catholics led to his removal from office in 1686, but he was reinstated in February 1688. At the Revolution, being a member of convention, he was one of the minority of five in the division on the forfeiture of the crown. King William was urged to declare him incapacitated for holding any public office, but refused. When the death of Dundee (July 1689) had finally destroyed the hopes of his party in Scotland, Mackenzie went to Oxford, where he did literary work. He died at Westminster on May 8, 1691.

While still a young man Sir George Mackenzie appears to have aspired to eminence in the domain of pure literature, his earliest publication having been *Aretina, or a Serious Romance* (anon., 1661); it was followed, also anonymously, by *Religio Stoici, a Short Discourse upon Several Divine and Moral Subjects* (1663); *A Moral Essay, preferring Solitude to Public Employment* (1665); and one or two other disquisitions of a similar nature. His most important legal works are entitled *A Discourse upon the Laws and Customs of Scotland in Matters Criminal* (1674); *Observations upon the Laws and Customs of Nations as to Precedency, with the Science of Heraldry* (1680); *Institutions of the Law of Scotland* (1684); and *Observations upon the Acts of Parliament* (1686); of these the last-named is the most important, the *Institutions* being completely overshadowed by the similar work of his great contemporary Stair. In his *Jus Regium: or the Just and Solid Foundations of Monarchy in general, and more especially of the Monarchy of Scotland, maintained* (1684), Mackenzie appears as an uncompromising advocate of the highest doctrines of prerogative. His *Vindication of the Government of Scotland during the reign of Charles II.* (1691) is valuable as a piece of contemporary history. The collected *Works* were published at Edinburgh (2 vols. fol.) in 1716–22; and *Memoirs of the Affairs of Scotland from the Restoration of King Charles II.,* from previously unpublished mss., in 1821.

See A. Lang, *Sir George Mackenzie of Rosehaugh* (1909).

MACKENZIE, HENRY (1745–1831), Scottish novelist and miscellaneous writer, the "Man of Feeling," born at Edinburgh, was educated at the high school and the university of his native town, and was then articled to George Inglis of Redhall, who was attorney for the crown in the management of exchequer business. In 1765 he was sent to London to prosecute his legal studies, and on his return to Edinburgh became partner with Inglis, whom he afterwards succeeded as attorney for the crown. His first and most famous work, *The Man of Feeling,* was published anonymously in 1771, and met with instant success. The "Man of Feeling" is a weak creature, dominated by a futile benevolence, who goes up to London and falls into the hands of people who exploit his innocence. One Eccles of Bath claimed the authorship of this book, bringing in support of his pretensions a ms. with many ingenious erasures. Mackenzie's name was then officially announced, but Eccles appears to have induced some people to believe in him. The first of his dramatic pieces, *The Prince of Tunis,* was produced in Edinburgh in 1773 with a certain measure of success. The others were failures. At Edinburgh Mackenzie belonged to a literary club, at the meetings of which papers in the manner of the *Spectator* were read. Mackenzie conducted two critical journals: *The Mirror* (1779–80) and *The Lounger* (1785–87). His critical work was good. He was the first critic to recognize the genius of Burns; he hailed the early works of Scott; and he was a faithful friend to many men of letters. His nickname, the "man of feeling," by no means represents the man of critical acumen and practical commonsense. *Waverley* was dedicated to him. No one now reads *The Man of Feeling,* but his commonplace book *Anecdotes and Egotisms of Henry Mackenzie* (edit. H. W. Thompson, 1928) is an interesting record.

Mackenzie was an ardent Tory, and wrote many tracts opposing the doctrines of the French Revolution. Most of these remained anonymous, but he acknowledged his *Review of the Principal Proceedings of the Parliament of 1784,* a defence of the policy of William Pitt, written at the desire of Henry Dundas. He was rewarded (1804) by the office of comptroller of the taxes for Scotland. In 1776 Mackenzie married Penuel, daughter of Sir Ludovick Grant of Grant. He was, in his later years, a notable figure in the social life of Edinburgh. He died on Jan. 14, 1831.

In 1807 *The Works* of *Henry Mackenzie* were published surreptitiously, and he then himself superintended the publication of his *Works* (8 vols. 1808).

See the *Prefatory Memoir,* by Sir Walter Scott, to an edition of his novels in Ballantyne's *Novelist's Library* (vol. v., 1823).

MACKENZIE, SIR MORELL (1837–1892), British physician, centre of a 19th-century *cause célèbre* over the death of the German emperor Frederick III (*q.v.*), was born at Leytonstone, Essex, on July 7, 1837. He studied at the London hospital, at Paris, Vienna and Budapest, where he learned the use of the newly invented laryngoscope under J. N. Czermak. In 1862 he took his degree and became a specialist in diseases of the throat. In 1863 he helped to found the Throat hospital in King street, Golden square, and became a leading authority.

In May 1887 Mackenzie was summoned to attend the German crown prince Frederick William, whose illness was difficult to diagnose. The summoning of the English specialist was attributed to the prince's wife, Victoria (called after his death the empress Frederick), but she was not responsible, still less, as stated in Germany, Queen Victoria. The German physicians who had attended the prince since the beginning of March had diagnosed his disease on May 18 as cancer of the throat; but Morell Mackenzie insisted (basing his opinion on a microscopic examination by R. Virchow of a portion of the tissue) that the disease was not demonstrably cancerous, that an operation for the extirpation of the larynx (planned for May 21) was unjustifiable, and that the growth might well be benign and therefore curable by other treatment. Mackenzie's opinion was followed; he was knighted in Sept. 1887 for his services, and decorated with the Grand Cross of the Hohenzollern Order. In November, however, it was ultimately admitted that the disease really was cancer; though Mackenzie, with very questionable judgment, more than hinted that it had become malignant since his first examination, in consequence of the irritating effect of the treatment by the German doctors. The crown prince became emperor, as Frederick III, on March 9, 1888, and died on June 15. A violent quarrel raged between Mackenzie and the German medical world. The German doctors published an account of the illness, *Die Krankheit Kaiser Friedrichs III* (1888), to which Mackenzie replied by a work entitled *The Fatal Illness of Frederick the Noble* (1888), the publication of which caused him to be censured by the Royal College of Surgeons. Mackenzie died on Feb. 3, 1892, leaving several books on laryngoscopy and diseases of the throat.

See R. S. Stevenson, *Morell Mackenzie: The Story of a Victorian Tragedy* (1946, 1947).

MACKENZIE, WILLIAM LYON (1795–1861), Canadian politician, was born near Dundee, Scotland, on March 12, 1795. In April 1820 he emigrated with his mother to Canada. There he became a general merchant, first at York, then at Dundas, and later at Queenston. The discontented condition of Upper Canada drew him into politics, and on May 18, 1824 he published at Queenston the first number of the *Colonial Advocate,* in which the ruling oligarchy was attacked with great asperity, and which roused great anger among the social and political set at York (Toronto), which was headed by John Beverley Robinson. In Nov. 1824 Mackenzie removed to Toronto, but he had little capital; his paper appeared irregularly, and was on the point of suspending publication when his office was attacked and his type thrown into the bay by a number of the supporters of his opponents. In an action against the chief rioters he was awarded £625 and costs, which enabled him to set up a much larger plant, and the *Colonial Advocate* ran till Nov. 4, 1834.

In 1828 he was elected member of parliament for York, but was expelled on the technical ground that he had published in his newspaper the proceedings of the house without authorization. Five times he was expelled and five times re-elected by his constituents, till at last the Government refused to issue a writ, and for three years York was without one of its representatives. In May 1832 he visited England, where he was well received by the colonial office. Largely as the result of his representations, many important reforms were ordered by Lord Goderich, afterwards earl of Ripon, the colonial secretary. While in England, he published *Sketches of Canada and the United States,* a statement of Canadian grievances. On his return in March 1834 he was elected mayor of Toronto. In Oct. 1834 he was elected member of parliament for York, and took his seat in Jan. 1835, the Reformers being now in the majority. A committee on grievances was appointed, and as chairman Mackenzie presented the admirable *Seventh Report on Grievances,* advocating responsible government.

In the general election of June 1836 the Tory party won a complete victory, Mackenzie and almost all the prominent Reformers being defeated at the polls. This totally unexpected defeat greatly embittered him. On July 4, 1836, he began the publication of the *Constitution,* which openly advocated a republican form of government. Later in the year he was appointed "agent and corresponding secretary" of the extreme wing of the Reform party. He was also in correspondence with Papineau and the other leaders of the Reformers in Lower Canada, who were already planning a rising. Early in Dec. 1837 Mackenzie gathered a mob of his followers at Gallows Hill, Toronto, with the intention of seizing the lieutenant-governor and setting up a provisional Government. The total failure of the revolt forced Mackenzie to fly to the United States with a price on his head. In the town of Buffalo he collected a disorderly rabble, who seized and fortified Navy island, in the river between the two countries, and for some weeks troubled the Canadian frontier. After the failure of this attempt he was put to the most pitiful shifts to make a living. In June 1839 he was tried in the United States for a breach of the neutrality laws, and sentenced to 18 months' imprisonment, of which he served over eleven. While in gaol at Rochester he published the *Carolina Almanac,* the tone of which may be judged from its references to "Victoria Guelph, the bloody queen of England," and to the cabinet as "Victoria Melbourne's bloody divan." He returned to Canada under the Amnesty Act 1849.

In 1851 he was elected to parliament for Haldimand, defeating George Brown. He at once allied himself with the Radicals (the "Clear Grits"), and became one of Brown's lieutenants. He was still miserably poor, but refused all offers to accept a government position. In 1858 he resigned his seat in the house, owing to incipient softening of the brain, of which he died on Aug. 29, 1861.

Turbulent, ungovernable, vain, often the dupe of schemers, Mackenzie united with much that was laughable not a little that was heroic. He could neither be bribed, bullied, nor cajoled. In 1832 he refused from Lord Goderich a position of great influence in Canada and an income of £1,500. He was a born agitator, and the evils against which he struggled were real and grave.

The *Life and Times* by his son-in-law, Charles Lindsey (Toronto, 2 vols., 1862), is moderate and fair, though tending to smooth over his anti-British gasconade while in the United States. An abridgment of this work was edited by G. G. S. Lindsey for the "Makers of Canada" series (1909). In *The Story of the Upper Canadian Rebellion* by J. C. Dent (2 vols., Toronto, 1885), a bitter attack is made on him, which drew a savage reply from another son-in-law, John King, K.C., called *The Other Side of the Story.* The best short account of his career is given by J. C. Dent in *The Canadian Portrait Gallery,* vol. ii. (Toronto, 1881). (W. L. G.)

MACKENZIE RIVER, a river of the Northwest Territories (*q.v.*), Canada, which discharges the waters of Great Slave lake into the Arctic ocean. Discovered and explored by Sir Alexander Mackenzie in 1789, it rises as the Finlay in north central British Columbia, flowing eastward to form the Peace (*q.v.*), which joins the discharge from Lake Athabasca as the Slave river and flows into Great Slave lake. From the Great Slave, the Mackenzie proper flows northwest for 1,100 mi. to empty into the Beaufort sea of the Arctic ocean near the Yukon border. The Mackenzie drains an area of 682,000 sq.mi., and is the longest river system in Canada. Ice-free from about the first week of June to the middle of October, the Mackenzie is navigable from its mouth to Great Slave lake. Connection with the railhead at Waterways, Alta., is made by way of the Slave and Athabasca (*q.v.*) rivers, with one 16-mi. portage from Fort Smith, N.W. Terr., to Fitzgerald, Alta. Boats also operate on the Liard river from Fort Nelson, B.C., to its junction with the Mackenzie at Fort Simpson and on the Peace from Peace River, Alta., to Fitzgerald except for the rapids near Fort Vermilion.

Settlements on the Mackenzie include Fort Providence, Wrigley, Fort Simpson, Fort Norman, Norman Wells, Fort Good Hope, Arctic Red River, Aklavik and Inuvik. Norman Wells is a petroleum centre, oil having been discovered there in 1920.

The mouth of the Mackenzie, a lake-strewn delta measuring 110 mi. in length and 40 mi. in width, is noted for its muskrat catch.

(J. R. M.)

MACKEREL, a common name for several genera of fishes of the family Scombridae (mackerels and tunas), which are swift, carnivorous fishes found in tropical and temperate seas, of fusiform shape, generally bluish above and silvery below, with small, thin scales, pointed head and rather large mouth. The spinous dorsal fin of slender spines that are depressible in a groove and the soft dorsal and anal fins are followed by a series of detached rays or finlets. The body ends with a slender caudal peduncle and widely forked caudal fin. The flesh is oily, generally red. These are energetic fishes in which the temperature is generally several degrees higher than that of the water.

The true mackerel genus *Scomber* includes about 10 species from tropical and temperate seas. *Scomber scombrus* is a valuable food fish found in the Mediterranean and on both sides of the north Atlantic; it reaches a length of about 18 in. It swims in large schools which approach the coasts in the spring; after spawning in the summer they return to the ocean. The air bladder is absent in *S. scombrus* but a small one is present in *S. colias,* termed Spanish mackerel in England and chub mackerel in America; this is a smaller and less valuable fish than the common mackerel and usually more southerly in its distribution. *S. japonicus,* the Pacific mackerel, which ranges from Alaska to Lower California, is an important commercial as well as an excellent game fish.

Scomberomorus and *Auxis* are important tropical genera, longer and more compressed than other Scombridae and with strong trenchant teeth. *Scomberomorus cavalla,* the king mackerel, one of the largest forms (recorded up to 100 lb.), is found from New England to Brazil. *Auxis thazard,* the frigate mackerel, ranges from Cape Cod to Puerto Rico and probably farther south.

McKIM, CHARLES FOLLEN (1847–1909), U.S. architect, who was of primary importance in the American neoclassical revival, was born in Chester county, Pa., on Aug. 24, 1847. The son of a relentless abolitionist, he was educated at Harvard and at the École des Beaux Arts and trained as a draftsman by H. H. Richardson while the latter was completing Trinity church, Boston. In 1879 he joined William Rutherford Mead and Stanford White to found McKim, Mead & White, perhaps the most successful and influential architectural firm in U.S. history. Until 1887 the firm excelled at informal summerhouses built of shingles, and McKim designed one of the most significant of these, the residence at Bristol, R.I., of W. G. Low (1887). In later years the firm was famous for championing the formal tradition of the Italian Renaissance and its classical antecedents. Among the celebrated examples of the formal planning of McKim are the Boston Public library (1887) and in New York the University club (1899), the Morgan library (1906) and the Pennsylvania station (1906–10). With D. H. Burnham and Richard Morris Hunt he charted the architectural program of the World's Columbian exposition at Chicago in 1893, which was classically inspired. He also aided Burnham in reviving Pierre L'Enfant's plan for Washington, D.C., and was the originator of the American Academy in Rome.

He died at St. James, Long Island, N.Y., on Sept. 14, 1909.

See Charles Moore, *Life and Times of Charles Follen McKim* (1920); Wayne Andrews, *Architecture, Ambition & Americans* (1955).

(W. As.)

MACKINAC, STRAITS OF, is the connection between Lakes Michigan and Huron. In their narrowest portion the straits are about 4 mi. wide but the straits area generally is considered as embracing a 30 mi.-long stretch of water which includes the passages between several islands in northwestern Lake Huron, Mackinac Island, within the straits, and an indefinitely defined portion of northeastern Lake Michigan. The straits, which provide a broad passage between the lakes, separates the lower and upper peninsulas of the state of Michigan. This natural barrier to land travel, which was traversed by state-operated ferryboats for many years, has been spanned by a bridge and two 20-in. submarine pipelines, carrying petroleum products from oil fields in the province of Alberta, across the straits from Pointe la Barbe on the north shore to McGulpin Point on the south shore.

Mackinac Bridge.—Extending from Mackinaw City, on the south side of the straits, to a point near St. Ignace, on the north side, the bridge with its approaches has an uninterrupted overwater length of 5 mi. and 44 ft. The main span is a suspension bridge with a total length of 8,344 ft. between cable anchorages. The centre span of the bridge, between towers, is 3,800 ft. long. A single deck carries four lanes of highway traffic and has a capacity of 6,000 cars per hour. The main towers are founded on bedrock more than 200 ft. below water level and extend 552 ft. above the water. The clearance under the centre span is 148 ft. above low-water datum (578.5 ft.). Built by the state of Michigan, with David B. Steinman as designer and supervisor of construction, the bridge cost $100,000,000. Construction began in July 1954, and the bridge was opened to traffic on Nov. 1, 1957.

See MACKINAC ISLAND; MICHIGAN, LAKE; HURON, LAKE.

(J. L. HH.)

MACKINAC ISLAND, a summer resort in Mackinac county, Mich., U.S., is located in the Straits of Mackinac, where the upper and lower peninsulas of Michigan nearly join. The island is 9 mi. in circumference and is covered with a thick growth of pine, cedar, birch and beech. After 1895 more than 80% of the area was operated as a state park by the Mackinac Island state park commission. It has a horse-and-buggy setting and automobiles are banned. The winter population of (1960) 942 is concentrated in the city on the south side.

The island was used by ancient Indians as a burial ground, and its name is a shortened form of the Indian Michilimackinac. Father Claude Dablon, a French Jesuit, wintered there in 1670 among the Huron Indians. During the American Revolution the British moved their fort from Mackinaw City to the island. Fort Mackinac was ceded to the Americans by the treaty of Paris in 1783, and during the War of 1812 a British landing party under Capt. Charles Roberts caught the U.S. garrison by surprise and forced its surrender. After the war the island was the centre of John Jacob Astor's fur-trading empire.

The fur trade declined in the 1830s and Mackinac, rich in historic lore and scenic attractions such as Arch rock, Skull cave, Devil's Kitchen and Sugar Loaf, was subsequently promoted as a resort centre.

Points of interest along Market street include the Astor house, the Edward Biddle house, and the Dr. William Beaumont memorial, which honours the U.S. army physician who began there in 1822 his famous experiments in digestion. Other buildings include the Grand hotel, built in 1887, and the Moral Rearmament association's world headquarters buildings. Two steamship ferry services operate from Mackinaw City and St. Ignace. (E. T. P.)

MACKINDER, SIR HALFORD JOHN (1861–1947), ranked for many years as Great Britain's outstanding geographer, but it was not until the events of World War II showed the wisdom of the forecasts he made from 1904 to 1919 that his name became widely known among students of political geography. He was born on Feb. 15, 1861 at Gainsborough, Lincolnshire. In Germany, Gen. Karl Haushofer twisted Mackinder's teachings for his own purposes in promoting his doctrine of *Geopolitik*. Mackinder's famous paper, "The Geographical Pivot of History" which he read before the Royal Geographical society in London in 1904 evaluated the age-old cleavages between the heartland and coastland, the regions accessible to horsemen and shipmen respectively, and the conflicts between their peoples, with Russia, the heartland power, at the centre of his deliberations. These thoughts were further developed after World War I in his book *Democratic Ideals and Reality* (1919). During World War II, in another classical exposé of political geography, *The Round World and the Winning of the Peace* (1942), he reiterated his concept of the heartland under the conditions of (pre-atomic and pre-guided missile) modern warfare.

It would be mistaken to consider Mackinder's contributions solely in the light of his heartland vision. His great achievement was to raise geography from the slough into which it had fallen in England. At Oxford university and later at the London School of Economics, he promoted the teaching of regional and world geography. From 1910 to 1922 he served as a member of parliament. (H. W. Wt.)

McKINLEY, WILLIAM (1843–1901), twenty-fifth president of the United States, was born in Niles, Trumbull county, O., on Jan. 29, 1843. His ancestors on the paternal side were Scotch-Irish who lived at Dervock, Co. Antrim, and spelled the family name "McKinlay." His great-great-grandfather settled in York county, Pa., about 1743, and from Chester county, Pa., his great-grandfather, David McKinley, who served as a private during the War of Independence, moved to Ohio in 1814. David's son James had gone in 1809 to Columbiana county, O. His son William McKinley (b. 1807), like his father an iron manufacturer, was married in 1829 to Nancy Campbell Allison, and to them were born nine children, of whom William, the president, was the seventh. In 1852 the family removed to Poland, Mahoning county, where the younger William was placed at school. At 17 he entered the junior class of Allegheny college. at Meadville, Pa., but he soon returned to Poland, where for a time he taught in a neighbouring country school. When the Civil War broke out in 1861 he enlisted as a Union army private, rising to the rank of major by 1865. After the war McKinley returned to Poland. and bent all his energy upon the study of law. He completed his preparation at the Albany (N.Y.) law school, was admitted to the bar at Warren, O., in March 1867, and began practice in Canton, O. He identified himself immediately with the Republican Party, and took part in the campaign work on behalf of Grant's presidential candidature in 1868. In 187j he first became known as an able campaign speaker by his speeches on behalf of Rutherford B. Hayes, the Republican candidate for governor of Ohio. In 1876 McKinley was elected to the national House of Representatives. Conditions both in Ohio and in Congress had placed him, and were to keep him for twenty years, in an attitude of aggressive and uncompromising partisanship. His Congressional district was naturally Democratic, and its boundaries were changed by Democratic legislatures for the purpose of causing his defeat. But he overcame what had threatened to be adverse majorities at all elections from 1876 to 1890, with the single exception of 1882. McKinley reflected the strong sentiment of his manufacturing constituency in behalf of a high protective tariff. In 1878 he took part in the debates over the Wood tariff bill. and in the same year he voted for the Bland-Allison silver bill. In Dec. 1880 he was appointed a member of the ways and means committee. succeeding James A. Garfield, who had been elected president in the preceding month, and to whose friendship, as to that of Rutherford B. Hayes, McKinley owed much in his earlier years in Congress. He was prominent in the debate which resulted in the defeat of the Democratic Morrison tariff bill in 1884, and in the defeat of the Mills bill for the revision of the tariff in 1887–1888. In 1889 he became chairman of the ways and means committee and Republican leader in the House of Representatives. In 1890 he introduced the tariff measure known as the McKinley bill, which reduced revenues by its high and in many cases almost prohibitive duties. Under its provision for reciprocal trade agreements reciprocity treaties were made with Germany, France, Italy and Belgium. In Europe there was bitter opposition to it by other countries. In the Congressional elections of 1890 McKinley was defeated. In 1891 he was elected governor of Ohio, and in 1893 was re-elected. In 1892 McKinley was the permanent president of the national Republican convention which met in Minneapolis and which renominated Benjamin Harrison on the first ballot, on which James G. Blaine received $182\frac{5}{6}$ votes, and McKinley, 182 votes. In 1896 he seemed for many reasons the most "available" candidate of his party for the presidency: he had no personal enemies in the party; he had carried the crucial state of Ohio by a large majority in 1893; his attitude on the coinage question had never been so pronounced as to make him unpopular either with the radical silver wing or with the conservative "gold-standard" members of the party. In the national Republican convention held in St. Louis in June he was nominated for the presidency on the first ballot. The convention adopted a tariff plank drafted by McKinley, and, of far greater immediate importance, a plank, which declared that the Republican Party was "opposed to the free coinage of silver, except by international agreement with the leading commercial nations of the world. . . ." This "gold standard" plank drove out of the Republican Party the Silver Republicans of the West, headed by Senator Henry M. Teller of Colorado. The national Democratic convention declared for the immediate opening of the mints to the free and unlimited coinage of silver at the ratio with gold of 16 to 1; and it nominated as its candidate for the presidency William Jennings Bryan of Nebraska.

There was a secession from the Democratic Party of conservatives who called themselves the National Democratic Party, were commonly called Gold Democrats, and who nominated John M. Palmer (1817–1900) of Illinois for president. McKinley, who had expected to make the campaign on the issue of a high protective tariff, was diverted to the defense of the gold standard as the main issue. The campaign was enthusiastic: the Republican candidate was called the "advance agent of prosperity" and the panic of 1893 was charged to the repeal of the McKinley tariff measure. McKinley was elected in November by a popular vote of 7,106,779 to 6,502,925 for Bryan, and by an electoral vote of 271 to 176. *(See* UNITED STATES : *History.)*

Following his inauguration the president summoned Congress to assemble in an extra session. McKinley's message urged revision of the tariff and revenue, and the Dingley tariff bill was accordingly passed through both houses, and was approved by the president on July 24.

The ensuing regular session of Congress was occupied chiefly with the situation in Cuba. President McKinley showed himself singularly patient and self-controlled in the midst of the popular clamour for intervention by the United States in behalf of the Cubans; but finally, on March 23, 1898, he presented an ultimatum to the Spanish government, and on April 25, on his recommendation, Congress declared war upon Spain. During the war itself he devoted himself with great energy to the mastery of military details; but there was bitter criticism of the war department resulting in the resignation of the secretary of mar, Russell A. Alger (*q.v.*). The peace treaty, signed at Paris, Dec. 10, was ratified by the Cnited States Senate on Feb. 6, 1899; and in accordance with its terms Puerto Rico, the Philippine archipelago, and Guam were transferred by Spain to the United States, and Cuba came under American jurisdiction pending the establishment there of an independent government. Two days before the ratification of the peace treaty, a conflict took place between armed Filipinos under the leadership of Emilio Aguinaldo and the American forces that were in possession of Manila. The warfare naged by these Filipinos against the United States, while having for the most part a desultory and guerrilla character, was of a very protracted and troublesome nature. Sovereignty over the Filipinos having been accepted by virtue of the ratification of the Paris treaty, President McKinley was not at liberty to do otherwise than assert the authority of the United States and use every endeavour to suppress the insurrection. But there was bitter protest against this "imperialism," both within the party by such men as George F. Hoar, Eugene Hale, Thomas B. Reed and Carl Schurz, and from the leaders of the Democratic Party. In the foreign relations of the United States, as directed by President McKinley. the most significant change was the cordial understanding established with the British Government. Other important foreign events during McKinley's administration were: the annexation of the Hawaiian islands (see HAWAII) in August 1898, and the formation of the Territory of Hawaii in April 1900; the cessation in 1899 of the tripartite (German, British and French) government of the Samoan islands, and the annexation by the United States of those of the islands east of 171°, including the harbour of Pago-Pago; the participation of American troops in the march of the allies on Pekin in August 1900, and the part played by McKinley's secretary of state, John Hay, in securing a guarantee of the integrity of the Chinese empire. In 1900 McKinley was unanimously renominated by the national Republican convention which met in Philadelphia in June, and which nominated Theodore Roosevelt, governor of New York, for the vice-presidency. The Republican convention demanded the maintenance of the gold standard, and pointed to the exceptional prosperity of the country resulting from the fulfilment of some of the most important of the pledges given by the Republican Party four years earlier. However, the tendency towards the concentration of capital in great industrial corporations had been active to an extent previously undreamt of, with incidental consequences that had aroused much apprehension; and the Democrats accused President McKinley and the Republican Party of having fostered the "trusts." But the campaign against McKinley and the Republican Party was not only "anti-trust" but "anti-imperialistic." William Jennings Bryan, renominated by the Democratic Party on a free silver platform, declared that imperialism was the "paramount issue" and made a second vigorous campaign. As the result of the polling in November, 292 Republican presidential electors and 155 Democratic electors were chosen. The Republican popular vote was 7,207,923, and the Democratic 6,358,133.

In the term of Congress immediately following the presidential election arrangements-were perfected for the termination of the American military occupation of Cuba and the inauguration of a Cuban republic. In the Philippines advanced steps had been taken in the substitution of civil government for military occupation, and a governor-general, Judge William H. Taft, had been appointed and sent to Manila. Prosperity at home was great, and foreign relations were free from complications. After an arduous term, the president had reached a period that promised to give him comparative repose and freedom from care. In these circumstances, President McKinley, accompanied by the greater part of his cabinet, set forth in the early summer on a tour to visit the Pacific coast. The route chosen was through the Southern states, where many stops were made, and where the president delivered brief addresses. The heartiness of the welcome accorded him seemed to mark the disappearance of the sectional feeling that had survived the Civil War. After his return he visited the city of Buffalo, New York, in order to attend the Pan-American exposition and deliver a public address. This address (Sept. 5, 1901) was a public utterance designed by McKinley to affect American opinion and public policy, and apparently to show that he had modified his views upon the tariff. It declared that henceforth the progress of the nations must be through harmony and co-operation and it maintained that the time had come for wide-reaching modifications in the tariff policy of the United States through commercial reciprocity arrangements with various nations. On the following day, Sept. 6, 1901, a great reception was held for President McKinley in one of the public buildings of the exposition. Advantage of this opportunity was taken by a young man of Polish parentage, by name Leon Czolgosz, to shoot at the president with a revolver at close range. One of the two bullets fired penetrated the abdomen. After the world had been assured that the patient was doing well and would recover, he collapsed and died on the 14th. The assassin, who professed to hold the views of that branch of anarchists who believe in the assassination of rulers, was promptly seized, convicted and executed. McKinley's funeral took place at Canton, O., on Sept. 19, amid marked public manifestations of mourning.

McKinley was married in 1867 to Ida Saxton (1847–1907).

Though he had not the personal magnetism of James G. Blaine, whom he succeeded as a leader of the Republican Party, McKinley had great personal suavity and dignity, and was thoroughly well liked by his party colleagues. As a politician he was always more the people's representative than their leader, and that he "kept his ear to the ground" was the source of much of his power and at the same time was his greatest weakness. His apparently inconsistent record on the coinage question becomes consistent if considered in the same way, as the expression of the gradually changing views of his constituency. He was an able but far from brilliant campaign speaker. His greatest administrative gift was a fine intuition in choosing men to serve him. His Speeches and Addresses were printed in 2 vols. (1893 and 1901).

See Jane Elliott Snow, *The Life of William McKinley* (1908); Charles Sumner Alcott, *The Life of William McKinley* (1916); Nicholas Murray Butler, *William McKinley and Twenty Years After* (1920); Herman Henry Kohlsaat, *From McKinley to Harding* (1923); Joseph Green Butler, *Life of William McKinley* and *History of National McKinley Birthplace Memorial* (1924); and Alfred L. Dennis, *Adventures in American Diplomacy*, 1896–1906 (1928).

McKINLEY, MOUNT, a peak of the Alaska range in south-central Alaska in lat. 63° 04' N. and long. 151° 01′ W., is the highest mountain in North America (20,320 ft. above sea level). On the north and west it rises abruptly 17,000 ft., while the southern and much more gradual slope begins from an even lower level. The upper two-thirds is covered with permanent snow fields that feed many glaciers. The greatest glaciers are on the relatively inaccessible southern slope. Muldrow (30 mi. long) and Peters are the largest on the northern slope.

The Indian name of the peak was Denali ("The Great One"). The modern name was applied in 1896 by W. A. Dickey in honour of William McKinley, who was elected president later that year. The first attempt to climb the mountain, made in 1903 by James Wickersham, was unsuccessful. Frederick A. Cook's much publicized (but fraudulent) claim that he had reached the summit inspired the conquest of the north peak in 1910 by two prospectors, William Taylor and Pete Anderson. The south peak (true summit) was finally attained June 7, 1913, after an expedition of three months duration led by Hudson Stuck and H. P. Karstens. In 1932, two climbers from a cosmic ray research expedition, Theodore Koven and Allen Carpe, lost their lives on the mountain. All successful ascents have been made from the north base, which became more accessible due to the Denali (park) highway.

The Mount McKinley National park (see NATIONAL PARK SYSTEM, THE) was created on Feb. 26, 1917. See also ALASKA.

(V. H. C.)

MACKINTOSH, CHARLES RENNIE (1868–1928), Scottish architect, designer and water-colourist, was one of the most significant personalities contributing to the rise of modern architecture. Born in Glasgow, Scot., on June 7, 1868, he was apprenticed to a local architect John Hutchison, and attended evening classes at the Glasgow School of Art. In 1889 he joined the firm of Honeyman and Keppie, becoming a partner in 1904.

In collaboration with three other students, one of whom, Margaret Macdonald, in 1900 became his wife, Mackintosh achieved an international reputation in the 1890s as a designer of unorthodox posters, craftwork and furniture. The outcome of this experimental work could be seen in four remarkable tearooms he designed for Miss Cranston in Glasgow (1896–1904) and in his domestic interiors of the early 1900s. In marked contrast to contemporary fashion this work was notable for its lightness, elegance and originality.

Mackintosh's chief architectural projects were: Glasgow School of Art (1896–1909); two unrealized projects — the 1901 International exhibition, Glasgow (1898) and "Haus eines Kunstfreundes" (1901); Windyhill, Kilmacolm (1900) and Hill house, Helensburgh (1902); the Willow Tearooms, Glasgow (1904–0j); and Scotland Street school (1904–06). Although all have some traditional characteristics, they reveal a mind of exceptional inventiveness and aesthetic perception. By 1914, however, Mackintosh had virtually ceased to practice and thereafter he devoted himself to water-colour painting.

He died on Dec. 10, 1928, in London.

See T. Howarth, *Charles Rennie Mackintosh and the Modern Movement* (1952); N. B. L. Pevsner, *Charles R. Mackintosh* (1950). (T. Hh.)

MACKINTOSH, SIR JAMES (1765–1832), Scottish publicist, was born at Aldourie on Oct. 24, 1765, and was educated at Aberdeen and at Edinburgh, where he took his degree in medicine in 1787. In 1788 he removed to London, and becoming interested in politics, in 1791 published his *Vindiciae Gallicae,* a reply to Burke's *Reflections on the French Revolution.* It was the only worthy answer to Burke that appeared, and won him a European reputation and many friends, including Burke himself. Its success finally led him to take up the legal profession. He was called to the bar in 1795. In 1797 his wife died, and next year he married Catherine Allen, sister-in-law of Josiah and John Wedgwood, through whom he introduced Coleridge to the *Morning Post.*

His greatest legal successes were his lectures (1799) at Lincoln's Inn on the law of nature and nations, and his defence (1803) of Jean Gabriel Peltier, a French refugee, tried at the instance of the French government for a libel against the first consul. In 1803 he was knighted, and received the post of recorder at Bombay, but he returned to England in 1812. He entered parliament in the Whig interest as member for Nairn, and he sat for that county, and afterwards for Knaresborough, till his death. He opposed the reactionary measures of the Tory government, supported and afterwards succeeded Romilly in his efforts for reforming the criminal code, and took a leading part both in Catholic emancipation and in the Reform Bill. From 1818 to 1824 he was professor of law and general politics in the East India Company's College at Haileybury. His *Dissertation on the Progress of Ethical Philosophy,* prefixed to the 7th edition of the *Encyclopædia Britannica,* and published in 1831, was severely attacked in 1835 by James Mill in his *Fragment on Mackintosh.* About the same time he wrote for the *Cabinet Cyclopaedia* a "History of England from the Earliest Times to the Final Establishment of the Reformation." His more elaborate *History of the Revolution* was published after his death. Already a privy councillor, Mackintosh was appointed commissioner for the affairs of India under the Whig administration of 1830. He died on May 30, 1832.

The *History of the Revolution in England,* breaking off where William of Orange is about to intervene, is chiefly interesting because of Macaulay's essay on it and its author.

See R. J. Mackintosh, *Memoirs of the Life of Sir James Mackintosh,* 2 vol., 2nd ed. (London, 1853).

MACKLIN, CHARLES (d. 1797), Irish actor and playwright, whose real name was McLaughlin; his distinguished though turbulent career, almost spanning the 18th century and made him a pillar of the English theatre. He first appeared as an actor at Bristol and in 1725 went to Lincoln's Inn Fields. London. A man of violent nature, he was a pioneer against the stilted declamation of his day. He went to Drury Lane theatre in 1733 and later was concerned in its management. In 1735 he killed a brother actor in the green room, over a dispute about a wig, but although prosecuted he received no sentence. He set the seal on his stage career at Drury Lane on Feb. 14, 1741, when he played Shylock, rescuing the part from all the comic "portrayals" with which it had long been surrounded.

Macklin played many parts with distinction but was constantly involved in disputes and lawsuits. He attempted to be a restaurateur but failed and returned to the stage. Two of his plays were outstanding, *Love à-la-mode* (1760) and *The Man of the World* (1781). He died on July 11, 1797, claiming to be 107 years old; he may indeed have been a centenarian, though this is subject to dispute.

See Edward A. Parry, *Charles Macklin* (1891). (W. J. M.-P)

MACK VON LEIBERICH, KARL, Freiherr (1752–1828), Austrian soldier, was born at Nenslingen, Bavaria, on Aug. 25, 1752. In 1770 he joined an Austrian cavalry regiment, becoming an officer seven years later. During the brief war of the Bavarian Succession he served on the staff of Count Kinsky, and subsequently under the commander-in-chief Field Marshal Count Lacy. He was promoted first lieutenant in 1778, and captain on the quartermaster-general's staff in 1783. In 1785 Mack married Katherine Gabrieul, and was ennobled under the name of Mack von Leiberich. In the Turkish war he was employed on the headquarters staff, becoming in 1788 major and personal aide-de-camp to the emperor, and in 1789 lieutenant-colonel. He distinguished himself greatly in the storming of Belgrade. Shortly after this, disagreements between Mack and Loudon, led to the former's demanding a court-martial and leaving the front. He was, however, given a colonelcy (1789) and the order of Maria Theresa, and in 1790 Loudon and Mack, having become reconciled, were again on the field together. During these campaigns Mack received a severe injury to his head, from which he never fully recovered. In 1793 he was made quartermaster-general (chief of staff) to Prince Josias of Saxe-Coburg, commanding in the Netherlands. He enhanced his reputation by the ensuing campaign, receiving a wound at Famars. In 1797 he was promoted lieutenant field marshal, and in 1798 accepted command of the Neapolitan army. Forced to take refuge from his own men, he escaped to the French camp, and was sent to Paris, whence he escaped in disguise two years later. He was not employed for some years, but in 1804 was made quartermaster-general of the army, with instructions to prepare for a war with France. He attempted hastily to reform the army, and in 1805 became the real commander (under titular commander-in-chief Archduke Ferdinand) of the army which opposed Napoleon in Bavaria, but his position was ill-defined and his authority treated with slight respect by his colleagues. (*See* Napoleonic Campaigns.)

See Schweigerd, *Oesterrezchs Helden* (Vienna, 1854); Wiirzbach, *Biogr. Lexikon* d. *Kaiserthums Oesterr.* (Vienna, 1867); Ritter von Rittersberg, *Biogr,* d. *ausgezeichneten Feldherren d. oest. Armee* (Prague, 1828); Raumer's *Hist. Taschenbuch* (1873) defends Mack.

McLANE, LOUIS (1786–1857), American lawyer, business executive, political leader and diplomat. was descended from Scottish grandparents of the Isle of Man who had moved to Philadelphia in 1731. His immediate family had settled in the three lower counties of Delaware, where Allan McLane, his father, had entered business with Robert Morris in 1773. He began the practice of law in 1807, served in Congress. 1817–27, and in the Senate, 1827–29. He first inclined toward Federalism, but by 1823 he had formed with Martin Van Buren a group of William H. Crawford Democrats and later supported Andrew Jackson when Crawford's ill-health forced him out of politics. As an able representative of the Middle Atlantic States free-trader exporting and carrying-trade interests, he was well qualified to negotiate for the opening of the British West Indian trade, which was the main business of the London post under the new Jackson Administration. His appointment was the signal for a great protectionist outcry against the "Wilmington conspiracy" to bargain away the advantages of the tariff of 1828. The Government allowed him to follow his own course in the negotiations, with the result that within ten months after he had presented his credentials, an agreement was reached which ended an irritation of nearly 50 years. The cabinet, as the British were privately informed, favoured a reduction of the American tariff; but this was not secured until the southern free-traders organized the nullification movement and brought about the adoption of the Compromise tariff of 1833, which McLane, who had returned in the meantime to the United States as secretary of the treasury, had influenced by formulating the administration tariff proposals. Then came a turning-point in his career. He refused to join Van Buren in approving Jackson's proposal to remove deposits from the bank without the authority of Congress and was transferred to the Department of State. He resigned the next year, 1834, breaking with Van Buren. From 1834–37 he was president of the Morris Canal and Banking Company (New York), and from 1837–47 president of the Baltimore and Ohio Railroad. In 1845, when the Democrats returned to office without Van Buren and when Anglo-American relations were strained over the Oregon question, McLane accepted from President Polk an appointment to return to England "upon condition that if he could induce the British Government to reconsider the rejection of the offer of '49 he. the President, would consult the Senate as to the propriety of accepting this compromise." Whatever may have been McLane's real influence upon Lord Aberdeen, he had the satisfaction of seeing another great difference between the two countries "amicably" settled, and this time in conjunction with the triumph of free trade—the repeal of the British Corn Laws and the substitution of the low Walker tariff of 1846 for the high Whig tariff of 1842.

BIBLIOGRAPHY.—There is no biography of Louis McLane, but *see* R. M. McLane's *Reminiscences, 1827–97;* Fitzpatrick (ed.), *Autobiography of Martin Van Buren;* Bassett (ed.), *The Andrew Jackson Papers;* Quaife (ed.), *Polk's Diary; The Aberdeen Papers* (ms.); *The Peel Papers* (ms.); *The C. R. Vaughan Papers* (ms.); and Benns, *The American Struggle for the British West India Carrying Trade.*

MACLAREN, CHARLES (1782–1866), Scottish editor, was born at Ormiston. Haddingtonshire. on Oct. 7, 1782, the son of a farmer and cattle dealer. He was almost entirely self-educated, and became a clerk in Edinburgh. In 1817 he established the *Scotsman* newspaper in Edinburgh and at first acted as its editor. Offered a post as clerk in the customhouse, he resigned his editorial position, resuming it again from 1820 to 1845. He was editor of the 6th edition of the *Encyclopædia Britannica* in 1820. From 1864–66 he was president of the Geological society of Edinburgh, where he died on Sept. 10, 1866.

MACLAURIN, COLIN (1698–1746), Scottish mathematician, who alone of Newton's British successors, ranked equal with continental mathematicians of his day. Born at Kilmodan, Argyllshire, and educated at the University of Glasgow, at 19 he was elected professor of mathematics in Marischal college, Aberdeen. Two years later he was admitted a fellow of the Royal society and made the acquaintance of Sir Isaac Newton. In 1719 he published *Geometria organica, sive descriptio linearum curvarum universalis,* in which he developed several theorems due to Newton, introduced the method of generating conics that bears his name and showed that many curves of the third and fourth degrees can be described by the intersection of two movable angles. In 1721 he wrote a supplement to *Geometria organica,* which he amplified in the *Philosophical Transactions* for 1735. This paper is principally based on the following general theorem, which is a remarkable extension of Pascal's hexagram: "If a polygon move so that each of its sides passes through a fixed point. and if all its summits except one describe curves of the degrees *nt, n, p,* etc., respectively, then the free summit moves on a curve of the degree *2mnp* . . . which reduces to *mnp* . . . when the fixed points all lie on a right line."

In 1722 Maclaurin traveled as tutor and companion to the eldest son of Lord Polwarth and after a short stay in Paris resided for a time in Lorraine, where he wrote an essay on the percussion of bodies, which was awarded the prize of the French Academy of Sciences for 1724. In 1725 he was made professor of mathematics in the University of Edinburgh on the recommendation of Newton.

In 1740 Maclaurin divided with Leonhard Euler and Daniel Bernoulli the prize offered by the French Academy of Sciences for an essay on tides. His *Treatise on Fluxions* (1742), written in reply to George Berkeley, contains his well-known essay on tides. In this he showed that figures of equilibrium for a homogeneous rotating fluid mass are the ellipsoids of revolution, later known as Maclaurin's ellipsoids. He also gave in his *Fluxions,* for the first time, the correct theory for distinguishing between maxima and minima in general and pointed out the importance of the distinction in the theory of the multiple points of curves. Maclaurin was the first to introduce into mechanics, in this discussion. the important conception of level surfaces. As a result of Maclaurin's suggestion, the newly formed (1731) Medical Society of Edinburgh was enlarged into the Philosophical society (1739) and later (in 1783) into the Royal Society of Edinburgh.

In 1745, nhen the rebels mere marching on Edinburgh, Maclaurin took a prominent part in preparing trenches and barricades for its defense. As soon as the rebel army got possession of Edinburgh. Maclaurin fled to England to avoid making submission to the Pretender. He died on June 14, 1746, at Edinburgh.

After Maclaurin's death his *Account of Newton's Philosophical Discoveries* was published by Patrick Murdoch, and also his *Algebra* in 1748. As an appendix to the latter appeared his *De linearum geometricarum proprietatibus generalibus tractatus,* an elegant treatise.

MACLEAN, SIR DONALD (1864–1932), British politician. the eldest son of John Maclean of Kilmoluag, Tiree, Scotland, was admitted a solicitor in 1887. After three unsuccessful contests. he entered the house of commons in 1906 as Liberal member for Bath. He failed to hold his seat at the general election of Jan. 1910, but in December of that year he was elected for Peebles and Selkirk, which he represented until 1918. He was member for Peebles and South Midlothian from 1918 to 1922, when he lost his seat. In the absence of Asquith from the house of commons, he became chairman of the Parliamentary Liberal party (1919–22). He nas deputy chairman, house of commons, 1911–18, and chairman of the London appeal tribunal, 1916–18. During World War I he was chairman of the Enemy Debt Treasury commission and of the house of commons military appeal tribunal. He was sworn of the privy council in 1916, and created K.B.E. in 1917. He died June 15, 1932.

McLEAN, JOHN (1785–1861), U.S. jurist, was horn in Morris county. N.J., on March 11, 1785. His father, a farmer, moved to Virginia in 1789, later to Kentucky and finally to Ohio. The boy's schooling was irregular, but he uent to Cincinnati to study law in the office of Arthur St. Clair, and in 1807 mas admitted to the bar. In 1812 he nas elected U.S. representative from the district which included Cincinnati, and in 1814 was re-elected. In 1816 he was appointed a judge in the supreme court of Ohio, nhich position he resigned in 1822 to become commissioner of the general land office under Pres. James Monroe. Monroe in 1823 appointed him postmaster general, in uhich office he continued throughout the administration of John Quincy Adams. His conduct of this office was notable for its efficiency and economy. and for the strict nonpartisan treatment of postmasters and other employees. Pres. Andrew Jackson continued McLean in office. but McLean refused to accept the president's views on patronage, and resigned. Jackson thereupon appointed him an associate justice of the supreme court. which position he held from 1830 until his death in 1861. His career on the bench was long and distinguished, his most famous decision, perhaps. being the dissenting opinion in the Dred Scott case. In 1848 he was considered as a presidential candidate at the Free Soil convention in Buffalo, and in 1856 he was the chief opponent of J. C. Frémont at the first Republican convention. receiving 196 votes. He received a number of votes in the Chicago convention which nominated Lincoln. His death occurred at Cincinnati on April 4, 1861.

MacLEISH, ARCHIBALD (1892–), U.S. poet, public servant and university professor, was born in Glencoe, Ill., May 7, 1892. Educated at Yale and Harvard law school, he first came to notice as a poet with *Tower of Ivory* (1917). The verse he published in the 1920s, *The Happy Marriage* (1924), *The Pot of Earth* (1925), *Streets in the Moon* (1926) and *Tlze Hamlet of A. MacLeish* (1928), shows the fashionable influence of Ezra Pound and T. S. Eliot. In *New Found Land* (1930) a simple lyric eloquence, the persistent MacLeish note, is heard.

In the 1930s MacLeish was concerned about the threats to American society, particularly the Fascist menace. *Conqziistador* (1932) is the first of his "public" poems. Others were collected in *Frescoes for Mr. Kockefeller's City* (1933), *Public Speech* (1936), and *America Was Promises* (1939). He wrote two radio verse plays on social themes, *The Fall of the City* (1937) and *Air Razd* (1938).

MacLeish served as librarian of congress (1939–44) and assistant secretary of state (1944–45), and in various governmental positions until 1949. He aided in the establishment of United Nations Educational, Scientific and Cultural organization (UNESCO). Dunng these years he wrote and spoke constantly in defense of American democracy. In 1949 he became Boylston professor at Harvard. Two later works are outstanding, *Actfive and Other Poems* (1948) and a verse drama. J. B. (1957).

MacLeish's collected works are *Collected Poems, 1917–1952* (1952); *A Time to Speak: the Selected Prose* (1941); *A Time* *to Act: Selected Addresses* (1943). (W. T.)

McLENNAN, JOHN FERGUSON (1827–1881), Scottish ethnologist who challenged the long-established theory that modern society and the state had evolved from a primordial, patriarchal family, was born at Inverness on Oct. 14, 1827, and educated at King's college, Aberdeen, and at Cambridge university. He was admitted to the bar in 1857, and in 1871 became parliamentary draftsman for Scotland. In *Primitive Marriage* (1865, reissued as *Studies in Ancient History*, 2nd series, 1896) he outlined his theory of social evolution, postulating small, promiscuous groups initially, with kinship recognized in the female line. Promiscuity was mitigated by a form of polyandry that led to reckoning descent in the male line and eventually to endogamy, or marriage within the group. The terms exogamy and endogamy mere introduced by McLennan, who also was the first to recognize the significance of totemism for the study of social origins. *The Patriarchal Theory* was published posthumously in 1885. McLennan's significance to ethnology lay in the stimulation of his challenging and persuasive theories, most of which, however, have not withstood the test of scientific criticism. He died on June 16, 1881, in Kent, England.

See E. B. Tylor in *The Academy*, vol. 20, pp. 9–10 (1885); R. H. Lowie, *The History of Ethnological Theory* (1937). (LE. A. W.)

MACLEOD, JOHN JAMES RICKARD (1876–1935), British physiologist and one of the discoverers of insulin (*q.v.*), was born on Sept. 6, 1876, near Dunkeld, Scotland, and was educated at Aberdeen grammar school, Marischal college, Aberdeen, and Leipzig university. From 1899 to 1902 he was demonstrator in physiology and then lecturer in biochemistry at the London hospital, holding also from 1901 to 1903 the Mackinnon research scholarship of the Royal society. From 1903 to 1918 he was professor of physiology at Western Reserve university, Cleveland, Ohio. subsequently becoming professor of physiology, director of the physiological laboratory and associate dean of the faculty of medicine in the University of Toronto, Ont. He died March 16, 1935.

Macleod's most important work was on the nature of the control of the metabolism of carbohydrates in the animal body, and, together with Sir Frederick Grant Banting, with whom he shared the Nobel prize for medicine in 1923, and C. H. Best, he achieved fame as one of the discoverers of insulin. Macleod's publications include *Practical Physiology* (1903); *Recent Advances in Physiology*, edited by Leonard Hill (1905); *Diabetes, Its Physiological Pathology* (1913); *Fundamentals of Physiology* (1916); *Physiology in ;Modern Medicine* (9th ed., 1941); and numerous papers on insulin, etc.

MACLEOD, NORMAN (1812–1872), Scottish divine, son of Rev. Norman Macleod (1783–1862), and grandson of Rev. Norman Macleod, minister of Morven, Argyllshire, was born at Campbeltown on June 3, 1812. In 1827 he became a student at Glasgow university, and in 1831 went to Edinburgh to study divinity under Dr. Thomas Chalmers. On March 18, 1838, he became parish minister at Loudoun, Ayrshire. At this time the troubles in the Scottish church were already gathering to a head. (*See* FREE CHURCH OF SCOTLAND.) Macleod took a middle course in the nonintrusion controversy, holding that the fitness of those who were presented to parishes should be judged by the presbyteries—the principle of Lord Aberdeen's bill. On the secession of 1843 he became pastor of Dalkeith. He was one of the founders of the Evangelical alliance, and from 1849 edited the *Christian Instructor* (Edinburgh). In 1851 he was called to the Barony church, Glasgow, where he remained until his death (June 16, 1872). Macleod instituted temperance refreshment rooms, a congregational penny savings bank, and held services specially for the poor. In 1860 he was appointed editor of the new monthly magazine *Good Words*, to which he was a large contributor. By far his best work was the spontaneous and delightful *Reminiscences of a Highland Parish* (1867). Macleod was moderator of the church assembly in 1869. In recognition of his wide sympathy and high ideals, Queen Victoria gave two memorial windows to Crathie church.

See *Memoir* of *Norman Macleod*, by his brother, Donald Macleod (1876).

MACLISE, DANIEL (1806–1870), Irish history painter, was born at Cork on Jan. 25, 1806. At the age of 16 he left the employ of a local bank to enter the Cork school of art, maintaining himself by portrait sketching. In 1825 he made sketches of Sir Walter Scott, one of which was lithographed. He went to London in 1827 and entered the Royal academy schools, where he carried off the highest honours. He exhibited subject pictures and portraits regularly at the Royal academy and in 1835 was elected associate and in 1840, academician. Maclise's fame rests on the 72 lithographed portraits of literary and other contemporary celebrities which first appeared in *Fraser's Magazine* (1830–36) under the pseudonym Alfred Croquis (later published as the *Maclise Portrait Gallery*, 1871) and the two vast (12 ft. by 45 ft.) frescoes for the Royal gallery in the house of lords. "The Meeting of Wellington and Blucher" was unsuccessfully begun in fresco in 1859 and completed in a new German "water glass" technique in 1861. Its companion "The Death of Nelson" was executed between 1861–64. Maclise's harsh colour is largely offset by his unusually retentive visual memory and gift for large-scale composition. Maclise died April 25, 1870, in London. (D. L. FR.)

MACLURE, WILLIAM (1763–1840), U.S. geologist, was born at Ayr, Scotland, Oct. 27, 1763. Maclure became known as the father of American geology, because of his publication of a geological map of the United States in 1809 which, with the exception of Guettard's mineralogical *Map of Louisiana and Canada*, was the earliest attempt at a geological map of the United States, and antedates William Smith's geological map of England by six years. The map, together with a memoir entitled *Observations on the Geology of the United States Explanatory of a Geological Map*, was the result of his voluntary and unaided labours.

Maclure was a liberal patron of science for many years and from 1817 until his death was president of the Philadelphia Academy of Natural Sciences, to which he gave his valuable private library and about $20,000. He died at San Angel, Mexico, March 23, 1840.

MacMAHON, MARIE EDMÉ PATRICE MAURICE DE, duke of Magenta (1808–1893), French marshal and president of the French republic. was born on July 13, 1808, at the château of Sully, near Autun. He was descended from an Irish family which went into exile with James II. Educated at the military school of St. Cyr, in 1827 he entered the army, and served in the first French campaign in Algeria. He gained distinction in the expedition to Antwerp in 1832. In 1833 he returned to Algeria. He led daring cavalry raids across plains infested with Bedouins, and distinguished himself at the siege of Constantine in 1837. He was almost constantly in Algeria until 1854. MacMahon commanded a division in the Crimean War, and in September 1855 he conducted the assault upon the Malakoff works, which led to the fall of Sevastopol. Declining the highest command in France, he was once more sent out, at his own request, to Algeria, where he completely defeated the Kabyles. After his return to France he voted as a senator against the unconstitutional law for general safety, brought forward in consequence of Orsini's abortive attempt on the emperor's life. MacMahon distinguished himself in the Italian campaign of 1859. Partly by good luck and partly by pushing forward without orders at a critical moment at the battle of Magenta, he secured victory. For this MacMahon received his marshal's baton and was created duke of Magenta. In 1861 he represented France at the coronation of William I of Prussia, and in 1864 he was nominated governor-general of Algeria. MacMahon's administration was unsuccessful and when the ill-fated Ollivier cabinet was formed, the emperor abandoned his Algerian schemes and MacMahon was recalled.

In 1870 MacMahon was appointed to the command of the Alsace army detachment (*see* FRANCO-GERMAN WAR). On Aug. 6, MacMahon fought the battle of Wörth (*q.v.*). He was compelled to fall back upon Saverne, and thence to Toul. The emperor then gave him supreme command of the new levies which he was mustering at Châlons, and he was directed to effect a junction with Bazaine. This operation he undertook against his will. He had an army of 120,000 men, with 324 guns; but large numbers of the troops were disorganized and demoralized. Early on Sept. 1, the decisive battle of Sedan began. MacMahon was dangerously wounded in the thigh, whereupon General Ducrot. and soon afterward General de Wimpffen, took command. MacMahon shared the captivity of his comrades, and was interned at Wiesbaden.

In March 1871 MacMahon was appointed by Thiers commander in chief of the army of Versailles; in that capacity he suppressed the Communist insurrection. and successfully conducted the second siege of Paris. On the resignation of Thiers on May 24. 1873. MacMahon was elected president of the republic by an almost unanimous vote. On Nov. 5, 1873.General Changarnier presented a motion in the assembly to confirm MacMahon's powers for a period of ten years, and to provide for a commission of thirty to draw up a form of constitutional law. The president consented, but in a message to the assembly he declared in favour of a confirmation of his own powers for seven years. and expressed his determination to use all his influence in the maintenance of Conservative principles. After prolonged debates the Septennate was adopted on Nov. 19 by 378 votes to 310. There was no *coup d'e'tat* in favour of "Henri V," as had been expected, and the president resolved to abide by "existing institutions." One of his earliest acts was to receive the finding of the court-martial upon his old comrade in arms, Marshal Bazaine, whose death sentence he commuted to one of twenty years' imprisonment in a fortress.

The president was popular in the rural districts of France, but in Paris and other large cities the Republican party was alienated by press prosecutions and the attempted suppression of Republican ideas. Matters were at a comparative deadlock in the national assembly, until the accession of some Orleanists to the Moderate Republican party in 1875 made it possible to pass various constitutional laws. In May 1877 the constitutional crisis became acute. A peremptory letter of censure from MacMahon to Jules Simon caused the resignation of the ministry. The duc de Broglie formed a cabinet. but Gambetta carried a resolution in the chamber of deputies in favour of parliamentary government. The president declined to yield, and being supported by the senate, he dissolved the chamber, by decree, on June 2;. The prosecution of Gambetta followed for a speech at Lille, in which he had said, "the marshal must, if the elections be against him, *se soumettre* ou *se démettre*." In a manifesto respecting the elections, the president declared: "I cannot obey the injunctions of the demagogy; I can neither become the instrument of Radicalism nor abandon the post in which the constitution has placed me."

But the elections in October resulted in the return of 335 Republicans and only 198 anti-Republicans, the latter including 30 MacMahonists, 89 Bonapartists. 41 Legitimists: and 38 Orleanists. As a last resort the president called to power an extraparliamentary cabinet under General Rochebouet, but the Republican majority refused to vote supplies, and after a brief interval MacMahon had to accept a new Republican ministry under Dufaure. The prolonged crisis terminated on Dec. 14,1877,and no further constitutional difficulties arose in 1878. But as the senatorial elections, held early in 1879,gave the Republicans an effective working majority in the upper chamber. they now called for the removal of the most conspicuous anti-Republicans among the generals and officials. MacMahon resigned the presidency on Jan. 30, 1879, and Jules Grévy was elected as his successor. MacMahon retired to private life. He died at Paris on Oct. 17, 1893.

A fine. tall, soldierly man, of a thoroughly Irish type, in private life MacMahon was universally esteemed as generous and honourable; as a soldier he was brave and able, without decided military genius; as a politician he was patriotic and well-intentioned, but with no real statecraft.

See Grandin, *Le Maréchal MacMahon*, 2 vol. *(1893)*; G. Hanotaux, *La France contemporaine*, vol. 2 (1905).

MacMANUS, TERENCE BELLEW (1823–1860), Irish rebel, was born at Tempo, Fermanagh. He joined the '82 Club in 1844.took part in the W. S. O'Brien outbreak in 1848,and was arrested in Cork and sentenced to death. The sentence was transmuted to transportation to Tasmania. MacManus escaped to America. He died in San Francisco in 1860. His body was taken back to Ireland and interred at Glasnevin,

McMASTER, JOHN BACH (1852–1932), U.S. educator and historian. who was a pioneer in the use of social rather than purely political materials, was born in Brooklyn, N.Y., on June 29, 1852. After he graduated from the College of the City of New York in 1872, McMaster worked as civil engineer and was an instructor in civil engineering at Princeton university, 1877–83. From 1883 until 1920he was professor of American history in the Cniversity of Pennsylvania.

His earliest writings were on engineering subjects, but he is best known for his *History of the People of the Lnited States, from the Revolution to the Civil War* (1883–1913). It was supplemented by *A History of the People of the United States During Lincoln's Administration* (1927). Among McMaster's other books are *With the Fathers*(1896) ; *A Brief History of the United States* (1907, rev. enl. ed., 1918 and 1924); and *The Life and Times of Stephen Girard, Mariner and Merchant* (1918). His textbooks were used in many U.S. elementary and secondary schools. He died in Darien, Conn., on May 24, 1932.

See E. F. Goldman, *John Bach McMaster* (1943).

MACMILLAN, the name of a family of English publishers. The founders of the firm were two Scotsmen, Daniel Macmillan (1813-j7) and his younger brother Alexander (1818–96). Daniel was born on the Isle of Arran on Sept. 13, 1813,and Alexander was born in Irvine on Oct. 3,1818. Daniel was for some time assistant to the bookseller Johnson at Cambridge, but entered the employ of Messrs. Seeley in London in 1837. In 1843 the brothers began business in Aldersgate street and in the same year they purchased the business of Newby in Cambridge. They began to publish educational works in 1844. In 1845 they took over the more important business of Stevenson in Cambridge. Daniel Macmillan died at Cambridge on June 27,1857. The firm had begun to prosper and in 18j8 a branch office was opened in London. Alexander Macmillan died in Jan. 1896. In little over half a century he had built up one of the most important publishing houses in the world which, in time, had its branches in the United States, Canada, Australia and India. Macmillan published the works of Tennyson, Charles Kingsley, T. H. Huxley, Lewis Carroll, Rudyard Kipling and many other great Victorian authors.

Frederick Orridge Macmillan(18 51–1936), the son of Daniel, became a partner in 1876 and first chairman in 1893,when the firm became a limited liability company. In 1898 the company purchased the business of R. Bentley and Son. Frederick's partners were his younger brother Maurice and his cousin George, both of whom died in 1936;they were succeeded by Maurice's sons Daniel (1886-), the chairman, and Maurice Harold (1894- ; *q.v.*), whose son Maurice Victor (1921-) is a director.

Bibliography.—T. Hughes, *Memoir of Daniel Macnzillan (1882)*; *A Bibliographical Catalogue of Macmillan & Co's Publications From 1843 to 1889 (1891)*; *C. L.* Graves, *Life and Letters of Alexander Macmillan* (1910); *C. L.* Morgan, *The House of Macmillan (1843–1943)* (1943).

McMILLAN, EDWIN MATTISON (1907-), **U.S.** physicist, recipient of the 1951 Nobel prize in chemistry, with Glenn T. Seaborg, for work on the chemistry of the transuranium elements, and co-discoverer of neptunium and plutonium, was born at Redondo Beach, Calif., on Sept. 18, 1907. He was educated at the California Institute of Technology (B.S., 1928; M.S., 1929) and Princeton university (Ph.D., 1932). He went to the University of California at Berkeley in 1932 and after a period as research fellow (1932–34) and associate (1934–35) he joined the faculty, advancing to a full professorship in 1946. From 1934 he was a member of the staff of the radiation laboratory, of which he became associate director in 1954. During World War II he was engaged in research on radar and sonar (asdic) and helped establish the Los Alamos, N.M., atomic energy laboratory, where he assisted in developing the first atomic bomb. In the spring of 1940 he discovered, with Philip H. Abelson. the first transuranium element, neptunium (atomic no. 93). thus opening the whole transuranium field. Later in 1940 he initiated the search for, and was a co-discoverer of, the next transuranium element, plutonium (atomic no. 94), with Seaborg and others. He developed the theory of the synchrotron independently of and nearly simultaneously with the U.S.S.R. physicist Vladimir I. Veksler; this theory *(Physical Review*, Sept. 1945) made possible the construction of huge machines for the acceleration of electrons and atomic projectiles to very high energies, opening the field of high energy physics and convenient study of the various fundamental particles. (G. T. Sg.; X.)

MACMILLAN, (MAURICE) HAROLD (1894–), British statesman, who was appointed prime minister on Jan. 10, 1957, and was elected leader of the Conservative party 12 days later, was born in London on Feb. 10, 1894. He came of a Scottish crofter family which early in the 19th century mas driven by poverty to find a living in England. His grandfather founded the famous London publishing house, of which Macmillan became an active director in 1924. His mother came from Spencer, Ind., (U.S.), and later acquired a peculiar love and knowledge of France. Macmillan, who was educated at Eton and st Balliol college, Oxford, served with the grenadier guards in World War I, was wounded three times and won the Military cross. In 1919 he became A.D.C. to the governor-general of Canada, the ninth duke of Devonshire, and in 1920 married one of the duke's daughters, Lady Dorothy Evelyn Cavendish.

Macmillan's political career divides itself broadly into two periods—one of party unorthodoxy (1924–40), and the other of orthodoxy which began after Sir Winston Churchill's appointment as prime minister in 1940. Macmillan sat in parliament for Stockton-on-Tees from 1924–29 and from 1931–4j, and, after defeat in the general election, was elected for Bromley, Kent, in a by-election in Nov. 1945. In his unorthodox phase he advocated a greater degree of economic control, to limit unemployment, than the bulk of his party thought desirable; he expressed his ideas in *Reconstruction: A Plea for a National Policy* (1933) and *The Middle Way* (1938). In prewar foreign affairs he was a bitter critic of Neville Chamberlain's appeasement policy. When &h-ston Churchill formed his coalition government in 1940, Macmillan was given office for the first time as parliamentary secretary to the ministry of supply. In 1942 he was made a privy councilor and after several months at the colonial office became minister resident in north Africa. A pioneer of the United Europe movement, he attended the 1948 congress out of which grew the Council of Europe. As minister of housing and local government, 1951–54, he was responsible for achieving a target of over 300,000 houses a year. He was minister of defense, 1954–55, and foreign secretary, 1955–56, and as chancellor of the exchequer, 1956–57, he introduced a premium bonds savings scheme, with periodical lottery prizes. In March 1957, soon after becoming prime minister as a result of Sir Anthony Eden's resignation, Macmillan conferred with Pres. Dwight D. Eisenhower in Bermuda on the middle east, Suez canal problems and the proposed reduction of British troops in Germany. In 1958 he toured the commonwealth and visited Washington, D.C., Ottawa and Paris. A firm advocate of holding a "summit" conference, he had exploratory talks with Kikita S. Khrushchev and other Soviet leaders in the U.S.S.R. in Feb. 1959 and visited western leaders in Paris, Bonn, Ottawa and Washington, D.C., in March. Macmillan announced a general election for Oct. 8, 1959. After a vigorous campaign the Conservative party was returned to power with a majority of 100 in the house of commons. In May 1960 Macmillan tried unsuccessfully to save the "summit" conference in Paris.

(J. F. B.; X.)

MacMONNIES, FREDERICK WILLIAM (1863–1937), U.S. sculptor and painter, whose long residence in France accounts for the strong French influence seen in all his work, was born in Brooklyn, N.Y., Sept. 20, 1863. In 1880 he was employed as a studio assistant by Augustus St. Gaudens. In 1884 he went to Paris to study sculpture with Jean Alexandre Falguière and Marius Jean Mercie. He returned to New York in 1887 and went again to Paris in 1889, where he remained until World War I. In 1891 he was awarded a medal of .the second class at the salon—an honour never before conferred on an American sculptor. His fame was established in the U.S. by his Columbian fountain, at the 1893 World's Columbian exposition in Chicago. Among the best known of his works are "Nathan Hale," in City Hall park, New York city, his "Bacchante," in the Metropolitan Museum of Art, New York city, the battle monument, at Princeton, N.J., and his decoration for the soldiers' and sailors' memorial arch at Grand Army plaza. Brooklyn, N.Y. He was also well known as a portrait painter. He died Mar. 27, 1937.

See Lorado Taft, *History of American Sculpture* (1924). (A. T. G.)

MACNAGHTEN, EDWARD MACNAGHTEN, 1ST BARON, (1830–1913), was the first law lord appointed to the British house of lords directly from the bar without previous judicial experience. Born in Bloomsbury on Feb. 3, 1830, he was educated at Dublin and Cambridge universities. He was called to the bar at Lincoln's Inn in 1857. Appointed a lord of appeal in ordinary in 1887 on the retirement of Lord Blackburn after only seven years practice as a queen's counsel, Baron Macnaghten was a distinguished practitioner in chancery; but his chief distinction as a judge was his literary gift of short summaries of the factual case before him and of simple restatement and classification of the legal rules applied. McNaghten's rule, or the right and wrong test for insanity as a defense in a criminal trial (*see* INSANITY), is not to be associated with his name but with that of a 19th-century criminal in whose case the rule was formulated. The best-known legal rule to which Baron Macnaghten's name is attached is his classification of charitable gifts into four divisions: "trusts for the relief of poverty; trusts for the advancement of education; trusts for the advancement of religion; and trusts for other purposes beneficial to the community." He died in London on Feb. 17, 1913. (A. DM.)

MACNAGHTEN, SIR WILLIAM HAY, BART. (1793–1841), British diplomat, was the second son of Sir Francis Macnaghten, Bart., judge of the supreme courts of Madras and Calcutta. He went out to Madras in 1809 and was transferred to the Bengal civil service in 1816. He was made secretary to Lord William Bentinck in 1830. In 1837 he was the trusted adviser of the governor-general, Lord Auckland, with whose policy of supporting Shah Shuja against Dost Mohammed, the reigning amir ot Kabul, he was closely identified. As political agent at Kabul he came into conflict with the military authorities and subsequently with his subordinate Sir Alexander Burnes. Macnaghten attempted to placate the Afghan chiefs with heavy subsidies; but when the drain on the Indian exchequer became too great and the allowances were reduced, this policy led to an outbreak. Burnes was murdered on Nov. 2, 1841; and because of the incapacity of the aged Gen. Sir Samuel Elphinstone, the British army in Kabul degenerated into a leaderless mob. Macnaghten tried to save the situation by negotiating with Dost Mohammed's son, Akbar Khan, by whom he was assassinated on Dec. 23, 1841.

McNAIR, LESLEY JAMES (1883–1944), U.S. army officer, who directed the training of ground combat troops during the mobilization for World War II, was born in Verndale, Minn., on May 25, 1883, and graduated from the U.S. Military academy in 1904. McNair served with Gen. Frederick Funston's expedition to Vera Cruz in 1914 and with Gen. John J. Pershing's punitive expedition into Mexico in 1916. In France during World War I, he was with the 1st division and the army of occupation in Germany.

Appointed chief of staff, general headquarters, U.S. army, in 1940 (title changed to commanding general, army ground forces, when the war department was reorganized in 1942), McNair prepared the army for combat by a rigorous training program that included the use of films, obstacle courses, live ammunition and large-scale maneuvers. He sought to perfect the military skills of the individual soldier, promote the proficiency of field force units and develop teamwork among the combined arms. By stressing standardization of military doctrine and organization throughout the army, he provided for the interchangeability of individuals and units, thereby making possible their rapid and effective utilization in the diverse theatres of operation.

Assigned to the European theatre in the summer of 1944, McNair visited the Normandy front to observe the battle and was killed near St. Lô on July 25, when bombs dropped by Allied planes fell short and landed on U.S. positions. (MN. BN.)

McNARNEY, JOSEPH TAGGART (1893–), U.S. army officer, one of the foremost military administrators of World

War II, was born at Emporium, Pa., on Aug. 28, 1893. After graduation from the U.S. Military academy at West Point in 1915, he follo ed a career in the air corps, which included service in France in World War I and school and staff experience in the 1920s and 1930s. McNarney was the chief architect of the important war department reorganization of March 1942, which established a simplified and effective structure. He was chosen immediately thereafter to be deputy chief of staff of the U.S. army, and his services in this position proved so valuable that he was not released for overseas duty until Oct. 1944, when he became commander of all U.S. forces in the Mediterranean. In Dec. 1945 he succeeded Gen. Dwight D. Eisenhower as commander of U.S. occupation forces in Germany, serving until early 1947 in that important and difficult position. McNarney retired in 1952 to enter private business. (A. GG.)

McNAUGHTON, ANDREW GEORGE LATTA (1887–), Canadian army officer, commander of the Canadian army in Great Britain during World War II, was born on Feb. 2 j, 1887, at Moosomin, Sask. While at McGill university he studied engineering and military subjects. Commissioned as a lieutenant in the Canadian artillery in 1910, he went overseas as a major in 1914, served both in France and Belgium and was twice wounded. He ended World War I as a brigadier general. In 1920 he was appointed director of military training. Three years later he became deputy chief of the Canadian general staff and in 1929 was made chief. as a major general. He held this high post until he became president of the National Research council of Canada in 1935. Keenly interested in scientific developments, particularly in aviation, he was himself joint inventor of the cathode ray direction finder.

When World War II broke out in 1939, McNaughton was recalled to the army and commanded the 1st Canadian division, which went overseas at the end of the year, and then in 1940, with the rank of lieutenant general, the 7th Canadian corps; and from April 1942 the 1st Canadian army overseas. Because of indifferent health he returned to Canada in 1944 and on Sept. 27, the date of his retirement from the army, was promoted full general. From Nov. 1944 to Aug. 1945 he was minister of national defense. From Jan. 1949 to June 1950 he acted as Canadian representative on the United Nations Security council.

(E. B. BN.)

McNEILE, HUGH (1795–1879), Anglican divine, was born at Ballycastle, Co. Antrim, on July 15, 1795, and graduated at Trinity college, Dublin, in 1810. He came under the influence of Edward Irving but was soon alienated by the latter's increasing extravagance. In 1834 he became incumbent of St. Jude's. Liverpool, where for 30 years he had great political as well as ecclesiastical influence, maintaining that "God, when he made the minister did not unmake the citizen." In 1835 McNeile entered on a long contest with the Liverpool corporation, which proposed to secularize its elementary schools by the introduction of the Irish national system. McNeile led a fierce agitation against the threatened withdrawal of the Bible as the basis of denominational religious teaching; before the new system could be introduced every child was provided for in new Church of England schools established by public subscriptions. McNeile was a zealous opponent of the Tractarian movement and a conspicuous leader of the evangelical party. In 1840 he published *Lectures on the Church oj England* and in 1846 (the year after John Henry Newman's secession to Rome) *The Church and the Churches,* maintaining the evangelical doctrine of the "invisible Church" in opposition to the teaching of Newman and Edward Pusey. In 1860 he was appointed a canon of Chester and in 1868 dean of Ripon.

MacNEILL, JOHN GORDON SWIFT (1849–1926), Irish historian and an authority on parliamentary procedure, was born in Dublin on March 11, 1849, and educated at Trinity college, Dublin, and Christ Church, Oxford. In 1875 he was called to the Irish bar. He became professor of constitutional and criminal law at King's Inn. Dublin. and from 1909 was professor in the h'ational University of Ireland. In 1887 he entered politics as the Nationalist representative of south Donegal, until the party was defeated by Sinn Fein in 1918. He was an accepted authority on parliamentary procedure and history. His books include *The Irish Parliament; What It Was and What It Did* (1885); *English Interference with Irish Industries* (1886); *How the Union Was Carried* (1887); *Titled Corruption* (1894); *Constitutional and Parliamentary History of Ireland* (1917); *Studies in the Constitution of the Irish Free State* (1925). In 1925 he published reminiscences and quotes a remark of Lord Fisher which is indicative of his political career: "Mr. MacNeill you are a damned good fighter! I wish to God I had you with me in the Navy!" MacNeill died in Dublin on Aug. 24, 1926.

MACOMER, a village of Sardinia, Italy, province of Nuoro, 95 mi. N.N.W. of Cagliari by rail. Population (1951) was 6,446. It is 1,890 ft. above sea level on the southern ascent to the central plateau (Campeda); and it is the junction of narrow-gauge lines branching from the main line eastward to Nuoro and westward to Bosa. The old parish church of S. Pantaleone has three Roman milestones in front of it, belonging to the Roman highroad from Carales to Turris Libisonis. The *nuraghe* of S. Barbara is fine. The Allies bombed Macomer in World War II.

MACON, NATHANIEL (1758–1837), U.S. political leader, was born at Macon Manor, N.C., Dec. 17, 1758. He studied at the College of New Jersey (now Princeton university) from 1774 to 1776, when the institution was closed because of the outbreak of the Revolutionary War. In 1777–80 he studied law at Bute county courthouse, N.C., and in 1781–85 served in the North Carolina senate. In 1791–1815 he was a member of the national house of representatives, and in 1815–28 of the United States senate. Macon's point of view was always local rather than national. He was essentially a North Carolinian first, and an American afterward; and throughout his career he was an aggressive advocate of state sovereignty and an adherent of the doctrines of the "Old Republicans." In congress he denounced Alexander Hamilton's financial policy, opposed the Jay treaty (1795) and the Alien and Sedition acts, and advocated a continuance of the French alliance of 1778. His party came into power in 1801, and he was speaker of the house in 1801–07. At first he was in accord with Thomas Jefferson's administration; he approved the Louisiana Purchase. and as early as 1803 advocated the purchase of Florida. For a number of years, however, he was politically allied with John Randolph in a group of about ten independents, called the "Quids." who strongly criticized Jefferson and opposed the presidential candidature of James Madison. By 1809, however, Macon was again in accord with his party, and during the next two years he was one of the most influential of its leaders. In Dec. 1809 he introduced resolutions recommending the complete exclusion of foreign war vessels from United States ports and the suppression of illegal trade carried on by foreign merchants under the U.S. flag. The substance of these resolutions was embodied in a bill which became law on May 1, 1810. This measure provided for the repeal of the Non-Intercourse act of 1809, authorized the president, "in case either Great Britain or France shall before the 3rd day of March next so revoke or modify her edicts as that they shall cease to violate the neutral commerce of the United States," to revive nonintercourse against the other and prohibited British and French vessels of war from entering U.S. waters. In 1812 Macon voted for the declaration of war against Great Britain. He opposed the Bank act of 1816, the "internal improvements" policy of John C. Calhoun (in the early part of his career) and Henry Clay and the Missouri Compromise. In 1824 Macon received the electoral vote of Virginia for the vice-presidency, and in 1826–28 was president pro tempore of the senate. He died at Buck Springs, N.C., on June 29, 1837.

See William E. Dodd, *The Life* of *Nathaniel Macon* (1903); E. M. Wilson, *The Congressional Career of Nathaniel Macon* (1900).

MÂCON, a town of east central France, capital of the *département* of Saône-et-Loire, 45 mi. N. of Lyons on the Paris-Lyon railway. Pop. (1954) 20.226. Mâcon *(Matisco)* was an important town of the Aedui, but under the Romans it was supplanted by Autun and Lyons. It suffered at the hands of the Germans, Burgundians, Vandals, Huns, Hungarians and even of the Carolingian kings.

In the feudal period it was an important countship sold in 1228 to the king of France, but at times in the possession of the dukes of Burgundy until the ownership of the French crown was established in the time of Louis XI.

In the 16th century Mâcon became a stronghold of the Huguenots, but afterward fell to the league, and only yielded to Henry IV in 1594. The bishopric, created by King Childebert, was suppressed in 1790.

Mâcon is situated on the Saône facing the plain of the Bresse; a bridge of 12 arches connects it with the suburb of St. Laurent on the opposite bank. The modern Romanesque church of St. Pierre is a large three-naved basilica. Of the old cathedral of St. Vincent (12th and 13th centuries), destroyed at the Revolution, nothing remains but the Romanesque narthex, now used as a chapel, the façade and its two flanking towers. The hôtel de ville contains a library, a theatre and picture gallery. Mâcon is the seat of a prefecture, and has tribunals of first instance and of commerce, and a chamber of commerce.

Copper-founding is an important industry, also printing; manufactures include casks, mats, esparto articles, powders, rope and utensils for the wine trade.

The town has a large trade in wine produced in the district, known as Mâcon. The railways from Paris to Marseilles and from Mont Cenis to Geneva, with a branch from Moulins are joined there.

MACON, a city of central Georgia, U.S., and the seat of Bibb county, is located about 75 mi. S.E. of Atlanta, on the Ocmulgee river, on the fall line. North Carolinians were the first settlers to build their homes on the east side of the river at Ft. Hawkins, a frontier trading post. The original settlement was called Newtown (1821), but after the Creek Indians ceded land west of the river, a site along its bank was platted in 1823 and named for Nathaniel Macon (*q.v.*). Newtown was annexed in 1829, and the city was chartered in 1832.

In the 1840s Macon became a market centre for cotton which was shipped downstream to Darien, and by the 1860s, with the coming of the railroads, its position as a trade and transportation centre had become established. During the American Civil War, Macon was a Confederate gold depository, and its factories produced munitions and supplies until Gen. Howell Cobb surrendered to the Union cavalry commander, Gen. James H. Wilson, on April 20, 1865.

Macon slowly rebuilt its economy during the Reconstruction period, and railroad shops, foundries, brickworks and textile mills were developed. The turn of the century saw civic improvements, which included the construction of a levee as a protection against river floods, and an extension of city limits. Economic stimulus was given during World War I with increased industrial employment and the influx of thousands of soldiers to camps Harris and Wheeler. The United States naval ordnance olant and Warner Robins air matériel area (now Robins air force base) became permanent installations after World War II.

In the 1960s the inhabitants in the metropolitan area were principally engaged in processing and distributing agricultural products from the surrounding fertile farm lands. which include cotton, grain. pulpwood, peaches. peanuts and pecans.

There are also industries based on nearby mineral resources, such as kaolin, granite, clays, limestone and lime. Scores of newer industries established in the area in the late 1940s and 1950s, include the manufacture of car accessories, candy, aircraft parts, drugs, clothing and chemicals.

The original settlers laid out exceptionally wide streets, nhich contain floral parkways. Macon's public parks are noted for their azaleas, camellias and glossy-leaved magnolias. The cultural atmosphere is enhanced by: Wesleyan college, a pioneer in higher education for women, established by the hlethodists in 1536; Mercer university, founded by the Baptists at Penfield in 1833 and moved to Macon in 1871; and Georgia Academy for the Blind (1851). Amid the splendour of ante-bellum Greek Revival houses with their majestic white columns adding old south charm to the city, there is a modest cottage on High street, the birthplace of Sidney Lanier (*q.v.*), Georgia's most renowned poet. These homes plus Indian mounds and relics. notably the Lamar mounds and village site, at Ocmulgee National monument are major tourist attractions.

The population of Macon city was 69,764 in 1960; the standard metropolitan statistical area comprising Bibb and Houston counties had a population of 180,403. (S. B. K.)

McPHERSON, AIMEE SEMPLE (1890–1944), U.S. evangelist and founder of the International Church of the Foursquare Gospel, was born near Ingersoll, Ont., Oct. 9. 1890. Her public career began as a missionary in China with her first husband, Robert Semple, a Pentecostal evangelist. She returned to the United States with her daughter after her husband's death, and a second marriage to Harold McPherson was ended by her turning to full-time itinerant evangelism and healing. In this she became an outstanding success, settling finally in Los Angeles, Calif., nhere for almost 20 years she preached to large congregations. Besides organizing (1926) and administering the International Church of the Foursquare Gospel. Mrs. McPherson built a radio station, founded and headed a Bible school, edited a magazine, wrote books and phamphlets and carried on extensive social service work. An attractive woman, she used her charms to the full. Her dynamic personality, prodigious energy and bizarre methods won for her countless friends and a number of enemies. Theologically she was fundamentalist and in her emphasis Pentecostal. The loyalty of her followers — in the face of her third marriage, which ended in a divorce, and various grave charges (unproved) against her — was constant.

Mrs. McPherson died on Sept. 27, 1944, from an overdose of sleeping ponders. Her son Rolf McPherson succeeded her, and the movement continued to grow, reporting in the late 1950s more than 700 churches.

Mrs. McPherson's published works include *This Is That* (1923); *In the Service of the King* (1927); and *Give Me My Own God* (1936). *The Story of My Life* was edited and published in her memory in 1951.

See Nancy B. Mavity, *Sister Aimee* (1931). (C. S. B.)

MACPHERSON, SIR DAVID LEWIS (1818–1896), Canadian financier and politician, mas born at Castle Leathers, near Inverness, Scot, on Sept. 12, 1818. In 1835 he emigrated to Canada, settling in Montreal, Que., where he built up a large fortune by "forwarding" merchandise. In 1853 he moved to Toronto, Ont., and obtained the contract for building a line of railway from Toronto to Sarnia, Ont., a project from which sprang the Grand Trunk railway. In 1864 he was elected to the Canadian parliament as member of the legislative council for Saugeen, Ont , and on the formation of the dominion, in 1867, was nominated to the senate. He published a number of pamphlets on economic subjects, of which the best-known is *Banking and Currency* (1869). In 1880 he was appointed speaker of the senate, and from Oct. 1883 till 1885 was minister of the interior in the Conservative cabinet.

In 1884 Macpherson mas knighted. He died on Aug. 6, 1896.

MACPHERSON, JAMES (1736–1796), Scottish "translator" of the Ossianic poems, was born at Ruthven. Inverness, on Oct. 27, 1736. He studied at King's college, Aberdeen (1753), at Marischal college and in Edinburgh. He is said to have written more than 4,000 lines of verse while a student, but though some of this was published, notably *The Highlander* (1758), he afterward tried to suppress it. On leaving college he taught in the school of his native place. At Moffat he met John Home, the author of *Douglas,* who encouraged him to publish translations from the Gaelic, as *Fragments* of *Ancient Poetry coliected in the Highlands of Scotland* (Edinburgh, 1760). Hugh Blair, who was a firm believer in the authenticity of the poems, got up a subscription to allow Macpherson to pursue his Gaelic researches. In the autumn he set out to visit western Inverness, the islands of Skye, North and South Uist and Benbecula. He obtained mss. which he translated with the assistance of Captain Morrison and the Rev. 4. Gallie. Later in the year he made an expedition to Mull. when he obtained other mss. In 1761 he announced the discovery of an epic on the subject of Fingal, and the next year published *Fingal, an Ancient Epic Poem in Six Books, together with Several Other* Poems *composed by Ossian, the Son of Fingal, translated from the Gaelic Language,* written in the musical measured prose of which he had made use in his earlier volume. *Temora* followed in 1763, and a collected edition, *The Works of Ossian,* in 1765.

The genuineness of these so-called translations from the works of a 3rd-century bard was immediately challenged in England, and Samuel Johnson, after some local investigation, asserted (*Journey to the Western Islands of Scotland,* 1775) that Macpherson had only found fragments of ancient poems and stories, which he had woven into a romance of his own composition. Macpherson never produced his originals, which he refused to publish on the ground of the expense. In 1764 he was made secretary to General Johnstone at Pensacola, West Florida, and when he returned, two years later, to England, after a quarrel with Johnstone, he was allowed to retain his salary as a pension. He wrote several historical works, the most important. of which was *Original Papers, containing the Secret History of Great Britain from the Restoration to the Accession of the House of Hanover; to which are prefixed Extracts from the Life of James II., as written by himself* (1775). He enjoyed a salary for defending Lord North's government, and held the lucrative post of London agent to Mohammed Ali, nabob of Arcot. He entered parliament in 1780, and at his estate, Belville, Inverness, he died, Feb. 17, 1796.

After Macpherson's death, Malcolm Laing, in an appendix to his *History of Scotland* (1800), propounded the view that the so-called Ossianic poems were altogether modern in origin, and that Macpherson's authorities were practically non-existent. For a discussion of this question *see* SCOTTISH LITERATURE : *In Gaelic.* Apart from the doubtful morality of Macpherson's transactions he was a great writer. He did not transcribe actual Celtic poems, but he appreciated natural beauty and his art, with its tenderness, did more than any single work to bring about the romantic movement in European, and especially in German, literature. It was translated into many European languages, and Herder and Goethe (in his earlier period) were among its admirers. Cesarotti's Italian translation was one of Napoleon's favourite books.

BIBLIOGRAPHY.—For Macpherson's life, see *The Life and Letters of James Macpherson . . .* (1894, new ed., 1906), by T. Bailey Saunders who has laboured to redeem his character from the suspicions generally current with English readers. The antiquity of the Ossianic poems was defended in the introduction by Archibald Clerk to his edition of the *Poems of Ossian* (1870). Materials for arriving at a decision by comparison with undoubtedly genuine fragments of the Ossianic legend are available in *The Book of the Dean of Lismore,* Gaelic verses, collected by J. McGregor, dean of Lismore, in the early 16th century (ed. T. McLauchlan, 1862); the *Leablzar na Feinne* (1871) of F. J. Campbell, who also discusses the subject in *Popular Tales of the Western Highlands,* iv. (1893). *See* also L. C. Stern, "Die ossianische Heldenlieder" in *Zeitschrift fur vergleichende Litteratur-geschichte* (1895; Eng. trans. by J. L. Robertson in *Trans. Gael. Soc. of Inverness,* xxii., 1897–1898); Sir J. Sinclair, *A Dissertation on the Authenticity of the Poems of Ossian* (1806); *Transactions of the Ossianic Society* (Dublin, 1854–61); *Cours de littérature celtique,* by Arbois de Jubainville, editor of the *Revue celtique* (1883, etc.); A. Nutt, *Ossian and the Ossianic Literature* (1899), with *a* valuable bibliographical appendix; J. S. Smart, *James Macpherson: an Episode in Literature* (1905), *Fragments of Ancient Poetry* was reprinted *in* 1917.

McPHERSON, JAMES BIRDSEYE (1828–1864), American soldier, was born at Sandusky, O., on Nov. 14, 1828. He entered West Point at the age of 21, and graduated (1853) at the head of his class, which included Sheridan. Schofield and Hood. He was employed at the military academy as instructor of practical military engineering (1853). A year later he was sent to engineer duty at New York, and in 1857 he was sent as superintending engineer to San Francisco, becoming first lieutenant in 1858. He was promoted captain during the first year of the Civil War, and towards the close of 1861 became lieutenant-colonel and aide-de-camp to Gen. Halleck, who in the spring of 1862 sent him to Gen. Grant as chief engineer. He remained with Grant during the Shiloh campaign, and acted as engineer adviser to Halleck during the siege operations against Corinth in the summer of 1862. In October he distinguished himself in command of an infantry brigade at the battle of Corinth, and on the 8th of this month was made major-general of volunteers and commander of a division. In the second advance on Vicksburg (1863) McPherson commanded the XVII. corps, fought at Port Gibson, Raymond and Jackson, and after the fall of Vicksburg was strongly recommended by Grant for the rank of brigadier-general in the regular army, to which he was promoted on Aug. 1, 1863. He commanded at Vicksburg until the following spring. He was about to go on leave of absence when he received his nomination to the command of the Army of the Tennessee, Grant's and Sherman's old army, which was to take part under Sherman's supreme command in the campaign against Atlanta (1864). This nomination was made by Sherman and entirely approved by Grant. McPherson commanded his army at the actions of Resaca, Dallas, Kenesaw Mountain and the battles about Atlanta. On July 22, when the Confederates under his old classmate Hood made a sudden and violent attack on the lines held by the Army of the Tennessee, McPherson rode up, in the woods, to the enemy's firing line and was killed. Grant is reported to have said "The country has lost one of its best soldiers and I have lost my best friend."

MACQUARIE, an island group in the Pacific ocean in long. 158° 54′ E. and lat. 54° 37′ S, The largest island is 21 mi. by 3 mi. The group is at the convergence of two submarine ridges, from Tasmania and through Auckland and Stenart Island to New Zealand. It is a scientific base and nature reserve. Australia has maintained a weather station there since 1948. This succeeded the temporary station of the Mawson Antarctic expedition. 1911–13.

MACREADY, WILLIAM CHARLES (1793–1873), English actor. manager and diarist, the greatest figure of the 19th-century stage in the development of techniques of acting and production. was born in London on March 3, 1793, the son of a minor Irish actor. who shortly afterward undertook a career as manager of provincial acting companies. Macready was entered at Rugby to prepare for the bar. but his father's financial difficulties and his own highly developed sense of personal responsibility caused him to abandon his formal education and take up temporarily, he thought. the theatre, a profession to which he was to make an outstanding contribution but for which he always felt an intense dislike. On June 7, 1810. he made his debut as Romeo at Birmingham and rapidly acquired fame in other Shakespearean and romantic roles in the provincial theatres. On Sept. 16, 1816, he appeared at Covent Garden. London. as Orestes in *The Distressed Mother,* a dull and outmoded tragedy by Ambrose Philips. Theatrical rivalry forced upon him a series of romantic and melodramatic villains, which he performed with such earnestness and truth that he became firmly established. though they did nothing to increase his affection for the stage. On Oct. 25, 1819, he was permitted to appear as Richard III in a text that he partially purged of the "improvements" of Colley Cibber, the first of his many important efforts to restore the original work of Shakespeare to the theatre. In 1820 he created the leading role in *Virginius,* the first produced play by James Sheridan Knowles, and from that time was recognized as belonging in the front rank of English actors, contested for the first place only by Edmund Kean.

Throughout his acting career at Covent Garden and at Drury Lane. Macready devoted himself wholeheartedly to his art. His method of long study and detailed rehearsal. at a time when the general practice was casual, conventional and inspirational, anticipated much of the naturalistic method of acting developed by Constantin Stanislavsky. In 1837 he undertook the management of Covent Garden, where he was able to extend his theory of acting to all the elements involved in production. He was thus the first to impose upon the theatre of realistic illusion the principle of unity: that the actors, from star to spear carrier, the designer, the costumer and all others connected with a performance be guided and controlled by the central ideas and concepts oi the playwright. Macready gave impressive demonstrations of his theory in notable revivals of *As You Like It, Macbeth, King Lear, Henry V* and *The Tempest,* as well as Handel's *Acis and Galatea.* The historical research that went into these productions was to have a strong influence on English stagecraft; the principle of theatrical unity was adopted and developed by the German predecessors of the duke of Saxe-Meiningen and anticipated the *régisseur* of the 20th century.

In addition to reviving standard plays, Macready also made industrious efforts to improve the repertory of modern drama. He worked closely with such professional playwrights as Sheridan Knowles and Bulwer-Lytton and worked tirelessly to persuade the leading literary figures of the day to turn to playwriting. For him. Robert Browning created *Strafford* and Sir Thomas Talfourd, *Ion*, Charles Dickens, his intimate friend for many years. assisted him in the search for plays, supported him in his managerial efforts and endeavoured without success to write a stageworthy comedy. After 1825 Macready moved freely in the highest literary and artistic circles of London: and the pages of his voluminous diary (twice edited, 1875, 1912) are a happy hunting ground for literary and historical scholars.

Macready made several professional tours outside England. In 1828 he joined a group of English players in Paris. where his distinctive style, a combination of domestic sensibility and emotional power. was eagerly welcomed by the new romantic school. particularly by Victor Hugo and Alfred de Musset. He visited America three times) in 1826, 1843 and 1848. He was much impressed by the political and social achievements of democracy, particularly in the field of public education, and seriously entertained thoughts of settling in New England. However, during his last visit, he was made the scapegoat of the Nativist political movement; their attacks on him as a foreigner and an aristocrat culminated in a public riot outside the Astor Place "opera house" in New York, during which more than 20 persons were killed by the militia and from which he narro ly escaped with his life (*see* FORREST! EDWIN). He abandoned all thoughts of emigrating, returned to England for his farewell performances and retired from the stage in his favourite role of Macbeth on Feb. 26, 1851.

Freed of his distasteful profession, he settled in Sherborne, Dorset, where he intended to devote himself to the education of his own large family and of the farm workers and labourers of the community. In 1823 he had married Catherine Atkins, an actress, who retired to motherhood and produced nine children. The family was cursed with ill health, the mother dying in 1852 and only one son and one daughter surviving Macready. In 1860 he married Cecile Louise Spencer. by whom he had a son. His lost years were spent in increasing gloom and unhappiness in Sherborne and later in Cheltenham, where he died on April 27, 1873.

Macready was an intellectual rather than an inspirational actor, at his best in such philosophical roles as Richelieu and Hamlet. He was capable of great emotional intensity! however, and in such parts as Lear or Byron's Werner. involving paternal or domestic feelings, he was unequaled. A lesser actor than Garrick and perhaps Kean when the latter was at his best, Macready was more important than either in his influence on the acting style and production techniques that made possible the art of the modern theatre.

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MACROBIUS, AMBROSIUS THEODOSIUS (fl. *c.* A.D. 400), Latin grammarian and philosopher, whose most important work is the *Saturnalia,* the last-known example of the long series of symposiums headed by the *Symposium* of Plato. He may be the Macrobius who was praetorian prefect in Spain (399), proconsul in Africa (410) and grand chamberlain (422). He was not Italian by birth. The *Saturnalia,* which is dedicated to Macrobius' son Eustachius, purports to give an account of discussions in private houses on the day before the *Saturnalia* and on three days of that festival. There is little attempt to give dramatic character to the dialogue. It is in seven books, parts of which are not extant, and contains countless quotations from earlier writers. It is also interesting for the light it throws on the educated society of the day. Its sources include Seneca: Gellius and Plutarch. The first book discusses, among other topics, the *Saturnalia,* the Roman calendar, the sun and other divinities. The second book. of which part is lost, is chiefly devoted to witticisms. The third book is partly concerned with the luxury of the ancients. The miscellaneous seventh book is partly concerned with scientific matters. The subject of part of the third book and of the fourth, fifth and sixth books is Virgil. who is treated with great reverence. His rhetoric and learning, or rather omniscience, is everywhere insisted upon.

Macrobius also wrote a commentary on Cicero's "Somnium Scipionis" ("The Dream of Scipio") from the *De Republica.* This is a neoplatonic work in two books. Plato's *Timaeus* is often mentioned. Macrobius may have used Porphyry's commentary on it, and he may also have used a neoplatonic commentary on Virgil. Of a third work by Macrobius entitled *De differentiis et societatibus Graeci Latinique verbi* ("On the differences and similarities of the Greek and Latin verb") only fragments remain.

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MACROZAMIA: see GYMNOSPERMS.

MACTAN, a low-lying coral island in the Philippines protecting the port of Cebu city (*q.v.*) and separated from Cebu island by a mile wide channel. Area 24 sq.mi. Pop. (1959 est.) 54,388. On April 27, 1521, Ferdinand Magellan invaded Mactan with a force of 49 Spaniards while 1,000 Cebuan allies and 11 Spanish guards watched from boats.

In the ensuing battle Magellan was killed by the Mactans under the leadership of Lapu-Lapu, the first Filipino to defeat a western conqueror. The island is a part of the province of Cebu (*q.v.*). Coconut growing and fishing are important in the economy. (R. E. HE.)

MACTARIS, 22 mi. S.E. of Le Sers, which is 103 mi. S.W. of Tunis by rail. an ancient town of North Africa, in which the influence of Punic civilization lasted until A.D. 200, when it became a Roman colony.

Mactaris has a fine arch of triumph of Trajan (A.D. 116), another triumphal arch; a temple of Apollo and Diana; an aqueduct. of nhich 12 arches are still standing, and (perhaps) the thermae which it supplied. and the remains of two mausolea.

MacVEAGH, (ISAAC) WAYNE (1833–1917), U.S. lawyer, diplomat and political reformer, was born near Phoenixville, Pa., on April 19, 1833. He graduated from Yale in 1853. Admitted to the bar in 1856, he was district attorney of Chester county, Pa., 1859–64. He held commands in militia forces raised to meet threatened Confederate invasions of Pennsylvania (1862–63). He became a leader in the Republican party, and from 1871 was a prominent opponent of his father-in-law, Simon Cameron, the Republican political boss in Pennsylvania.

MacVeagh was minister to Turkey, 1870–71, a member of the state constitutional convention of 1872–73, and chairman of the "MacVeagh commission," sent in 1877 by Pres. Rutherford B. Hayes to Louisiana; it secured the settlement of the contest between the two existing state governments and thus made possible the withdrawal of federal troops from the state. He was also attorney general of the Cnited States in 1881 under Pres. James Garfield, but resigned after Garfield's death.

An advocate of civil service reform and tariff reduction, he supported (1892) Grover Cleveland, the Democratic nominee for the presidency, and was later ambassador to Italy. He returned to the Republican party in 1896. In 1903 he was chief counsel of the United States before The Hague tribunal in the case of Germany, Great Britain and Italy against Venezuela. MacVeagh died at Washington, Jan. 11, 1917.

MACWHIRTER, JOHN (1839–1911), British landscape painter, was born near Edinburgh on March 27, 1839. He was elected member of the Koyal Scottish Academy in 1867, A.R.A. in 1879 and R.A. in 1893. His "June on the Austrian Tyrol" was bought in 1892 out of the Chantrey bequest. He died in London on Jan. 28, 1911.

MADÁCH, IMRE (1823–1864), Hungarian poet, author of a poetic drama which has won fame in Hungary and, in translation, in other European countries for its lofty philosophical thought and its effectiveness on the stage. He was born on Jan. 21, 1823, at Alsósztregova, and died there on Oct. 4, 1864. A nobleman by birth, he spent his life in farming and public service.

Intelligent, with keen and catholic interests, Madách indulged in poetry and wrote several dramas, all rather weak. He secured himself a place of honour in Hungarian literature by his *Az ember tragédiája* (1861; Eng. trans. The Tragedy of *Man*, 1933), a breath-taking drama in 15 acts covering the past and future of mankind, from the Creation to an ice age caused by the cooling of the sun. The central figures are Adam (who in some of the scenes assumes the personality of a well-known figure, e g. Miltiades, Tancred, Repler, Danton), Eve and Lucifer (dramatically a most rewarding role) who, in a spirit of negation and out of spite, wishes to demonstrate the failure of God's work and the futility of man's endeavour to improve. Though his demonstration —in Madách's presentation — seems to carry conviction, he is vanquished through his inability to take into account God's infinite mercy to which Adam should pin his hopes. (Ds. Sr.)

MADAGASCAR (Malagasy Republic), an island in the Indian ocean about 250 mi. off the east coast of Africa. It was a French colony from 1896 to 1946, a territory of the French Cnion until 1958 and since then it has formed part of the French Community as the Malagasy Republic.

After Greenland, New Guinea and Borneo, Madagascar is one of the largest islands in the world. Its area is 227.760 sq.mi. with a maximum length of 995 mi. and a maximum width of 360 mi. It lies in the southern hemisphere between 11° 57' and 25° 38' lat. S. and 43° 12' and 50° 17' long. E. and is thus almost entirely within the tropics; the Tropic of Capricorn crosses the southern end of it. The Mozambique channel separating it from Africa is only 248 mi. wide at its narrowest part.

Madagascar is surrounded, at a distance of 185 mi. to 560 mi. by small groups of volcanic islets: the Comoro Islands, the Mascarene Islands and the Seychelles.

This article is divided into the following sections and subsections:

I. PHYSICAL GEOGRAPHY

1. Geology and Paleontology. — The former hypothesis that the island was at one time part of Gondwanaland (*q.v.*), an immense continent joining southern Africa to India, is now disputed. It seems probable that a gulf corresponding to the southern part of the Mozambique channel existed from the end of the Paleozoic era and that the subsidences or slow driftings which have brought the island to its present position took place at the beginning of the Mesozoic era. Very ancient Pre-Cambrian foldings have affected an assemblage of paragneissic formations with granitic intrusions. On these formations rest three more recent series, also traversed by granitic intrusions of which the youngest, schists and quartzites, are of the Devonian period; they have been distorted by movements of the Hercynian orogenesis, as is shown by the faults and subsidences which divide up the central massif. The interior of the island has the appearance of a horst to which are opposed the western plateaus with their regular sedimentary layers. From the foot of the hills to the Mozambique channel the strata run from Carboniferous to Middle Jurassic; these formations are called Karroo by analogy with the similar African ones. At the end of the Cretaceous, the sea invaded the east coast for the first time: the advances and withdrawals of the sea occurred from then on in regular succession and different layers accumulated: Upper Jurassic marls, Cretaceous marl-sandstone deposits, Eocene and Miocene limestones which seem to mark the end of marine sedimentation. The Neogene is continental everywhere, yellow sands on the west coast, southern clay sheets passing into the Androy sands laterally, lacustrine deposits in the interior. Tertiary movements have only slightly modified the sedimentary layers of the coastal regions, but have on the other hand violently affected the old shelf. Ancient fractures have come together again and new ones have appeared, accompanied by volcanic manifestations everywhere. Cretaceous eruptions showed in basaltic flows, Miocene eruptions in the extreme north, pro-Quaternary eruptions represented by basaltic flows and the recent systems of the Montagne d'Ambre, of the Ankaratra and of the Itasy. Violent earthquakes have often shaken the island and bear witness even today to the strength of orogenic forces.

Numerous fossil remains have shown the existence of a whole giant fauna, giant land tortoises and Lemuridae (*Megaladapis, Archoeoindris*) much bigger than the modern species. A giant bird, *Aepyornis*, was perhaps contemporary with the first inhabitants of the island. It was about the size of an ostrich, but it was completely wingless and had enormous feet. Its eggs, whose fossils have been found until recently, were bigger than ostrich eggs. Reptiles also seem to have been very large, *e.g.*, the Bothriospondylus, related to the Diplodocus, which measured more than 66 ft. Finally, traces of fossil fishes whose species have disappeared are very often found in the lacustrine deposits.

2. Relief and Drainage. — The island consists of three large parallel longitudinal zones. the central plateau formed from ancient systems; a narrow littoral strip to the east; and a zone of sedimentary formations comprising low plateaus and vast plains to the west.

The Plateau.—Between 2.500 and 4,500 ft. the plateau is composed of ancient crystalline and eruptive rocks. It has been several times folded and worn down and is tilted to the west where the slope is less sheer than it is to the east. The whole is covered with a red soil, a lateritic clay resulting from the breakdown of the rocks by rain and heat and which owes its colour to the iron oxide it contains. Where this red soil is covered with humus it bears forests and crops, but where it has been leached it forms a sterile lateritic covering.

Three massifs of the plateau are over 6,500 ft. in height: the Tsaratanana in the north, separated from the rest of the plateau by the swell of Androna, nhose volcanic summit (9,468 ft.) is the highest point on the island; the Ankaratra in the centre, an enormous volcanic mass whose summit, Tsiafajavona, is 8,674 ft. high. The Ankaratra is a watershed separating three basins: the Imerina in the centre of the island where Tananarive stands on the Betsimitatra plain; the Itasy with its famous lake of volcanic origin; the Vakinankaratra, full of extinct volcanoes and hot springs. Farther south. the Andringitra, a vast granitic massif. dominates the Betsileo district. The plateau slopes more regularly toward the extreme southern plain but its boundaries to east and west are more abrupt. To the east it descends in a sharp fault by steps of 1 to 200 ft. This cliff, called the Great cliff or Cliff of Angavo is often impassable and is itself tordered by an escarpment (Betsimisaraka) which overhangs the coastal plain. Behind the scarp face are the remains of ancient lakes (Alaotra). To the south the two steep gradients meet forming the plateaus of the Mahafaly and the Androy, which in most places overhang the sea in precipitous cliffs. Toward the west, on the other hand, the descent is made in a series of steps, like the Tampoketsa which leads to the plains of Majunga or the plateaus of the Isalo. Sometimes, however, the plateau is bordered by an escarpment, less high than that of the east but still impassable (cliff of Bongolava). Finally, to the extreme north, the plateau is separated by the low sedimentary belt of the Ambre massif, which includes a series of volcanic craters.

The Eastern Coastal Zone. — This zone has an average width of 30 mi., and is a narrow alluvial plain terminating at the sea in a low coastline bordered with extensive lagoons linked together by the Canal des Pangalanes. To the south of Farafangana, the coast becomes rocky but still inhospitable, and it is only in the southeastern tip of the island that there are little bays. There, at Sainte-Luce and Fort-Dauphin were the first French settlements.

The Western Zone.—This is everywhere broader, being from 62 mi. to 124 mi. wide. Its sedimentary layers slope toward the Mozambique channel and produce a succession of hills, especially in the Sakalava country. One side of these steep hills dominates the hollows formed in the soft sediments, while the other descends to the sea in rocky slopes (Borna-Bamaraha). The coast itself is straight, bordered by small dunes and fringed with mangroves.

The currents in the Mozambique channel have favoured the deposit of alluvium and the growth of deltas. On the northwestern coast there are estuaries and bays (Diégo-Suarez). This coast is bordered by coral 'reefs and volcanic islands like that of Nossi-Bé (Nosy BC) which protects the bay of Ampasindava.

The hydrography of the island is also to be explained by' the asymmetry of its relief. The rivers of the east are short, turbulent, and have an abundant flow. They discharge either into the lagoons, through sandy mouths which are constantly shifting, or directly on to the coast with rapids and waterfalls.

These are the rivers Maningory (whose source is Lake Alaotra), Loky, Bemarivo and the northern Mananara in the northeast; the Ivondrona, Mananjary, Faraony, Mananysatra rivers in the east. The most important rivers are those which have captured plateau streams: the Mangoro, in the centre, which drains part of the intermediate slope and receives the Onive from the plateau; and the southern Mananara, nhich receives two tributaries from the slope and one from the plateau. The western rivers are much longer, regular and often navigable over long stretches. But they carry masses of alluvium which block their estuaries. The chief are the Sofia, the Betsiboka, which is in Tananarive province and navigable for over 150 mi., the Tsiribihina, formed by three rivers of which two come from the plateau, the Mangoky which ends in a huge delta, and the Onilahy, which flows through arid country and has a less abundant flow (it has a well-sheltered estuary to the south of Tulear).

All these rivers are very important, not only for navigation but because, intersected by dams, they can provide power and water for irrigation of crops. There are numerous lakes of volcanic origin (Itasy, to the west of the Ankaratra, Titriva near Antsirabé). Lake Alaotra is the last survivor of the immense lakes which once occupied the eastern slope. To the southwest Lake Tsimanampetsotsa is a huge salt lake covering $7\frac{3}{4}$ sq mi. without outlet.

3. Climate.—The individuality of the island's climate is explained essentially by two phenomena: the asymmetry of the relief and the winds. The plateau forms a permanent obstacle to the winds, and is the major factor in the differentiation of the climatic regions.

The winds are of three kinds: sea breezes, trade winds and monsoons. The sea breezes have only a local effect in cooling the shores, and their influence is hardly felt inland. The trade is the dominant mind. Caused by the anticyclone situated over the Indian ocean between Madagascar and Australia, it blows from the southeast almost continuously, but is particularly violent during the southern winter (May to September). The east coast is thus to windward and has a high rainfall (139 in. per year at Maroantsétra in Antongil bay). But once past the cliff of Angavo and over the plateau, the trade wind loses its humidity and behaves like a foehn; it does not bring rain to the Sakalava country, which receives its rainfall from the monsoon. The latter is most noticeable during the southern summer (October–April) when the sun is near its zenith. It comes from the north as a continuation of the Indian monsoon but produces northwesterly winds because of deviation (Majunga has a rainfall of 64 in. from November to April, and an annual total of 65 in.). The southwest receives scarcely any rainfall, except from occasional storms, and so is a semidesert region. The central plateau enjoys a tropical mountain climate with well differentiated thermal seasons (at Tananarive the hot season lasts five months, the cool season seven and there are 53.5 in. of rainfall, of which only 4 in. occurs during the six winter months. Lastly, the influence of the cyclones must be noted as they devastate the island periodically. Madagascar lies in the path of the southwestern cyclones of the Indian ocean, and Tamatave is one of the most exposed places (cyclone of 1927).

4. Vegetation.—The vegetation zones are likewise longitudinal. The screw pines and palms of the east coast dunes are succeeded inland by the reeds of the lagoons and by the viha, a kind of wide-leaved arum which grows in the marshes, and, on the low hills, by scrub. Most of the swamps have been turned into rice fields and the slopes have been planted. Toward the escarpment the vegetation becomes more dense: the savoka is sometimes formed by scrub (Longozo, *Haronga, Citrus*) and sometimes by a denser brushwood (Ravenala, the traveler's tree, with giant leaves at the top of a smooth trunk; sevabe and dingadinga, varieties of bamboo), but it is never suitable for timber. The true forest (ala) is higher up though it now covers only a small area (about 7% of the island). It consists of small thin trees 65–80 ft. high and of varied kinds. At their base grow ferns, dwarf palms and grasses; there are also numerous lianas and epiphytes. The plateau is an area of grassland, and there are no trees except round the villages. The grasses are mostly burned by the cattle raisers and gradually disappear allowing the red earth to be seen. In the plains of the west the grassland gives place to savanna: the grasses, which are taller, are scattered with fire resisting trees like the satrana, a large variety of palm. The savanna, which produces a very monotonous countryside, is tending to spread into the Sakalava country and into the forest of deciduous' trees which formerly wooded the whole west of the island. On the western plateaus, however, there remain the baobab trees and in the lower parts, the raffia palm.

In the north and northeast (Montagne d'Ambre, Tsaratanana, Nossi-Bé) the vegetation is the same as in the east. savoka tending to replace the forest. By contrast, the Androy region in the extreme south is characteristic. It is the region of Karroo scrub, with spiny succulents. A great number of the plants in the island are unique and many are in danger of becoming extinct through constant burning.

5. Animal Life.—The unique form of Madagascar animal life is equally remarkable. At first, the island had no monkeys, deer or snakes. It has, nevertheless, three quarters of the known Lemuridae of the world; about 40 species are found there, including the *Indris,* 39 in. high (eastern forests, around Tamatave and Antonpil bay) and the Microcebus the size of a fist. *Propithecus* is found in the south and east and it has been possible to tame other species of lemur like the maki and the varika.

The nocturnal aye-aye (*Daubentonia madagascariensis*) is a species peculiar to Madagascar. Other vertebrates include many kinds of hedgehogs, bats, civet cats and rodents. Birds are very numerous: guinea fowl (akanga), partridge, pigeons, herons, ibis, flamingoes, egrets, owls, birds of prey (papango, voromahery). Crocodiles are found in all waters, except in the coldest parts of the plateaus.

Various land and sea tortoises are found, chameleons of all sizes, geckos, lizards, snakes, including the do which is 10–13 ft. long, but is harmless. There are few fresh-water fish, but sea water fish and crustaceans abound on the coasts and in the lagoons. Certain species are peculiar to the island, like the globefish, bristling with spines, and the cofferfish. Finally, insects abound: grasshoppers, termites, cockroaches, all sorts of mosquitoes, of which some very dangerous ones attack cattle, but also the Madagascar Bombyx (moth) which gives a valuable silk, and more than 800 species of butterfly. Man has imported domestic animals: the zebu, which has great importance in Madagascan life, the fat-tailed sheep, dogs, poultry and pigs, these last being mostly raised by Europeans. (J. D.)

11. THE PEOPLE

The people of Madagascar. collectively known as Malagasy (in French *malgache*), appear to be a mixture from very ancient times of Indonesians and Africans who arrived there by sea at various periods. The majority exhibit a blend of Indonesian and African characteristics. In general one can distinguish 18 peoples who correspond to geographical regions or to kingdoms no longer existent. The principal peoples are as follows: (1) In the east: the

Betsimisaraka ("the inseparable multitude"); the Antemoro, of whom the noble orders claim Arab descent and who use Arab script; the Tanala ("people of the forest"); the Antesaka; and the Antanosy. These peoples are in general of medium stature and dark. (2) On the plateau: the Merina, around Tananarive, of whom the higher castes, the nobles (Andriana) and the bourgeois class (Hova) are often of an almost pure Indonesian type; the Betsileo (around Fianarantsoa); the Sihanaka around Lake Alaotra; to the north the Tsimihety; to the south the Bara who are tall and of African type. (3) In the west: the Sakalava; the Vezo, who are fishermen; the Mahafaly and the Antandroy ("people of the brambles"), who inhabit the dry southern region; and some Makoa, who came from Africa, often as slaves, and are distributed amongst the Sakalava.

1. Language. — The Malagasy language belongs to an Indonesian group, with some peculiarities of its own such as the vocalization of final letters, the existence of a definite article, and the "relative" mood of verbs. It contains some words of Bantu, Swahili, Arab, English and French origin. The existence of dialects, involving changes in certain consonants and final letters and some differences in vocabulary, does not affect the basic unity of the language.

From 1820 the Merina dialect, written in Latin characters, has become the official language, In this the letter o is pronounced as French ou (English *oo*); final a and y are almost silent. Malagasy literature includes proverbs, orations, stories, folk tales and poems. The soft and musical quality of the language has earned it the title of "the Italian of the east."

2. Religion. — The traditional religion is founded on ancestor worship. The dead are mostly buried in stone tombs, by family or clan, and are believed to keep watch over the living and to reward or punish them according to their deserts. They are invoked, either on special occasions of illness or disaster, or in special ceremonies such as the festival of the dead in the southeast and the Famadihana, "festival of returning," when the dead are moved from one tomb to another, on the plateau. The supreme being, called Zanahary, "the Creator," or Andriamanitra, "the Fragrant One," stands above the dead in the divine hierarchy and is associated with them in the ceremonies. There is also a belief in invisible beings who inhabit trees and stones, in water spirits and in certain animals as ancestors or kin. Divination is employed, based mainly on *sikidy,* akin to Arab geomancy. The mass of taboos (*fady*), imposed either by custom, by the date of birth or by sorcerors, fill the life of the Malagasy with inhibitions, and there is also the fear of spellbinders.

Formerly various kinds of trial by ordeal were practised in order to discover spellbinders and criminals. Notable among these was the tanghin poison ordeal. Today almost half of the people, especially among the Merina and the Betsileo and in the towns, have been converted to Christianity about equally divided between Protestant and Catholic. In the northwest there are about 70,000 Moslems.

3. Social Customs. — The traditional Malagasy family is patrilineal and includes collateral branches. The title of father and mother is given to all the elders, and that of children to all the younger generation. The clan (*foko*) includes families of the same origin The fokon'olona is that part of a clan which lives in the same village and whose decisions are taken by the heads of its families. This patriarchal system is on the decline in the Christian areas and in the towns, but respect for elders persists. The artificial relationship of blood brotherhood between two persons can be created by a special ceremony.

Malagasy society is divided into castes, which are in most cases limited to three: nobles, freemen and former slaves. Intermarriage betneen the castes is prohibited in principle. Polygamy has disappeared in the Christian areas. Marriage involves various ceremonies: a delegation to the prospective bride's family, sacrifices, the carrying off of the bride, etc. Children are always desired and the chief fear of women is sterility. Adoption is easy and is frequently undertaken.

The Malagasy house is always rectangular with the long sides running from north to south, the door on the west and an acutely angled roof. The materials vary with the region: clay is used in the central area, wood and branches on the coasts. On the east coast the houses are built on piles, or stilts. Clothing consisted formerly of the loincloth (of bark or cotton), the sheath dress (of rush matting or raffia) and the lamba, a kind of toga made of cotton or silk. These are giving way increasingly to imported clothing and materials. Traditional art, which is much less rich than that of Africa, comprises wooden statues, rush matting and coloured baskets, and decorated plates and spoons. Musical instruments betray especially African or Indonesian ancestry; notable is the *valiha,* a kind of zither made from bamboo. The same is true of the traditional dances which still accompany certain festivals. A love of music and poetry is a characteristic of the Malagasy.

III. HISTORY

The island was certainly inhabited during the Iron Age by Indonesian and African navigators. For many centuries the Malagasy have been divided into a number of peoples, separated from one another by a wide extent of uninhabited country.

"Arab" *Influence.*—The Indian ocean was frequented during the early middle ages by Indonesians and the Indians, who left traces in the population of Madagascar. From the 9th century the "Arabs" (correctly, Moslems of diverse origins), already established on the east coast of Africa and on the Comoro Islands, formed settlements on both the northwest and southeast coasts of the island. In the southeast they became merged in the general mass of the people, especially among the Antemoro.

In the northwest were several large "Arab" colonies, which occupied the ports of Anorotsangana, Mojanga (Majunga) and several others, retaining their distinct nationality.

Early European Connections. — The Alexandrian geographer Ptolemy speaks of an island called Menuthias, which might be Madagascar. Marco Polo has a chapter upon "Madeigascar," but his accounts of it are confused with those of the mainland of Africa, even the name later adopted for the island being a misunderstanding of that of the mainland port of Mogadishu.

The first European voyager to see the island was a Portuguese named Diogo Dias, captain of one of the ships of a fleet bound for India. Separated from his companions by a storm near the Cape of Good Hope, he sighted the eastern coast of the island on Aug. 10, 1500. That day being the feast of St. Lawrence, Madagascar was named the "Isle of St. Lawrence." Portuguese missionaries between 1600 and 1619 made unsuccessful efforts to convert the tribes on the southeast and western coasts. In the time of Charles I unsuccessful attempts were made to form English settlements in the southwest and on the island of Nossi-Bé. From 1642 the French held the extreme southeast point of the island at Fort-Dauphin, and the governor, Etienne de Flacourt, gave the first substantial description of the island. But in 1674 the garrison was partly massacred and partly evacuated. The king of France, however, maintained his claims to the sovereignty of the whole island.

In the late 17th and early 18th centuries Madagascar was the haunt of many pirates, including John Avery, Captain Misson and William Kidd. Between 1768 and 1786 two fresh attempts at settlement were made by the French, one by the comte de Modave at Fort-Dauphin and the other by D'Aladar de Benyowski at Antongil bay. In 1750 the island of Saint-Marie became French. In 1803 Sylvain Roux set up a French agency at Tamatave, which was occupied by the English in 1811.

The First *Kingdoms.*—Trade in arms and slaves allowed the development of Malagasy kingdoms. At the beginning of the 17th century the most important, those of the Antemoro, Antesaka, Betsileo and Merina (Hova), were still confined to small areas, the last named to the neighbourhood of Tananarive. In that century a southern Sakalava chief, Andriandahifotsi, conquered all the western plains, and his son conquered the northwest (Boina) and the extreme north. The Sakalava dominions, held by descendants of the founder, occupied half the island, but they disintegrated in the 18th century. In this century the half-caste Ratsimilaho (son of an English pirate) set up the kingdom of Betsimisaraka, which very soon disappeared.

At the end of the 18th century the disunited hlerina kingdom was unified by the great king Andrianampojnimerina (1787–1810). Imerina was soundly organized and the Sakalava incursions checked. Turning his attention to expansion, the king brought the Betsileo into subjection. At his death he bequeathed to his son Radama a single political ambition: "The sea will be the boundary of my ricefield" (*i.e.*, of his kingdom).

Merina Rule.—Radama I (1810–28) was a shrewd and enterprising man. He was helped by the English governor of hlauritius, Sir Robert Farquhar, who, failing to obtain the backing of the home government to replace the French in Madagascar, adopted a policy of supporting the Merina. Radama saw that it was necessary for his people to be educated and civilized, and, making a treaty with Farquhar to abolish the export of slaves, he received in compensation an annual subsidy of arms, ammunition and uniforms, as well as English training for his troops. He was thus enabled to establish his authority over a large part of the island. For some years a British agent, James Hastie, resided at Radama's court. During the same period (1820) Christian teaching was begun in the capital by the London Missionary society. The language was reduced to a systematic written form: and the art of printing introduced; the Scriptures were translated and many schools were formed.

The bright prospects thus opening up were clouded by the death of Radama at the age of 36 and the seizure of the royal authority by his first wife, Queen Ranavalona. She looked with much suspicion upon the European ideas then gaining ground. In 1835 the Christian religion was declared illegal. Of the Christian Malagasy about 200 suffered death, while many hundreds were punished by fine, degradation, imprisonment and slavery.

A few Europeans remained in Madagascar, notably the Frenchman Jean Laborde, who introduced many industries. During the queen's rule there were frequent rebellions and distant provinces were desolated by barbarous wars; for some years all Europeans were excluded, and foreign commerce almost ceased. An ill-managed attack upon Tamatave in 1846 by a combined British and French force ended in failure.

This reign of terror was brought to an end in 1861 by the death of the queen and the accession of her son, the good Radama II. But a concession he signed, giving great powers to a French company, combined with his weakness soon brought an end to his reign and his life. He was put to death in his palace (1863) and his wife Rasoherina was placed on the throne. The new sovereign refused to ratify the agreement with the French company, but treaties were concluded with the British, French and United States governments. Beside the London Missionary society, other Christian agencies were permitted to work, including the Jesuits and the Anglicans: the Society of Friends and the Norwegian Lutherans. The French explorer Alfred Grandidier explored the island and brought back much scientific information.

At the death of Rasoherina in 1868, she was succeeded by her cousin, Ranavalona II. One of the first acts of the new queen was the public recognition of Christianity; and soon afterward she and her husband, the prime minister, mere baptized, the Merina in general soon putting themselves under Christian instruction. Ranavalona II, her predecessor and her successor mere in turn married to the prime minister, Rainilaiarivony, who became virtual ruler of the country. Many measures tending to improve the administration were introduced. The hlerina now ruled the central part of the plateau directly; the kingdoms of the east and northeast were vassals; but the south and west were independent. The Merina army, well organized under Radama I, had since declined and Merina expansion had consequently ceased. Revenue was derived from customs, duties, fines and from a money offering, called *hasina,* presented on a great variety of occasions to the sovereign. The government also claimed the unpaid services of the community for public work. Consuls appointed by the British, French and U.S. governments were accredited to the Malagasy sovereign.

Relations With the *French.*—While Merina rule would have satisfied British interests in the island, it was otherwise with the French. The tradition of their former settlements and influence was strong; in 1840 they had taken under their protection the Sakalava ruler of the northwest coast. But a treaty concluded in 1868, while establishing French consular jurisdiction in Madagascar, recognized Ranavalona II as queen of Madagascar. A change came under the third republic. The French government revived its claim to a protectorate over the Sakalava of the northwest coast, and in 1883, following Malagasy rejection of French demands, Tamatave was bombarded and occupied by marines. By a treaty signed on Dec. 17, 1885, it was agreed that the foreign relations of Madagascar should be directed by France; that a resident should live at the capital; and that the Diégo-Suarez bay, together with surrounding territory, should be ceded to France. Queen Ranavalona II had died on July 13, 1883, and had been succeeded by her cousin Ranavalona III. In 1890 the British government, in return for concessions in Zanzibar, consented to recognize a French protectorate over Madagascar, but the Malagasy prime minister, Rainilaiarivony, continued to arm and train, with the help of British officers, a large body of native troops. Toward the close of 1894, the French government sent an ultimatum and war followed. An expeditionary force under Gen. J. C. Duchesne landed at Majunga and met with no effectual resistance. On Sept. 30, 1895, the French forces reached Tananarive, and on the evening of the same day the French entered the capital. The protectorate a-as established. Early in 1896, however, a serious rebellion broke out in several parts of Imerina. This movement was not only anti-French but also anti-Christian. Gen. J. S. Gallieni was sent out to relieve the then resident general.

French Rule.—Gallieni abolished royalty; Madagascar had already been declared a colony of France. Queen Ranavalona III was exiled to Réunion and subsequently to Algeria, where she died in 1917. Meanwhile, by 1898, the authority of France was established throughout the island. Gen. Gallieni, whose firm and vigorous administration and desire to treat the Malagasy justly made him liked, retired in 1905. In accordance with the usual French colonial system the tribes were all placed under the direct control of French officials, but large numbers of natives were employed in the French administration, and the few Malagasy who became thoroughly assimilated were given French citizenship.

Notwithstanding these measures the growth of a sense of Malagasy nationality could be discerned among the Merina. During World War I an anti-French secret society, the V.V.S., mas discovered. Madagascar enjoyed considerable economic development during the governorships general of Marcel Olivier (1924–30) and Léon Cayla (1930–40). But World War II brought economic crisis with the cessation of exports. The island declared for the Vichy government in 1940, and to prevent its invasion by the Japanese it was occupied in 1942 by the British. who handed it over to the Free French authorities in 1943. But it had been considerably disturbed by these events. In 1946, all the Malagasy had been granted French citizenship; but in 1947 a nationalist rising took place on the east coast. Subsequently new political institutions (in particular, local assemblies) were established without difficulty. On Oct. 14, 1958, the congress of the elected assemblies proclaimed an autonomous republic within the French Community and Philibert Tsiraana, a Tsimihety, was elected president. In 1960 the Malagasy Republic gained complete independence while remaining a member of the Community.

IV. POPULATION

The population of Madagascar which, at the first census in 1900, was 2,500,000, in 1956 4,934,375, and by 1960 exceeded 5 000,000. Increase is now at the rate of more than 100,000 a year. The average density is 20.7 to the sq.mi.; in the rice-growing regions of the east coast and the alluvial valleys and lake basins of the plateau it exceeds 77.7 but is less than 12.9 in the pastoral west and the forest-covered cliff regions. The most numerous peoples are the Merina (1,200,000), the Betsimisaraka (800,000) and the Betsileo (600,000). The population other than Malagasy is less than 100,000, including 70,000 French, 13,000 Indians and 7,000 Chinese. The number of Comoro is rapidly increasing on the northwest coast.

The people are essentially peasants. The capital is Tananarive or

Antananarivo (*q.v.*), pop., (1956) 193,476, which stands on a steep hill jutting into the surrounding rice fields. There are four towns with a population of 30,000 to 50,000; Tamatave (*q.v.*), Majunga, Diégo-Suarez and Fianarantsoa. The other principal centres, each with 10,000 to 30.000 inhabitants, are Antsirabe, Tulear, Manakara, Mananjary and Fort-Dauphin. Internal migrations brought the rice cultivators of the southeast (Antesaka) and those of the plateau (Merina and Betsileo) to the almost empty plains of the west, which they put under cultivation. This Malagasy "Far West" already has an immigrant population greater than the Sakalava. The Tsimihety, who increase rapidly, expand in all directions. Some Antandroy, to escape from the famines of the extreme south, find paid employment all over the island. There is a large proportion of Merina in the towns, where they are merchants or officials.

V. ADMINISTRATION

The constitution of the Malagasy republic, which became law on April 29, 1959, establishes a presidential regime. The president of the republic, who is elected for seven years, is also the head of the government. The parliament comprises two assemblies: a national assembly elected for five years by universal suffrage (male and female) and a senate representing national organizations; two-thirds of the senators are nominated by the provincial councils general. The Malagasy Republic is represented in France by a haut *représentant* and in certain other countries by ambassadors.

Madagascar is divided into six provinces: Diégo-Suarez, Majunga, Tamatave, Tananarive, Fianarantsoa and Tulear. The provinces, which have a large measure of financial autonomy, are themselves divided into districts and communes (formerly cantons) varying in number, which are administrative units. Large towns have elected municipal councils. Rural communes constitute centres of economic advancement. The president of the French community is represented by a high commissioner general. Many French officials are employed in the central and provincial services. Medical services include 60 hospitals and 300 medical stations. The fight against endemic diseases has succeeded in removing the plague and reducing malaria.

About half the children of school age attend public or private schools (200,000 boys and 150,000 girls). There are eight *lycées,* an institute of higher education and a Madagascar Institute of Scientific Research (I.R.S.M.). Education is conducted in Malagasy and French.

VI. THE ECONOMY

The traditional economy of Madagascar is based principally on the cultivation of rice and the raising of oxen. The rice fields are of Asiatic type with water levels and embankments. The grazing of oxen often takes the place of cultivation. Food consists of millet (in the south), cassava; potatoes, taro or coco, beans and some fruits (bananas, guavas and mangoes), together with fish from the streams, and berries and wild roots. The zebu (humped ox) is used both for tillage and for sacrifice, the beef being eaten during the ceremonies, and it provides visible capital. Poultry is abundant in all the villages. This subsistence economy has been changing during the 20th century through the opening up of the island to world commerce. The traditional products have been improved and new products created in the following ways.

Rubber is no longer cultivated but wax from wild bees is gathered. Scientific study has been devoted to fishery, especially that of tunny, prawns, mullet and whales. The forests have had to be protected and replanting has altered the denuded appearance of the plateau. Raffia fibre is a product peculiar to Madagascar.

Agriculture. — The rice-growing area has been doubled. Rice is grown mostly for local requirements but some special varieties of high quality (such as the long vary lava) have been developed for export. The American rices of Carolina had their origin in Madagascar. Cassava meal and tapioca are prepared from manioc (Manihot). "Cape pea," a kind of large haricot grown in the southwest, is exported to England.

"Robusta" coffee is the chief product of the east coast and the most important item of exported produce (60,000 tons). Madagascar is the world's chief producer of vanilla and ranks second for cloves (east coast). Perfume plants, peanuts (Lake Alaotra), "Maryland" tobacco (west and plateau), sugar (northwest), sisal (extreme south), potatoes (plateau) are substantial items.

Stockbreeding. — There are more than 6,000,000 head of zebu cattle on the natural pastures of the west and the plateau. Pigs are reared in the centre, sheep and Angora goats in the south.

Minerals. — The main resources are graphite and mica. A seam of coal in the southwest (Sakoa) has not been worked. There is some uranium, and precious stones (beryl, amethyst and garnet) are found.

Industry. — The only active industries are agricultural and chief among these are rice husking, the manufacture of starch from manioc, sugar refining, tobacco curing, meat preserving and tanning. There is abundant water power, but the two main barrages supply electricity chiefly to Tananarive. Nine-tenths of the inhabitants live by agriculture and the variety of products avoids serious shortages. Most of the peasants are owner-farmers. Europeans own some plantations (sugar, tobacco and sisal), sawmills and mines.

Trade. — The distance of the main markets of the world is a handicap to Madagascar's exports owing to the high cost of freight. The lack of domestic industry necessitates the importation of most manufactured goods. Wholesale trade is principally the care of French companies and retail trade is, to a large extent, in the hands of Indians and Chinese. The chief exports are coffee, rice, cloves, tobacco, vanilla, sugar, dried vegetables, raffia and preserves. Of secondary importance are graphite, perfumed oils, sisal, manioc starch and hides. Coffee represents about half the total value. About two-thirds-of the exports are bought by France and one-sixth by the United States. Principal imports include materials and clothing, motor vehicles, petroleum products, machinery, iron, tools and cement; approximately two-thirds of these come from France.

Communications. — In former times all transport was on foot; important personages were carried by *filanzane* (palanquin) and goods were slung at the two ends of a pole across the shoulders. Roads have now been constructed all over the country; they are mostly simple, tracks suitable for motor traffic but subject to seasonal interruptions. The principal centres are linked by asphalt roads. The total mileage of roads is about 18,650. Two railways cross the cliffs to link the plateau with the east coast: the Tananarive-Côte Est (T.C.E.) to Tamatave, about 230 mi.: and the Fianarantsoa-Cbte Est (F.C.E.) to Manakara, about 102 mi. The former has two branches, to Lake Alaotra and to Antsirabe.

The chief port is Tamatave (*q.v.*), which has equipment and quay berths. Diégo-Suarez, which has one of the finest roadsteads in the world, is unfortunately too remote from the centre. Majunga has only a lighterage port. Minor ports are Manakara, Fort-Dauphin, Tulear, Morondava, Analalava and Vohemar. The principal airport is Arivonimamo, 27 mi. west of Tananarive. Secondary airfields are numerous and local airlines provide daily services.

See also Index references under "Madagascar" in the Index volume.

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MADAN, MARTIN (1726–1790), English preacher and writer of the Methodist revival. Educated at Westminster school and Christ Church, Oxford: he was called to the bar in 1748 but abandoned his career and the pleasures of society after hearing John Wesley preach. He was ordained in 1750 and appointed chaplain to the Lock hospital, London. A powerful itinerant preacher, he became known as "Counsellor Madan." His acutely argued *Thelyphthora . . . A Treatise on Female Ruin* (1780), advocating polygamy to check the evils of adultery, seduction and prostitution, was bitterly attacked, but he maintained that his views were strictly in accordance with Holy Scripture. He died at Epsom on May 2, 1790.

MADAUROS, an ancient city of Numidia (near the modern Mdaourouch, 55 mi. N. of Tebessa by rail), which became a Roman colony at the end of the 1st century after Christ. It was the birthplace of Apuleius, and its schools were celebrated. Among its ruins are some large thermae, a fine Roman mausoleum, a large Christian basilica of the Byzantine period, with a nave and two aisles, and a Byzantine fortress built about A.D. 535.

See Joly, *Mdaourouch.*

MADDALONI, a town of Campania, Italy, in the province of Caserta, about 3½ mi. S.E. of Caserta, with stations on the railways from Caserta to Benevento and from Caserta to Avellino, zoo ft. above sea level. Pop. (1951) 22,174. It is prettily situated at the base of one of the Tifata hills, the towers of its medieval castle and the church of San Michele crowning the heights above. The fine old palace of the Caraffa family, once dukes of Maddaloni, the old college now named after Giordano Bruno, and the institute for the sons of soldiers are the chief points of interest. About 2½ mi. east of Valle di Maddaloni, the Ponti della Valle, an aqueduct built by the orders of Charles III of Naples and his son to convey the water of the Tiburno to Caserta (19 mi.), is carried across the valley between Monte Longano and Monte Gargano by a threefold series of noble arches rising to a height of 210 ft. The work was designed by Lodovico Vanvitelli and constructed 1753–59.

MADDEN, SIR FREDERIC (1801–1873), English palaeographer, of Irish extraction, was born at Portsmouth on Feb. 16, 1801. In 1826 he entered the British Museum, and in 1828 he became assistant keeper of manuscripts. In 1833 he was knighted, and in 1837 became keeper of manuscripts, retiring in 1866. He edited for the Roxburghe club *Havelok the Dane* (1828), discovered by himself among the Laudian manuscripts in the Bodleian, *William and the Werwolf* (1832) and the old English versions of the *Gesta Romanorum* (1838). The edition (1850) in parallel columns, of what are known as the "Wycliffite" versions of the Bible, from the original manuscripts, upon which he and Forshall had been engaged for 20 years, was published by the University of Oxford. In 1866–69 he edited the *Historia Minor* of Matthew Paris for the Rolls Series. In 1833 he wrote the text of Henry Shaw's *Illuminated Ornaments of the Middle Ages;* and in 1850 edited the English translation of Silvestre's *Paléographie universelle.* He died on March 8, 1873, bequeathing his journals and other private papers to the Bodleian library.

MADDER or DYER'S MADDER, the root of *Rubia tinctorum* and perhaps also of R. *peregrina,* both native European plants, and of *R. cordifolio,* a native of the hilly districts of India and of northeastern Asia and Java; the last supplies Indian madder, or *manjit. Rubia* is a genus of about 40 species of the madder family, Rubiaceae. It much resembles the familiar lady's or yellow bedstraw *(Galium verum)* and the cleavers or catchweed bedstraw (G. *aparine)* of hedges and woodlands, having similarly whorled leaves, but the parts of the flowers are in fives and not fours, while the fruit is somewhat fleshy *(see* BEDSTRAW).

The red colouring principle of madder, alizarin, is now made synthetically, and the once extensive use of madder as a dye has nearly disappeared. The dye properties appear to have been known from the earliest times; cloth dyed with madder has been found on the Egyptian mummies, and it was used for dyeing the cloaks of the Libyan women in the days of Herodotus. Madder also mas employed medicinally, especially in the treatment of amenorrhea, by the ancients and in the middle ages. A remarkable physiological effect of alizarin is that of colouring red the bones of animals and the claws and beaks of birds that feed upon madder. This property was utilized by physiologists in ascertaining the manner in which bones develop and the functions of the various types of cells found in growing bones. The only British species of *Rubia* is *R. peregrina,* found in Wales, southern and western England and eastern and southern Ireland. *R. tinctorum,* a native of western Europe, was once extensively cultivated in southern Europe, France and the Netherlands. *Rubia* is neither naturalized nor cultivated in the United States. *See* also ALIZARIN.

MADEC, RENÉ-MARIE (1736–1784)—called Medoc in Anglo-Indian writings—French adventurer in India, was born at Quimper in Brittany on Feb. 7, 1736, of poor parents. He went out to India and served under Dupleix and Lally, but being taken prisoner by the British he enlisted in the Bengal army. Deserting with some of his companions shortly before the battle of Buxar (1764), he became military instructor to various native princes, organizing successively the forces of Shuja-ud-Dowlah, namab of Oudh, and of the Jats and Rohillas. He took service under the emperor Shah Alam in 1772, and when that prince was defeated at Delhi by the Mahrattas, Madec rejoined his own countrymen in Pondicherry, where he took an active part in the defense of the town (1778). After the capitulation of Pondicherry he returned to France with a considerable fortune, and died there in 1784. At one time he worked for a French alliance with the Mogul emperor against the British, but the project came to nothing.

See Émile Barbé, *Le Nabob René Madec* (1894).

MADEIRA or FUNCHAL, a group of islands in the North Atlantic ocean, which belong to Portugal, and consist of two inhabited islands named Madeira and Porto Santo and two groups of uninhabited rocks named the Desertas and Selvagens. Pop. (1930) 211,601; (1950) 266,990; area, 308 sq.mi. Funchal, the capital, is on the south coast of Madeira island, in 32° 37′ 4j" N. and 16° 54′ W. It is about 360 mi. from the coast of Africa, 53j from Lisbon. 1,215 from Plymouth, 240 from Teneriffe, and 480 from Santa Maria, the nearest of the Azores.

Madeira (pop. in 1950, 264,002), the largest island of the group, has a length of 36 mi., an extreme breadth of 14 mi., and a coast line of 95 mi. Pico Ruivo, the highest summit, stands in the centre of the island, and has a height of 6,106 ft., while some of the adjacent summits are very little lower. The depth of the ravines, the rugged peaks, often snow-covered, the bold precipices of the coast and the proximity of the sea afford many scenes of picturesque beauty or striking grandeur. The greater part of the interior is uninhabited, though cultivated, for the towns, villages and scattered huts are usually built either at the mouths of ravines or upon the lower slopes that extend from the mountains to the coast. The ridges between the ravines usually terminate in lofty headlands, one of which, called Cabo Girão, has the height of 1.920 ft., and much of the seaboard is bound by precipices of dark basalt. The north coast, having been more exposed to the erosion of the sea, is more precipitous than the south, and presents everywhere a wilder aspect. On the south there is left very little of the indigenous forest which once clothed the whole island. A long, narrow and comparatively low rocky promontory forms the eastern extremity of the island; and there is a tract of calcareous sand, known as the fossil bed, containing land shells and numerous bodies resembling the roots of trees, probably produced by infiltration.

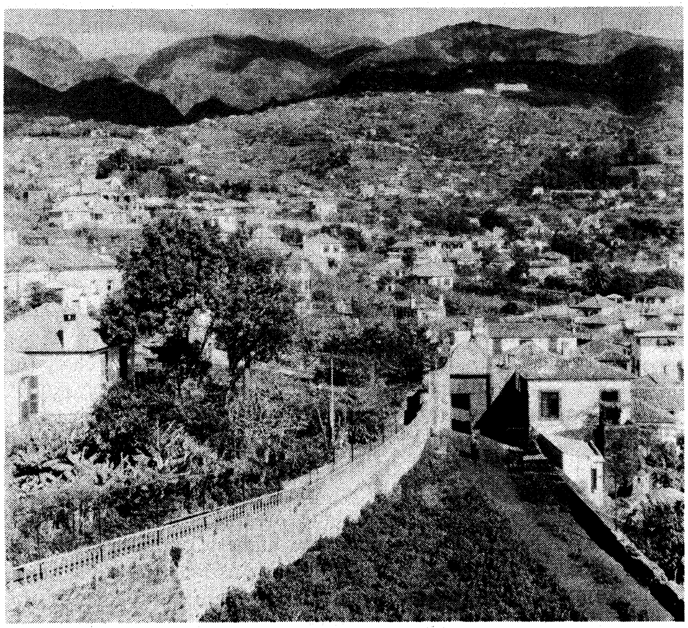
Porto Santo is about 25 mi. S.E. of Madeira. Pop. (1950) 2,888. It has a length of 7 mi. and a width of 4 mi. The capital is Porto Santo, called locally the *villa* or town. At each end of the island are hills. of which Pico do Facho. the highest, reaches the altitude of 2,139 ft. Little but barley is grown, the limited requirements of the inhabitants being supplied from Funchal.

The Desertas lie about 11 mi. S.E. of Madeira, and consist of three islands. Ilheo Chão, Bugio and Deserta Grande, together with Sail Rock off the north end of Ilheo Chão. They present lofty precipices to the sea on all sides. Rabbits and goats abound on them. The archil weed grows on the rocks and is gathered fbr exportation. The largest islet (Deserta Grande) is 7 mi. long and attains the height of 1,450 ft.

The Selvagens or *Salvages* are a group of three islands, 156 mi. from Madeira, and between Madeira and the Canary Islands. The largest island is the Great Piton, 1.6 mi. long. and 1.4 mi. broad.

Geology.—All the islands of the group are of volcanic origin. They are the summits of very lofty mountains which have their bases in an abyssal ocean. The greater part of what is now visible in Madeira is of subaerial formation, consisting of basaltic and trachytic lavas, beds of tuff and other ejectamenta, the result of a long and complicated series of eruptions from innumerable vents.

There are no data for determining when volcanic action began in this locality, but looking at the enormous depth of the surrounding sea it is clear that a vast period of time must have elapsed to allow of a great mountain reaching the surface and then rising several thousand feet, as well as to excavate the deep and wide ravines that everywhere intersect the island. At the present day there are no live craters or smoking crevices, as in the Canaries and Cape Verdes, nor any hot springs, as in the Azores.



JAMES SAWDERS

A VIEW OF FUNCHAL, ADMINISTRATIVE CENTRE FOR THE MADEIRAS

The rarity of crateriform cavities in Madeira is remarkable. There exists, however, to the east of Funchal, on a tract 2,000 ft. high, the Lagoa, a small but perfect crater 500 ft. in diameter and with a depth of 150 ft.; and there is another, which is a double one, in the district known as Fanal, in the northwest of Madeira, nearly 5,000 ft. above the sea. The basalt, of which much of the outer part of the island is composed, is of a dark colour and a tough texture, with small disseminated crystals of olivine and augite, and often forms a rude columnar structure. The basalt yields good building stone, some of which is quarried.

Climate. — Observations taken at Funchal observatory (80 ft. above sea level) in the last 20 years of the 19th century showed that the mean annual temperature is about 6j° F. The mean minimum for the coldest part of the year (October to May inclusive) does not fall below 55°, and the average daily variation of temperature in the same period does not exceed 10°. The mean humidity of the air is about 75 (saturation= 100). The prevalent winds are from the north or from a fe points east or west of north, but these winds are much mitigated on the south coast by the central range of mountains. A hot and dry wind, the leste of the natives, occasionally blows from the east-southeast, the direction of the Sahara, and causes the hill region to be hotter than below; but even on the coast the thermometer under its influence sometimes indicates 93°. As the thermometer has never been known to fall as low as 46" at Funchal, frost and snow are there wholly unknown; snow falls on the mountains once or twice during the winter, but seldom below the altitude of 2,000 ft. Madeira has a high reputation as a health resort for persons suffering from chest diseases and is well known as a winter resort.

Animal **Life.**—No species of land mammal is indigenous to the Madeiras. The rabbit, black rat, brown rat and mouse have been introduced. The first comers encountered seals, and this amphibious mammal (*Monachus albiventer*) still lingers at the Desertas. Among the many species of birds which breed in these islands only one, a wren (Regulus madeirensis), is endemic, but five other species are known elsewhere only at the Canaries. These are the green canary (Fringilla butyracea, the parent of the domesticated yellow variety), a chaffinch (Fringilla tintillon), a swift (Cypselus unicolor), a wood pigeon (Columba trocaz) and a petrel (*Thalassidroma* bulwerii). There is also a local variety of the blackcap, distinguishable from the common kind by the extension in the male of the cap to the shoulder.

The only land reptile is a small lizard (Lacerta *dugesii*), which is destructive to the grape crop. The loggerhead turtle (*Caouana* caretta, Gray) is frequently captured and cooked. but the soup is inferior to that made from the green turtle of the West Indies.

Many kinds of fish, such as the mackerel, horse mackerel, groper, mullet, braise, etc., are caught in abundance and afford a cheap article of diet. Several species of tunny are taken plentifully in spring and summer, one of them sometimes attaining the weight of 300 lb. The only fresh-water fish is the common eel, which is found in one or two of the streams.

A large majority of the land shells are considered to be peculiar. Many of the species are variable in form or colour, and some have an extraordinary number of varieties. About 43 species are found both living and fossil in superficial deposits of calcareous sand in Madeira or Porto Santo. These deposits were assigned by Lyell to the Newer Pliocene period. Some species have not been discovered alive elsewhere.

By the persevering researches of T. V. Wollaston the astonishing number of 695 species of beetles at the Madeiras was brought to light as early as 1870. The proportion of endemic kinds is large, and it is remarkable that 200 are either wingless or their wings are so poorly developed that they cannot fly, while of 23 of the endemic genera all the species are in this condition. Upward of 100 moths have been collected, the majority being of a European stamp, but probably a fourth are peculiar to the Madeiran group. Among Neuroptera a certain number are peculiar.

The bristle-footed worms of the coast were studied by P. Langerhans, a large number being found new to science. There is a white stony coral allied to the red coral of the Mediterranean which would be valuable as an article of trade if it could be obtained in sufficient quantity. Specimens of a rare and handsome red Paragorgia are in the British Museum and Liverpool museum.

Vegetation. — The vegetation is strongly impressed with a south-European character. Many of the plants in the lower region undoubtedly were introduced and naturalized after the Portuguese colonization. A large number of the remainder are found at the Canaries and the Azores, or in one of these groups, but nowhere else. Lastly, there are about 100 plants which are peculiarly Madeiran, either as distinct species or as strongly marked varieties. Among the large number of ferns three are endemic species and six others belong to the peculiar flora of the North Atlantic islands. A connection between the flora of Madeira and that of the West Indies and tropical America has been inferred from the presence of six ferns found nowhere in Europe or North Africa but existing on the islands of the east coast of America or on the Isthmus of Panama. A further relationship to that continent is to be traced by the presence in Madeira of the beautiful ericaceous tree Clethra arborea, belonging to a genus which is otherwise wholly American, and of a *Persea,* a tree laurel, also an American genus. The dragon tree (Dracaena draco) is almost extinct. Among the trees most worthy of note are four of the laurel order belonging to separate genera, an Ardisia, *Pittosporum, Sideroxylon,* Notelaea, Rhamnus and Myrica — a strange mixture of genera to be found on a small Atlantic island. Two heaths of arborescent growth and a whortleberry cover large tracts on the mountains. In some parts there is a belt of the Spanish chestnut about the height of 1,500 ft. There is no indigenous pine tree as in the Canaries, but large tracts on the hills have been planted with *Pinus* pinaster, from which the fuel of the inhabitants is mainly derived. Several of the native trees and shrubs now grow only in situations which are nearly inaccessible, and some of the indigenous plants are of the greatest rarity. But some plants of foreign origin have spread in a remarkable manner. Among these is the common cactus or prickly pear (Opuntia tuna), which in many spots on the coast is sufficiently abundant to give a character to the landscape. The coast being rocky and the sea unquiet, the species of Algae are few and poor.

Agriculture. — A large portion of the land was formerly entailed in the families of the landlords (morgados), but entails have been abolished by the legislature, and the land is now absolutely free. An incredible amount of labour has been expended upon the soil, partly in the erection of walls intended to prevent its being washed away by the rains, and to build up the plots of ground in the form of terraces. Watercourses have been constructed for purposes of irrigation, without which at regular intervals the island would not produce a hundredth part of its present yield. These watercourses originate high up in the ravines, are built of masonry or driven through the rock, and wind about for miles until they reach the cultivated land. Some of them are brought by tunnels from the north side of the island through the central crest of hill. Each occupier takes his turn at the running stream for so many hours, day or night, at a time notified to him.

The system of cultivation is primitive. Few of the occupiers own the land they cultivate; but they almost invariably own the walls, cottages and trees, the land alone belonging to the landlord. The tenant practically enjoys fixity of tenure, for the landlord is seldom in a position to pay the price at which the tenant's share is valued. The métayer system regulates almost universally the relations between landlord and tenant, the tenant paying a certain portion of the produce, usually one half or one third. There are few meadows and pastures, the cattle being stall-fed when not feeding on the mountains. Draught labour is performed by oxen.

The two staple products are wine and sugar. The vine was introduced from Cyprus or Crete soon after the discovery of the island by the Portuguese (1420), but it was not actively cultivated until the early part of the 16th century. The wine usually termed Madeira is made from a mixture of black and white grapes, which are also made separately into wines called Tinto and Verdelho, after the names of the grapes. Other wines, known as Bual. Sercial and Malmsey, are made from varieties of grapes bearing the same names. (See MADEIRA WINE.) The sugar cane is said to have been brought from Sicily about 1452. A considerable quantity of spirit, consumed on the island, is made by the distillation of the juice or of the molasses left after extracting the sugar.

The common potato, sweet potato and gourds of various kinds are extensively grown, as well as the *Colocasia* esculenta, the *kalo* of the Pacific islanders, the root of which yields an insipid food. Most of the common table vegetables of Europe are plentiful. Besides apples, pears and peaches, all of poor quality, oranges, lemons, guavas, mangoes, loquats, custard apples, figs, bananas and pineapples are produced. The last two are articles of export.

Population and Administration. — The inhabitants are of Portuguese descent, with probably some intermixture of Moorish and negro blood. Both men and women in the outlying country districts wear the *carapuça,* a small cap made of blue cloth in shape something like a funnel, with the pipe standing upward. The men have trousers of linen, drawn tight, and terminating at the knees; a coarse shirt covered by a short jacket completes their attire. The population increased 20% in the years 1900–20. Many of the able-bodied males emigrate to Brazil or the United States. The density of population (866.8 per sq.mi. in 1950) is great for an agricultural district containing no large town.

Funchal (pop., 1950, 37,035), headquarters of Madeiran commerce and shipping, is described in a separate article. The other chief towns are Camara de Lobos (3,257), Machico (4,734), Santa Cruz, Ponta do Sol and Calheta. Each of these is the capital of a commune (concelho), to which it gives its name. Madeira is connected by regular lines of steamships with Great Britain, Germany, Portugal, Cape Colony, Brazil and the United States.

The archipelago is officially styled the district of Funchal; it returns members to the Portuguese Cortes, and is regarded as an integral part of the kingdom. The district is subdivided into the eight communes already enumerated. Funchal is a Roman Catholic bishopric in the archiepiscopal province of Lisbon.

History. — It has been conjectured, but on insufficient evidence, that the Phoenicians discovered Madeira at an early period. Pliny mentions certain Purple or Mauretanian Islands, the position of which with reference to the Fortunate Islands or Canaries might seem to indicate the Madeiras. There is a romantic story to the effect that two lovers, Robert Machim, a Machin, or Macham, and Anna d'Arfet, fleeing from England to France (c. 1370) were driven out of their course by a violent storm and cast on the coast of Madeira at the place subsequently named Machico, in memory of one of them. João Gonçalvez Zarco first sighted Porto Santo in 1418, having been driven thither by a storm while he was exploring the coast of West Africa. Madeira itself was discovered in 1420. It is probable that the whole archipelago had been explored at an earlier date by Genoese adventurers; for an Italian map dated 1351 (the Laurentian portolano) shows the Madeiras quite clearly, and there is some reason to believe that they were known to the Genoese before 1339. When Zarco visited Madeira in 1420 the islands were uninhabited, but Prince Henry the Navigator at once began their colonization, aided by the knights of the Order of Christ. Sanctioned by the pope and by two charters which the king of Portugal granted in 1430 and 1433, the work proceeded apace; much land was deforested and brought into cultivation, and the Madeiran sugar trade soon became important. Slavery was abolished in Madeira in 1775, by order of Pombal. In 1801 British troops, commanded by Gen. W. C. Beresford, occupied the island for a few months, and it was again under the British flag from 1807 to 1814. It shared in the civil disturbances at the accession of Dom Miguel, but after 1833 was peaceful.

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MADEIRA RIVER in Brazil, is the main affluent of the Amazon (*q.v.*), formed in the northeast corner of Bolivia by the junction of the Mamoré and the Beni (*qq.v.*). The Madeira, which flows north, is the focal point of a riverine complex made up of the Beni, the Mamoré and the Guaporé. These rivers and their tributaries connect eastern Bolivia, part of eastern Peru and western Mato Grosso with the Amazon and the Atlantic. The Beni is navigable from Reyes to the Esperanza rapids near its confluence with the Mamoré. From Riberalta, after passing the rapids, the Beni joins the Mamoré near the town of L'illa Bella. From there they flow northward as the Madeira, constituting the Bolivia-Brazil frontier until uniting with the Abunb. The Mamoré and its tributaries flow across the eastern plains of Bolivia. The Guaporé, or Itenéz, the largest affluent of the Mamoré, rises in Mato Grosso and flows northwest until its confluence with the Mamoré near Puerto Sucre.

The Madeira is 2,012 mi. long from the upper sources of the Mamoré, and the general width is from ½ mi. to 1,000 yd. When the river is at half flood the current flows at about four miles per hour. It is navigable by seagoing vessels most of the year from its mouth near Manaus to the San Antonio falls 807 mi. upstream. This is the first of 19 falls or rapids (cachoeiras) blocking further passage. The Madeira-Mamoré railway, extending for 227 mi. between Pôrto Velho and Guajarb Mirim, provides a link with the upper sources of the Madeira. The rainy season generally commences at the end of October and ends in March. In the dry season its diminution is great and navigation is adversely affected, particularly on the upper reaches of the Madeira's affluents.

The exploration of the Madeira valley began in the 16th century and parts of the region are still unexplored. Notable Portuguese expeditions which ascended the Madeira into Bolivia were those of Francisco de Melo Palheta (1723), and José Gonçalves da Fonseca (1749), who reached Mato Grosso in western Brazil. In the 19th century the Madeira region was explored by José Augustín Palacios (1884), Lardner Gibbon (1853), a U.S. naval officer, Gen. Quintín Quevedo (1861) and José and Francisco Keller (1867–68). Rio da Duvida (River of Doubt), a tributary of the Madeira, was named Río Roosevelt following its exploration by the Roosevelt-Rondon expedition in 1914.

The heavily forested, rainy tropical region through which the Madeira flows is almost uninhabited except for occasional settlements of Indians and *mestizos* who dwell along the banks and gather forest products such as Brazil nuts and rubber.

(J. L. Tr.)

MADEIRA WINE. The Portuguese planted vines in Madeira within a few years of its colonization in 1420, and ordinary unfortified beverage wines were already being exported to Europe by the beginning of the 16th century. The Navigation act of 1663 (which prohibited all exports from France, Spain, Italy and Portugal to any British colony except in a British ship). by exempting Madeira and the Azores, stimulated trade in Madeira. Sugar canes were uprooted and replaced by vines, and sales of wine to British ships and to India, and especially to the West Indies and America, became considerable. In the middle of the 18th century the Madeira merchants discovered that by following the principles used in the making of port wine and adding up to 3% grape brandy both during and after fermentation they produced a wine that pleased the rich settlers of New England and Virginia. (It is such a fortified wine that is produced today.) But in 1852 a vine fungus, oïdium. swept the island and killed almost every plant; the dissolution of the East India company (an important customer) and the opening of the Suez canal, which meant that eastbound ships no longer called at Funchal, also hit the wine trade. Sherry and Marsala captured the market and Madeira never recovered its former prosperity.

However, a small and slowly increasing quantity of high-quality Madeira is still exported, the wines usually being called after the vine that produced them. The most popular are malmsey (*q.v.*), verdelho, bual and sercial. Sercial is a full-bodied but true wine, and the others are richer dessert wines. All are dark brown in colour, with an unmistakable tang or burnt bittersweet flavour. This derives from the process whereby, after the juice has been fermented and partly fortified, it is placed in ovens called *estufas*, the cheaper wines being left for three months at 140° F. and the most expensive ones for six months at 110° F.

Madeira takes several years to mature, and blending of old and young wine is practised to keep the period of maturation to the minimum. It is a very long-lived wine and bottles over 100 years old have been known. "Rainwater" Madeira was light in colour and body and was very popular in Charleston and the southern states, but is now infrequently seen.

See H. Vizetelly, *Facts About Port and Madeira* (1880); A. L. Simon and E. J. Craig, *Madeira* (1933). (C. C. H. F.)

MADERNO (Maderna), **CARLO** (1556–1629), leading Roman architect of the early 17th century, was born at Capolago, near Lugano. From 1603 until his death in 1629 he was chief architect of St. Peter's in Rome.

Maderno built the nave and façade of the church (1607–17). Consonant with the spirit of the Counter-Reformation, Maderno reverted to the scheme of early Christian and medieval cathedrals; by adding the nave he transformed Michelangelo's Greek-cross plan into a longitudinal one. His façade has been both criticized for impairing the effect of Michelangelo's dome and admired for its forceful grouping of huge engaged columns. Besides the façade of Sta. Susanna (1596 ff.) Maderno designed the Palazzo Barberini for the family of Pope Urban VIII (1625). His buildings determined the style of early baroque architecture. The Palazzo Barberini was completed by Francesco Borromini and Giovanni Lorenzo Bernini, whose works were influenced by Maderno.

See Nina Caflisch, *Carlo Maderno* (1934). (W. Lz.)

MADERO, FRANCISCO INDALECIO (1873–1913), Mexican revolutionary leader and president from 1911 to 1913, was born in Parras, Coahuila, on Oct. 30, 1873, the scion of a wealthy landowning family. His education, received in Paris and California, was intended to train him for a career in business and agricultural management. He became a believer in the efficacy of democracy and a devotee of spiritism with its emphasis on human progress.

After five years in Europe, he returned to Mexico in 1893 and for a time devoted himself to agricultural activities; he merits recognition as a leading pioneer in the development of the Laguna cotton region. As a landowner, Madero was known for his disinterested promotion of the well-being of his tenants. Influenced by his democratic ideology, Madero chose politics as his means of serving his countrymen. Prior to the 1905 gubernatorial election in Coahuila he helped organize the Benito Juárez Democratic club and served his apprenticeship as a political writer on its weekly, El *Demdcrata*. Undiscouraged by this unsuccessful effort, hfadero learned that efforts against the dictatorship of Porfirio Diaz (*q.v.*) in individual states would inevitably fail; while awaiting an opportunity for a national democratic movement, he supported and encouraged independent journalists and carried on an extensive correspondence regarding political organization.

It was Diaz himself who inadvertently brought on a renewal of political activity when he stated to the U.S. journalist James Creelman that Mexico was ready for democracy. This declaration prompted a flood of political literature and a flurry of political activity. Madero contributed to the political reawakening by the publication, early in 1909, of his book La *sucesidn presidencial en 1910*, in which he emphasized the problem of militarism and viewed the immediate political situation. Madero helped to organize the Antire-electionist party and became its presidential candidate. His correspondence, organization of political clubs and tireless and courageous campaign travels earned for him the designation of "apostle of democracy." On the eve of the farcical election, Madero was' arrested on charges of fomenting a rebellion and insulting the authorities. Released on bond, he escaped across the border. From San Antonio, Tex., he issued the "Plan of San Luis Potosi," a political document which had as its principal planks effective suffrage and no re-election and which called for the revolution to begin on Nov. 20, 1910. While the initial response was sporadic, Pascual Orozco kept the rebellion alive in Chihuahua. The Diaz government, unsuccessful in the suppression of the movement by military means, undertook successively political reforms and negotiations with the rebels. However, the conflagration continued to spread and after the surrender of Ciudad Juarez a compromise peace was arranged.

For five months the conservative Francisco de la Barra directed an interim government whose mission was to restore order and conduct new elections. Friction occurred between revolutionaries and old regime elements and divisions appeared among the revolutionaries themselves. The presidential election resulted in a sweeping triumph for Madero, who assumed office Nov. 6, 1911. His administration was brief and difficult. He suffered from lack of political experience and was handicapped by his own overly optimistic idealism. Preoccupied with giving the people democratic conditions under which the needed reforms could be effected, Madero was attacked by the entrenched advocates of the old regime who opposed any change and by revolutionary elements nho were insistent on far-reaching social and economic changes. He also had to contend with a hostile press, the harassment of U.S. Ambassador Henry Lane Wilson and a series of armed rebellions. Conservative-inspired movements were led by Bernardo Reyes and Pascual Orozco in the north and by Félix Diaz in Veracruz while Emiliano Zapata led land-hungry peasants in hforelos.

In the light of these overwhelming difficulties, the accomplishments of Madero's administration were not inconsiderable. The press and labour enjoyed freedom; agrarian reform was studied and humble beginnings of change were initiated; education was promoted; and democratic principles were applied. Many believe that Madero was moving or would have moved in the direction that the revolution demanded when, in Feb. 1913, a military revolt broke out in Mexico City. The betrayal of Gen. Victoriano Huerta caused Madero's overthrow. On Feb. 22, 1913, while being transferred to prison, Madero was assassinated by the escort.

In death Madero provided a symbol for revolutionary unity in the continuing struggle against the Huerta regime. His career and martyrdom served as an inspiration and exemplar for the establishment of a democratic polity in Mexico.

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MADHAVA ACHARYA (fl. *c.* 1380), Hindu statesman and philosopher, lived at the court of Vijayanagar, the vigorous south Indian kingdom that so long withstood Moslem influence. He had his education under three masters: Vidyatirtha was the most iniportant of them! looked upon as an incarnation of Mahesvara and worshiped by the pupil at Sringeri under the name Vidyasankara; the other teachers were Bharatitirtha and Srikanthanatha. His younger brother Sayana (d. 1387), also a statesman and the minister of four successive Vijayanagar kings, is best known as the commentator of the Vedas; Sayana's commentaries were influenced by Madhava, who patronized the scholars collaborating in his brother's great work. Madhava turned ascetic about 1377 and was thereafter known as Vidyaranya. According to tradition he died in Sringeri in 1386, at the age of 90. He was part author of *Jivanmuktiviveka* and Panchadasi, works of Vedanta philosophy; *Dhatuvritti,* a treatise of Sanskrit grammar; and *Nyayamalavistara,* on the Mimamsa system; as well as the *Parasarasmritivyakhya,* an elaborate comment on the *Parasarasmriti,* adding a chapter on law to those on custom and penance in the original. Madhava Acharya should not be confused with his contemporary Madhavamantrin, statesman, warrior and author, or with a later Madhava, the author of Sarvadarsana *Samgraha* ("Compendium of Speculations"). (K. A. N. S.)

MADHVA (ANASDATIRTHA; PURNAPRAJNA) (*c.* 1199–*c.* 1278). a prominent Hindu philosopher, was born at Rajatapitha near Udipi in south Kanara. Little is known of his life, but 37 Sanskrit works are attributed to him, dealing chiefly with the interpretation of Hindu sacred writings and the explanation of his own theological system.

According to Madhva, Vishnu (Krishna) is the one eternal God who rules the world and grants salvation to his devotees. Both souls (jiva) and matter (prakriti) coexist eternally with Vishnu. The individual souls are spiritual beings of atomic size, blissful by nature. As they are from eternity connected with matter and subject to the law of retribution for their deeds (karma), they wander about in bodies of angels (deva), men, animals and infernal beings, subject to pain and suffering. The inanimate world originates from primordial matter, out of which all elements and the organs and bodies of the souls are produced by evolution. The aim of man must therefore be to become free from impurities, ignorance, passion, karma and matter. The means of salvation is the grace of Vishnu, who predestines the souls to deliverance, permanent transmigration or eternal damnation in hell.

Madhva's teaching differs in two points from that of other Vedantins who like him base their doctrines on the Upanishads, the Bhagavad-Gita and the Brahma sutras: believing in the metaphysical reality of souls and matter, he repudiates all theories which attempt to reduce them to an illusion (maya), and he rejects all pantheistic ideas, as God is only the efficient, not the material, cause of the universe.

Madhva's philosophy is called dvaita ("dualism"), because it acknowledges a difference in kind between God and souls. Salvation therefore consists not in the absorption of the soul into the absolute but in the independent existence of the released in Vishnu's supernatural world.

See also INDIAN PHILOSOPHY.

See H. von Glasenapp, *Madhva's Philosophie* (1923); S. Daspupta, *History of Indian Philosophy,* vol. iv (1949). (H. v. G.)

MADHYA BHARAT, a former state of India, was formed by the union of 25 former princely states of the old Central India agency, with whose western tract (with the exclusion of Bhopal and the addition of Gwalior) it virtually coincides. The states incorporated were Alirajpur, Barwani, Dewas Senior, Dewas Junior, Dhar, Gwalior, Indore, Jaora, Jhabua, Khilchipur, Narsingarh, Rajgarh and Ratlam; and Sailana, Situmau, Jobat, Kathiawara, Khaniadana, Kurwai, Mathwar, Piploda, Muhammadgarh, Pathari and the Bhumia estates of Nimkhera, Jamnia and Rajgarh. The former state was bounded on the north by Rajasthan, on the east by Uttar Pradesh and Madhya Pradesh, on the south by Bhopal and on the west by Bombay. Area 46,478 sq.mi.; pop. (1951) 7,954,154. On Nov. 1, 1956, the state was incorporated as a part of Madhya Pradesh (*q.v.*) by the Reorganization of States act.

The Vindhya and Satpura ranges intersect the region, and the Narbada and the Chambal are the most important rivers flowing through it. Gwalior (pop.. 1951 census, 241,577) was the winter and Indore the summer capital.

Wheat and cotton are produced in great quantity in the black cotton soil of the southern plateau, where the rainfall is heavier and the climate more temperate than in the northern lowlands. Maize, rice, oilseeds, peanuts, sugar cane and fruit are important products Textiles, oil, matches, sugar, cement and engineering are the chief industries, and the potteries of Gwalior are well known. Manganese, iron ore and asbestos are found in large quantities.

The union was inaugurated on May 28, 1948. The maharaja of Gwalior was appointed *rajpramukh* for life; the *rajpramukh* governed on the advice of a ministry, and there was a state assembly of 99 members. The administration of the merged states was integrated, and an agreement was reached with the government of India in Sept. 1949 gradually to abolish internal customs duties either within five years or when the sales tax yielded Rs. 20,000,000, whichever was earlier. In Oct. 1951 the ownership of all landed estates was vested in the government, and compensation, equal to eight times the net annual income payable over a period of ten years, was promised to the expropriated landowners.

The region is served by 1,100 mi. of railway, 4,500 mi. of roads and 1.000 mi. of irrigation canals. There are more than 500 hospitals and dispensaries. (S. GL.)

MADHYA PRADESH, the largest state in India, where it occupies part of the central zone. Until the reorganization of the states on Nov. 1, 1956, it was the largest, but it then lost 8 of its 22 districts to Bombay (Akola, Amravati, Bhandara, Buldana, Chanda, Nagpur, Wardha and Yeotmal) and received the former states of Madhya Bharat (except Sunil Tappa of Bhanpura tehsil of Mandsaur district), Bhopal and Vindhya Pradesh, as well as the Sironj subdivision of Kotah district of Rajasthan which was included in the Bhilsa district of Madhya Pradesh. With the dissolution of Bombay in 1960 it regained the rank of largest. The area is 171.210 sq.mi. (formerly 130,272 sq.mi.). Madhya Pradesh is bounded on the north by Uttar Pradesh, on the west by Rajasthan and Bombay, on the south by Andhra Pradesh and on the east by Orissa and Bihar.

PHYSICAL FEATURES

The state comprises a large portion of the broad belt of hills and plateau country which separates the northern plains from the Deccan. From the Chambal river, a stretch of which forms the northwestern boundary with Rajasthan, it rises to the Vindhya mountains and then slopes down to the Narbada valley and rises again in the Satpura range in the south. In the east are to be found some hilly tracts, but that area is in the main composed of open country forming the upper basin of the Mahanadi river. The Narbada, the chief river of Madhya Pradesh, rises in the Maikala hills in the east and flows west along a narro valley between the Vindhya and Satpura ranges. The Son also rises in the Maikala range and flows northwest to the foothills of the Kaimur range where it turns and flows northeast and is joined by parallel tributaries from the south. The Ken river rises in the Bhaurer range north of Jabalpur and flows north to join the Jumna in Uttar Pradesh. Also draining the northern plateau are the Dhasan, Betwa and Sind, all flowing into the Jumna. To the south of the Narbada, the Tapti flows west in a parallel course, after rising in the Mahadeo hills, a continuation of the Satpura range.

Climate. — In climate the Vindhyan and Satpura districts are comparatively temperate; the Narbada valley is hot. The northern tracts enjoy a very pleasant cold season. Except in the tracts nearest Bengal, where the "rains" produce an exceedingly steamy atmosphere, the state has the advantage of a reasonably cool, rainy season, since both the cyclonic storms from the Bay of Bengal and the steady current of the southwest monsoon from the Arabian sea bring it moisture-laden clouds. The annual rainfall varies from 25 in. to 30 in. in the west, from 30 in. to 50 in. in the centre round Bhopal, and from 50 in. to 60 in. in the east. The monsoon period is divided between early rains, often deficient; middle rains, seldom failing completely; and late rains, premature cessation of which frequently causes severe losses.

Jungle Flora and Fauna.—The most outstanding feature of the physiographical aspect of Madhya Pradesh is the vast extent of jungle. Of the great trees of these forests the sal *(Shorea robusta)* is among the most important.

Mammals in the jungle include wild buffalo, gaur (bison), tiger, nilgai, red dog. panther, hyena, sambar, black buck and many other larger kinds of deer, wild pig, wild cat and innumerable monkeys. There are peacocks, jungle fowl, sand grouse, partridges and green pigeon, and many varieties of duck and other waterfowl on the big tanks. Snipe abound in the paddy fields. Crocodiles are to be found in the rivers, and there are cobra and the deadly Russell's viper and krait and many other types of snakes in the forests and plains.

There is an immense variety of insects.

In 1955 the Kanha wildlife sanctuary. 180 mi. N.E of Nagpur, was declared a national park. The park covers 99 sq.mi and is known chiefly for the Indian swamp deer (barasingha), but it also has tiger, leopard, gaur, chital, black buck, sambar and barking deer.

POPULATION

The population in 1959 was estimated at 27,940,000 (pop. [1951] 26,071,637). The capital is Bhopal (pop., 1951, 102,333).

A large proportion of the people are of aboriginal and old Dravidian races, Gonds being the most numerous. *(See* GONDWANA.) The total population of the Adivasis (aboriginals) was 4,015,232 in 1957. This includes the Maria. Muria. Parja and Bhathra tribes in Bastar district, the Pandos and Korwas in Surguja district, the Oraons in Jashpur, the Munda and Korkus in Betul, the Gonds and Baigas in Mandla, and Bhils in Jashpur, Bhopal, Jhabua, Dhar and Nimar. Most of the rest are Hindus.

In Madhya Pradesh as it was at the time of the 1951 census, as many as 377 languages and dialects were mother tongues. The new state boundary lines of 1956 were drawn partly on a basis of language and race.

ECONOMICS

Agriculture.—The large majority of the population is dependent on agriculture, and almost every crop groan in India is to be found in Madhya Pradesh. A line drawn from Satna in the north to Balaghat in the south roughly divides the agriculture of the country. East of that lihe. where the rainfall is heavy, the principal crop is rice; west of it wheat, grain, maize, oilseeds, sugar cane, fruit, tobacco. cotton and jowar (sorghum) are chiefly grown. The Narbada valley and the Vindhyan districts are the great wheat-producing areas; Khargone and Khandwa districts (south of the Narbada) are the great cotton and jowar tracts. But while cotton and jowar are quite insignificant in the rice country, and rice is insignificant west of the Satna-Balaghat line, practically every district in the state contains some heavy black soil areas that produce wheat and cold-weather crops. This variety of soil and cropping affords a certain degree of insurance against capricious rainfall. Rice is the most important cereal; the others are wheat, jowar, maize, barley and pulses and peas of many kinds. There are considerable sugar cane and banana plantations, and oranges and citrus fruits are grown in large quantities. The state as a whole is a surplus area, and production has been increased by long-term planning. Minor irrigation and tank projects were nearing completion in 1956, and a major scheme in Hoshangabad district on the Tawa river was soon to be begun. The latter would irrigate 590,000 ac. and enable an additional annual production of 200.000 tons of food grain. The main cash crops are cotton and sunn hemp; there are also large areas under oilseeds, peanuts, linseed and sesame.

Vast tracts (about 51% of the total area of the state) are under forest, and the state is the largest producer of timber, firewood and minor forest produce in India. Animal husbandry is receiving increasing attention.

Mining and Heavy **Industry.**—Madhya Pradesh is very rich in minerals. and the eastern region is believed to be the most highly mineralized area in the whole country. Systematic geological mapping and surveying had been begun by 1956. The manganese deposits, chiefly in Balaghat district and in the districts of Nagpur and Bhandara now in Bombay state, are among the best in the world. Iron ore is to be found in Durg, Jagdalpur and Saugor districts and in the former Madhya Bharat region (that in Jagdalpur is believed to be of high-grade quality), but mining was not far developed by 1956. The chief coal mines are in Chhindwara and Ambikapur districts; development of those at Korpa had been undertaken by 1956. Limestone is found in large quantities in the Vindhyan ranges and there are bauxite deposits, asbestos and alluvial gold in the state.

The extent and variety of mineral deposits makes Madhya Pradesh an obvious centre of heavy industry. and in 1956 work was begun on the construction of a steel plant at Bhilai in Durg district. Limestone and manganese are to be found in the neighbourhood, and there are large iron deposits at Dalli-Rajara. 50 mi. to the south, and blending coal is available 140 mi. away at Korpa. The U.S.S.R. agreed in 1955 to furnish all the equipment (to be paid for over a period of 12 years) and technical assistance needed for the construction and operation of the steel works. The other major industry in the state is newsprint manufacture. The Nepa mills at Nepanagar in Khandwa district, the first of their kind in India, began production in 1955 using salai wood, which is grown in large quantity in the state.

Other industries include textiles, oil and sugar refining, cement and match manufacturing and engineering. There are old-established potteries at Gwalior.

ADMINISTRATION

The state is divided into seven administrative divisions—Bhopal, Bilaspur. Gwalior. Indore, Jabalpur, Raipur and Rewa. By 1957 it had been decided that a bicameral legislature should take the place of the unicameral administration. (S. GL.)

MADI, a tribe of Negroes who live in the Nile valley along the Bahr el-Jebel south of the Bari. The Madi proper live in Uganda just beyond the Sudan frontier; the Sudan Madi live east of the river. The Madi speak a language belonging to the Madi-Moro group.

The Moro. who live in the Amadi district of the Sudan, speak a dialect of Madi and are called Madi by their neighbours; they erect remarkable megalithic monuments over their dead.

(A. J. AL.)

MADISON, JAMES (1751–1836), 4th president of the United States, often called "the father of the constitution," was born at Port Conway, in King George county, Va., on March 16, 1751. His great-great-grandfather, John hladdison (so spelled), a ship carpenter. came from England to take up 600 ac. in 1653. His father, also named James illadison, was the owner of large estates in Orange county. Va.

In 1769, Madison entered the College of New Jersey (now Princeton university). Graduating in 1771, he remained for another half year pursuing studies under the direction of the college president. John Witherspoon (1723–94). In 1772 he returned to Virginia. where he continued his reading and studies in religion and law. In Dec. 1774, as friction between the colonies and England increased. he was chosen a member of the Orange county committee of public safety of which his father was elected chairman. In the spring of 1776 he was chosen a delegate to the Virginia constitutional convention, where he was on the committee which drafted the declaration of rights and the Virginia constitution; he played a major role in the formulation of the article on religious freedom in the declaration of rights. As the constitution provided that the members of the convention should constitute the house of delegates, Madison became a member of the first Virginia state legislature. But in 1777, largely, it seems, because he refused to treat the electors with rum and punch after the custom of the time) he was not re-elected. In November of the same year he was chosen a member of the privy council or council of state, in which capacity he took a prominent part from Jan. 14, 1778, until the end of 1779, when he was elected a delegate to the continental congress.

As a member of the continental congress during the final stages of the Revolutionary War, he drafted instructions in 1780 to John

Jay, then representing the United States at Madrid, that in negotiations with Spain he should insist upon the free navigation of the Mississippi and upon the principle that the United States succeeded to British rights affirmed by the treaty of Paris of 1763. When the government under the articles of confederation faced collapse because of the failure of the states to respond to requisitions of congress for supplies for the Federal treasury, Madison was among the first to advocate the granting of additional powers to congress, and urged that congress should forbid the states to issue more paper money. In 1781 he favoured an amendment to the articles of confederation giving congress power to enforce its requisitions; and in 1783, in spite of the open opposition of the Virginia legislature, he advocated that the states should grant to congress for 25 years authority to levy an import duty. In the same year he was a member of the committee which reported a skillful compromise on the Virginia proposal as to the terms of cession to the confederation of the unoccupied western territory, held by several states.

When his term in congress expired, in Nov. 1783, Madison returned to Virginia to study law. In the following year he was elected to the house of delegates. As a member of its committee on religion, he opposed giving special privileges to the Episcopal (or any other) Church, and spoke against a general assessment for the support of the churches of the state. His petition of remonstrance against the proposed assessment, drawn up at the suggestion of George Nicholas (c. 1755–99). was widely circulated and procured its defeat. On Dec. 26, 1785. Thomas Jefferson's bill for establishing religious freedom in Virginia, which had been introduced by Madison, was passed. In the Virginia house of delegates, as in the continental congress, he opposed the further issuance of paper money; and he tried to induce the legislature to repeal the law confiscating British debts.

Meanwhile he did not lose sight of the interests of the confederation. His proposal for a conference between Maryland and Virginia relating to the navigation and commerce of the Potomac river led to a meeting of commissioners from the two states in March 1785. When the Maryland legislature proposed to invite Pennsylvania and Delaware to join in an arrangement, Madison. seeing an opportunity for more general agreement, proposed that all the states should be invited to send commissioners to consider commercial questions. 4 resolution to that effect was adopted (Jan. 21, 1786) by the Virginia legislature. This led to the Annapolis convention of 1786, and that in turn led to the Philadelphia convention of 1787.

In April 1787, Madison wrote a paper based on his study of confederacies, ancient and modern, in which he declared that no confederacy could long endure if it acted upon states only and not directly upon individuals. As the time for the convention of 1787 approached, he drew up an outline of a new system of government, the basis of the "Virginia plan," sometimes called the "Randolph plan" because it was presented in the convention by Edmund Randolph.

Madison's scheme, as expressed in a letter to George Washington, April 16, 1787, was that individual sovereignty of states was irreconcilable nith aggregate sovereignty, but that the "consolidation of the whole into one simple republic would be as inexpedient as it is unattainable." He considered as a practical middle ground changing the basis of representation in congress from states to population, thus giving the large states a greater voice. He favoured giving the national government "positive and complete authority in all cases which require uniformity" and a negative authority on all state laws, a power he felt might best be vested in the senate, a comparatively permanent body. He also favoured electing the lower house for a short term; providing for a national executive and national judiciary chosen by the legislature; creating a council to revise all laws, and including an express statement of the right of coercion; and finally, obtaining the ratification of a new constitutional instrument from the people, and not merely from the legislatures.

The "Virginia plan" was the basis of the convention's deliberations which resulted in the constitution favourably voted on by the convention on Sept. 17, 1787. Madison, always an opponent of slavery, disapproved of the compromise (in Art. I, sec. 9 and Art. V) postponing to 1808 (or later) the prohibition of the importation of slaves. He took a leading part in the debates of the convention, of which he kept careful notes, afterwards published by order of congress (3 vol., 1843). He spoke before the convention more frequently than any delegate except James Wilson and Gouverneur Morris.

In spite of the opposition of the Virginia leaders, George Mason and Edmund Randolph, Madison induced the state's delegation to stand by the constitution in the convention. To meet the objections brought against it throughout the country, he joined Alexander Hamilton and John Jay in writing The Federalist, a series of 85 papers, of which 29 (numbers 10, 14, 18. 19, 20, 37 through 58, 62, 63) were written by him. In the Virginia convention for ratifying the constitution (June 1788), when eight states had ratified and it seemed that Virginia's vote would be needed to make the necessary nine, Madison appeared at his best against such opponents of ratification as Patrick Henry, George Mason, James Monroe, Benjamin Harrison, William Grayson and John Tyler. Against an originally adverse public opinion and against the eloquence of the opponents of the constitution, Madison and his associates, Edmund Pendleton, John Marshall, George Nicholas, James Innes and Henry Lee, won a significant victory. At the same time, Madison's labours in behalf of the constitution alienated from him valuable political support in Virginia. He mas defeated by Richard Henry Lee and William Grayson for the U.S. senate, but in his own district he was chosen a representative to congress, defeating James Monroe.

Madison took his seat in the house of representatives in April 1789, and assumed a leading part in the legislation necessary to the organization of the new government. He drafted a tariff bill giving certain notable advantages to nations with which the United States had commercial treaties. hoping to force Great Britain into a similar treaty; but his policy of discrimination against England mas rejected by congress. It was his belief that such a system of retaliation would remove the possibility of war arising from commercial quarrels. He introduced resolutions calling for the establishment of three executive departments — foreign affairs, treasury and war — the head of each to be removable by the president.

Most important of all, Madison proposed nine amendments to the constitution, which were the basis of the Bill of Rights embodied in the first ten amendments. A staunch friend of the constitution. Madison believed that the instrument should not be interpreted loosely. He opposed Hamilton's measures for the funding of the debt, the assumption of state debts and the establishment of a national bank and on other questions. He bided more and more with the opposition, gradually assuming its leadership in the house of representatives and playing a leading role in the formation of the Jeffersonian Republican party. Madison objected to carrying out the recommendations in Hamilton's famous report on manufactures (Dec. 5, 1791), which favoured a protective tariff.

In 1793–96 he strongly criticized the administration for maintaining a neutral position between Great Britain and France. He wrote for the public press five papers (signed "Helvidius"), attacking the "monarchical prerogative of the executive" as exercised in the proclamation of neutrality in 1793 and denying the president's right to recognize foreign states. He found in Washington's attitude an "Anglified complexion," in direct opposition to the popular sympathy with France and French republicanism. In 1794 he again tried his commercial weapons, introducing in the house of representatives resolutions based on Jefferson's report on commerce, advising retaliation against Great Britain and discrimination in commercial and navigation laws in favour of France; and he declared that the friends of Jay's treaty were "a British party systematically aiming at an exclusive connection with the British Government."

In 1797 Madison retired from congress, but not to a life of inactivity. In 1798 he joined Jefferson in opposing the Alien and Sedition laws, and Madison himself wrote the resolutions of the Virginia legislature declaring that the powers of the federal government were limited by the compact to which the states were parties, and affirming that, in case of a "deliberate, palpable and dangerous" exercise of powers, not granted by the constitution, the states had the right and the duty to interpose their power. The Virginia resolutions and the Kentucky resolutions (the latter having been drafted by Jefferson) were met by dissenting resolutions from the New England states, from New York and from Delaware. In answer to these, Madison, who had become a member of the Virginia legislature in the autumn of 1799, wrote for the committee to which they were referred a report elaborating and sustaining in every point the Virginia resolutions.

Madison became secretary of-state upon Jefferson's accession to the presidency in 1801. Because of their close relationship it is difficult to separate their roles in the diplomacy of 1801–09. The great achievement was the purchase of Louisiana, and following it, the success with the Barbary pirates. Their failures were their inability to acquire Florida and the hopelessness of the relationship with England and France.

During eight years as secretary of state, Madison had continually to defend the neutral rights of the United States against the encroachments of European belligerents; in 1806 he published *An Examination of the British Doctrine which subjects to Capture a Neutral Trade not open in Time of Peace*, a careful argument against the doctrine set forth by Great Britain in 1756 and extended in 1793 and 1803.

In 1808 Madison was elected president by 122 electoral votes over his Federalist opponent. Charles C. Pinckney, who received 47 votes. Taking office at a moment of crisis in relations between the United States and Great Britain, the first years of his administration were dominated by problems of foreign affairs. For two years the president did the work of his incapable secretary of state, Robert Smith, who was replaced in 1811 by James Monroe.

While many historians have viewed President Madison as a weak and indecisive executive, pushed hesitantly into war by congress, Madison's most exhaustive and critical biographer, Irving Brant, rejects this verdict. Brant depicts a president who led congress and the nation. When his peace policy of economic coercion failed, he aroused public opinion both to change the complexion of congress in the elections of 1810 and to support the War of 1812. The country, however, was not adequately prepared for war, nor was it united in support of what many called "Mr. Madison's War." Re-elected in 1812 in spite of formidable opposition, Madison grew increasingly unpopular as disaster followed the armies (*see* WAR OF 1812); the New England Federalists called for his resignation and even talked secession. In general, congress was more to blame than either the president or his official family, or the army officers. With the declaration of peace the president again gained a momentary popularity. In the postwar period, Madison assented to a new nationalistic program which included the creation of the Second Bank of the United States and a protective tariff.

Retiring from the presidency in 1817, Madison returned to his home, Montpelier, Orange county, Va., which he was to leave in no official capacity except in 1829, when he was a delegate to the state constitutional convention and served on several of its committees. Madison took an interest in education, in emancipation of slaves, and in agricultural questions, to the last. He died at Montpelier on June 28, 1836.

Madison was married in 1794 to Dolley (or Dolly) Payne Todd (1768–1849), a widow of great social charm. Her plump beauty was often remarked, notably by Washington Irving, in contrast to Madison's delicate figure and wizened face. He was! as Henry Adams wrote, "a small man, quiet, somewhat precise in manner, pleasant, fond of conversation, with a certain mixture of ease and dignity in his address."

Henry Clay, contrasting him with Jefferson, said that Jefferson had more genius, Madison more judgment and common sense; that Jefferson was a visionary and a theorist, Madison, cool, dispassionate, practical and safe. The broadest and most accurate scholar among the "founding fathers," he was particularly an expert in constitutional history and theory.

See also UNITED STATES OF AMERICA: *History*.

BIBLIOGRAPHY.—Madison's life is most competently and exhaustively treated in Irving Brant, *James Madison* (5 vol., 1941–56). Older biographies were written by J. Q. Adams (1850), W. C. Rives (3 vol., 1859–69) covering the period before 1797, S. H. Gay (1884), and Gaillard Hunt (1902). Madison's *Writings* (9 vol., 1900–10) were edited by Hunt, who also edited *The Journal of the Debates in the Convention which framed the Constitution of the United States, as Recorded by James Madison* (1908). *See* also Henry Adams, *History of the United States, 1801–1817* (9 vol., 1889–91); S. F. Bemis, ed., *American Secretaries of State and Their Diplomacy*, iii (1927); N. E. Cunningham, Jr., *The Jeffersonian Republicans* (1958); Adrienne Koch, *Jefferson and Madison: the Great Collaboration* (1950). (N. E. CU.)

MADISON, the capital of Wisconsin, G.S., the seat of Dane county and the University of Wisconsin; lies in the south central part of the state in a rich agricultural region of gently rolling wooded hills. Four lakes linked together by the Yahara river furnish a picturesque site for the city, located on an isthmus between the two largest, Lake Mendota (15.2 sq.mi. in area), and Lake Monona (5.5 sq.mi.). Pop. (1960) city 126.706; standard metropolitan statistical area (Dane county) 221,095. (For comparative population figures *see* table in WISCONSIN: *Population.)* Surrounded by a number of populous communities Madison began a program of annexation about 1940 which by 1958 had trebled its area and accounts in part for the population increase. Two independent residential villages, Maple Bluff and Shorewood Hills, lie within Madison's boundaries. Middleton borders it on the northwest.

History.—Madison was founded in 1836, a year of frenzied speculation in public lands and tomnsites in the newly created Territory of Wisconsin. The pleasant wooded knoll between the lakes caught the eye of one of Wisconsin's most far-sighted and inveterate speculators, James Duane Doty, who laid out a townsite for a company of investors which included Gov. Stevens T. Mason of Michigan. It was named for Pres. James Madison, who had recently died. That fall Doty lobbied a bill through the legislature, which was then meeting at the temporary capital of old Belmont, making Madison the permanent capital. The place was uninhabited but construction was quickly begun on a capitol and late in 1838 the legislature held its first session in the unfinished building. Controversies over the legal title to the townsite and financial stagnation following the panic of 1837 retarded settlement.

In 1846, when a village government was established, the lonely inland community still numbered only 626 inhabitants. Due in large measure to the efforts of Leonard J. Farwell, the "second father of Madison," small industries soon began to move in. The state university opened its doors in 1849, a railroad reached Madison in 1854, and in 1856 the city was incorporated. Its growth thereafter was unspectacular but steady, following the pattern laid down in early years.

The Economy.— Government operations, federal, state, county and city, account for much of the city's prosperity. Federal agencies include the G.S. forest products laboratory, the first of its kind in the world, and the world headquarters for the U.S. Armed Forces institute. The white granite capitol (the third on the site, constructed 1906–17) stands in the centre of the city in a 14-ac. wooded park. Nearby is the county and city building (completed in 1957), and a mile away is the University of Wisconsin, occupying 320 ac. within the city limits and an additional 1,654 ac. in Dane county. (For further discussion of the university *see* WISCONSIN: *Education.)*

Institutional agencies occupy more than a quarter of the land area of the city. This is divided almost equally among three groups: the city, for schools, parks, government buildings; the state and the university; and semi-public organizations such as churches, hospitals and lodges. The number employed by government agencies in Madison exclusive of educational staffs was estimated at 14,000 in the 1960s.

Industries developed substantially after World War I. In the early 1960s the city had more than 150 industrial plants employing more than 12,000 persons. Because of its central location and good transportation facilities, Madison became a jobbing and distributing centre for the wholesale trade. Truax field, used jointly by the city and the U.S. air force, serves as the commercial airport.

Other Facilities. — ?*ladison is noted for its numerous public and parochial schools, its libraries and its hospitals. There are numerous parks and playgrounds, golf courses. bathing beaches, picnic grounds and other forms of recreational areas in the city. The city has a high proportion of professional. managerial and technical personnel. Its people are a middle-income population. (AL. E. SM.)

MADIUN, a regency and town of the province of East Java, Indon. The regency has an area of 443 sq.mi. and a population (19j6 est.) of 468,690. Rice, corn (maize), sugar cane, cassava. coffee, coca, chinchona, coconuts and peanuts are grown. Teak is obtained from the forests. Madiun became a Dutch residency (area, 2,512 sq.mi.) after the rebellion of 1825–30. Occupied by the Japanese during World War II, the residency became part of the Republic of Indonesia after the war. Thereafter it was broken up and the regency of Xladiun created.

Madiun. the capital city, is located on the banks of the Madiun river and has large railway shops and irrigation works. Pop. (1956 est.) 86,713.

MADRAS, a state of India, in the south of the Indian peninsula. It is bounded on the northeast by Andhra Pradesh state, on the northwest by Mysore state and on the southwest by Kerala state. Its area is 50.132 sq.mi. and population (1951 census for post-Nov. 1956 area) 29.974.936. The 1961 census was 33,650,-917. The capital is Madras (*q.v.*). Madras came to enjoy provincial autonomy in 1937 and became a state of the republic of India in 1950. In 1948–49 the area of the state was enlarged by the inclusion into existing districts of three former Madras states. viz., Banganapalle, Pudukkottai and Sandur, but in 1953 it ceded to the newly constituted state of Xndhra 10 of its 25 districts, and at the same time part of the Bellary district was transferred to Mysore state. This reduced the area of Madras state by 67,428 sq.mi. and its population by 21,281.513. A further revision of the state's boundaries was recommended in the report of the States Reorganization commission. 1955. The reorganized state came into existence on Nov. 1. 1956. and according to this arrangement the district of Malabar and the district of South Kanara were transferred to the states of Kerala and Mysore respectively. A part of Coimbatore district was also transferred to Mysore state.

In turn. Madras got a few taluks. south of the former Travancore-Cochin state. These are now constituted into a district by name Kanyakumari. At present, the state has 13 districts, further divided into 101 taluks. The total number of villages is 17,285.

Physical Features. — The state is bounded on the western side by the Western Ghats, on the east by the Bay of Bengal and on the south by the Gulf of Mannar. The vast plain covering the whole of the south and extending up to the eastern coast line comprises the major part of the state; the mountainous region is in the centre and north. The Eastern Ghats enter Madras state from Andhra state in the north and run across the state in a southwesterly direction until they merge with the Nilgiri hills which are connected with the Western Ghats. The highest peak in the Nilgiris is Mt. Dodabetta (8,640 ft.).

The Western Ghats, a steep and rugged range of mountains rise to 8,841 ft. (Amai Mudi peak) and more at certain places, run along the whole length of the western boundary of the state at a distance varying from 50 to 100 mi. from the sea. There is only one gap in the range. the Palghat gap, about 20 mi. wide, 1.000 ft. high, which facilitates communication between the west coast and Madras state.

The most important river in the state is the Cauvery which rises in Coorg in the Western Ghats and after flowing across the Mysore plateau drops into the plains of Madras at the falls at Sivasamudram. With a large tributary system it crosses the peninsula and reaches the Bay of Bengal through an alluvial delta. Other rivers of importance are the Ponnaiyar (or Penner), the Palar, the Vaigai, the Tambraparni and the Netravati. Marine cretaceous deposits are found in three detached areas, near Tiruchirapalli (Trichinopoly), Viruddachalam and Pondicherry.

Climate. — The climate of Madras varies in accordance with the height of the mountain chain on the western coast. Where this chain is lofty, as between Malabar and Coimbatore. the rain clouds are checked and give a rainfall of 150 in. on the side of the sea and only 20 in. on the landward side. Where the range is lower. the rain clouds pass over the hills and carry their moisture to the interior districts. The Nilgiri hills enjoy the climate of a temperate zone, with a moderate rainfall. The clouds on the Western Ghats sometimes obscure the sun for months at a time. Along the eastern coast and central tablelands the rainfall is low and the heat excessive. At Madras, the average rainfall of 50 in. is above the mean.

Flora.—Madras. which can be roughly divided into five main vegetational regions, contains over 4,500 species of flowering plants. In the west and south is dense evergreen forest. The characteristic plant of the sal region, in the north, is the sal tree (*Shorea robusta*) which does not occur south of the Godavari river. In the Deccan region. from the Godavari west and south to Coimbatore, the forest is mainly deciduous with teak (*Tectona grandis*), *Terminalia tomentosa* and *T. coriacea*, etc. In the semi-desert region. stretching roughly from the southern part of Coimbatore to the coastal strip. the vegetation consists of small-leaved thorny trees and shrubs such as *Dalbergia spinosa*, *D. coromandeliana*, *Acacia planifrons*. Characteristic plants of the rich flora of the wet region—the coastal strips. the Western Ghats and the western plain up to about 6.000 ft.—are *Hopea parviflora* and the Indian copal tree (*Vateria indica*); *Xylia xylocarpa* occurs near the coast; teak, rosewood (*Dalbergia latifolia*), *Pterocarpus marsupium*, which provides wood for building and furniture and a medicinal gum-resin called kino. *Terminalia crenulata* and the ornamental *Lagerstroemia lanceolata* are found in the deciduous forest inland; species of Guttiferae. Myrtaceae, Euphorbiaceae. Orchidaceae, etc., grow in the wet forests higher up. and in the dense forest tracts are reedlike bamboos, a profusion of mosses. tree and other ferns, the only indigenous conifer (*Podocarpus latifolius*) and the two tree composites (*Vernonia monosis* and *V. travancorica*). The alpine region in the higher Nilgiris and other ranges, above 6,000 ft.. consists of open grasslands with alpines and small bushes; *e.g.*, the small blue *Parochetus communis* and the big yellow *Hypericum mysorense*. Belts of mangroves and of halophytic chenopods occur in the deltas of both coasts, while on the dry foreshores, where the beefwood tree (*Casuarina equisetifolia*) has been planted, creeping sand-binders include *Hydrophylax maritima*, *Ipomoea biloba*, *Sesamum prostratum* and *Spinifex squarrosus*.

Fauna.—Wild animals include the elephant, bison, sambar and ibex of the Western Ghats and Nilgiris. The elephant is protected by law from indiscriminate destruction. The cattle are small but along the Mysore frontier a superior variety is carefully bred by the wealthier farmers.

HISTORY

Until the British conquest the nhole of southern India had never acknowledged a single ruler. The Tamil country in the extreme south mas traditionally divided between the three kingdoms of Pandya. Chola and Kerala. The nest coast supplied the nucleus of a monarchy which afterward extended over the highlands of Mysore and took its name from the Carnatic. On the northeast the kings of Kalinga at one time ruled over the entire line of seaboard from the Kistna to the Ganges. (*See* INDIA.) The Mohammedan invader first established himself in the south in the beginning of the 14th century.

Ala ud-Din, the second monarch of the Khilji dynasty at Delhi, and his general Malik Kafur conquered the Deccan and overthrew the kingdoms of Karnataka and Telingana. which were then the most powerful in southern India. But after the withdrawal of the Moslem armies the native monarchy of Vijayanagar (*q.v.*), arose out of the ruins.

In 1565 this monarchy was overuhelmed by a combination of the four Mohammedan principalities of the Deccan. At the close of the reign of Aurangzeb, although that emperor nominally extended his sovereignty as far as Cape Comorin. in reality southern

India had again fallen under a number of rulers who owed no regular allegiance. The nizam of the Deccan, virtually an independent sovereign, represented the distant court of Delhi. The most powerful of his subordinates was the nawab of the Carnatic, with his capital at Arcot.

Vasco da Gama cast anchor off Calicut on May 20. 1498, and for a century the Portuguese retained the commerce of India. The Dutch, superseding the Portuguese at the beginning of the 17th century, were quickly followed by the English, who concluded a treaty with the zamorin of Calicut; but no settlement was established until 1664. The Portuguese eventually retired to Goa and the Dutch to the Spice Islands. The first English settlement on the east coast was in 1611, at Masulipatam, even then celebrated for its fabrics. Farther south Fort St. George, the nucleus of Madras city, was erected in 1640. Pondicherry became a French settlement in 1674. The War of the Austrian Succession in Europe lit the first flame of hostility on the Coromandel coast. In 1746 Madras was forced to surrender to Mahé de la Bourdonnais, and Fort St. David remained the only English possession in southern India. By the peace of Aix-la-Chapelle Madras was restored to the English, and English influence was generally able to secure the favour of the rulers of the Carnatic and Tanjore, while the French succeeded in placing their own nominee on the throne at Hyderabad. Robert Clive, whose defense of Arcot in 1751 forms the turning point in Indian history, defeated Joseph Dupleix, and in 1760 the crowning victory of Wandewash was won by Colonel (afterward Sir Eyre) Coote, over the comte de Lally. A year later, despite help from Mysore, Pondicherry was captured.

In 1763 the tract encircling Madras city, then known as the Jagir and now as the Chingleput district, was ceded to the British by the nawab of Xrcot.

In 1765 the Northern Circars, out of which the French had recently been driven. were granted to the East India company by the Mogul emperor. but at the price of an annual payment of £90,000 to the nizam of Hyderabad. Full rights of doininion were not acquired until 1823.

In 1792 Tipu was compelled to cede the Baramahal (now part of Salem district), Malabar and the Dindigul subdivision of Madura. In 1799, on the reconstruction of Mysore state after Tipu's death, Coimbatore and Kanara were appropriated as the British share; and in the same year the Maratha raja of Tanjore resigned the administration of his territory, though his descendant retained titular rank till 185j. In 1800 Bellary and Cuddapah were made over by the nizam of Hyderabad to defray the expense of an increased subsidiary force. In the following year the dominions of the nawab of the Carnatic, extending along the east coast almost continuously from Nellore to Tinnevelly, were resigned into the hands of the British by a puppet who had been put upon the throne for the purpose. The last titular nawab of the Carnatic died in 1885. (See also HYDER ALI.)

After the beginning of the 19th century Madras experienced no regular war, but occasional disturbances called for measures of repression. In 1836 the zamindari of Gumsur in that remote tract was attached by the government for the rebellious conduct of its chief.

In 1879 the country round Rampa on the northern frontier was the scene of riots necessitating calling out the troops. More serious were the "Anti-Shanar riots" of 1899, when the Maravans of Tinnevelly and parts of Madura, resenting the pretensions of the Shanans, a toddy-drawing caste, to a higher social and religious status, organized attacks on Shanan villages. In Aug. 1921, as a result of Rhilafatist agitation, the fanatical Moplahs of Malabar (Moslems of Arab descent) broke out into rebellion; thousands of innocent Hindus were either massacred or forcibly converted to Islam before order was restored (Feb. 1922).

SOCIAL AND ECONOMIC CONDITIONS

Population. — Of the population in 1951 30,558,981 were Hindus. 3,248,608 Mohammedans, 1,432,761 Christians, 32,353 Jains and 461.786 were of other religions. The average death rate was 21.9 and birth rate 32.4j per 1,000. The best-known aboriginal tribe, the Toda (*q.v.*), is found in the Nilgiris. The chief Mohammedan tribes are Labbai, Moplah, Sheikh, Sayad, Pathan and Dudecula.

Broadly speaking, the entire population of Madras belongs to the five linguistic offshoots of the great Dravidian stock dominant throughout southern India. At an early period these races appear to have accepted some form of the Brahmanical or Buddhist faiths. Many storms of conquest later swept over the land, and colonies of Mogul and Maratha origin are to be found here and there. But the evidence of language proves that the ethnical character has remained stable under all these influences and that the Madras Hindu, Mohammedan, Jain and Christian are of the same stock.

Of the five Dravidian languages Tamil is spoken by 24,075,196 persons, Telugu by 3,323,142, Kannada by 1,217,146 and Malayalam by 5,208,587.

Administration. — Formerly a presidency of British India, officially styled the Presidency of Fort St. George, Madras is now a state of the Indian republic, with a local ministry and legislature. For purposes of administration, the state is divided into 13 districts, each under the charge of a collector, with subcollectors and assistants. Local government is organized through panchayats (village committees) and district boards.

The superior court of justice is the high court at Madras, with a chief justice and 8 puisne judges; there are also 19 district and sessions judges for criminal and civil law cases.

The chief educational institutions are the Madras and Annamalai universities founded in 1857 and 1928 respectivcly. In 1957 there were 23,268 recognized public educational institutions with 3,285,-023 pupils.

Agriculture and Forestry. — Over the greater part of Madras artificial irrigation is impossible and cultivation depends upon the local rainfall. The main sources of irrigation are channels, tanks (small man-made lakes) and wells.

Out of the net area cultivated (14,030,000 ac.), 4,500,000 ac. were irrigated in 1956–57. A number of major and minor irrigation schemes have been drawn up.

The principal food staples are rice and cholum, cambu, ragi and varagu (four kinds of millet). The most common oilseed is peanut. Sugar is derived from cane and the sap of palms. The principal fruit trees are coconut. areca nut. jack, tamarind and mango, and other crops include coffee, rubber, tobacco and tea. Cotton is grown mostly in the districts of Coimbatore, Tirunelveli, Ramanathapuram and Madurai, and the greater part of the coffee-growing area is in the Nilgiri hills. The tea plant has also been introduced into the Nilgiri hills. The greater part of the soil is held by the cultivators direct from the government under the tenure known as ryotwari. (See RYOT.)

Of the total population 61.54% were engaged in agriculture according to the 1951 census.

Forests cover a total area of 6,564 sq.mi. Experimental afforestation has received much attention. It has been estimated that in the year 1956–57 forests in Madras state yielded more than 47,400 tons of timber, 146,900 tons of firewood and 1,566 tons of sandalwood. The forests contain teak, ebony, rosewood, sandalwood and redwood trees. There were Iarge-scale plantations of teak, wattle, eucalyptus and cashew in 1957.

Mining and Manufactures. — The mineral wealth of the state is largely undeveloped, though excellent iron has been smelted by local smiths from time immemorial. The principal minerals are mica, barites, gypsum, bauxite, limestone, china clay, magnesite, etc., and a scheme for mining lignite in Neyveli, South Arcot district, was begun in the mid-1950s.

The chief industries in Madras are cotton ginning, spinning and manufacturing, coffee curing, oil pressing, rice curing, ropemaking, sugar refining, tanning, tile and brickmaking, and the manufacture of cement, glass, matches, salt and soap. The railway works are also considerable. A number of new industrial establishments arose in different parts about the middle of the 20th century, including plants for the manufacture of automobiles, bicycles, etc. The Integral Coach factory of the Indian railways is located near Madras city.

Trade and Communications. — The continuous seaboard of

Madras, without any natural harbours of the first rank, has tended to create a widely diffused trade. Madras city conducts nearly one-half of the total sea-borne commerce; then Tirunelveli. with the harbour at Tuticorin, Tanjore and South Arcot. Madras has most of the coastal trade. The chief staples of the export trade are cotton and cotton piece goods, peanuts, hides and skins, tea and coffee, coir manufactures. rice and oil.

The state is well supplied with railways, which naturally have their centre in Madras city, the chief seaport. The broad-gauge line of the Southern railway connects with Bombay and Bangalore and also crosses the peninsula to Kozhikode (Calicut) and Mangalore on the west coast. The total length of railways is over 6,000 mi.. of cement and concrete roads 239 mi., of black-top-surface roads 4,431 mi., of metalled roads 10,274 mi. and of unmetalled roads 8.20; mi.

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MADRAS, the capital and the chief port of Madras state, India: is situated on the eastern coast of India. in lat. 13° 4 N., long. 80° 17 E. Nearly 50 sq.mi. in area, it is the largest town in extent in the Indian republic. The population in 1951 was 1,416,056, as compared with 777,481 in 1941.

The city can be reached by sea, air, rail and road. Ships of all countries call at the port, and there is an airport at Minambakkam, on the southern trunk road, a few miles away from the city. Madras is the southern terminus and headquarters of the Indian railways and from it railway lines branch out to all parts of the country. Many important trunk roads also converge on the city. The principal waterways of the city are the Cooum river, which cuts the city into two almost equal halves, the Adyar three miles to the south of the Cooum and the Buckingham canal, which connects the Cooum with the Adyar.

Fort St. George is the centre from which the city has expanded toward the north. south and west. To the north of the fort is George Town, a densely populated block about a mile square, comprising the principal business part of the city with the banks, customshouse and high court. On the sea front are the mercantile offices, the pier and the harbour, and to the south of the fort are the densely populated, centuries-old hamlets of Triplicane and Mylapore, which contain many ancient Hindu temples. To the east of Mylapore is San Thomé. the cathedral which is reputed to contain the tomb of Thomas the apostle. To the south of San Thomé and beyond the Adyar river, is the international headquarters of the Theosophical society. Along the sea front for more than 2 mi.. from San Thomé to Fort St. George, runs the broad Marina, one of the most beautiful promenades in the world. Facing the Marina, are the library, colleges, and offices of the University of Madras, and the government offices. The southern trunk road area beyond the Cooum river and the northern trunk road area are rapidly becoming industrialized and in the former area are situated the offices of several important newspapers, the state legislature buildings and the legislators' hostel. Though the centre of the city and the area around it are congested, its outskirts and suburbs! especially the new housing colonies such as Ayanavaram. Shenoy Nagar, Thyagarayanagar and Gandhi Nagar have a pleasant rural appearance. Viewed from the air, the city looks quite green, since, even in the most congested parts, there are fine trees, gardens and parks. The Madras municipal corporation, the oldest in the east, consists of 81 members, under an elected mayor and deputy mayor, with a paid commissioner as its chief executive. The University of Madras, constituted in 1857 as an examining body, was reorganized in 1923 as a teaching and residential university with a large number of constituent, affiliated and approved colleges throughout the state.

Madras possesses some special industries, the most important of which are the film and textile industries, engineering—structural and mechanical—and automobile and railway coach building. Though entirely artificial, the harbour is thoroughly equipped and has accommodation for 18 vessels, 9 at moorings and 9 at the quays. The depth at the moorings ranges from 28 ft. to 31 ft. 6 in. and at the quays from 26 ft. to 30 ft. The chief exports are seeds, nuts, hides, skins, condiments, textiles, ores, tobacco and vegetable oils.

The chief imports are coal, coke. food grains, mineral oils, metals, timber, textiles, building materials, machinery, hardware, paper, stationery, tanning substances and chemical fertilizers. The chief places of interest are the Marina, the museum. the municipal stadium, the zoo, the agri-horticultural gardens and the Adyar gardens.

History.—The foundation of Madras dates from Feb. 20, 1640, when the English actually settled on land granted to them in 1639 by the local Hindu chief. The building of Fort St. George was started in 1640 and completed in 1653, and a gradually increasing population settled around its walls. From these small beginnings, the city has extended and expanded through three centuries, into a modern city of 50 sq.mi. (J. V. S. R.)

MADRAZO, a family of Spanish artists.

JOSÉ DE MADRAZO Y AGUDO (1781–1859), portrait and history painter and etcher, was born at Santander. April 22. 1781, and died in Madrid, May 8, 1859. A supporter of Charles IV, he followed the king to France after his abdication in 1808 and became a pupil of J. L. David, whose influence shows clearly in his portraits. He went to Rome, and in 1819 returned to Madrid. where he was appointed keeper of the Prado and director of the Academia de San Fernando.

FEDERICO DE MADRAZO Y KUNTZ (1815–1894), portrait and history painter, José's eldest son, was born in Rome. Feb. 9, 1815, and died in Madrid, June 10, 1894. He was a pupil of his father. of the Academia de San Fernando and of F. Winterhalter in Paris (where J. A. D. Ingres was among his portrait subjects). His "Godefroy proclamé roi de Jérusalem" was commissioned for Versailles in 1837. After a long stay in Rome he returned to Madrid as a fashionable portraitist. becoming painter-in-ordinary to the court and in 1859 succeeding his father in the direction of the Prado and the Academia. He was the founder of *El Artista, El Renacimiento, El Sevnanario pintoresco* and other journals.

José's second son, LUIS DE MADRAZO Y KUNTZ (1825–1897), was a successful history painter, and his youngest son, JUAN DE MADRAZO Y KUNTZ (1827–1880), was architect of the English church and other buildings in Madrid. RAIMUNDO DE MADRAZO Y GARRETA (1841–1920), Federico's eldest son and pupil. was a portrait. subject and genre painter who eventually settled in France. Federico's youngest son and pupil. RICARDO DE MADRAZO Y GARRETA (1852–1917), also a pupil of Mariano Fortuny, was a genre painter and sculptor.

MADRE DE DIOS, a montaña department of southeastern Peru, bounded north by Brazil and Loreto, east by Bolivia, west by Cuzco and south by Puno. Area 30,271 sq.mi. Pop. (1955 est.) 33,289. The department, created in 1902, is an isolated region of dense forests subject to periodic inundation. The climate is generally hot and humid with heavy rainfall; however, there is a fairly well-marked dry season from April through September. Economic resources of the department comprise rubber of the high-quality Beni-Acre type, Brazil nuts, medicinal plants and hardwoods. Crops cultivated include rice, cassava, bananas, sugar cane and other tropical commodities.

Puerto Maldonado, pop. (1958 est.) 1,910, capital of the department, is situated at the confluence of the Madre de Dios and Tambopata rivers. It may be reached by air but otherwise transport is by river craft. The population is largely Indian and mestizo with a small colony of Japanese. (J. L. TR.)

MADRE DE DIOS RIVER rises in the Cordillera de Carabaya near Paucartambo in southern Peru and flows 615 mi. north and northeast past Manú in Peru and Puerto Heath on the Peru-Bolivia border to meet the Beni river at Riberalta, Bol. The Beni and bfamore unite northeast of Riberalta to form the Madeira river, one of the major tributaries of the Amazon. In Peru the Madre de Dios flows through the sparsely settled department of Madre de Dios, which has less than 0.4% of the total Peruvian population. The Madre de Dios river is generally navigable for small craft on the upper course but its efficiency, like that of most rivers in eastern Bolivia, is much reduced by rapids and tree trunks. Traffic on the river is interrupted just below Puerto Heath.

During the days of the rubber boom in the Amazon basin there were numerous rubber stations on the Madre de Dios, but after 1912 production ceased to be commercially important. The climate is hot and humid and the entire region is largely covered with virgin forest. There is still some gathering of rubber, balata, chicle and other products along the river's course. In a few small areas there is some unimpressive production of cacao, coffee! cotton, fruits, sugar cane and cassava. Development of this isolated area through which the Madre de Dios flows does not appear likely, but the river is the main communication line with the outside world. (L. WE.)

MADRID, a province of central Spain, formed in 1833 of districts previously included in New Castile, and bounded on the west and north by Ávila and Segovia, east by Guadalajara, southeast by Cuenca and south by Toledo. Pop. (1950) 1,823,410, of whom 1,571,939 inhabited the city of Madrid; area, 3,090 sq.mi. Madrid belongs to the basin of the Tagus, being separated from that of the Douro by the Sierra de Guadarrama on the northwest and north, and by the Sierra de Gredos on the southu-est. Like the rest of Castile, Madrid is chiefly of Tertiary formation; the soil is mostly clayey, but in part sandy. The southeastern districts are the best watered: and produce in abundance fruit, vegetables, wheat, olives, esparto grass and excellent wine. To the north there is timber for fuel and building. The royal domains of the Escorial, Aranjuez and El Prado, and the preserves of the nobility, are wooded and supplied with game. The Sierra de Guadarrama has quarries of granite, lime and gypsum, and is known to contain iron, copper and argentiferous lead. Other industries are chiefly confined to the capital. All the great railways converge in this province, and it contains 221 mi. of line. Besides Madrid! the towns (1950 pop.) of Aranjuez (21,910, mun.), Alcalá de Henares (15,004, mun.) and the Escorial are described in separate articles. Other towns with more than 10,000 inhabitants are Puente de Vallecas, Chamartin, Carabanchel Bajo, Vistalegre-Ventas and Pueblo-Nuevo-Ventas. The population of these towns has been included in the aggregate municipal population of Madrid.

MADRID, the capital of Spain, lies almost in the centre of the Iberian peninsula. Pop. (1897) 397,816; (1950) 1,571,939; (1957 municipal census) 1,910,000.

The highest capital city of Europe, it is situated on the Meseta, an undulating plateau of sand and clay. On the northwest, beyond the Manzanares river (a 50-mi.-long tributary of the Jarama, which flows into the Tagus), the city is bounded by heath and parkland, the former comprising the royal hunting preserves (Casa de Campo); farther north is the Sierra de Guadarrama (7,972 ft.), the inner valleys of which, still fairly well wooded, are much frequented by the *Madrileños*. On the other sides Madrid is surrounded by agricultural land, mostly treeless and bare in appearance, but well cultivated. The highest point in Madrid is 2,373 ft. above sea level. This altitude and the open situation of the town makes it liable to sudden variations of temperature. On the other hand, to these same circumstances Madrid owes its clear, pure atmosphere which makes its climate healthful and reasonably pleasant except in July and August, when the heat becomes oppressive.

The Moorish name of the town (Majrit), first historical evidence of its existence, appears to have been mentioned in 932 when Ramiro II razed its walls but left it in Moorish hands. Traces have been found of a Roman settlement and even some indications of human habitation in prehistoric times. Nevertheless, Madrid must be considered a modern town by Spanish standards, and only gained some claim to fame when Alfonso VII granted it certain privileges. The parliament (*Cortes*) was twice summoned in Madrid (1309 and 1478). Henry III, John IV of Portugal and Henry IV of Castille all spent considerable periods of time in the town. where the latter king died. Philip II, taking into account its central position and healthful surroundings, established his capital there in 1561, a decision generally thought to be transitory. In fact, it mas only in 1607, under Philip III, that Madrid finally attained its present status. It has never become a city. During the War of the Spanish Succession, Madrid took the Bourbon side against the Habsburgs. In 1808 it gave the signal for a mass uprising against the troops of Napoleon, remaining afterward obdurately hostile to his brother Joseph, whom he had placed on the Spanish throne. Ferdinand VII, on his return from imprisonment by Napoleon in 1814, bestowed upon the town the title of "heroic." As a consequence of the political vicissitudes of the 19th and 20th centuries the life of the capital was disturbed more than once. The disturbances remained sporadic until the Spanish civil war of 1936–39, when. as seat of the government, Madrid became the scene of the two-and-a-half years' siege, which ended on March 28, 1939, with the entry of the nationalist troops. All traces of the damage suffered were completely obliterated.

Madrid is the see of a bishopric, the headquarters of an army corps and residence of the captain general of the 1st military region, the focus of the main roads and railways, a banking centre, the seat of a university, of the supreme court and of all branches of the central administration. The head of the state lives in the former royal palace of El Pardo, 9 mi. from the city proper. Economically the importance of Madrid considerably increased. In the 1960s it was the second Spanish industrial town after Barcelona.

Development and General Description.—Madrid has known four well-defined periods of development: the first, under the house of Austria, shortly after having been chosen capital; the second, under Charles III (1759–88), one of the so-called enlightened despots; the third stretching from the end of the reign of Isabella II (1868) to the regency of Maria Cristina of Habsburg (1885–1902); and the last, which includes World Wars I and II, interrupted by the Spanish civil war of 1936–39.

From the first period dates the Plaza Mayor, built in 1619, rectangular in shape and 430 ft. long, ornamented by an equestrian statue of Philip III and two small fountains. It has witnessed many a solemnity, from tournaments to bullfights and autos-da-fé. To the same period also belong the building housing the foreign office. the remnants of the royal palace of El Buen Retiro (an artillery museum) and the town hall. To Charles III are due the Puerta de Alcalá, one of the two city gates worthy of mention (the other being the Puerta de Toledo), the finance ministry and the observatory. He also completed the royal palace, constructed in 1735–64 by Filippo Iuvara and G. B. Sachetti. The middle of the 19th century saw the opening of a new opera house (Teatro Real, 1850), the installation of water mains (1858) and the construction of the square knomn as Puerta del Sol.

José de Salamanca, a prominent banker, gave a new impetus to the extension of Madrid, by planning and financing the fashionable district bearing his name. From 1900 progress continued at a steady but leisurely pace. In 1910 the opening. through a maze of old streets, of the commercial thoroughfare popularly called Gran Vía took place. Roughly one mile long, it became a smart shopping and amusement centre and altogether changed both the face and the tempo of life of central Madrid. Flanked by tall modern buildings including the 14-story telephone exchange, the Gran Via ends at the Plaza de Espaiia, where stand the Cervantes monument and the Espaiia skyscraper, reputed to be the tallest in Europe.

In 1919 the first subway was built. From that time the town's growth has been swift and constant. Between 1947 and 1951 nearly all the outlying suburbs were annexed to the capital and the municipal territory increased tenfold. A planning organization, the Comisaria Superior de Ordenación Urbana, was created. Developments after 1939 included reconstruction of the university city, destroyed during the civil war; new canalization of the Manzanares, thereby reclaiming further land along its banks, where a vast scheme of working-class dwellings, green spaces and artificial beaches has been carried out; the erection of the group of buildings housing the Higher Council for Scientific Research; and the construction of the Barajas international airport, linked with the capital by a magnificent highway. The Castellana avenue was prolonged for nearly a mile, the main roads leading into the town nidened and embellished, a new ring road constructed and several important housing schemes, comprising blocks of flats

(Barrios de la Concepción de la Quintana, del Niño Jesús, etc.) and suburban garden cities (Puerta de Hierro. la Florida). completed. Other municipal developments included an extension of the subway, replacement of streetcars by buses and trolley buses, improvements in sanitation and lighting. and new athletic fields, including the gigantic Chamartín stadium.

In the course of its somewhat haphazard growth Madrid has become the common modern type of sprawling city and has therefore no definite form. the only feature retained of its previous shape being that it still measures rather more from north to south than from east to west.

The Puerta del Sol (reputedly named after a gate, which stood there until 1510 and had on its front a representation of the sun) used to be the centre of Madrid and the busiest spot. Devoid of all architectural interest, it has become peripheral, and several other centres have sprung up in different parts of the town. On the north side of the Puerta stands a square red brick building erected in 1768 as a post office. later the police headquarters. The three-mile-long Calle de Alcalá starts in the Puerta del Sol. It contains the finance and education ministries, a theatre, two churches, nine of Spain's main banks and the Real Academia de Bellas Artes. founded in 1752 as an academy of art and music. Its collection of Spanish masters includes some of the best works of Murillo and Goya.

The Bank of Spain stands where the Calle de Alcalá intersects the Prado, an avenue laid out with gardens and adorned on the right side by the fountain of Apollo and on the left by an obelisk commemorating the rising against Napoleon. The Prado connects two oval plazas in each of which is a fountain one representing Neptune and the other Cybele. At one end of the avenue stand the Prado museum and the Church of St. Jerome (founded by the "Catholic Sovereigns" Ferdinand and Isabella and the scene of royal weddings and ceremonies); at the other the general post office (1916) and the ministry of marine; in the middle the exchange (1894). The Paseo del Prado has great architectural distinction. bounded on one side by a residential quarter including the Retiro gardens, a park with ponds, fountains, monuments and a zoo. A royal palace, built for Philip IV and destroyed during the French occupation. once stood there.

Northward the Prado is continued by the Calvo Sotelo (formerly the Paseo de Recoletos) and the Castellana, in which are the national library, the mint, the Columbus monument, foreign embassies and residences of the aristocracy and the well-to-do.

Near the Puerta del Sol lies the Plaza de Oriente. A statue of Philip IV on horseback, designed by Velázquez, presides over its gardens, the whole dominated by the royal palace. built on an eminence overlooking the Manzanares. It replaces the old Alcizar, nhich burned down on Dec. 28, 1734, and contains richly decorated rooms, a priceless library, collections of tapestries and a famous armoury. Southeast of the plaza and down to the Manzanares stretch the *barrios bajos*, Madrid's most typical and poorest section.

Among the churches the following deserve mention: San Francisco el Grande (18th century, designed by Francesco Sabattini); San Andrés (17th century), one of the finest, which was set on fire by the mob and gutted in 1936; Capilla del Obispo (Gothic and Renaissance. 1520); San Pedro (Hispano-Moorish), built on the site of a mosque; Montserrat (baroque); Comendadoras and San Placido (both 18th century); and, lastly, San Isidro, used as a cathedral since 1885 (built from 1623 to 1665).

Of secular buildings, the following are notable: the Casa de Cisneros (plateresque); the Casa de los Lujanes, where Francis I of France, captured at Pavía. was kept prisoner; and above all the Prado museum, originally planned as a museum of natural science and formally opened in 1819. The building was designed by Juan de Villanueva, as were the entrance to the adjoining botanic gardens and the nearby observatory. In the Prado are exhibited the paintings collected by the Spanish monarchs from the 15th century. representing almost the entire range of western painting, mainly Spanish, Flemish and Italian, up to the 19th century. A new wing was added in 1956. There are 20 other museums in Madrid, some of them first class: archaeological, artillery, naval and decorative arts museums among them. Of the private collections three are outstanding, nameiy the Lázaro Galdiano. Cerralbo and Valencia de Don Juan. The Toledo and Segovia bridges (1735 and 1584) spanning the Manzanares are worthy of note.

'Education and Culture. — Until 1836, when the university founded in Alcalá by Francisco Cardinal Jiménez de Cisneros was transferred to the capital, Madrid had no university of its own. Older existing institutions, such as the Medical College of San Carlos (1786) and the Royal Institute of San Isidro, were merged with it, and the University of Madrid became the foremost university in Spain. Among the buildings in the reconstructed university city are several newly created *colegios mayores* or students' residences. Madrid also contains teachers' training colleges, schools of arts and crafts, a conservatory of music, colleges of agriculture, architecture and engineering, etc. The principal learned societies are the royal academies for the cultivation of the Spanish language, of history, moral science, jurisprudence, medicine and pharmacy, mostly created in the 18th century and later incorporated into a body called the Institute of Spain.

From the time it was made a capital Madrid has had a vigorous and lively cultural life. The atmosphere of the town. its light and colour, the temperament of its people, generous, quick-witted, easygoing, even if perhaps superficial, form the background of the literary trend known as *Madrileñismo*, which extols the capital's charms and explores its past and present; the writers Ramón de Mesonero Romanos, in the 19th century, and later Ramón Gómez de la Serna being its main exponents. The so-called *zarzuela* ("musical comedy") and *saiaete* ("light prose comedy") based on Madrid lore are the outcome of the same feeling.

Industries. — In 1900 Madrid was almost exclusively an administrative and commercial centre. Industries making luxury and fancy goods, pharmaceutical products, leather articles, furniture: etc.. began to develop. After 1940, however, Madrid took its place among Spain's chief industrial cities and there are important factories manufacturing aircraft, radio and electrical equipment of all kinds (including domestic appliances), rubber, plastics, optical equipment, trucks and motor engines.

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MADRIGAL is the name given to a form of concerted vocal music, Italian in origin. The earliest school of madrigal writing flourished in northern Italy in the 14th century and is quite distinct from the later one that began about 1530. The early madrigal is a poetical form as well as a musical one, similar to the ballade or ballata, in which two or three strophes of three lines each (iambic pentameters) are followed by a final ritornello of two lines; in each strophe two lines rhyme with one another. For this type of madrigal the suggested derivation from *mandra* ("flock") may nell be correct, since early writers associate it with the *pastourelle* of the troubadours and its subject matter is generally idyllic and contemplative, if not exactly pastoral.

The principal composers to write in this form were Jacopo da Bologna and Giovanni da Cascia (or da Firenze); their settings are for two or three voices, of which the topmost is usually very ornate.

The madrigal was already becoming obsolete by the time of Francesco Landino (c. 1325–97) and it fell into complete oblivion during the 1jth century. When it was revived by the humanistic circle which gathered about Cardinal Pietro Bembo in the early years of the 16th century it is probable that. whatever its original derivation had been, *madrigale* was thought of simply as equivalent to *matricale*, meaning "in the mother tongue"; *i.e.*, Italian and not Latin, for it is applied to poems without any fixed form. The madrigals of this period were intended as a literary return to the more elevated style of antiquity, in contrast to such current forms as the *frottola* and the *strambotto*. The music to which they were set was likewise intentionally dignified, and it drew upon the style of the contemporary sacred motet and upon Josquin des Prés's sonorous chansons; nevertheless the break was not a sudden one, and the first of these madrigals (published in 1533) are still similar to *frottole*.

The earliest group of 16th-century madrigal composers includes Philippe Verdelot, Jacob Arcadelt, Adrian Willaert and Costanzo Festa. It will be noted that northern (French and Flemish) composers preponderate, and it was not until the middle of the century that native Italian composers began to play a large part in the composition of madrigals. Whereas the earlier madrigalists had aimed at a placid, almost abstract, musical accompaniment to the words, Cipriano de Rore, Andrea Gabrieli, Philippe de Monte and Orlando di Lasso cultivated a new and detailed expressiveness, with words such as *acerbo* ("bitter"), *ira* ("anger"), *pianti* ("weepings") underlined by dissonances, and *gioia* ("joy") or *riso* ("laugh") set to swiftly running figures. Although the application of these expressive symbols at times appears naïve, the result was the rapid development of a new musical language, one which had repercussions on the setting of words to music throughout Europe.

The final stage of the Italian madrigal, although it produced much superb music, can be seen as a decline from this intimate fusion of music and poetry. In the hands of composers such as Luca Marenzio, Don Carlos Gesualdo and Claudio Monteverdi the musical language of the madrigal became ever richer and more varied, but with this went a tendency to set stilted and epigrammatic poems of negligible literary value. The increasing independence of the separate voice parts eventually resulted in the complete breakup of the old polyphonic texture; in the later madrigals of Monteverdi, for example, passages for one or more solo voices are punctuated with sonorous passages for the full group, and unity is achieved not by continuity of texture but by the use of an accompanying *basso continuo*. From this type of accompanied madrigal it was a comparatively short step to the cantata, which in the 17th century was to take its place as the most elevated form of secular vocal music.

In France, Germany and Spain, the Italian madrigal made its influence felt on the native forms of secular part song, but nowhere was it so enthusiastically imitated or so completely naturalized as in England. Madrigals had been known in court since the later years of Henry VIII, but it was not until the 1580s that they achieved real popularity. In 1588 Nicholas Yonge was able successfully to publish a large collection of Italian madrigals in English translation under the title *Musica Transalpina,* and similar collections followed it. William Byrd (1542 or 1543–1623) was already a mature artist and was little influenced in his secular music by the Italian style, but his pupil Thomas Morley embraced it wholeheartedly, and even had two of his sets published in an Italian version as well as in the original English. Morley excelled in the lighter and more cheerful types of madrigal, such as canzonets ("little short songs" as he calls them) and ballets: the latter he modeled on the *balletti* of Giovanni Giacomo Gastoldi, but achieved a more elaborate musical development and a stronger sense of harmonic direction. John Wilbye (1574–1638) and Thomas Weelkes (1577?–1623) brought to the English madrigal a new depth of feeling and on occasion a profound melancholy that is not characteristic of the Italian school; Wilbye is the purer stylist, but Weelkes the bolder and more individual.

Of the later English madrigal publications those of Orlando Gibbons and Thomas Tomkins, published in 1612 and 1622 respectively, are the best, but although the fashion for madrigals lasted only about 40 years in England it had in that comparatively short space of time produced a remarkable quantity of fine music.

Uniquely in Europe, it seems, the tradition of madrigal singing was revived in England in the early 18th century. The Madrigal society (founded by John Immyns in 1741, and still in existence) and, less specifically, John C. Pepusch's Academy of Ancient Music kept the practice alive in London, and it also flourished among the lay clerks of cathedral and collegiate churches throughout the country. At these meetings both English and foreign madrigals were sung, together with later compositions written in imitation of their style. In the 19th century there appeared two studies of the madrigal repertory—T. Oliphant's *La Musa Madrigalesca* (London. 1837) and E. F. Rimbault's *Bibliotheca Madrigaliana* (London, 1847), and G. E. P. Arkwright provided both historical studies of the composers and editions of their music in a more scientific way at the beginning of the 20th century. However, it was the work of E. H. Fellowes, above all, that made this repertory available for study and performance; his complete edition of *The English Mudrigal School,* 36 vol. (London, 1913–24) is among the monuments of British musicology; and his book *The English Madrigal Composers,* 2nd ed. (London, 1948), and his edition of the poetic texts in *English Madrigal Verse* (Oxford, 1920) form a worthy complement to it. Fellowes' work led to a widespread revival of madrigal singing in England and the United States.

Studies and editions of the two Italian schools of madrigalists are too scattered and extensive to be listed here, but details of the earlier may be found in any bibliography of the Italian Ars Nova, while an indispensable guide to the later is A. Einstein's *The Italian Madrigal,* 3 vol. (Princeton, Oxford, 1949). Einstein left the vast collection of manuscript scores on which he had based his comprehensive survey to Smith college, Northampton, Mass., where they form a unique library for any student of the subject. A general survey and detailed bibliography may be found in G. Reese, *Music in the Renaissance* (New York and London, 1954). (J. J. N.)

MADRÍZ, a small department in the northwestern part of the Central Highlands in Nicaragua. Area 531 sq.mi. Pop. (1950) 33,178, of which 89% was rural. Somoto, pop. (1950) 2,313, is the largest town and departmental capital. Despite its rugged relief, and because of rather fertile valley soils and 60 or more inches of rain per year, the department is significant in the production of swine, cattle, horses, mules, coffee, brown sugar (panela), cotton, vegetables and subtropical fruits. Until the construction of the Inter-American highway across the department, giving it access to Managua, 136 mi. away, Madriz depended chiefly upon pack and air transportation. (C. F. J.)

MADROÑA *(Arbutus menziesii)*, a handsome North American tree of the heath family *(Ericaceae),* called also madrone, madroño and laurelwood, native to the coast region from British Columbia to southern California. It is a widely branched tree, growing to a height of 125 ft., with a trunk diameter exceeding 4 ft.; polished crimson to dark-brown bark; large, lustrous, dark-green leaves, nearly white beneath; small, heathlike, white flowers in dense clusters; and bright orange-red, berrylike fruit.

MADURA, an island of Indonesia (Dutch MADOERA), lying off the northeast coast of Java, from which it is separated by a shallow strait of less than $1\frac{1}{2}$ mi. It is over 100 mi. long and 24 mi. wide and has an area of 2,113 sq.mi. Pop. 2,000,000. It has an undulating surface, but no mountains, 700 ft. being the greatest elevation in the west and 1,565 ft. that of the east. In the north the hills run down nearly to the sea; in the northwest and south there are extensive alluvial plains, while the south coast is fringed with islets, shoals and mudbanks. The geological formation reveals the relation of Madura to northern Java, since it consists largely of the same limestone rocks, of Tertiary formation, with low alluvial tracts. There are hot springs. Off the eastern coast are several islands—Sapudi, and the Kangean group, Kangean Island being 25 mi. long and from 3 to 15 mi. wide, with hills reaching 1,500 ft.

The climate, flora and fauna of Madura resemble those of east Java. Vegetation is luxuriant, but the soil is not as fertile as the average soil in Java, and one indication of this is that rice has to be imported to meet the needs of the population. Maize and cassava are the main crops, but rice, coconuts, coffee, coca, kapok and most of the usual Malayan fruits and vegetables are grown, and kapok, copra and coconut oil figure largely in exports, also teak, from the extensive forests in the northwest. The island is well adapted for cattle-breeding, which is engaged in extensively, and the wide expanse of coast, well sheltered on the southern side, gives opportunity for a great deal of fishing; the Kangean Islands and Sapudi yield timber, trepang and tortoise shell. The principal industry is salt panning, which is a government monopoly. The salt is obtained from saline springs and from sea water; the largest pans are situated at Kalianget. Manufacture is according to European method and employs many. Production after World War II fluctuated between 130,000 and 320.000 tons. Petroleum has been found and is worked on a small scale. The Madurese (Moslems). who are keen traders, fishermen and sailors but not very good craftsmen, are shorter, but more sturdily built than the Javanese ; they are also more independent. and quick-tempered, but thrifty and hard-working. and their moral standard is high: they have their own peculiar amusements of bullracing and bull-fighting; the races. usually held in the month of September, attract huge crowds. The capital and seat of the resident is Pamekasan, in the central southern part of the island. not far from the coast (pop. 23,121), which has modern buildings, including a hotel. Other towns are Sumenep (pop. 33,628), near which are the tombs of the princes of Sumenep; Bangkalan (pop. 19,8j1), with the old palace of the sultan of Bangkalan, or Madura, and an interesting mosque; Sampang (pop. 15,000); Kamal; and Kalianget. Dutch influence was established in Madura late in the 17th century. and the power of the ambitious prince of Madura was circumscribed by the division of the island into three regencies. bladura (or Bangkalan), Pamekasan. and Sumenep, each having its own prince, or sultan. After much native misrule, the regencies were, in 1885, united under a residency attached to Java. In 1950 Madura became part of the Republic of Indonesia. (E. E. L.)

MADURA (Anglicization of MADURAI), a city and district in Madras state. Republic of India. The city is situated on the right bank of the Vaigai river, and has a station on the Southern railway 345 mi. S.E. of Madras. Pop. (1961) 424.975. In Madura city are a government industrial school and the American college, affiliated to Madras university. Cotton and silk weaving are special industries, with brass work and wood carving.

The city was the capital of the Pandpan dynasty, which ruled over this part of India from the jth century B.C. to the end of the 11th century A.D. The immense rectangular precincts of the Great temple are dominated by ten elaborately carved and coloured gopuras, or gate towers, of which the largest is 152 ft. high. The temple, which contains a "hall of a thousand pillars," is said to have been built in the reign of Viswanath, first ruler of the Nayak dynasty. The splendid palace of Tirumala Nayak, which covers a large area, has been restored and is used for public offices. Also, there are Vasanta, a hall 33 ft. long, and the Tamakam, a pleasure palace.

In 1310 Madura was plundered by a Moslem army under Malik Kafur. It formed part of the empire of Mohammed ibn Tughlak until 1334 when Sayyid Ahsan, the governor of Mabar, revolted and established the independent sultanate of Lladura which after 1378 was absorbed by the Hindu empire of Vijayanagar. In the middle of the 16th century the governor Viswanath established the Nayak dynasty. which lasted for a century. The greatest of the line was Tirumala Nayak (reigned 1623–59), who adorned Madura with many public buildings. and extended his empire over adjoining districts. Later Mohammedans again invaded Lladura and compelled him to pay them tribute, After his death the kingdom of Madura gradually fell to pieces, being invaded by both Mohammedans and Marathas. About 1736 the district fell into the hands of the nawab of the Carnatic, and the line of the Nayaks was extinguished. About 1764 British officers took charge of Lladura in trust for the last independent nawab of the Carnatic, whose son finally ceded his rights of sovereignty to the East India company in 1801.

THE DISTRICT OF MADURA has an area of 4,910 sq.mi. Pop. (1961) 3,204,866. It consists of a section of the plain stretching from the mountains east to the sea, coinciding with the basin of the Vaigai river, and gradually sloping to the southeast. The plain is broken by the outlying spurs of the ghats, rising 8,000 ft. above sea level. They enclose a plateau of about 100 sq.mi. On it is situated the sanatorium of Kodaikanal, and fruit is grown and coffee planting carried on. Other crops are millets, rice, other food grains. oilseeds and cotton. Tobacco is grown chiefly near Dindigul. The Periyar tunnel through the Travancore hills conveys the rainfall across the watershed for irrigation.

MADURESE LANGUAGE, like most languages of Indonesia, is one of the Malayo-Polynesian languages (*q.v.*). It is most closely related to the languages of western Indonesia such as Javanese and Malay. It is the native language of about 8,000,000 Indonesians and thus shares with Malay third position among the languages of the country. Its speakers are distributed mainly over Madura and nearby islands, the Kangean and Sapudi Islands and the section of the eastern peninsula of Java which faces Madura. There are two main dialects: Western Madurese. which has two subdialects with centres respectively at Pamekasan and Bangkalan. and Eastern hladurese with its centre at Sumenep. Madurese has different status styles: the *alos* (literally "fine") for deferential address, the *kasar* (literally "coarse") for familiar address and the *tengngaqan* (literally "middle") for othernise undefined address. The difference between the styles is not as great as that of the Javanese and Sundanese styles.

Madurese is traditionally written in an adapted form of the Javanese alphabet. Madurese formerly was rarely used in writings because of the domination by Javanese princes and then by the Netherlands Indies government. The chief original Madurese writings are some historical norks. the remainder being mainly translations from the Javanese. (I. DN.)

MADVIG, JOHAN NICOLAI (1804–1886), Danish philologist. whose chief work was the study and teaching of Latin and Greek and the improvement of the classical schools, was born on the island of Bornholm on Aug. 7, 1804. He was educated at Frederiksborg and at the University of Copenhagen, where in 1829 he became professor of Latin language and literature. In 1848 Madvig entered parliament and became minister of education and later (1852) director of public instruction. From 1856 to 1863 he was president of the council and leader of the National Liberal party.

Madvig died at Copenhagen on Dec. 12, 1886.

Besides his unsurpassed edition of Cicero's *De finibus* (1839; 3rd ed.. 1876), Madvig published *Der römische Stats Forfatning og Forvaltning,* 2 vol. (1881–82); *Livseringringer* (1887); and many works on Latin grammar and Greek syntax.

See J. E Sandys, *History of Classical Scholarship,* 2nd ed , iii (1908).

MAEBASHI, industrial city and communications centre. is the capital of Gumma prefecture. Japan. The city grew rapidly in size and population after World War II. Pop. (1947) 90,432; (1960) 181,937. Maebashi remains a centre of sericulture and silk-yarn production in spite of the general decline of the silk industry.

An old castle town, in the Muramachi period it was called Umayabashi and in the Tokugawa period it was the seat of the hlatsudaira family. (C. A. MR.)

MAECENAS, GAIUS (CILNIUS), Roman patron of letters. was probably born betneen 74 and 64 B.C., perhaps at Arretium. Expressions in Propertius (ii, 1, 25–30) seem to imply that he had taken some part in the campaigns of Mutina, Philippi and Perusia. He prided himself on his Etruscan lineage and claimed descent from the princely Cilnii of Arretium. His great wealth may have been in part hereditary, but he owed his position and influence to his close connection nith the emperor Augustus He first appears in history in 40 B.C., when he was employed by Octavian in arranging his marriage with Scribonia, and afterward in assisting to negotiate the peace of Brundusium and the reconciliation with Antony. It was in 39 B C. that Horace mas introduced to Maecenas, who had before this received Varius and Virgil into his intimacy. In the "Journey to Brundusium" (Horace. *Satires,* i. 5) in 37, Llaecenas and Cocceius Nerva are described as having been sent on an important mission, and they were successful in patching up, by the treaty of Tarentum, a reconciliation between the two claimants for supreme power. During the Sicilian war against Sextus Pompeius in 36, Maecenas was sent back to Rome and was entrusted with supreme administrative control in the city and in Italy. He was vice-gerent of Octavian during the campaign of Actium, when. with great promptness and secrecy, he crushed the conspiracy of the younger Lepidus; and during the subsequent absences of his chief in the provinces he again held the same position. During the latter years of his life he fell somewhat out of favour with his master.

Maecenas died in 8 B.C., leaving the emperor heir to his wealth.

He seems to have been of great use to Augustus in the establishment of the empire, and was credited with having influenced him towards a humane policy. The best summary of his character as a man and a statesman is that of Velleius Paterculus (ii. 88), who describes him as "of sleepless vigilance in critical emergencies, far-seeing and knowing how to act, but in his relaxation from business more luxurious and effeminate than a woman." His character as a munificent patron of literature has made his name a household word. His patronage was exercised with a political object, and he sought to use the genius of the poets of the day to glorify the new régime. The diversion of Virgil and Horace towards themes of public interest may be ascribed to him, and he endeavoured less successfully to do the same thing with Propertius. The great charm of Maecenas in his relation to the men of genius who formed his circle was his simplicity, cordiality and sincerity. He admitted none but men of worth to his intimacy, and when once admitted they were treated like equals. Much of the wisdom of Maecenas probably lives in the Satires and Epistles of Horace. It has fallen to the lot of no other patron of literature to have his name associated with works of such lasting interest as the Georgics of Virgil, the first three books of Horace's Odes, and the first book of his *Epistles.*

Maecenas himself wrote in both prose and verse. His prose works on various subjects—Prometheus, Symposium (a banquet at which Virgil, Horace and Messalla were present), De *cultu* suo (on his manner of life)—were ridiculed by Augustus, Seneca and Quintilian for their awkward style. Dio Cassius states that Maecenas was the inventor of a system of shorthand.

There is no good modern biography of Maecenas. The best known is that by P. S. Frandsen (1843). See "Horace et Mecène" by J. Girard, in La *Révue politique* et *littéraire* (Dec. 27, 1873); V. Gardthausen, *Augustus* und seine *Zeit,* i. 762 seq.; ii. 432 *seq.* The chief ancient authorities for his life are Horace (Odes with Scholia), Dio Cassius, Tacitus (Annals), Suetonius (*Augustus*). The fragments have been collected and edited by F. Harder (1889).

MAELDUIN or **MAELDUNE, VOYAGE OF,** an early Irish romance. The text exists in an 11th-century redaction, by a certain Aed the Fair, the "chief sage of Ireland," but dates back to the 8th century. It belongs to the group of Irish romance, the Navigations (Imrama), resembling the classical tales of the wanderings of Jason, of Ulysses and of Aeneas. Maelduin, the foster-son of an Irish queen, learnt on reaching manhood that he was the son of a nun, and that his father, Ailill of the edge of battle, had been slain by a marauder from Leix. He set sail to seek his father's murderer, taking with him, in accordance with the instructions of a sorcerer, 17 men. His three foster-brothers swam after him, and were taken on board. This increase of the fateful number caused Maelduin's vengeance to be deferred for three years and seven months, until the last of the intruders had perished. The travellers visited many strange islands, and met with a long series of adventures, some of which are familiar from other sources. The Voyage of St. Brendan (*q.v.*) has very close similarities with the Maelduin, of which it is possibly a clerical imitation, with the important addition of the whale-island episode, which it has in common with "Sindbad the Sailor."

Imram Curaig Mailduin, is preserved, in each case imperfectly, in the Lebor *na* h Uidre, a ms. in the Royal Irish academy, Dublin; and in the Yellow Book of Lecan, ms. H. a16 in the Trinity college library, Dublin; fragments are in Harleian ms. 5,280 and Egerton ms. 1,782 in the British Museum. There are translations by Patrick Joyce, Old Celtic Romances (1879), by Whitley Stokes (a more critical version, printed together with the text) in Revue celtique, vols. ix. and x. (1888–89). See H. Zimmer, "Brendan's Meerfahrt" in Zeitschrift fur deutsch. Altertum., vol. xxxiii. (1889). Tennyson's Voyage of *Maeldune* includes the framework of the romance.

MAELIUS, SPURIUS (d. 439 B.C.), a wealthy Roman plebeian, who during a severe famine bought up a large amount of corn and sold it at a low price to the people. Lucius (or Gaius) Minucius, the patrician praefectus annonae (president of the market), thereupon accused him of courting popularity with a view to making himself king. The cry was taken up. Maelius, summoned before the aged Cincinnatus (specially appointed dictator), refused to appear, and was slain by Gaius Servilius Ahala; his house was razed to the ground, his corn distributed amongst the people, and his property confiscated. The open space called Aequimaelium, on which his house had stood, preserved the memory of his death.

See Livy, iv. 13; Cicero, De senectute 16, De amicitia 8, De *republica,* ii. 27; Florus, i. 26; Dion. Halic. xii. 1.

MAELSTROM, a term originally applied to the Moskenstrom, a strong current running between the islands of Moskenaes and Mosken in the Lofoten Islands off the west coast of Norway. Its power has been much exaggerated though it is dangerous in certain states of wind and tide. The original name occurs on Mercator's Atlas of 1595; the term has been used generically for large whirlpools elsewhere and figuratively for any turmoil of wide-reaching influence. It is probably from Dutch *malen,* "to grind," and *stroom,* "a stream."

MAENAD, one of the female attendants of Dionysus (*q.v.*); they also are called Bacchae, Lenae, Thyiades, Clodones and Mimallones.

MAERLANT, JACOB VAN (c. 1225–*c.* 1291), the pioneer of the didactic poetry which flourished in the Netherlands in the 14th century. A Fleming by birth, he was born in Vrije van Brugge (Damme?). The details of his life are disputed, but he was probably sexton at Maerlant near Brielle on Voorne between 1255 and 1265(?) and was employed by Albrecht van Voorne, Nicholas Cats, lord of North Beveland, and Floris V, count of Holland. About 1266 he became clerk to the court at Damme, where he died shortly after 1291. Maerlant reveals careful education by his intimate knowledge of both Latin and French. His early works were versions of medieval romances—Alexanders *Geesten* (*c.* 1225), based on Gautier de Châtillon's Latin *Alexandreis; Historie* van den *Grale* Merlyn (c. 1260), freely translated from Robert de Borron's early contributions to the Arthurian cycle; *Torec* (c. 1262); and, most important, the *Historie* van Troyen (c. 1264), from the Roman de Troie ascribed to Benoît de Sainte-Maure. These chivalric epic romances belong to the period of Maerlant's contact with the world of nobility, but it is interesting that even in them he shows a tendency to treat his subjects historically and to correct and amplify his sources by reference to Latin texts.

When Maerlant began to write with the definite aim of providing instruction, he turned entirely to Latin sources, writing a scientific compilation, Der Naturen Bloeme (1266–69?), after Thomas of Cantimpré's De natura *rerum;* a life of St. Francis (before 1273), based on Bonaventura; the Rijmbijbel (1271), after Petrus Comestor's *Historia Scolastica;* and, finally, his most important work, *Spieghel* Historiael, an adaptation with additions of his own of Vincent of Beauvais's Speculum *historiale,* begun c. 1282 and completed after his death by Philippe Utenbroeke and Lodewijk van Velthem.

These moralizing rhymed encyclopaedic works were written to satisfy the rising class of commoners who wished for instructive reading in their own language. Among Maerlant's many followers in this kind the most notable were Jan van Boendale, Lodewijk van Velthem and Jan de Weert. His own considerable gifts as a religious poet are also more fully shown in his strophic poems—especially *Wapene* Martijn, a dialogue poem in which he discusses the decadence of the period and treats moral problems with great earnestness—and in his fervent Disputacie van Onser Vrouwen ende *vanden Heilighen Cruce* and Van den *Lande* van Oversee which scourges the laxity of the church and calls for a new crusade.

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MAES (MAAS), **NICOLAES** (NICOLAS) (1632–1693), Dutch painter, a follower of Rembrandt, was born at Dordrecht. About 1650 he went to Amsterdam, where he entered Rembrandt's studio. Before his return to Dordrecht in 1654 Maes painted a few Rembrandtesque genre pictures, with life-size figures and in a deep glowing scheme of colour, as in the "Reverie" at the Ryks museum in Amsterdam, the "Card Players" at the National Gallery, London, and the "Children with a Goat Carriage," in the collection of the late J. P. Morgan, New York. In his best period, from 1655 to 1665, Maes devoted himself to domestic genre on a smaller scale, retaining to a great extent the magic of colour he had learned from Rembrandt.

His favourite subjects were women spinning, or reading the Bible, or preparing a meal. He visited Antwerp between 1660 and 1670, and his Antwerp period coincides with a complete change in style and subject. He devoted himself almost exclusively to portraiture, and abandoned the intimacy and glowing colour harmonies of his earlier work for a careless elegance which suggests the influence of Van Dyck. The change gave rise to the theory of the existence of another Maes, of Brussels. Maes is well represented at the National Gallery by five paintings: "The Cradle," "The Dutch Housewife," "The Idle Servant," "The Card Players," and a man's portrait. At Amsterdam, besides the splendid examples to be found at the Ryks museum, is the "Inquisitive Servant" of the Six collection. At Buckingham Palace is "The Idle Servant," and at Apsley House "Selling Milk" and "The Listener." There are examples in New York, Boston, Philadelphia, San Francisco and other American cities.

MAESTRO: *see* WINDS, MOUNTAIN AND LOCAL.

MAETERLINCK, MAURICE (1862–1949), Belgian-French dramatist and poet, of Flemish extraction, was born at Ghent on Aug. 29, 1862. He was educated at the Collège Sainte-Barbe, and then at the university of Ghent. In 1887 he settled in Paris, where he immediately became acquainted with Villiers de l'Isle-Adam and the leaders of the symbolist school of French poetry. At the death of his father, Maeterlinck returned to Belgium, where he thenceforth mainly resided: in the winter at Ghent, in the summer on an estate at Oostacker. His career as an author began in 1889, when he published a volume of verse, *Serres chaudes*, and a play, *La Princesse Maleine*, the latter originally composed in metre, but afterwards rewritten in prose. In 1890 he published, in Brussels, two more plays, *L'Intruse* and *Les Aveugles;* followed in 1891 by *Les Sept princesses.* His strong leaning to mysticism was now explained, or defined, by a translation of the *Adornment of the Spiritual Marriage* of Ruysbroeck (*q.v.*) which Maeterlinck brought out in 1891. In 1892 appeared *Pelléas et Mélisande,* followed in 1894 by those very curious and powerful little dramas written to be performed by marionettes: *Alladine et Palomides, Intérieur* and *La Morte de Tintagiles.* In 1895 Maeterlinck brought out, under the title of *Annabella*, a translation of Ford's *'Tis Pity She's a Whore,* with a preface. Two philosophical works followed. a study on Novalis (1895) and *Le Trésor des humbles* (1896). In 1896 he returned to drama with *Aglavaine et Se'lysette* and to lyric verse with *Douze chansons.* 4 monograph on the ethics of mysticism, entitled *La Sagesse et la destine'e,* was issued, as a kind of commentary on his own dramas, in 1898; and in 1901 Maeterlinck produced a volume of prose, in which philosophy, fancy and natural history were mingled—La *Vie des abeilles.*

The nature of Maeterlinck's early writings, whether in prose or verse, was strictly homogeneous. Whether in philosophy. or drama, or lyric, Maeterlinck was exclusively occupied in revealing, or indicating, the mystery which lies only just out of sight, beneath the surface of ordinary life. In order to produce this effect of the mysterious he aimed at an extreme simplicity of diction, and a symbolism so realistic as to be almost bare. His plays are occupied with the spiritual adventures of souls, and the ordinary facts of time and space have no influence upon the movements of the characters. We know not who these orphan princesses, these blind persons. these pale Arthurian knights, these aged guardians of desolate castles, may be; we are not informed whence they come, nor whither they go; there is nothing concrete or circumstantial about them. Their life is intense and consistent, but it is wholly of a spiritual character; they are mysterious with the mystery of the movements of a soul. In spite of the shadowy action of Maeterlinck's plays, which indeed require some special conditions and contrivances for their performance, they are produced with remarkable success before audiences who cannot be suspected of mysticism, in most of the countries of Europe. His later work, published after he settled in France, presents a marked

Several of his prewar essays, collected in *The Buried Temple* (1902), *The Double Garden* (1909), *Life and Flowers* (1907), and more particularly his book on *Death* (1912). were inspired by a reaction against his early mystic and fatalistic tendencies. The same contrast applies to the spirit of such plays as *Monna Vanna* (1909) and *Mary Magdalene* (1909), in which the action is concentrated in a few important scenes, more according to the Racinian than to the Shakespearian method.

His interest in Shakespeare is nevertheless shown in his essay on King Lear, *Life and Flowers,* and in the translation of *Macbeth* (1910). *The Blue Bird* (1910), produced in 1911, still increased the popularity of the Belgian writer in English-speaking countries. It was followed by *The Betrothal* (1919), produced in London in 1921. Maeterlinck wrote a war play dealing with the German occupation of Belgium, *The Burgomaster of Stilemonde* (1920), produced in London by Sir J. Martin Harvey. *The Miracle of St. Anthony* and *Mountain Paths* appeared in 1919, and *The Cloud that Lifted* and *The Power of the Dead* in 1923. Most of the works of Maurice Maeterlinck have been translated into English.

Maeterlinck was awarded the Nobel prize for literature in 1911. He died May 6. 1949, near Nice, France.

See J Bithell, *Life and Writings of Maurice Maeterlinck,* "Great Writers" (1913); G. F Sturgis, *The Psychology of Maeterlinck as Shown in his dramas* (1914); *M.* Clark, *Maurice Maeterlinck, poet and philosopher* (1915); *H* Meyer-Benfey, *Das Maeterlinck-Buch* (1923).

MAFEKING, a town in the Cape Province, near the frontier of the Bechuanaland Protectorate; 25° 52′ S., 25° 41′ E.; altitude 4,194 ft. Its pop. (1951) of 6,965 makes it the trade centre for the protectorate and the western Transvaal. It is also the headquarters of the railway system between Kimberley and Bulawayo, and is the chief seat of the administration of the Bechuanaland Protectorate. The native town. a separate entity, situated about a mile away. is the chief place of the Barolong tribe, and has a population of about 3.000. The town was besieged by the Boers from Oct. 12, 1899, to May 17, 1900. *(See* SOUTH AFRICAN WAR, 1899–1902.) In memory of those who died in its defense, the English church was erected and also a memorial before the town hall.

MAFFEI, FRANCESCO SCIPIONE, MARCHESE DI (1675–1755), Italian dramatist and scholar, who in his verse tragedy *Merope* (1713) attempted to introduce French classical simplicity into Italian drama, was born at Verona, June 1. 1675. After studying at Parma, he fought in the War of the Spanish Succession. Becoming interested in the archaeology of his native town, he wrote a valuable account of its history and antiquities, *Verona illustrata* (1731–32). He died in Verona, Feb. 11, 1755.

Besides *Merope,* his works include *Teatro italiano,* a collection of 12 plays (1723), translations of the *Iliad* and the *Aenead,* and many scholarly studies.

A modern edition of Maffei's works by A. Avena appeared in 1928.

See G. Gasperoni, *Scipione Maffei e Verona Settecentesca* (1955).

MAFIA (MAFFIA). A word of uncertain origin. anglicized as mafia, used to designate a specific form of criminality which arose on the great landed estates *(latifundia)* of Sicily as a result of bad government during a long period of the island's history, and more especially during the disorders consequent on the Napoleonic invasion of south Italy. Lawless conditions led the owners of large estates to place their lands in the charge of energetic ruffians who exercised almost despotic powers over a terrorized peasantry. The contiguity of the estates enabled these men to form an organization which gradually became very extensive and powerful, so much so that in time it turned against the landowners themselves. The members of the organization were not very numerous. but, bound by close ties of fellowship and capable of any crime, they compelled the landowners to employ persons of their choice, fixed the compensation they claimed for their services, and the rents and price of the lands and of the crops entrusted to their protection. Their activities sometimes extended to neighbouring towns; they made it practically impossible for lands or crops to be sold at open auction, and effectively hindered efforts likely to interfere with their interests.

On the other hand, fierce quarrels of all kinds arose among them leading to terrible acts of revenge, whence the formation of bands of outlaws, at feud among themselves, and all the crimes consequent on outlawry.

A complicated code of traditions regulated the *mafia,* based on so-called *omertà* (from Sicilian omu, man), the obligation never, under any circumstances. to apply for justice to the legally constituted authorities, and never to assist in any way in the detection of crime committed against oneself or others. Absolute silence was required and enforced by ruthless reprisals, the right to avenge injuries being reserved to the victims or their families. Like the Camorra (*q.v.*), the Mafia was soon powerful in various social classes.

After the fall of the local Bourbon monarchy in 1860, the Italian government endeavoured with varying success to rid Sicily of the Mafia; but in the various Sicilian provinces the police authorities continued to tolerate it. When the fascist regime came into power, after 1922, it used its exceptional powers to capture and bring to trial the leaders of the Mafia. In a series of trials at Palermo and neighbouring Termini Imerese, in 1927, the accused, in batches of as many as 150, were brought before the courts; and their victims gave evidence against them. The leaders received life sentences and heavy punishment was meted out to their accomplices. Unfortunately, the fascist government used this occasion to get rid, at the same time, of honest Sicilians strongly opposed to it. And this fact became an advantage for the legend of the Mafia which, although composed of criminals, did not lack in its distant origins a certain chivalrous element, since it had once appeared to many as a force fighting Spanish misrule and feudal abuses.

In spite of all repressive efforts the Mafia persisted. Following World War II the land reforms weakened its power in the rural areas of central and western Sicily. Its strongholds, and its extortionary and other activities were then directed more to industrial, business and construction enterprises.

Organized crime in the Cnited States, some observers have pointed out, bears many resemblances to the Mafia in its philosophy, methods of operation and local organization. In 1950–51, the U.S. senate special crime investigating committee reported that U.S. gangster syndicates had close business relations with the Mafia. Similar allegations were made in 1958 by witnesses before the U.S. senate select committee on improper activities in the labour management field.

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MAFRA, a town of Portugal, 20 mi. N.W. of Lisbon. Pop. (1950) 3,116. Mafra is remarkable for its monastery, church and palace, built by John V in 1717–32 in consequence of a vow to build a convent for the poorest friary of the kingdom—which proved to be a small Franciscan settlement there. The building is in the form of a parallelogram and it is said to be lighted by no fewer than 5,200 windows. The church is sumptuously built of marble and richly adorned with statues and other objects of art. In each of the twin towers there is a chime of 57 bells.

MAGADHA, an ancient kingdom of India. mentioned in the Ramayana and the Mahabharata. It comprised that portion of Behar lying south of the Ganges, with its capital at Pataliputra or Patna. The scene of many incidents in the life of Gautama Buddha. it was a holy land and was also the seat of the Maurya empire founded by Chandragupta Maurya and, later, of the Gupta dynasty. See INDIA: History.

MAGALLANES (Spanish form of Magellan), the southernmost province of Chile, extending from 48° 40' S. to Cape Horn and including the mainland west of the Argentine frontier, the numerous islands fronting the Pacific, the Fuegian archipelago and the western half of Tierra del Fuego (*q.v.*). Pop. (1960) 73,037. Area 52,285 sq.mi. The area to the west of the Andes is one of the most inhospitable regions of the world, with cool rainy conditions prevailing throughout the year. Many of the islands are barren and where forests occur the terrain prevents their commercial exploitation. The channels, fiords, mountains and glaciers make it a region of great scenic beauty. The area east of the Andes, both on the mainland and on Tierra del Fuego, consists of extensive glacial plains covered with tussock grass. Rainfall on these plains nowhere exceeds 40 in. annually.

For three centuries after its discovery by Magellan in 1520 the region was inhabited only by nomadic tribes; of which the chief survivors are the Alacaluf (*q.v.*) in the western channels. In 1843 the settlement of Fuerte Bulnes on the Strait of Magellan established Chile's claim to the area. Six years later Punta Arenas was founded as a penal settlement. The discovery of gold and of the region's pastoral possibilities in the 1880s speeded the occupation of the province. The principal settlements are Punta Arenas (*q.v.*), the provincial capital and chief distributing and administrative centre on the Strait of Magellan, Puerto Natales, serving Ultima Esperanza, and Porvenir, the port of Tierra del Fuego. There are large estancias in the region east of the Andes where an estimated 2,500,000 sheep produce 80% of Chile's wool. Some frozen mutton is exported from four freezing plants to the United Kingdom but central Chile is the major market. The discovery of petroleum in northern Tierra del Fuego at Manantiales widened the economy of the province. (G. J. B.)

MAGAZINE: see PERIODICAL.

MAGDALENA, a department in Colombia. lies on the northern coast between the Magdalena river on the west and the Sierra de Perija and the Guajira peninsula, on the east. Area 18.071 sq.mi. Pop. (1961 est.) 500,640. Much of the terrain is swamp, flood plain or high mountains including the Sierra Nevada de Santa Marta. The department is the oldest government jurisdiction in Colombia; its capital city, Santa Marta (*q.v.;* pop., 1961 est., 62,650), was founded in 1525. In the second half of the 20th century the excellent natural harbour at Santa Marta experienced a boom as the construction of the Atlantic railway neared completion. The new railroad was planned to link Santa Marta with Bogotá via the Magdalena valley. It would connect with existing railroads to other major inland industrial centres. In 1955 the department had 160 small industrial enterprises, but the major economic activity is banana raising in the vicinity of Santa Marta. Very poor transportation facilities within the department limit development outside the Santa Marta area. (R. L. GE.)

MAGDALENA RIVER, rises at the bifurcation of the central and eastern ranges of the Colombian Andes and flows north for 956 mi. to the Caribbean. The major tributaries of the river are the San Jorge, the César and the Cauca (*q.v.*), all of which enter at the northern lowlands and make that area a flood plain with many swamps. The mouth of the Magdalena must be dredged to enable ocean-going vessels to have access to the port of Barranquilla (*q.v.*) near its mouth. Other major river towns from south to north are Neiva, Girardot and Honda. The smaller ports of Puerto Berrio. Puerto M'ilches and Barrancabermeja service adjacent highland areas. The river is navigable by shallow-draft steamboats between Neiva and the sea, interrupted only by the rapids at Honda. The course of the river is quite straight, the current is fast and the depth is subject to sharp variations. November is the month in which steamboat traffic is most liable to interruption.

The Magdalena has been a major commercial artery since the Spanish conquest. From colonial times to mid-19th century, goods were carried in keelboats manned by rivermen (*bogas*) who were as tough and dissolute as those of the Mississippi. Steamboats, first introduced in 1822, were profitably operated only after 18jo when the tobacco boom provided sufficient bulk cargo. The steamboat in the 20th century was subject to competition by air freight and highway, and the end of major steamboat cargo service seemed probable upon completion of the Atlantic railway. See also COLOMBIA: Physical *Geography*. (R. L. GE.)

MAGDALENIAN, in archaeology. the term given the last great major cultural tradition of the Upper (late) Paleolithic stage in Europe, named after a site at La Madeleine, in lower Vézère, France. In England it is found at Cheddar and Kent's cavern. See ARCHAEOLOGY: *Culture* History of the Pleistocene.

MAGDEBURG, a city of Germany, in the district of the same name, capital of the former Prussian province of Saxony. It lies mainly on the left bank of the Elbe. 88 mi. S.W. of Berlin, 177 ft. above sea level. Pop. (1950) 206,305.

Magdeburg. which at the beginning of the 9th century was a small trading settlement on the frontier of Slavonic lands. owes its early importance to Otto I who established the Benedictine monastery of Bergen there about 937. In 962 it became the seat of an archbishop, but the boundaries of the new archbishopric were fixed six years later. It comprised the bishoprics of Havelberg, Brandenbusg, Merseburg, Meissen and Zeitz-Naumburg. The archbishopric played a great part in the germanization of Slavonic lands east of the Elbe-Saale line.

Although burned down in 1188, Magdeburg became a flourishing commercial town during the 13th century, and was an important member of the Hanseatic league. It became celebrated for establishing in the 13th century an autonomous municipal administration, a model of which, known as the "Magdeburg law" (*Magdeburger Recht*), was later widely adopted not only in Germany but also in many countries of eastern Europe.

From the 13th century the citizens were almost constantly at variance with the archbishops, and by the end of the 1jth century had become nearly independent of them but failed to achieve the status of a *Reichsstadt*. Under Archbishop Albrecht, a member of the house of Hohenzollern, Magdeburg embraced the Reformation in 1524 and was thenceforth governed by Prdtestant titular archbishops. During the Thirty Years' War Magdeburg successfully resisted Wallenstein for seven months in 1629, but was taken by storm by Tilly on May 20. 1631. The city was sacked and almost entirely burned, and the great part of its 40,000 inhabitants were butchered. By the peace of Westphalia (1648) the archbishopric was converted into a secular duchy, to fall to the Hohenzollern electorate of Brandenburg on the death of the last administrator (August, of the Saxon house of Wettin), which happened in 1680.

On Nov. 11, 1806, the fortress of Magdeburg surrendered to Napoleon without fighting and until 1813 was part of the kingdom of Westphalia. The fortress, established in the 17th century on an island in the Elbe between the old town and the Friedrichstadt on the right bank of the river. was dismantled in 1912.

The most important building in Magdeburg is the cathedral, dedicated to St. Maurice and St. Catherine. This structure. with two 344-it.-high towers, begun in the 13th and completed in the 16th century, exhibits an interesting blending of Romanesque and Gothic architecture. The Liebfrauenkirche, the oldest church in Magdeburg, is a Romanesque edifice of the 11th century, completed in the 13th century and restored in 1890–91. The Renaissance town hall (*Rathaus*) was built in 1691 and enlarged in 1866. In front of the town hall stood an equestrian statue of Otto I, erected about 1290. With the exception of the Breite Weg and the Otto von Guericke street running from north to south, the streets of the old town are narrow and crooked. Kloster Berge garden, in the south of the city, is situated on the site of the convent of Berge, which was founded in 968 and suppressed in 1809.

Toward the end of World War II Magdeburg suffered heavily from British and C.S. air bombing. Especially devastating was the R.A.F. attack on the night of April 1j–16, 1945, followed by a daylight bombing by the U.S.A.F. On that day 65% of the city was destroyed. Captured on April 18, 1945, by the U.S. army, Magdeburg was later evacuated and included in the Soviet zone. With the exception of the industries little reconstruction was undertaken.

hfagdeburg was before World War II an important industrial centre with ironworks producing armour and varied machinery. Of equal importance were a synthetic oil plant, chemical factories! textile mills and sugar refineries. By the 1960s these and other industries were working again at capacity level.

Six railway lines join in Magdeburg linking the city with Berlin. Dessau. Leipzig. Halberstadt. Helmstedt (Brunswick) and Stendal. Seven arterial highways radiate from the city. The *Autobahn* Berlin-Ruhr crosses the Elbe north of Magdeburg. The city is also a river port, the importance of which greatly increased when the Mittelland canal. linking the Rhine with the Elbe (slightly northnard from Magdeburg), was inaugurated on Oct. 30. 1938. Another system of canals links Magdeburg with Berlin and the lower Oder. This makes Magdeburg the most important inland port of the German Democratic Republic.

MAGEE, WILLIAM (1766–1831), archbishop of Dublin, was born at Enniskillen, County Fermanagh, and educated at Trinity college. Dublin, nhere he was elected fellow in 1788. He was ordained in 1790. His *Discourses on the Scriptural Doctrines of Atonement and Sacrifice* (1801), a polemic against Unitarian theology, was answered by Lant Carpenter. Magee was appointed professor of mathematics and senior fellow of Trinity in 1800, but in 1812 he resigned and in 1813 became dean of Cork. In 1819 he was consecrated bishop of Raphoe. In 1822 the archbishop of Dublin was translated to Armagh, and Magee succeeded him at Dublin. Though generally tolerant. he opposed the movement for Catholic emancipation. He died on Aug. 18, 1831.

See *Works of the Most Reverend William Magee, D D. (1842).*

MAGEE, WILLIAM CONNOR (1821–1891), British divine. vas born at Cork and educated at Trinity college, Dublin. In 1864 he became dean of Cork and chaplain to the lord lieutenant. His remarkable powers were shown in the defense of the Irish church at the time of the disestablishment proposals of 1868, when his brilliant speeches induced Disraeli to offer him the bishopric of Peterborough. He justified his appointment by his magnificent speech when the Disestablishment bill reached the house of lords in 1869. He took up the temperance question, and declared in the house of lords that he would rather see "England free than England compulsorily sober," an utterance nhich the extreme advocates of total abstinence misquoted and attacked. He supported the movement for abolishing the recitation of the Xthanasian creed in the public services of the Church of England Magee took a prominent part in the ritualist controversy, opposing what he conceived to be romanizing excess in ritual, as well as the endeavour of the opposite party to "put donn ritualism." as Disraeli expressed it, by the operation of the civil law. His incisive nay of putting things earned for him the title of the "Militant Bishop." He died on May 5, 1891, about four months after his appointment to the see of York.

See Canon J C MacDonnell, *Life* and *Letters,* 2 vol. *(1896).*

MAGELLAN, FERDINAND (*c.* 1480–1521), the first to undertake a voyage around the globe, was born at Sabrosa in the Villa Real district of the Traz-os-Montes province of Portugal. He was a son of Pedro de Magalhães, and belonged to the fourth order of Portuguese nobility (*fidalgos de cota de armas*). He was brought up as a page of Queen Leonor, consort of King John II the Perfect.

Service in the Indies.—In 1495 he entered the service of Manuel the Fortunate. John's successor, and in 1504 enlisted as a volunteer for the Indian voyage of the first Portuguese viceroy in the east. Francisco de Almeida. He sailed on March 25, 1505; was nounded at Cannanore on March 16, 1506; was then sent with Nuno Vaz Pereira to Sofala to build a Portuguese fortress at that place. He returned to India early in 1508 and was again wounded at the battle of Diu on Feb. 3, 1509. At Cochin (Xug. 19, 1509) he joined Diogo Lopes de Sequeira on his famous voyage intended for the Spice Islands, when the Portuguese almost fell victims to Malay treachery at Malacca. Before Oct. 10, 1510, he had been renarded for his many services with the rank of captain. He again distinguished himself at the taking of Malacca by Albuquerque (July–August 1511), and was then sent on by the viceroy with Antonio d'Abreu to explore the Spice Islands (Moluccas). Leaving Malacca at the end of Dec. 1511, this squadron sailed along the north of Java. passed betneen Java and Madura, left Celebes on their left, coasted by the Gunong Api volcano, touched at Bura and so reached Amboina and Banda. At the last-named they found such abundance of spices that they came straight back to Malacca nithout visiting Ternate. as had been intended.

Fitting Out the Expedition.—Magellan returned to Portugal in 1512. On July 14 of that year he was raised to the rank of *fidalgo escudeiro,* and in 1j13 he accompanied a Portuguese expedition against Azamor in Morocco. The city was taken on Aug. 28–29, 1513, but Magellan was subsequently wounded, and lamed for life. in a sortie; he was also accused of trading with the Moors. The accusation was subsequently dropped, but Magellan fell into disfavour with King Manuel, who let him understand that he mould have no further employment in his country's service (after May 15, 1514). Magellan formally renounced his nationality and went to offer his services to the court of Spain. He reached Seville on Oct. 20, 1517, and thence went to Valladolid to see Charles V. With the help of Juan de Aranda, one of the three chief officials of the India house at Seville, and of other friends, especially Diogo Barbosa, a Portuguese like himself, naturalized as a Spaniard, who had acquired great influence in Seville and whose daughter Magellan now married, he gained the ear of Charles and of the powerful minister Juan Rodriguez de Fonseca, bishop of Burgos, the persistent enemy of Columbus, the steady supporter of his great successor.

Magellan proposed to reach the Spice Islands of the East Indies by the west; for that purpose he hoped to discover a strait at the extreme south of South America, and is said to have declared himself ready to sail southward to 75° to realize his project. Ruy Faleiro the astronomer, another Portuguese exile, aided him in the working out of his plan, and he found an invaluable financial ally in Christopher de Haro, a member of a great Antwerp firm, who owed a grudge to the king of Portugal. On March 22, 1518, Magellan and Faleiro, as joint captains-general, signed an agreement with Charles V., by which one-twentieth of the clear profits were to fall to them; further, the government of any lands discovered was vested in them and their heirs, with the title of *Adelantados*. On Xug. 10, 1519, the fleet of five vessels, under Magellan's command, left Seville and dropped down the Guadalquivir to S. Lucar de Barrameda, at the mouth of the river, where they remained more than five weeks. On Sept. zo, the armada put to sea. Of the vessels which composed it, the "Trinidad" was the flagship, and the "Vittoria" the only one which accomplished the circumnavigation. Antonio Pigafetta of Vicenza, an Italian gentleman who has left the best history of the voyage, went as a volunteer in Magellan's suite. Faleiro stayed behind, having cast his horoscope and found that the venture would be fatal to him. Before starting, Magellan made his will and addressed a memorandum to Charles V., assigning geographical positions connected with the controversy he was intending to settle: viz., the proper drawing of a demarcation-line between the spheres of Spain and Portugal in the East Indies, and the inclusion of the Moluccas within the Spanish sphere.

Passing the Straits.—Steering south-west and calling at Teneriffe (Sept. 26–Oct. 3), Magellan sighted South America at Cape St. Augustine, near Pernambuco on Nov. 29; thence he followed the east coast of the New World down to the La Plata estuary, which he examined in the hope of finding a passage at this point (Jan. 11–Feb. 6, 1520). On March 31, following, he arrived at Port St. Julian (in 49° 20′ S.) where he wintered. Here he crushed a formidable mutiny (April 1–2), and made acquaintance with the natives, whom he called *Patagonians* ("Big Feet"), whose great size and lofty stature are magnified by Pigafetta to gigantic proportions. Leaving Port St. Julian on Aug. 24, 1520, he discovered on Oct. 21, the cape of the Eleven Thousand Virgins, the eastern entrance of the long-sought passage. Through this strait, 360 m. long, often narrow and very tortuous, fringed by snow-clad mountains, he guided his armada for thirty-eight days, weakened by the desertion of one vessel (the "S. Antonio"). On Nov. 21, a council of pilots and captains was held to consider the continuation of the voyage, and on Nov. 28, the fleet rounded Cabo Deseado, the "desired" western terminus of the strait of Magellan. To the south of the passage lay the forbidding land "stark with eternal cold," which from the many fires here observed Magellan named "Tierra del Fuego." The expedition now entered the "Great South Sea," first sighted by Vasco Nuñez de Balboa (*q.v.*), which, from the steady and gentle winds that drove the fleet across the immeasurable expanse, was by Magellan called "Pacific." For ninety-eight days Magellan crossed this sea from Cabo Deseado to the Ladrones. On the whole transit he discovered only two islands, sterile and uninhabited, which he called "St. Paul's" (Jan. 24, 1521) and "Shark Island" (Feb. 3). The explorers had no fresh provisions, little water (and that bad), and putrid biscuit; the ravages of scurvy became terrible. The worst fears of Magellan were realized; ox-hides, sawdust, and rats had to be eaten.

Magellan's Death.—At last, on March 6, 1521, the Ladrones (so named by Magellan from the thievish habits of the natives) came in sight, Guam being probably the first port of call. Here the fleet rested, watered, revictualled and refitted; on March 9 they started again westward; and on March 16 sighted the southern point of Samar Island in the archipelago, since 1542 called the Philippines, but named by Magellan, its first discoverer, after St. Lazarus. On April 7, the squadron arrived at Cebu, south-west of Samar, in the heart of the Philippines; here Magellan contracted a close friendship and alliance with the treacherous native sovereign, who professed Christianity the better to please and utilize his Catholic friends. Undertaking an expedition to conquer, for the Catholic faith and the king of Cebu, the neighbouring island of Mactan, Magellan was killed there in a fight with the islanders (April 27, 1521). The king of Cebu after this got into his power several leaders of the squadron, including Juan Serrano, one of the two admirals elected to replace Magellan, and then murdered them.

The survivors, burning one of the three remaining vessels, left the Philippines, and made their way to the Moluccas (Nov. 6), visiting Borneo on the way (July 9–Sept. 27, 1521). At Tidor a heavy cargo of cloves was taken in; the "Trinidad," becoming leaky, stayed behind with her crew; and the "Vittoria," under Juan Sebastian del Cano, proceeded to Europe alone (Dec. 21, 1521). To double the Cape of Good Hope the "Vittoria" reached between 40° and 41° S. (April 7–16, 1522) and suffered from contrary winds, heavy seas, scurvy and starvation. In the Cape Verde Islands (July 9–15, 1522) 13 of the crew were detained prisoners for a time by the Portuguese. Only 18 men returned with del Cano to Seville in the first vessel that had ever made the tour of the earth. Though Magellan had not quite reached the Spice Islands when he fell at Mactan, his task had then been accomplished. He had already reached and passed the longitude of the Moluccas, where he had already been; the way home from the Philippines by the Indian Ocean and the Cape of Good Hope was perfectly known to the Portuguese, himself included. Magellan's name has never received its due recognition in general history. It ranks with those of Columbus, Marco Polo, and Henry the Navigator. The circumnavigation of the globe is as great an event as the discovery of America. Magellan achieved what Columbus planned—the linking of west Europe with east Asia by direct transit over the western ocean.

Magellan's Straits, the Magellanic clouds (not first observed by him), and Magellan's Land—a name long given to Patagonia and that hypothetical southern continent of which Tierra del Fuego was considered only a portion, and now again bestowed by Chile on her territory in the extreme south—preserve the memory of the first circumnavigator. The largest of the oceans has also kept the flattering name given to it by the man who first crossed it.

Bibliography.—No record of his exploits was left by Magellan himself; and contemporary accounts are less detailed and consistent than could be wished. The best is that of Antonio Pigafetta. a volunteer in the fleet. It is printed in Ramusio, and exists in four early MS. copies. one in Italian and three in French.

Other authorities are: (1) The narrative of an unknown Portuguese in Ramusio's *Navigationi et viaggi;* (2) the *Derrotero* or Log-Book in the Seville Archives, supposed to be the work of Francisco Albo, *contramaestre* of Magellan's flagship, the "Trinidad": this consists mainly of nautical observations; (3) the narrative of the so-called Genoese pilot, written in excellent Portuguese, and printed in vol. iv. of the *Collecão de noticias* of the Lisbon Academy; (4) various *informaciones* and other papers in the Seville Archives, especially bearing on the mutiny; (5) the letter of Maximilian of Transylvania, under-secretary to Charles V, to the cardinal of Salzburg; (6) the references in Correa and Herrera, often based on good information, and adding points of interest to other records. Of these (1)-(3), (5), and an instance of (6) are translated in the Hakluyt Society's volume. Magellan's two wills (i.) executed at Belem on Dec. 17, 1504, on the eve of his departure with Almeida, (ii) executed at Seville on Aug. 24, 1519, just before starting on his voyage round the world, are both of some value for his life

See also Lord Stanley of Alderley, *The First Voyage round the World by Magellan, translated from . . . Pigafetta*, etc., Hakluyt Society (London, 1874); Diego de Barros Arana, *Vida e viagems de Fernão*

de Magalhães, a trans. of the Spanish life by Fernando de Magalhães Villas Boas (Lisbon, 1881); F. H. H. Guillemard, *Life of Magellan* (London, 1890); *Magellan . . . the original text of the Ambrosian MS.* (of Pigafetta), with English translation, notes, bibliography, etc., by J. A. Robertson (Cleveland, U.S.A., 1906). Before the appearance of this indispensable work, the best edition of Pigafetta had been in vol. iii. part 5 of the *Raccolta di documenti e studi pubblicati nella r. commissione colombiana,* edited by Andrea da Mosto (Rome, Ministry of Public Instruction, 1894). *See* also O. Koelliker, *Die Umsegelung der Erde durch Magellan* (1908); E. Oberhummer, *F. Maghalães, und die Bedeutung der ersten Erdumsegelung* (1921); A. S. Hildebrand, *Magellan* (1925); Plischke, *F. de Maghalães* (1926).

MAGELLAN, STRAIT OF (Spanish ESTRECHO DE MAGALLANES), a channel, named for its discoverer. Ferdinand Magellan (*q.v.*), at the southern extremity of South America between the mainland (Magallanes; *q.v.*) and Tierra del Fuego (*q.v.*). It connects the South Atlantic and Pacific oceans and follows a winding course of about 360 mi. with widths varying from 2 to 20 mi.

MAGELLANIC CLOUDS (named after Ferdinand Magellan), two cloudlike condensations of stars in the southern sky. The Large Cloud is in the constellation Dorado at right ascension 5 hr. 26 min., declination $-69°$; the Small Cloud in Tucana at right ascension 0 hr. 56 min., declination $-73°$. They are two companion galactic systems to the Milky Way, consisting of myriads of stars and many gaseous clouds; they are located at a distance of about 140,000 light-years from the sun, and are visible to the unaided eye for observers located in the southern hemisphere.

MAGENDIE, FRANÇOIS (1783–1855), French physiologist and father of experimental pharmacology, was born at Bordeaux on Oct. 6, 1783. He graduated M.D. at Paris in 1808 and, while prosector of anatomy, demonstrated in 1813 the passive role of the stomach in vomiting and investigated the action of emetics. His pioneer work on the localization of the site of drug action laid the scientific foundation for the introduction into medical practice of such drugs as strychnine and morphine. With P. J. Pelletier he discovered emetine in 1817. His announcement in 1822 that the anterior roots of the spinal nerves are motor in function and the posterior roots sensory led to prolonged controversy with Sir Charles Bell (*q.v.*), who claimed to have made the same discovery in 1811. From 1813 to 1831 Magendie taught experimental physiology privately, being appointed in the latter year professor of medicine at the Collège de France. Elected to membership of the Academy of Sciences in 1821, he was its president in 1837. A superb experimenter and a bold vivisectionist, Magendie founded the *Journal de physiologie expérimentale* (1821–31) and wrote *Précis élémentaire de physiologie* (2 vol., 1816–17) and *Formulaire pour la préparation et l'emploi de plusieurs nouveaux médicaments* (1821). Magendie is commemorated by the "foramen of Magendie" in the brain (1828). He died at Sannois, near Paris, on Oct. 6, 1855.

See J. M. D. Olmsted, *François Magendie* (1945). (WR. R. B.)

MAGENTA, a town of Milano province in Lombardy, Italy. lies 364 ft. above sea level and 16 mi. W. of Milan by rail in an industrial and agricultural region. Pop. (1951) 12,453. The town increased greatly after World War II. Its chief buildings are the cathedral, with a façade of Carrara marble, the commercial high school, the stadium, and the ossuary containing the remains of 9,000 killed at the battle of Magenta (June 4, 1859). There is a public park with a zoological garden. Magenta is a communications centre between Milan and Turin and its chief industry is the making of matches while other factories produce artificial silk and door locks.

Magenta derives its name from Marcus Maxentius, a Roman. general and emperor (306–312), who had his headquarters there, at Castra Maxentia. Historically the battle of Magenta, which resulted in a victory for the Franco-Sardinians under Napoleon III over the Austrians, represented an important step toward Italian national independence. (G. CI.)

MAGGIORE, LAGO, the largest lake in Lombardy, north Italy (Verbanus Lacus of the Romans), area 82 sq.mi., length 41 mi., greatest width 7 mi.. greatest depth 1.220 ft., surface 636 ft. above sea level. The Ticino flows through, north to south. on its way to the Po; the Tosa or Toce comes in on the west from the Val d'Ossola below the Simplon pass, the Tresa enters from the lake of Lugano on the east. The upper end of the lake (16 sq.mi.) is in the Swiss canton of Ticino. Locarno, at the northern or Sniss end. is 14 mi. S.W. of Bellinzona by rail on the St. Gotthard line. On the east shore are Luino and Laveno. On the west shore are (reckoning from north to south) Cannobio, Pallanza. Baveno, Stresa and Arona. Opposite (southeast) Baveno are the famous Borromean Islands (*q.v.*), while southwest of Baveno rises the glorious viewpoint of the Monte Mottarone (4,892 ft.) between Lago Maggiore and the Lake of Orta.

MAGH, a term applied to immigrants from Burma long settled in the southeast districts of Bengal. Apparently of Tai origin, they entered Bengal from Arakan toward the end of the 18th century. Most of them came under Bengali influence, but in the south of the Chittagong Hill tracts, where their culture is comparatively pure, the script and dress are Burmese and the language an Arakanese dialect. Elsewhere the Bengali dress and language prevail The religion of the Arakanese-speaking Maghs is animistic Buddhism. The race is divided into endogamous clans and in modern times there were still strong traces of a political organization under clan chiefs, the most powerful of whom are known as the Bohmong and the Mong Raoja, the former being a lineal descendant of the Mon kings of Pegu. In the hills shifting was still preferred to plow cultivation in modern times, but the villages, containing from 10 to 50 houses, were invariably built on the banks of streams.

The houses were flimsy structures on bamboo piles and a relic of the communal house for men was sometimes found in the form of a roofed platform built at the end of the village street.

See Hutchinson, *Account of the Chittagong Hill Tracts* (1906). (J. P. M.)

MAGIC. The magic art is of ancient lineage and wide distribution. Civilization even yet is not entirely devoid of all elements of magical belief and ritual. But in primitive cultures magic is still a living reality. a serious practical means of commanding success in any critical human undertaking.

PRIMITIVE

The importance of the magic art in primitive culture provoked an extensive theoretical discussion in which such authoritative writers as Tylor. Frazer, Westermarck. Preuss. Hubert and Mauss, Marett, Lehmann. Lowie and Malinowski, took a prominent part. Sir James Frazer, in particular, in his great classical treatise The *Golden Bough*, formulated a distinct and coherent theory of magic on which all subsequent studies were largely built. These various contributions were reviewed by H. Hubert and Marcel Mauss and by R. R. Marett. As a preliminary. the useful distinction drawn by Frazer between magic and religion may be noted, its essence being that magic consists in the direct control by man of the forces of nature, while religion relies upon the propitiation of these and other higher powers.

(1.) **The** Sociology of **Magic.**—Magic, as Frazer so fully showed, is not merely a type of belief or a piece of man's intellectual apparatus, but an art in which theory and dogma at every step are translated into action. It is always a very practical affair. It has to bring rain to crops or game to the nets, to give stability to a house or lightness to a canoe. to inflict or ward off misfortune, disease or death, to win a loved one, to give skill in war, speed in travelling, beauty at the feast or the dance. It is distinctively a human art, in that it is practised only through man's agency and for his benefit. At the same time it involves a recognition of the supernatural, a belief in the power of magic, wielded by man, to turn aside the normal operation of the forces of the external world. Its roots lie in the diversity of human activities; it is a way of handling the forces of nature, of bending them to man's will, of safeguarding his welfare and shaping his destiny.

Magic invests its practitioners with social power. In nearly all communities the magician is the one person who can be compared with the chief in point of influence, prestige and authority. Magic thus acts as a force of social control. The important practices of the craft tend to be carried on largely by special experts, often constituting a distinct class in the community, and these, desiring to ensure the continuity of their knowledge, and prizing it as a thing of great value, transmit it only to their descendants. So magic is appropriated, forms the subject of well defined claims and privileges, and is handed down through families and clans in exclusive possession. The magic art is also of economic interest, since its practitioners are usually remunerated by those who seek their services, while even the transmission of the lore is often a matter for compensation by a substantial payment. Magic on its traditional side is linked by mythology with the dim past of gods and heroes, with the origins of man, and the beginnings of the tribal culture. Legends of the miraculous deeds of ancestors bear witness to the power of the ritual, while their names are frequently cited in charm and spell. (See also FOLK DANCE.)

(2.) Elements of the Magical Art.—As Dr. Bronislaw Malinowski clearly shows, every act of magic is characterized by things said, things done, and a person officiating. Hence the spell, the rite and the condition of the performer are fundamentals.

(i.) The Spell. The spell, the uttering of words according to a formula, *i.e.,* in a set order, is everywhere regarded as the outstanding part of the magical act. In fact by some peoples the word for spell, as the Maori karakia or the Kiriwinian megwa, is used also to mean magic as a whole. The virtue of the magic lies primarily in the formula, which is believed to have been handed down from immemorial antiquity. Hence the insistence upon the correct recital of it, lest variation in the text render the magic of no avail. The customary rigidity of the formula does vary in different communities. Thus among the Polynesians any slip, any omission, any alteration of wording deprived the magic of its efficiency, and in the most important sacred ritual was thought to involve the death of the practitioner from supernatural causes. But elsewhere individual changes of wording within the main frame of the formula are permissible. Nevertheless, it is always well defined by tradition, variations are minor and of a customary kind, and no major extemporization is possible. Since the spell is in fact the backbone of magic, its language is naturally correlated with the aim of the ritual. There are constant references to objects or actions, the mention of which is supposed to influence the desired end. A Maori spell to give speed and grace to a canoe, for instance, speaks of the swiftness of a bird on the wing, the lightness of a sea-gull floating on the water, and gives the names of a number of woods noted for their buoyancy. Metaphor and simile are freely used, while onomatopoeic effect is introduced, as speed-noises or the wailing of the sea. References to traditional and mythological events are frequent, ancestral names are recited, and, coupled with the cryptic and archaic language in which the spell is often couched, are apt to render it obscure to any but those trained in this type of magical lore. Thus magic maintains its bond with tradition.

(ii.) The *Rite.* Accompanying the magical formula is a set of actions, the rite, the primary function of which is to convey the spell to the object which it is desired to affect. Thus when a Maori dart-thrower wished to make a good cast he would spit upon the implement and repeat a charm beginning "Fly forward, my dart, like a meteor in the heavens." Like the spell, the rite is definitely prescribed in form and is often in distinct correspondence with the words uttered. Thus movement described in the spell is carried out or imitated by the performer, substances which produce effects analogous to those desired are handled and mentioned. The sprinkling of water on the ground, for instance, is often part of the magic of rain-making, the destruction of an image by fire accompanies a charm to bewitch an enemy with burning pains. Attractive scents are used in love magic, powdered lime is released by Melanesian sailors in danger from flying witches, to make a magic fog which will blind their pursuit. The rite is thus the vehicle of the spell and its equivalent, the translation of the word into action.

(iii.) Condition of the Performer. Since magic is of such importance the performer must handle it with care. In all communities he is hedged around by taboos; he must refrain from eating certain foods, from casual sexual indulgence, and from other contaminating things. If he fails to conform, then he nullifies the power of his art; breach of taboo, in fact, is the cause most frequently assigned for failure of magic. The emotional attitude of the magician is also of interest. In the rite of black magic which consists in pointing a bone or dart at a victim, the wizard twists and turns the instrument in the air and assumes a state of excitement and fury as if he actually were performing the deed of stabbing his enemy. Dr. Malinowski stresses the importance to the theory of magic of this simulation of the real act; he sees in fact in the sympathetic emotional condition of the performer, the fundamental basis of the art. Magic, for him, is a ritualized expression of an emotional state of desire, which, baulked of its object, nevertheless is constrained to find outlet in speech and gesture. In the spontaneous outburst of word and act lies the germ of spell and rite, in the illusion of subjective experience—the conviction that such actions have really had their effect—rests the foundation of the belief in magical efficiency.

(3.) The Essence of Magical Power.—Dr. Marett ascribes the basic idea of magic to the belief of the native in a vague mysterious power, supernatural and immaterial, animating all things. Hubert and Mauss and Prof. K. Th. Preuss have independently arrived at somewhat the same conclusion. *"Mana,"* it is said, "is the mother-idea of magic." This notion of a mystic impersonal force is held by many primitive peoples, being termed *mana* in parts of the Pacific, hasinu by the Malagasy, and *wakan,* orenda, *pokunt* and *manitou* by various American Indian tribes. But examination of its content shows that it is a concept of an extremely general order. The essence of magical power, on the other hand, is very restricted; it is fixed in man, it is bound by human tradition, it is even localized at times in the body of the wizard. It is not, like *mana,* a universal force latent in all things, which man has taken and utilized for his own ends. The real virtue of magic is embodied in the spell, and to a less extent in the rite. Magic is born of the emotional tension of specific situations; it is not the concrete use of a general abstract concept. The idea of *mana* is certainly closely intertwined with the practice of magic, but they are interlacing stems which spring from a different root.

The value of Marett's contribution to the theory of magic lies in his stress on the emotional aspect of the performance, analysing the state of mind of the savage in his magical experiences. By his psychological treatment he counteracted the tendency to an over-intellectualistic study of primitive beliefs. (See MANA.)

(4.) Magic and Primitive Science.—By Edward Tylor, the great pioneer in anthropology, magic was regarded as developing from the thought-processes of primitive man by mistaken association of ideas, and becoming organized into "an elaborate and systematic pseudo-science." This position has been more explicitly formulated by Sir James Frazer. He advances the view that magic really represents the attempt of man to formulate a body of principles by which the sequence of events throughout the world may be determined. "Magic is a spurious system of natural law as well as a fallacious guide of conduct; it is a false science as well as an abortive art."

The label of "bastard science" affixed by Frazer has not remained unchallenged. Hubert and Mauss, in their study of magic, and Dr. Marett from the psychological side, point out that there are radical differences between the magical and the scientific attitude of man towards his environment. By his analysis of garden magic in Melanesia in conjunction with the actual agricultural operations, Dr. Malinowski shows that the native outlook upon the two is essentially different. Empirical knowledge of soils and plant growth, of wind and weather, is utilized to cope with the known and calculable requirements of the industry; the native is well aware that careful tillage, weeding, repairing of fences and replacement of damaged seed are essential for a good harvest. On the other hand, to secure the right amount of rain and sun, avoid insect pests, or unaccountable failure of the crop, to ward off the ill-luck which sometimes dogs his steps he has recourse to magical aid. So also in canoe-building, fishing, warfare, love-making, the birth of children and matters of health and death, primitive man recognizes both a natural and a supernatural set of conditions, facing the first with rational technique and empirical knowledge, embodied even in rudimentary theoretical laws, the second with the arts of magic. The same duality is to be found in the economic life of the Maori (Raymond Firth) and evidence is accumulating to show that this must be a phenomenon of universal occurrence. Primitive man has his real science, running side by side with his magic. The two are closely bound together in the practical activity, the body of rational knowledge being utilized to deal with the mechanical efficiency of the undertaking, while the ritual of magic deals with the incalculable elements therein, the luck and chance upon which so much of success depends.

It is permissible, then, with Sir James Frazer, to call magic a pseudo-science if the limitations of the term be borne in mind. Magic is akin to primitive science in that it exists to serve very definite, often similar ends, and is possessed of a theory, a system of principles which dictates the manner in which the ritual must be performed. Like science, it has developed a special technique which is handed down from one generation to another. But these resemblances are little more than superficial; the difference is fundamental. Science, even as represented by the rudimentary equipment of the savage, is based on experience, is open to correction by observation and experiment, is ever marked by the thirst for further knowledge and the attempt at a more exact classification and description, a more careful elucidation of the general principles governing the behaviour of the material world. Magic, on the other hand, is governed by tradition, is largely impervious to the lessons of observation, and shows no desire to make profit by experiment. The underlying mental attitude is one of implicit faith, based upon emotional rather than upon rational experience. It is clear, then, that the real roots of science are to be found, not in the magic art of primitive man, but in his rudimentary store of knowledge and his attempts at rational enquiry, stimulated by the practical needs of his technology, into the nature of his physical environment.

(5.) The Continuity of Belief.—It is not difficult to see the hollowness of the pretensions on which magic bases its claim to power. The sky will not really give forth thunder and rain in reply to sympathetic rites, animals do not obligingly come to the hunter through a muttered spell, nor can that *more coy game, woman,* be ensnared by the waving of a wand. Why, then, is not the fallacy of this hocus-pocus exposed, and "the whole monstrous farrago," as Tylor called it, discarded as futile? The answer usually advanced is that the faise ritual of magic does not exist entirely in its own strength, but associated with it are elements of medical skill or political craft of the practitioner, which sustain its reputation when in need. Again, success is bound to come in a large proportion of cases by the mere laws of chance, aided by the shrewdness of the magician in selecting the opportune moment for the exercise of his art. This is helped by the general inability of the human mind to appreciate negative evidence when strong forces of belief are entrenched on the side of an established institution. One success counts more in retrospect than a dozen failures. More important still is what Dr. Malinowski has termed "the current mythology of magic," that is, the stories of prowess which tend to circulate round every magician of influence, exaggerated tales of wonderful cures, of game attracted, of lovers united, of enemies slain by the craft of his spells. These stories reach back into the mists of antiquity, forming a body of instances which can be drawn upon at any moment to vouch for the efficacy of the art. This halo of myth, of magical miracle, is the strength of the belief in magic, its buckler against the assaults of rational experience. The real basis for the continuity of magic, however, lies even deeper in the sphere of its cultural utility.

(6.) The Value of Magic to Man.—Magic is not merely a vain replica of science. Despite the fallacy of its premises and the illusory nature of its claims it possesses a real validity in human life. The magical rites performed in agriculture, for instance, are of undoubted efficacy to the native. By proceeding step by step in close contact with the actual stages of the work, of which it regulates the times and seasons, by imposing taboos, by investing the task with serious import and a supercatural sanction, the magic reinforces order and punctuality within the industry, and acts as a very valuable factor of organization, wielded as it usually is by the expert who has charge of the practical arrangements. Again, the magical ritual enters at the point where man's knowledge and foresight begin to fail, where chance, luck and the incalculable elements of nature begin, where reliance on rational technique can no longer avail. By providing him with a firm belief in his own powers, by promising him control, illusory though it may be, over these all important factors of success, it gives man that much needed psychological backing of confidence and assurance which is so essential to the accomplishment of his desire.

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(R. F.)

Egyptian.—The processes of Egyptian magic, or *hike* were a spoken formula, which must be exactly as prescribed in order to be efficacious, and an act or gesture, often to be performed at a particular time and under special conditions of place and position. The choice of word and act is based on the doctrine of sympathy and homoeopathy, *i.e.,* the belief that two things which have once been connected may continue to react on each other even when separated, and that like has power to affect like. Thus a burn may be cured by the recitation of the words used by Isis over her son Horus when he was once burnt, and one may cause one's enemy pain by maltreating a wax image of him, indeed the mere knowledge of the Sun-god's name was sufficient to give Isis magical power over him. From similar conceptions arose the belief in protective amulets which assumed such vast importance both for the living and for the dead.

There was no class of professional magicians in Egypt—there is not even a general word for magician. It is not surprising, however, to find that those who exercise the art on a large scale are often priests, and more particularly lector-priests, *i.e.,* those whose business consisted especially in the study and reading of sacred books. At the same time it would seem that magic on a small scale was within the reach of everybody who was prepared to observe the conditions, and to judge from the papyri which have come down to us it must have played a very large part in every day life.

It was used not only to escape death, to drive out disease, to avert the evil eye, to cure a snake bite, but also to drive rats from a barn. and to prevent the approach of a storm: there is even a spell to secure the various advantages summed up in the phrase "to be blessed every day."

MAGIC SQUARE, an arrangement of numbers in the form of a square so that every column, every row, and each of the two

8	1	6
3	5	7
4	9	2

16	3	2	13
5	10	11	8
9	6	7	12
4	15	14	1

	18	25	2	9	
17	24	1	8	15	17
23	5	7	14	16	23
4	6	13	20	22	4
10	12	19	21	3	10
11	18	25	2	9	

FIGS. 1, 2 AND 8.—TYPES OF MAGIC SQUARES

diagonals, add up alike, this sum being called the *constant.* Strictly speaking the numbers used should be consecutive from 1 up to n^2, where n is the number of cells (or squares) in any side. Such an arrangement of n^2 numbers is called a square of the nth order. Thus fig. 1 complies with all the conditions and is a magic square of the 3rd order. These squares are of very great antiquity and appear to have been known from very ancient times in China and India, where, as at the present time, magic squares were worn engraved on metal or stone as amulets or talismans.

They appear to have been introduced into Europe early in the Christian era though the first known writer on the subject was Emanuel Moschopoulus, a Greek of uncertain date who lived in Constantinople, probably about 1300. His work in manuscript is in the National Library in Paris (ms. No. 2,428). Cornelius Agrippa (1486–1535) constructed squares of the orders 3, 4, 5, 6, 7, 8, 9, which were associated with the seven astrological

3	1	4	2	5
5	3	1	4	2
2	5	3	1	4
4	2	5	3	1
1	4	2	5	3

15	0	20	5	10
0	20	5	10	15
20	5	10	15	0
5	10	15	0	20
10	15	0	20	5

18	1	24	7	15
5	23	6	14	17
22	10	13	16	4
9	12	20	3	21
11	19	2	25	8

FIGS. 4, 5 AND 6. —DE LA HIRE'S METHOD OF CONSTRUCTION

"planets," Saturn, Jupiter, Mars, the Sun, Venus, Mercury and the Moon. The magic square of the 4th order shown in fig. 2 is to be seen in Albrecht Durer's picture of "Melancholy." The date of the work (1514) is indicated in the two central cells of the bottom row, but whether this was intentional or a mere coincidence is not known (see Notes and Queries, Feb.–March 1918). In later times the subject has been investigated as a mathematical curiosity and has a large though scattered literature of its own. The three main lines of enquiry are construction, enumeration and classification.

Construction. — It is convenient to deal with these squares in three classes. Those of an odd order, those of a doubly-even order (that is where n is of the form $4m$) and those of a singly-even order (where n is of the form $2[2m+1]$). These vary in difficulty in their order. The smallest possible square of an odd order is, of course, that of the 3rd order shown in fig. 1, to which there is that one fundamental solution only. Eight different arrangements may be obtained by merely turning the page round and also turning it round in front of a mirror. These so-called reversals and reflections are not usually counted as different. A square of the odd order may immediately be written down in the manner shown in fig. 3, described first by De la Loubère. Here we start at the central cell in the top row and proceed diagonally upwards to the right. As the 2 is outside the square we bring it to the bottom of the column, thus giving it the position it occupies on the outside square. Having written the 3, the 4 falls outside the square, so we insert it at the opposite end of the row and write in the 5. As the next square is occupied by the 1 we write the 6 beneath the 5 and proceed until the 10 falls outside the square and so on. It will be noted that 16 falling outside the square at a corner is written beneath the 15 as in the case of an occupied square. This can be a p plied to any square of an odd order, but, like so many methods that have been adopted, it only produces one type of square, though it may be modified to form a limited number of other squares. Thus we may start with the 1 in any cell and always get a square that

NASIK

1	14	7	12
15	4	9	6
10	5	16	3
8	11	2	13

ASSOCIATED

1	14	12	7
8	11	13	2
15	4	6	9
10	5	3	16

SIMPLE

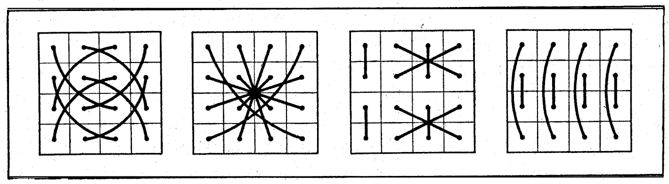
16	3	10	5
1	12	7	14
8	13	2	11
9	6	15	4

SEMI-NASIK

1	14	12	7
4	15	9	6
13	2	8	11
16	3	5	10

FIGS 7, 8, 9 AND 10.— TYPES OF MAGIC SQUARES OF THE 4TH ORDER

is magic in rows and columns, but not necessarily in the diagonals. Bachet (1612) used a somewhat similar method. Another method devised by De la Hire, may be used for the construction of squares of any order. He employed three subsidiary squares though one of these has been dispensed with by later writers. In fig. 4, the numbers 1, 2, 3, 4, 5, are arranged so that every number appears once and once only in every row and column, and in one diagonal, the other diagonal having repetitions of 3. In fig. 5, the numbers 0, 5, 10, 15, 20, are similarly treated only the repeated 10's are in the other diagonal. These squares superimposed and added produce fig. 6, which is a perfect magic square. Similar methods have been devised for the construction of magic squares and some of these will be found in the books named at the end of this article. But most of the writers on the subject develope their own favourite schemes. It is not difficult to construct squares of particular types but the ideal solution is, of course, a method completely general for squares of every order, that will include every possible arrangement of the order dealt with. Such a solution is probably not discoverable. Magic squares of singly-even orders (such as those where $n=6$, 10, 14, 18, etc.) are generally the most difficult of all to construct and their treatment is largely empirical. Large



FIGS. 11, 12, 13 AND 14.— GRAPHIC SOLUTIONS OF TYPES OF FOURTH ORDER

collections of squares of the higher orders have been compiled by Violle and others, so that examples are easily obtainable.

Classification. — This is a matter of individual taste and may be called the elegant branch of the subject. Taking the case of the 4th order the solutions can all be classified under the four types shown in figs. 7 to 10.

The Nasik square (so named by the Rev. A. H. Frost after the town in India where he lived) is the most perfect type conceivable. Here all the broken diagonals sum to the constant 34. Thus, for example, $15+14+2+3$ and $10+4+7+13$ and $15+5+2+12$. As a consequence its properties are such that if you repeat the square in all directions you may mark off a square 4×4 wherever you please and it will be magic. It should be noted that Nasik squares can be constructed for any doubly-even orders and for any odd orders. But a Nasik square of a singly-even order is impossible. The number of fundamentally different Nasik squares of the 5th order is sixteen.

In the case of the associated squares every number if added to the number that is equidistant in a straight line from the centre gives 17. Thus 1+16, 2+15, 3+14, etc. Durer's square (fig. 2) is also associated The simple square is one that fulfils the simple conditions and no more. The semi-Nasik has the property that the opposite short diagonals of two cells together sum to 34. Thus $14+4+11+5=34$. $12+6+13+3=34$. And in this order there are 48 Nasiks, 384 semi-Nasik (which include 48 associated) and 448 simple, making a total of 880. The Nasik square is also sometimes called diabolique and pandiagonal and the semi-Nasik semi-diabolique.

A graphic illustration of each type is shown in figs. 11 to 14, if placed beneath the squares to which they apply. Every Nasik square takes the form of fig. 11 and every associated that of fig. 12, but the graphic forms for the simple and semi-Nasik squares are considerably varied. There are 12 such graphic forms in all of the 4th order, and these are shown in Amusements in Mathematics. (See bibliography.)

2 23 25 7

2	23	25	7	8
4	16	9	14	22
21	11	13	15	5
20	12	17	10	6
18	3	1	19	24

FIG. 15.—A BORDERED SQUARE

Another type of magic square is the bordered, an example of which is shown in fig. 15 where it will be seen that a square of the 3rd order is surrounded by a border so as to form a square of the 5th order. In fig. 16 we have an example of an extension first considered by Frénicle (c. 1602–75). Here the borders may be successively stripped off to produce magics of the 9th, 7th, 5th and 3rd orders, and these concentric or progressive squares for odd and even orders respectively may be constructed without any limit whatever.

Composite squares also may be formed in certain cases. If we know how to construct a square of the mth and nth orders we can directly make one of the mnth order as in fig. 17 where m and n are each 3. It will be noted that each subsidiary square is successively constructed in the same order as the smallest one and each successive square is placed in the larger square, again in the same order. A more difficult but very elegant type of square is that of two degrees, as in fig. 18. Here we have a magic square of the 8th order with the constant 260 and every square of four cells summing to 130. If for every number we substitute in its allotted place its square then it will also be entirely magic with the constant 11180. A Nasik square of this kind and order has been constructed.

16	81	79	78	77	13	12	11	2
76	28	65	62	61	26	27	18	6
75	23	36	53	51	35	30	59	7
74	24	50	40	45	38	32	58	8
9	25	33	39	41	43	49	57	73
10	60	34	44	37	42	48	22	72
14	63	52	29	31	47	46	19	68
15	64	17	20	21	56	55	54	67
80	1	3	4	5	69	70	71	66

FIG. 16. — CONCENTRIC SQUARE

71	64	69	8	1	6	53	46	51
66	68	70	3	5	7	48	50	52
67	72	65	4	9	2	49	54	47
26	19	24	44	37	42	62	55	60
21	23	25	39	41	43	57	59	61
22	27	20	40	45	38	58	63	56
35	28	33	80	73	78	17	10	15
30	32	34	75	77	79	12	14	16
31	36	29	76	81	74	13	18	11

FIG. 17.—COMPOSITE SQUARE

No square of two degrees is possible for any order smaller than the 8th.

Enumeration. — The very difficult question of enumerating the squares of the different orders has attracted the attention of many mathematicians but very little progress has been made during the last 200 years. Of the 3rd order there is only one fundamental arrangement as stated above. Of the 4th order there are 880 different fundamentals. These were all given by Frénicle in a posthumous work of 1693 and this has been frequently confirmed by later writers. It was shown in the *Queen,* Jan. 15, 1910, how the complete set might be so written out if desired (*see* also Frolow's *Carrés Magiques*).

All told there are 549,504 fourth order magic squares in rows and columns.

7	53	41	27	2	52	48	30
12	58	38	24	13	63	35	17
51	1	29	47	54	8	28	42
64	14	18	36	57	11	23	37
25	43	55	5	32	46	50	4
22	40	60	10	19	33	61	15
45	31	3	49	44	26	6	56
34	20	16	62	39	21	9	59

FIG 18.—A SQUARE OF TWO DEGREES

No enumeration for larger squares has been completed. Particular types of squares, however, have been counted. Thus there are 28,800 Nasik and 174,240 bordered squares of order 5, and 567,705,600 bordered squares of order 6.

Actual formulas counting the so-called uniform step squares of J. Willis of any odd order n have been given by D. N Lehmer.

The number of magic squares of order n increases very rapidly with n, as does also the difficulty of enumeration.

Extensions and Variations. — Though strictly speaking the magic square should be composed of a natural sequence of numbers from 1 to n^2 this condition is sometimes dispensed with. Any arithmetical progression will serve, as in fig. 19, where the numbers in the series used have a common difference of 2. But squares of the 3rd order may be formed with any nine numbers if we can write them thus:

1	2	3
7	8	9
13	14	15

where the horizontal differences are all alike and the vertical differences also all alike but not necessarily the same as the horizontal. The arrangement is shown in fig. 20. This applies equally to the higher orders. Thus fig. 21 is constructed from the numbers

1	2	3	4
6	7	8	9
11	12	13	14
16	17	18	19

and is a Nasik square.

A general solution for squares of the 4th order in which any numbers (all different but not necessarily consecutive) are used was given by Ernest Bergholt in *Nature* for March 26, 1910. Then the question of the construction of magic squares with prime numbers only, and with the smallest possible constants, has been investigated. A summary of results will be found in *The Monist* (Chicago) for Oct. 1913. The formation of squares composed of consecutive composite numbers has also been considered. These can be formed for any order without the use of tables of primes though the method will not always give the smallest possible constant. First write down any consecutive numbers, the smallest being greater than 1, say, for the 3rd order, 2, 3, 4, 5, 6, 7, 8, 9, 10. The only prime factors of these numbers are 2, 3, 5 and 7. Add

15	1	11
5	9	13
7	17	3

14	1	9
3	8	13
7	15	2

1	17	8	14
18	4	11	7
12	6	19	3
9	13	2	16

FIGS. 19, 20 AND 21. — EXTENSIONS TO OTHER SQUARES

the product of these four numbers, 210, to each of the nine numbers. The result is the nine consecutive composite numbers 212 to 220 inclusive with which we can form a magic square. Yet a square with a smaller constant may be formed, as in fig. 22, with the numbers 114 to 122 inclusive. But it would be difficult to find empirically (if possible) a lower solution for the 4th order than we get by the rule, using the numbers 510512 to 510527 inclusive.

Subtracting, multiplying and dividing magic squares have also of late been investigated, and examples of the 3rd order are given in figs. 23, 24 and 25. In fig. 23, a subtracting square, you get a constant 5 by subtracting the first figure in a line from the second and the result from the third. The operation may, of course, be

121	114	119
116	118	120
117	122	115

SUBTRACTING

2	1	4
3	5	7
6	9	8

MULTIPLYING

12	1	18
9	6	4
2	36	3

DIVIDING

3	1	2
9	6	4
18	36	12

FIGS. 22. 23, 24 AND 25.—SUBTRACTING, MULTIPLYING AND DIVIDING MAGIC SQUARES

performed in either direction but in order to avoid negative numbers it is more convenient simply to deduct the middle number from the sum of the two extreme numbers. In fig. 24, which is a multiplying square, the constant 216 is obtained by multiplying together the three numbers in any line. In the dividing square (fig. 25) the constant 6 is obtained by dividing the second number in a line by the first in either direction and the third number by the quotient. But again the process is simplified by dividing the product of the two extreme numbers by the middle number. This question has been dealt with in *Amusements in Mathematics.*

Other extensions of the problem such as magic polygons, magic cubes, magic circles and magic stars have also attracted the attention of mathematicians. Attempts have also been made to construct a magic knight's tour. The knight has to be played once to every square of the chessboard in a complete tour, or non-re-entrant path, numbering the squares visited in order, so that when completed the square shall be magic with the constant 260. The nearest approach to a solution is shown in fig. 26 given by C. F. Jaenisch in *Applications de l'Analyse Mathématique au Jeu des Echecs* (St. Petersburg, 1862). Unfortunately it is not a perfect magic square because the diagonals are incorrect, one adding 264 and the other 256—requiring only the transfer of 4 from one diagonal to the other. Probably a perfect solution is impossible but no rigid proof of this has been obtained. Magic squares have been devised for construction with dominoes and playing cards;

46	55	44	19	58	9	22	7
43	18	47	56	21	6	59	10
54	45	20	41	12	57	8	23
17	42	53	48	5	24	11	60
52	3	32	13	40	61	34	25
31	16	49	4	33	28	37	62
2	51	14	29	64	39	26	35
15	30	1	50	27	36	63	38

FIG. 26.—ATTEMPT AT THE KNIGHT'S-MOVE SQUARE

also with coins and postage stamps, where one is restricted, of course, by the limitations of issue, coins and stamps of certain convenient values not being in existence. These interesting questions are of a puzzle character and often call for considerable mathematical analysis, though, as a man said of Paradise Lost, they "prove nothing" and lead nowhere. They are therefore strictly speaking of no direct mathematical importance.

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MAGINN, WILLIAM (1793–1842), Irish poet and journalist, was born at Cork on July 10, 1793. The son of a schoolmaster, he graduated at Trinity college, Dublin, and after his father's death in 1813 succeeded him in the school. He first made his mark as a parodist and a writer of humorous Latin verse in *Blackwood's*. In 1821 he visited Edinburgh, where he made acquaintance with the Blackwood circle. He is credited with having originated the idea of the Noctes arnbrosianae, of which some of the most brilliant chapters were his. His connection with Blackwood lasted, with a short interval, almost to the end of his life. His best story was "Bob Burke's Duel with Ensign Brady." In 1823 he moved to London. He was employed by John Murray on the short-lived Representative, and was for a short time joint editor of the Standard. Maginn was the original of Captain Shandon in Thackeray's Pendennis.

MAGINOT, ANDRÉ (1877–1932), French statesman and one of the sponsors of the Maginot line, was born at Paris on Feb. 17, 1877. After studying political science and law, he entered the civil service and rose to be assistant to the governor general of Algeria in 1907.

In 1910 Maginot abandoned government service for politics, being elected to the chamber of deputies and, in 1913, becoming undersecretary of state for war. He was inducted into the army as a private at the outbreak of World War I, and was seriously wounded, being crippled for life. On his recovery. in 1916, he resumed his political career as a deputy and served as minister of colonies, pensions or war in six successive cabinets. During his last term as minister of war (Nov. 1929–Jan. 1931), he reorganized the army and directed the construction, on the French northeast frontier, of the system of fortifications named after him (see FORTIFICATION).

Maginot died at Paris on Jan. 7, 1932.

Maginot's name became a symbol of the belief in elaborate fixed defenses that dominated French military thought before World War II and stood in sharp contrast to German tactics that stressed rapid movement of tanks, planes and motorized infantry. (M. V.)

MAGISTRATE, in general, one vested with authority to administer the law or one possessing large judicial or executive authority. In this broad sense the word is used in such phrases as "the first magistrate" of a king in a monarchy or "the chief magistrate" of the president of the United States. In countries deriving their legal systems substantially from the Roman law, it signifies more particularly the holder of a judicial office, whereas in England it is annually applied to minor or subordinate judicial officers, whether unpaid, as justices of the peace, or paid, as stipendiary magistrates. (See POLICE COURTS and JUSTICE OF THE PEACE. See also ROMAN LAW; CONSUL, etc.)

The term magistratus in ancient Rome originally implied the office of magister (master) of the Roman people, but was subsequently applied also to the holder of the office, thus becoming identical in sense with magister, and supplanting it in reference to any kind of public office. The fundamental conception of Roman magistracy is tenure of the imperium, the sovereignty which resides with the Roman people, but is by it conferred either upon a single ruler for life, as in the later monarchy, or upon a college of magistrates for a fixed term, as in the Republican period. The Roman theory of magistracy underwent little change when two consuls were substituted for the king; but the subdivision of magisterial powers which characterized the first centuries of the Republic, and resulted in the establishment of 20 annually elected magistrates of the people, implied some modification of this principle of the investiture of magistrates with supreme authority. For when the magistracies were multiplied a distinction was drawn between the magistrates with imperium, namely consuls, praetors and occasionally dictators, and the remaining magistrates, who, although exercising independent magisterial authority and in no sense agents of the higher magistrates, were invested merely with an authority (potestas) to assist in the administration of the state. At the same time the actual authority of every magistrate was weakened not only by his colleagues' power of veto, but by the power possessed by any magistrate of quashing the act of an inferior, and by the tribune's right of putting his veto on the act of any magistrate except a dictator; and the subdivision of authority, which placed a great deal of business in the hands of young and inexperienced magistrates, further tended to increase the actual power as well as the influence of the senate at the expense of the magistracy.

In the developed Republic magistracies were divided into two classes: (a) magistrates of the whole people (*populi* Romani) and (b) magistrates of the plebs. The former class is again divided into two sections: (1) curule and (2) noncurule, a distinction which rests mainly on dignity rather than on actual power, for it cuts across the division of magistrates according to their tenure or nontenure of imperium.

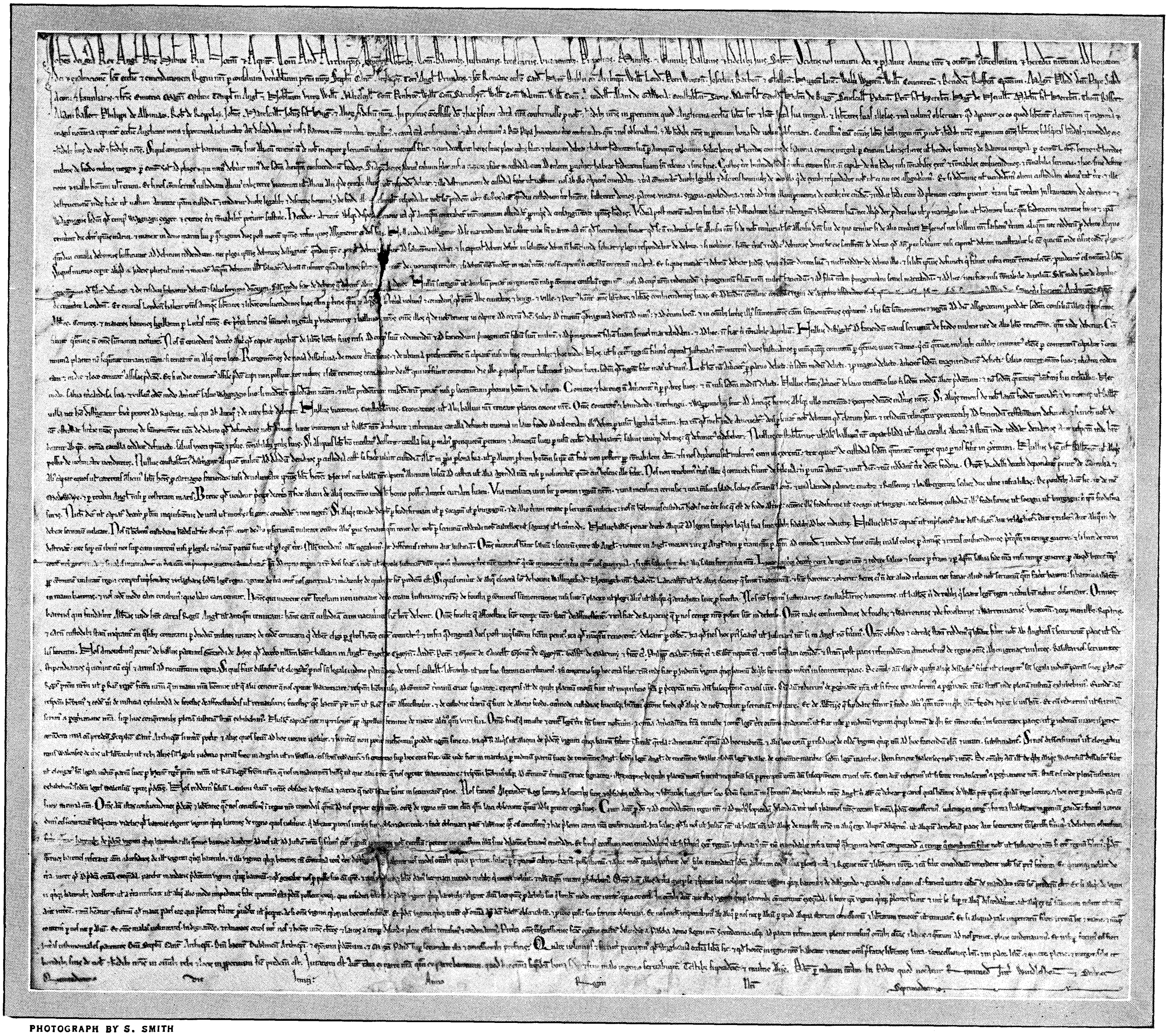
The powers possessed by all magistrates alike were two: that of enforcing their enactments (coercitio) by the exercise of any punishment short of capital, and that of veto (intercessio) of any act of a colleague or minor magistrate. The right of summoning and presiding over an assembly of that body of citizens with whose powers the magistrate was invested lay with the higher magistrates only in each class, with the consuls and praetors, and with the tribunes of the plebs. Civil jurisdiction was always a magisterial prerogative at Rome, and criminal jurisdiction also, except in capital cases, the decision of which was vested in the people at least as early as the first year of the Republic, was wielded by magistrates until the establishment of the various quaestiones *perpetuae* during the last century of the Republic. But in civil cases the magistrate, though controlling the trial and deciding matters of law, was quite distinct from the judge or body of judges who decided the question of fact; and the *quaestiones* perpetuae, which reduced the magistrate in criminal cases to a mere president of the court, gave him a position inferior to that of the praetor only in so far as the praetor controlled the trial in some degree by his *formula*, under which the judges decided the question of fact.

Tenure of magistracy was always held to depend upon election by the body whose powers the magistrate wielded. Thus the magistrates of the plebs were elected by the plebeian council, those of the people in the Comitia (*q.v.*). In every case the outgoing magistrate, as presiding officer of the elective assembly, exercised the important right of nominating his successor for election.

MAGNA CARTA was issued by King John in June 1215, under compulsion from his barons. From the time of its issue it became a symbol to barons and people alike, and king after king, throughout the middle ages, was expected to confirm it. Its clauses were regarded with veneration long after they were out of date, and men read into them meanings which would have surprised their original drafters. Seventeenth century lawyers, ignorant of the law of the early 13th century, knowing nothing of the conditions of the time, saw in the charter a solemn grant to the people of England of rights which the Stuart kings were withholding. Trial by jury, the principle of habeas corpus, the right of parliament to control taxation, all these were thought to have been secured by Magna Carta. Even the great historians of the 19th century wrote of the charter with more enthusiasm than judgment. Modern criticism has done much to put it in its rightful per-

MAGNA CARTA

PLATE



PHOTOGRAPH BY S. SMITH

REPRODUCTION OF MAGNA CARTA FROM THE ORIGINAL IN LINCOLN CATHEDRAL

Transliteration of the first three-and-a-third lines: Johannes Dei gratia, rex Anglie, dominus Hybernie, dux Normannie et Aquitannie, comes Andegavie, archiepiscopis, episcopis, abbatibus, comitibus, baronibus, justiciariis forestariis, vicecomitibus, prepositis, ministris, et omnibus ballivis, et fidelibus suis, salutem. Sciatis nos, intuitu Dei, et pro salute anime nostre, et omnium antecessorum, et heredum nostrorum, ad honorem Dei, et exaltationem sancte ecclesie, et emendationem regni nostri, per consilium venerabilium patrum nostrorum Stephani Cantuariensis archiepiscopi, totius Anglie primatis et sancte Romane ecclesie cardinalis; Henrici Dublinensis archiepiscopi, Willelmi Londoniensis, Petri Wintoniensis, Joscelini Bathoniensis et Giastoniensis, Hugonis Lincolniensis, Walteri Wygornensis, Willelmi Coventrensis, et Benedicti Roffensis, episcoporum; magistri Pandulfi domini pape subdiaconi et familiaris, fratris Eymerici, *magistri militie templi* in *Anglia,* et *nobilium* virorum Willelmi Mariscalli comitis Penbrok, Willelmi comitis Saresberie, Willelmi comitis Warennie, Willelmi comitis Arundellie, Alani de Galweya constabularii Scottie. Warini filii Geroldi, Petri filii Hereberti, Huberti de Burgo senescalli Pictavie, Hugonis de Nevilla, Mathei filii Hereberti, Thome Basset, Alani Basset, Philippi de Albiniaco, Roberti *de Roppelay*, Johannis *Mariscalli, Johannis filii Hugonis*, et aliorum *fidelium* nostrorum; Imprimis concessise Deo et hac presenti carta nostra confirmasse pro nobis et heredibus nostris in perpetuum:

Translation should read: John, by the grace of God, king of England, lord of Ireland, duke of Normandy and Aquitaine, and Count of Anjou: to the archbishops, bishops, abbots, earls, barons, justices, sheriffs, reeves, ministers, and to all bailiffs, and faithful subjects, greeting. Know that we, by divine impulse, and for the salvation of Our soul, and of the souls of Our ancestors and of Our heirs, and for the honour of God, and the exaltation of Holy Church, and the amendment of Our kingdom, by advice of Our venerable fathers, Stephen, archbishop of Canterbury, primate of all England, and cardinal of the holy Roman Church: Henry, archbishop of Dublin; the bishops William of London; Peter of Winchester; Jocelin of Bath and Glastonbury; Hugh of Lincoln; Walter of Worcester; William of Coventry; Benedict of *Rochester;* and Master *Pandulph,* sub-deacon and Counsellor; Brother *Eymeric,* master of the Temple in England, and the noble William Marescall, earl of Pembroke; William earl of Salisbury; William earl de Warenne; William earl of Arundel; Alan of Galloway, constable of Scotland; Warin Fitzgerald, Peter Fitzherbert; Hubert de Burgh, seneschal of Poitou; Hugh de Neville, Matthew Fitzherbert; Thomas Basset; *Allan* Basset; Phillip *d'Aubigny,* Robert of Ropsley, John Marshal!, John *Fitzhugh,* and others *Our* liegemen; have in the first place granted to God, and by this Our Present charter, confirmed on behalf of Ourselves and Our heirs for ever:

spective, but many writers have gone too far in their destructive criticism. It has often been suggested that the charter was drawn up in the interests of the barons alone, and that other clauses were inserted merely to attract support. There is an element of truth in the charge. The barons were naturally more interested in defining their own position than in securing advantages for the boroughs, or freedom of election for the church. That the king himself, that contemporary chroniclers, that foreign observers, should describe the charter as an agreement between king and baronage was almost inevitable, for the barons supplied the motive force by which the king was brought to terms. Their relations with the king were the shifting sand on which feudal society was built, and the charter of necessity dealt at greater length with them. But an examination of the history of John's reign, of the circumstances leading to the issue of the charter, of the charter itself and the other documents which belong to the period of negotiation, show that those who drafted the charter took pains to secure through it, not only baronial demands, but administrative reforms.

The relations between king and baronage had never been precisely defined. The charter issued by Henry I at his coronation covered only a small part of the field, and did not name the amount of the relief nor deal with the military service due from the king's tenants. The legal changes of the 12th century meant that the king's court had more power than ever before, while the baronial courts were losing business to it. On the whole the barons favoured the new methods of procedure. They were willing to submit to the firm rule of a king who should keep the understandings that governed their relations with him. So long as their reliefs were reasonable, so long as the king behaved with reason with regard to his rights of marriage, did not take excessive scutages, or insist on too much military service, they would not rebel. They might and did complain of acts of oppression, of the rigidity of the forest laws, but there had been no general antagonism between Henry II and any class of his subjects. Richard I prepared the way for the charter by his continual demands for money. His crusade meant a heavy drain at the moment of his accession; his ransom meant another extortion, four years afterward; and then his war with Philip of France began. But the country was well governed by the civil service created by Henry II.

The Grievances Against John.—John inherited the fruits of his brother's policy. The possessions of his house in France were lost to Philip Augustus. Continual and increasingly heavy scutages, accompanied by fines ne *transfretet* taken from barons who did not accompany the king on his campaigns, irritated the baronial and knightly class, particularly as Normandy seemed permanently lost. The great inquest of service of 1212 increased their unrest by suggesting that the king intended to exact all that was his due, and a scutage at three marks on the knight's fee for the expedition which ended in disaster, in 1214, determined their opposition. The church was alienated by its treatment during the Interdict, when its property was taken into lay hands and its revenues went to the royal treasury. The quarrel with the church reacted on the general administration. The last eyre of John's reign was that of 1208; the exactions of local officers, therefore, went uncorrected, and the pleas which should have come before the judges went unheard. This collapse of the judicial administration must have done more than anything else to bring the masses of men over to the baronial side. Royal rights with regard to purveyance (*q.v.*), bridge and castle building had been stretched to the utmost by John's servants, and there existed no machinery to enforce upon royal officials payment for the food, carts, or timber which they took for the king's service. Distrusting his barons, John relied on mercenaries, and rewarded them with positions in the local government of England. They cared only for the king's interests and nothing for the welfare of their shires. Against John many men desired vengeance for personal reasons. William de Braiose was driven into exile. his wife and son starved to death because they knew that John himself had murdered his nephew, Arthur. It was unsafe for contemporary chroniclers to tell too much of the scandals of John's private life. But there seems no doubt that the baronial leader. Robert Fitzwalter, wished to avenge his daughter, possibly the daughter that another rebel, Geoffrey, earl of Essex. had married. Many barons had been forced to pay far higher reliefs than had been customary. John had tried to forestall active measures against him by demanding hostages from all prominent barons. The appointment, on the eve of John's departure for his last foreign expedition, of Peter des Roches, bishop of Winchester, to the justiciarship vacated by the death of Geoffrey Fitz Peter was a further grievance, for Peter was, before everything, the king's man.

The first sign of revolt had come more than a year earlier. In Sept. 1212, on his way to a Welsh expedition, John mas warned both by his daughter, Joan, wife of Llewylyn of Wales, and by the king of Scots, that his barons were planning to betray him to the Welsh. He abandoned the expedition and Robert Fitzwalter and Eustace de Vesci, a prominent northern baron, left the country. They persuaded the pope that they were suffering for righteousness' sake, and came back with other exiles when John and Innocent were reconciled in 1213. The reconciliation brought to England the new archbishop, Stephen Langton, who returned to his native land with the intention of using his position as chief adviser of the king to compel him to restore good government to the land. John was absolved after swearing on the Gospel that he would love, defend and maintain the church, restore the good laws of his predecessors, particularly Edward the Confessor, do away with bad laws, judge all men according to the just judgments of his court, and give to every man his rights. The king then prepared to sail to Poitou, leaving the archbishop and justiciar in control of the administration to give effect to his promises. At St. Albans, early in August, they took the first steps toward the restoration of good government. Later in the month, at St. Paul's, the first suggestion that a charter should be demanded seems to have been made by the archbishop, who apparently did not know of the existence of Henry I's coronation charter. Langton realized at once that a formal charter was the best way of securing reforms in the administration, and John's observance of them. He took a few of the leading barons aside, read them Henry I's charter and suggested that it should be the basis of their program. He must also have discussed the needs of the country with the justiciar and the other judges. In all probability the actual drafting of some of the clauses of the charter was begun by such men in private talk at this time.

John, in the meantime, had forgotten his promises in his just rage against the northern barons, who should have been awaiting him on the south coast, ready to embark to France. He found all in confusion there and, obliged to put off his expedition, turned north determined on vengeance. The archbishop pursued him, catching him up at Northampton and pointing out that the occasion demanded that the northern barons should be tried in the king's court and not punished till they had been found guilty. Though he resented the archbishop's interference, John gave way. It was this crisis combined with the new idea of a charter that probably gave occasion for a compilation known as "the unknown charter of liberties." Not mentioned by any contemporary, the document was unknown until the 19th century. There is no evidence that it was anything more than a basis for discussion or an attempt to draft the baronial demands. It contains none of those clauses characteristic of the later charter, which attempt administrative reforms and link Magna Carta rather with the Statutes of Edward I than with the charters of Henry I and Stephen.

The Crisis.—By whatever means it was secured, some compromise must have been made, for the king departed on Feb. 2, 1214, on his last expedition to Poitou, and during his absence no active steps were taken against him, although a demand for a scutage of three marks, issued from abroad, roused bitter resentment. When John returned defeated, all parties felt that the time had come to insist on definite guarantees for the future. John met the barons at Bury St. Edmunds on Nov. 4, 1214, and received a definite refusal to pay the scutage. After the king had departed they solemnly swore to withdraw their allegiance from him unless he would confirm their liberties by charter. They agreed to present their demands soon after Christmas, and in the meantime to prepare for war. John tried to win over his ecclesiastical opponents by issuing, on Nov. 21, a charter to the church, in which he granted freedom of election. On Jan. 6 the barons put before the king at the Tower general demands that a charter should be issued on the lines of Henry I's charter, but incorporating administrative reforms which some at least of the barons desired. The archbishop and William Marshall, earl of Pembroke, were anxious for reform without war. Through their mediation John secured a truce till Easter. On Jan. 15, he reissued the charter to the church, and ordered the sheriffs in every county to take oaths of allegiance to the king. Both sides appealed to the pope and the king took the cross. The pope had a double reason for protecting him; he was both a vassal and a crusader.

In Easter week the barons met at Stamford to force a charter from the king. Contemporary chroniclers emphasize the fact that the backbone of the resistance was a group of northern barons; but to label the baronial resistance as northern is inaccurate, as the contemporary chroniclers themselves imply. In Lincolnshire, Norfolk, Suffolk and Essex it was particularly strong; the great men of Essex and Hertfordshire, the earl of Essex, the earl of Oxford, Robert Fitzwalter, were almost to a man against the king, and with them were joined many barons of the second rank and men of rich knightly families from the other three eastern counties. The midland counties supplied such great names as William d'Albigny and John, the constable of Chester and the west, the Fitz Alans, and Fulk Fitz Warin. From the southwest came William Malet and William de Montecute. That fewer supporters for the baronial party should come from the southwest, the northern midlands, and the honour of Lancaster was natural, since these were John's own lands. That the opposition should be stronger in the southeast is again to be expected. The men of Essex were more nearly in touch with modern thought, and modern thought was much occupied with the duties of the king. But John's enemies were everywhere. John had, however, certain supporters among the greatest barons in the land. The earl of Chester, almost a sovereign prince himself, could do no other than take the king's side, though one may suspect that he approved the charter, since he issued a comprehensive charter to his own men at some phase in the struggle, a document known as the Magna Carta of Chester. The earl of Pembroke, a man grown old in the service of the royal house, the earl of Salisbury, half brother to the king, the earl of Warenne, the earl of Arundel, and earl Ferrars were all on the royal side, but Ralf of Coggeshall tells us that even when a baron supported John his knights were generally on the other side.

The archbishop had created a situation which he could not control. The barons were eager for war. The king was determined not to give way unless he were forced, and scornfully refused to consider the schedule that the barons at Stamford sent for his seal by the hands of the archbishop and the marshal. On May 5 the barons renounced their allegiance and chose Robert Fitzwalter as leader. The title he took, "Marshal of the army of God and Holy Church," emphasized the righteousness of the cause. Four days later John issued a charter to London, granting the privilege of an annually elected mayor, but it came too late to win support for him. Robert Fitzwalter, lord of Baynard's castle, on the outskirts of the city, dominated city politics. The king's offer, next day, to submit his quarrel with the barons to arbitration was in vain. When the barons entered London, easily quelling any opposition, the king realized that he must come to terms, and on June 15 met them at Runnimede, between Staines and Windsor. The barons came prepared with a document, which survives, as the Articles of the Barons. It was sealed on the first day of the conference and became the basis for discussion. The more elaborate charter contained amendments on both sides.

THE CONTENTS OF THE CHARTER

The charter is drawn up in the ordinary form of a contemporary grant of land or privileges. The convenience of modern commentators has necessitated the adoption of a traditional division into clauses, a division often unfortunate in that it suggests a separation where the originators of the charter were clearly following out a line of thought. In summarizing the contents it is impossible to follow the order of the clauses and at the same time give a coherent impression of the contents of the document. The intention of the men who drew up the charter was to state the law as it should be. It is the first detailed statement of feudal law, the first clear agreement between the king and his barons as to the exact demands which the king can make on them and which they can make on their men. Its emphasis on the use of the feudal council inaugurates no new policy, but simply reiterates the recognized, though not always followed, feudal practice. The statements about debt were a serious attempt to deal with one of the most pressing problems of administration and, indeed, of social intercourse, the chronic need of money, felt by all alike, and the consequent impossibility to get anyone to pay his debts. The judicial clauses were drafted with the obvious aim of restoring judicial eyres and improving the efficiency of the royal courts. The much quoted clause about the writ Precipe was a natural attempt to curb what was, to the barons, unfair competition with the feudal courts, competition which Ranulf Glanville himself, though a royal justiciar, had hardly approved. It does not express a desire to go back upon the judicial changes of the last 50 years, but merely a feeling that the baron who had been bearing the burden of the day in the matter of judicial labour ought not to be deprived of the cases which would still be settled in his court unless he failed to do justice. A serious attempt was made in the charter to eliminate the abuses of local government, abuses which had existed in the earliest days of Norman rule, and which successive kings had fought against in vain. During his quarrel with the church John made no effort to deal with them, and, indeed he had aggravated them by the appointments he had made to local offices. John had been interested in the development of his towns, and the charter confirmed to towns the privileges they had won. All classes of the community expected something from the charter, and the drafters did their best to satisfy the general desire. The charter therefore ranges widely over the whole field of society and administration. But it also contains clauses which reflect the bitterness of the time, clauses that must have irritated the king almost beyond endurance. Since all mercenaries were to leave the land it was but to insult the king to name a few. The determination of the barons to be rid of old grievances, particularly those connected with the forests, to right old wrongs, even those of another generation, almost destroyed the charter itself. But without the spur that the bitterness of personal hatred gave, the charter would never have been won. If the famous clause promising that no freeman shall be taken or imprisoned or disseised or outlawed or exiled . . . without the judgment of his peers or by the law of the land, was the outcome of the memory of John's attack on the northern barons in 1213, it was a guarantee of security against arbitrary rule to all men, whether barons or simple free men.

The Clauses.—The charter may be summarized as follows, the numbers in brackets being the traditional numbers of the clauses:

I. The clause reiterating the grant of free election to the church (1).

II. Clauses which chiefly concerned the barons: (a) Inheritance.—Military tenants are to have their inheritances on payment of the ancient relief, £100 for an earl or baron, 100*s.* for a knight. (b) Wardship.—Heirs who have been in wardship are to have their inheritances without relief. The heir in wardship is to be safeguarded from the rapacious guardian, who is to hand over the land well stocked (2–5). The king will not claim prerogative wardship, *i.e.*, if a man holds of the king by other than military tenure and of some other lord by military tenure, the king will not claim the wardship of his heir by reason of the land that is held of him (37). Barons who have founded abbeys are to have the custody of them when they are vacant (46). (c) Marriage.—Heirs are to be married without disparagement, the kinsfolk of the heir being consulted. A widow is to have her marriage portion and her inheritance at once on her husband's death, and shall give nothing for it or for her dower. The latter shall be assigned to her within 40 days during which she can stay in her husband's house. No widow shall be forced to remarry provided that she gives security not to remarry without her lord's consent (6–8). (d) Debt.—Lands or rents are not to be seized for the payment of debt while the debtor has sufficient chattels to pay the debt. The debtor's sureties are not to be distrained so long as the debtor himself can pay. If the sureties are called on they are to hold the debtor's lands till their payment has been made up to them. No interest is to be paid on debts to the Jews while the heir of the debtor is under age. The king will only take the principal if the debt comes into his hands. When anyone dies in debt to the Jews or to other people his wife and children are to be first provided for, and the debt is to be paid out of the residue of his estate (9–11). Debts to the king are to be the first charge on the estate of crown tenants, the residue is to be left to the disposal of his executors in accordance with the will of the dead man. If no debt is owing to the crown the estate may be disposed of according to his will reserving to his wife and children their reasonable shares. If a free man dies intestate, his kin and friends under the direction of the church shall divide his chattels, after the dead man's debts have been paid (26–27). (e) Service and rules for holding the *feudal* council.—No scutage or aid is to be taken without the common council of the kingdom, that is, without the matter being brought before the feudal council of tenants in chief, except for the ransoming of the king's body, the knighting of his eldest son and the first marriage of his eldest daughter. In these cases the aid is to be a reasonable one (12). The archbishops, bishops, abbots, earls and greater barons are to be summoned to the council individually by letter stating the cause of the summons; all those who hold of the king in chief are to be summoned generally through the sheriffs or royal bailiffs. Forty days' notice is to be given and on the appointed day the business is to proceed even if all those summoned are not present (14).

III. Clauses which principally affect subtenants and freemen as well as barons: All the customs granted to his dependents by the king all men in the kingdom shall observe towards theirs (60). The king will not allow anyone to take an aid from his free men except on the three aforesaid occasions, and the aid then is to be a reasonable one (15). No one is to be forced to do more service for a knight's fee or other free tenement than he ought to do (16). No constable shall compel a knight to give money in lieu of castle guard if the knight wishes to do it in person or through a competent deputy. Service on an expedition shall free a knight from a proportionate amount of castle guard (29). "No freeman shall be taken, or imprisoned, or disseised, or outlawed, or exiled, or in any way destroyed, nor will we go upon him, nor will we send upon him, except by the legal judgment of his peers or by the law of the land" (39). "To no one will we sell, deny, or delay right or justice" (40). All persons are to be free to come and go in time of peace, except outlaws and prisoners (42).

IV. Clauses referring to towns, trade and merchants: The aids of the city of London are to be governed by the same rule as the baronial aids, and the city is to have its ancient liberties and free customs. All other cities, boroughs, towns and harbours, are to have their liberties and free customs (12–13). There is to be one measure of wine and ale and corn within the realm, namely the London quarter, and one breadth of cloth, and it is to be the same with weights (35). All merchants are to be free to come and go, to stay in the land and to buy and sell, except in time of war. In time of war merchants of enemy countries in England are to be treated as English merchants are treated in the enemy countries (41). All kydells are to be removed from the Thames and the Medway and throughout all England except the sea coasts (33).

V. Clauses reforming judicial and legal matters: Common pleas are not to follow the court but to be held in some certain place (17). For the taking of inquisitions of novel disseisin, mort d'ancestor, and darrein presentment two justices are to be sent through the realm four times a year and with four knights of each county chosen by the county are to hold the assizes on the day and in the meeting place of the shire court. If all cannot be taken on the one day, enough knights and freeholders are to remain to conduct the business (18, 19). Amercements are to be in accordance with the measure of the offence. They are not to be so heavy, in the case of grievous crimes, as to deprive any man of his means of livelihood. They are to be assessed by the honest men of the neighbourhood (20). Earls and barons are to be amerced by their peers according to the measure of their offence (21). Clerks shall only be amerced according to the measure of their offence and only the lands which they hold by lay tenure shall be answerable for the amercement (22). The lands of those convicted of felony shall only be held by the king for a year and a day and then shall return to the lord of the fee (32). The writ called *Precipe* shall not in future be issued to anyone touching any tenement whereby a free man may lose his court (34). Nothing shall henceforth be given for a writ of enquiry touching life or limb, but it shall be granted freely and not denied (36). No one is to be taken or imprisoned upon the appeal of a woman for the death of any other than her husband (54).

VI. Clauses intended to check the abuses of local officers: No town or individual shall be forced to make bridges or maintain river banks except such as ought to be so maintained by ancient custom and right (23). No sheriff, constable or bailiff is to hold the pleas of the crown (24). All counties, hundreds, wapentakes and ridings are to be at their old farm without any increment, except the king's demesne manors (25). No constable or bailiff is to take a man's corn or other chattels without immediate payment unless the owner allows a respite (28). No sheriff, bailiff or any other person shall take a freeman's horses or carts for carriage duty except with the owner's consent (30). Neither the king nor his bailiffs are to take a man's timber for castle-building or any other royal work without the consent of the owner of the wood (31). No justice, constable, sheriff or bailiff is to be appointed but such as knows the law and is willing to observe it (45). No bailiff upon his own bare word without credible witnesses is to send a man to the ordeal (38).

VII. Forest Clauses: Men who dwell without the forest are not to come before the justices of the forests on a general summons but only when they are concerned in special cases (44). All forests made by John are to be disafforested and all evil customs of the forests abolished. Justice is to be done with regard to the forests made by Henry II and Richard I (47, 48).

VIII. Clauses of temporary interest, to correct temporary abuses: All hostages and charters taken from the English barons are to be returned (49). Welsh grievances are to be considered and Welsh hostages are to be returned (56–68). Scottish hostages are to be returned and justice is to be shown to Alexander, king of Scotland (59). Certain named mercenaries and their followers are to be sent away. All mercenaries are to be dismissed (50, 51). Justice is to be done in the case of wrongful dispossessions by John himself, Henry II or Richard I (52). In all cases the king is to have the crusader's respite. Illegal fines and amercements are to be remitted. The 25 barons who were to be responsible for the maintenance were to judge any disputed matters, together with Stephen Langton, archbishop of Canterbury.

IX. The form of security for the maintenance of the provisions of the charter: The barons were to choose 25 of their number to be the guardians of the charter. If the king or one of his officers did anything contrary to its terms the offence was to be notified at once to 4 of the 25 who were to go to the king or the justiciar and ask that the matter might be corrected. If it were not corrected within 40 days the 4 barons were to refer the matter to the rest of the 25, who together with the community of the whole land "shall distrain and trouble us in all possible ways by taking our castles, lands and possessions." When redress has been forced upon the king, former relations with him were to be resumed. Anyone who wished could swear to obey the 25. The king would enforce the oath on anyone who refused to take it. On the death of one of the 25 the survivors were to appoint his successor. A majority of them were to decide questions in dispute. The king promised that he would not directly or indirectly do anything by which the concessions might be revoked or diminished.

War Again.—In this last clause lies the weakness of the charter and of the whole baronial position. The legalization of temporary rebellion inevitably affected the tempers of both sides. At the same time, in the opinion of the archbishop and the moderate party, it was likely to secure not peace and good government but prolongation of the time of disorder. The baronial choice fell on some of the worst malcontents. The mayor of London was the only member of the 25 who was of less than baronial rank, no bishops were among them, and the only one of them who had any sympathy with the king's point of view was the count of Aumâle, a thoroughly untrustworthy person. The moderate men secured the appointment of a second committee of 38 men, chosen from all parties, and containing some of the wisest of the king's supporters. The work of this body was to hold the balance between the king and the 25. But despite this arrangement war broke out. The charter as it was issued can have satisfied no one. Some of the northern barons had even withdrawn before agreement was reached; other barons evidently cared only for those clauses which secured to themselves either general promises or the redress of 'individual grievances. Stephen Langton, the wiser earls and the judges saw the clauses by which they hoped to secure a well run administration wrecked by such insistence on personal questions. For the moment the king seemed willing to keep his part of the bargain. The charter was sent into every shire for publication by the sheriff and orders were sent to sheriffs and bailiffs that men should swear allegiance to the 25, and that enquiries should be set on foot as to the evil customs to be abolished. Peter des Roches ceased to be justiciar, and Hubert de Burgh was appointed. Some of the foreign mercenaries were dismissed, and some of the offending sheriffs removed. Enquiries were also set on foot as to claims of individuals against the king. This compliance did not last long. The tyranny of the a j was not to be borne by one so impatient of control as John. He made ready for war, sending to Aquitaine and Flanders for mercenaries, and to the pope for spiritual help.

While the king made ready for war the baronial leaders remained in London, making no other preparations than negotiations with the French king for help against John. The northern barons who had withdrawn from the negotiations for the charter fortified their castles. All over the country the king's lands were attacked and his deer stolen. The administration was disorganized; the business of the exchequer at a standstill. Stephen Langton and the bishops could do nothing. The pope annulled the charter and excommunicated the baronial leaders. The archbishop refused to publish the excommunication, little as he approved of the baronial attitude, and left the country with his office in abeyance.

In October a party of barons seized Rochester castle, but John laid siege to it and it fell on St. Andrew's day. No substantial help came from France till January 1216, and Louis, son of Philip Augustus, whom the barons wished to make king, only landed in May. Meanwhile John was isolating the baronial stronghold of London by the fortification of Windsor, Hertford, Berkhampstead and Bedford castles. One company of the royal army occupied itself in reducing East Anglia and Essex. The king in person quelled resistance in the north, and appointed trustworthy men to keep the northern barons in subjection. Had it not been for French help the rebellion would have been over before the summer of 1216. The coming of Louis meant the desertion of many of John's French mercenaries. Louis' momentary success drew to his side some of the greater barons who had hitherto supported John, the earls of Warenne, Arundel and Salisbury and the count of Aumble. War was renewed all over the country. Alexander of Scotland raided the north. Lincoln castle was besieged by barons acting in the name of Louis. In Yorkshire the rebel barons rose again, and in Nottinghamshire the castles of Nottingham and Newark were taken by them. But the king's cause was by no means lost. In the north the men appointed by John had little difficulty in upholding his authority. Even in the south Louis made little headway. Although he took Winchester, he could not take the castles of Windsor or Dover. Meanwhile, resentment against French domination began to be felt among the barons. John reorganized his forces in the southwest, drew off the besiegers of Windsor castle and passed into the eastern counties, where he intended to crush resistance as he had done in the north in the previous winter. At Kings Lynn he was seized with dysentery. He crossed the Wash and managed to struggle to Newark, where he died on Oct. 19, 1216. With his death the need for further opposition to royal authority was gone, for the moderate party took control of affairs in the name of the young Henry.

The Reissues of the Charter.—The charter was at once reissued with certain significant changes. All clauses of a purely temporary nature were omitted, as well as those dealing with mercenaries and the redress of grievances. With them went the promise that only justices, constables, sheriffs and bailiffs who know the law and are willing to observe it shall be appointed (45). Clauses which might affect the royal power to raise money were omitted, together with those relating to the Jews, the feudal aids, and the farms of the shires. The clause laying down the way in which the barons should be consulted in the feudal council was omitted. These omissions were all matters of policy. It was not the time to haggle over personal grievances, nor could Henry's advisers rightly bind the young king in matters of general policy. The mercenaries were needed to fight Louis. Money was needed from whatever source. The necessity of the moment, too, added a provision that payment for goods for royal castles might be postponed for three weeks. Other changes, slight though they were, showed that those who reissued the charter had sufficient time and interest to consider the advantage of authoritative statements on difficult legal points. The position of the heir in his lord's wardship and the position of a widow with regard to her dower are more precisely defined. The form of security for the maintenance of the charter was omitted, but a clause was inserted promising full consideration of everything that needed correction.

In the reissue of the following year, 1217, the clauses omitted in 1216 were not replaced. The regency council might be using the charter as a political weapon to win men to their side, but they regarded it as above all an administrative measure, a guide to and a check on judges and local officers in the difficult years of reconstruction. The rights of the widow are still more carefully defined. The rules for the taking of assizes are modified. There are three fresh clauses forbidding a freeman to give or sell so much of his land as may hinder the proper performance of his services to his lord; regulating the conduct of the sheriff with regard to the holding of the shire court; and forbidding the practice of giving land to a religious house and receiving it back as its tenant. The delay of 3 weeks in the payment of goods taken for the use of a royal castle in 1216 is extended in 1217 to 40 days, but in 1217 the carts of ladies, knights and parsons are exempt from cartage duties. The provision in the 1215 issue that service with the army exempts from castle guard is limited by the statement that the exemption only applies to fiefs from which service with the army is due. If the clause which declares that the promises made by the king to his tenants shall be observed by his men to theirs is weakened by the saving clause reserving* to "all archbishops, bishops, abbots, priors, templars, hospitalers, earls, barons and all other as well ecclesiastical as secular persons their liberties and free customs which they had before," it is, at any rate! made clear that all villeins, not only the king's, are protected from excessive amercements. The forest clauses were omitted and issued later in a separate charter. It is to this issue that the name Magna Carta became attached in contrast with the charter of the forest. The edition of 1225 contained nothing new, except the statement that the charter is issued of the king's free and spontaneous will and in return for an aid. That later issues of the charter were no more than confirmations of this edition is not surprising. The administrative system was yearly becoming more complicated, the law more intricate. A carefully drawn statute was needed at the end of the century to deal with a matter for which a short clause would have sufficed in 1217.

There still exist four originals of the charter of 1215, two of them in the cathedral churches in which they were originally deposited, Lincoln and Salisbury, the other two in the British Museum. The Lincoln Charter was considered the most perfect and was reproduced in the Statutes of the Realm in 1810. The charter was commented on by Sir Edward Coke in his *Second Institute* published by order of the Long Parliament in 1642, but modern criticism was begun by William Blackstone in *The Great Charter and the Charter of the Forest* (1759). Richard Thornson's *Essay on the Magna Carta of King John* (1829) was a serious attempt to collect all the information on the circumstances and people connected with the charter. It also contains a useful section on the existing manuscripts, copies and printed editions of the charter. Modern authorities to be consulted are C. Bémont, *Chartes des libertés anglaises* (1892); W. S. McKechnie, *Magna Carta* (1905); Petit-Dutaillis, *Studies Supplementary* *to Stubbs' Constitutional History* ii (1908); R. L. Poole, "The Publication of Great Charters by the English Kings," *Eng. Hist. Review* (1913); *Magna Carta Commemoration Essays* (1915); F. M. Powicke, *Stephen Langton* (1928). (D. M. S.)

MAGNA GRAECIA, the name given (first, apparently, in the 6th century B.C.) to the group of Greek cities (*e megale Hellas*), along the coast of the "toe" of south Italy (or more strictly those only from Tarentum to Locri, along the east coast), while the people were called Italiotes (*Italiotai*). The interior continued in the hands of the Bruttii, the native mountaineers, from whom the district was named in Roman times (*Brettia* also in Greek writers). The Greek colonies, at first trading stations, grew into independent cities. An early trade in copper was carried on between Greece and Temesa (Homer, Odyssey, i, 181), chiefly by Euboeans; and Cyme (Cumae) in Campania was founded in the 8th century B.C., when the Euboean Cyme was still a great city. After this the energy of Chalcis went onward to Sicily. and the states of the Corinthian gulf carried out the colonization of Italy, Rhegium having been founded, it is true, by Chalcis, but after Messana (Zancle), and at the request of the inhabitants of the latter.

Sybaris (721) and Crotona (703) were Achaean settlements; Locri Epizephyrii (about 710) was settled by Ozolian Locrians, so that. had it not been for the Dorian colony of Tarentum, the southern coast of Italy would have been entirely Achaean. Tarentum, whatever its origins, early became the only foreign settlement of the Spartans. Ionian Greeks fleeing from foreign invasion founded Siris about 650 B.C., and, much later, Elea (540).

The Italian colonies, planted among friendly peoples. grew much more rapidly than the Sicilian Greek states, which had to contend against Carthage. After the Achaean cities had combined to destroy the Ionic Siris, and had founded Metapontum as a counterpoise to the Dorian Tarentum, there was little strife among the Italiotes. An amphictyonic league, meeting at the temple of Hera on the Lacinian promontory. fostered a feeling of unity. The Pythagorean and Eleatic systems of philosophy had their chief seat in Magna Graecia. They sent competitors to the Olympic games (among them the famous Milo of Croton); and the physicians of Croton early in the 6th century (especially in the person of Democedes) were reputed the best in Greece. In 510 Croton. having defeated the Sybarites in a great battle, totally destroyed their city.

In the war between Athens and Syracuse, Magna Graecia took comparatively little part; Locri was strongly anti-Athenian, but Rhegium, though the headquarters of the Athenians in 427, remained neutral in 415. Foreign enemies pressed heavily on it. The Lucanians and Bruttians on the north captured one town after another. Dionysius of Syracuse attacked from the south; and after he defeated the Crotoniate league and destroyed Caulonia (389 B.C.), Tarentum (*q.v.*) remained the only powerful city. Repeated expeditions from Sparta and Epirus tried in vain to prop up the decaying Greek states against the Lucanians and Bruttians; and when in 282 the Romans appeared in the Tarentine gulf the end was close at hand. The aid which Pyrrhus brought did little good to the Tarentines, and his final departure in 274 left them defenseless. Malaria increased as population diminished. Many of the cities disappeared, and hardly any were of great importance under the Roman empire; some, like Tarentum, maintained their existence into modern times. Archaeological investigations of great importance have been made. (T. A.)

MAGNASCO, ALESSANDRO (LISSANDRINO) (1667–1749), Italian painter distinguished for his genre painting with small figures, was born at Genoa, where he studied under his father, Stefano. He afterward worked in Milan with an obscure Venetian painter, Filippo Abbiati. He began as a portrait painter, but only one self-portrait is known. His later scenes were from the lives of monks, nuns, gypsies or bandits, frequently set in romantic landscapes. These are extremely loosely painted in a dramatic, almost ecstatic manner, influenced by P. Morazzone and reminiscent of Salvator Rosa, Jacques Callot and M. Cerquozzi. Very few are dated or datable.

Some time between 1693 and 1698 he met Sebastiano Ricci, through whom he exercised a marked influence on Venetian 18th-century painting. Later he moved to Florence, where he found employment at the court of the grand duke, and after traveling about Tuscany and Emilia he returned to Milan, where he remained from 1711 until 1735. He then returned to Genoa, where he died on March 12, 1749.

Magnasco was exceedingly prolific both as a painter and a draftsman and occasionally collaborated with C. Spera, C. Tavella, M. Ricci and Perugrini, inserting figures in their landscapes. Though he had no pupils, he had several imitators, notably the Neapolitan Ciccio and the Milanese Coppa.

See B. Geiger, *Saggio d'un Catalogo delle Pitture di Alessandro Magnasco* (1945) and A. Morassi, Catalogue of the *Mostra di Magnasco* (1949), both have full bibliographies. (F. J. B. W.)

MAGNATE, a noble, a man in high position, by birth, wealth or other qualities. The term which is derived from Late Lat. magnas, a great man, was specifically applied to the members of the upper house in Hungary, the Forendihaz or house of magnates.

Its popular application to a wealthy man is usually satirical.

MAGNESIA, in ancient geography the name of two cities in Asia Minor and of a district in eastern Thessaly, lying between the Vale of Tempe and the Pagasaean gulf.

(1) MAGNESIA AD MAEANDRUM, a city of Ionia, situated on a small stream flowing into the Maeander, 15 Roman miles from Miletus and rather less from Ephesus. According to tradition it was founded by colonists from the Thessalian tribe of the Magnetes, with whom were associated, according to Strabo, some Cretan settlers. It was thus not properly an Ionic city, and for this reason, apparently, was not included in the Ionian league, though superior in wealth and prosperity to most of the members except Ephesus and Miletus. It was destroyed by the Cimmerii in their irruption into Asia Minor, but was soon after rebuilt, and gradually recovered its former prosperity. It was one of the towns assigned by Artaxerxes to Themistocles for support in his exile. His statue stood in its market place. Thibron, the Spartan, persuaded the Magnesians to leave their indefensible and mutinous city in 399 B.C. and build afresh at Leucophrys, an hour distant, noted for its temple of Artemis Leucophryne, which, according to Strabo, surpassed that at Ephesus in the beauty of its architecture, though inferior in size and wealth. Its ruins were excavated by Dr. K. Humann for the Constantinople museum in 1891–93; but most of the frieze of the temple of Artemis Leucophryne, representing an Amazon battle, had already been carried off by Texier (1843) to the Louvre. It was an octostyle, pseudodipteral temple of highly ornate Ionic order, built on older foundations by Hermogenes of Alabanda at the end of the 3rd century B.C. In front of the west facade stood a great altar. An immense *peribolus* wall is still standing (20 ft. high), but its Doric colonnade has vanished. The railway runs right through the precinct, and much of Magnesia has gone into its bridges and embankments. South and west of the temple are many other remains of the Roman city, including a fairly perfect theatre excavated by Hiller von Gaertringen, and the shell of a large gymnasium. Part of the Agora was laid open to Humann, but his trenches have fallen in. The site is so unhealthful that even the Circassians who settled there in the 19th century almost all died off or emigrated.

Magnesia continued under the kings of Pergamum to be one of the most flourishing cities in this part of Asia; it resisted Mithradates in 87 B.C., and was rewarded with civic freedom by Sulla; but it appears to have greatly declined under the Roman empire, and its name disappears from history, though on coins of the time of Gordian it still claimed to be the seventh city of Asia.

See K. Humann, *Magnesia am Maeander* (1904).

(2) MAGNESIA AD SIPYLUM, a city of Lydia, about 40 mi. N.E. of Smyrna, was unknown before the battle of 190 B.C. In 197 B.C. the Romans, after being freed of all danger from Carthage, had forced the submission of Philip V of Nacedon (see CYNOSCEPHALAE), while Antiochus, overrunning Asia Minor, had penetrated into Thrace. The Mediterranean world could not hold two such powerful rivals, and the inevitable clash was hastened by Antiochus's subsequent invasion of Greece. If by his dilatory and

limited strategy he lost his opportunity, he roused the Romans, reviving from the war weariness that followed the struggle with Hannibal, to a sense of danger, and, not content with his repulse, they prepared a counterinvasion—all the more because Hannibal was now at the side of Antiochus. The expedition was placed under the consul Lucius Scipio, whose election was due to the promise of his famous brother, Publius Scipio Africanus, to accompany him as his lieutenant. The latter's combination of strategy and diplomacy ensured the expedition's secure and unchecked passage from Greece and across the Dardanelles into Asia Minor. But illness prevented him reaping the tactical fruits, and the decisive battle was fought while he was still on his sickbed. Antiochus with an army computed at 62,000 foot and over 12,000 horse had fallen back behind the Hermus river and there at Magnesia—the modern Minissa—fortified a strong camp. Though the Romans counted only two legions and proportionate allied contingents—about 30,000 in all—an attack was decided upon. "The Romans never despised an enemy so much." However, Antiochus saved them the trouble and came out to offer battle. Even so, they evidently missed the master-hand of Scipio Africanus, and were even in jeopardy for a time. For while they were driving in the enemy's centre, and their cavalry were attacking his left flank, Antiochus himself with his right wing cavalry crossed the river—left almost unguarded—and fell upon the Romans' left flank. The troops there were dispersed and took refuge in the camp, where only the resolution of the tribune left in charge rallied them and staved off the danger until reinforcements arrived. Foiled here and seeing a heavy concentration developing against him, Antiochus fled from the battlefield, and the remnants of his demoralized army followed him to Sardis. Antiochus, with his subject states making their peace with Rome, was forced, more through Africanus's strategy than his brother's tactics, to sue for a peace which removed him to the eastern side of the Taurus range and left Asia Minor free for Roman exploitation.

MAGNESITE, one of the calcite group of rhombohedral carbonate minerals, consisting of magnesium carbonate, is a principal source of magnesium. It is mined in Austria, Czechoslovakia, Yugoslavia. Greece, the Ural mountains, Madras (India), Manchuria, California, Washington and Nevada. It is used for making refractory firebricks for lining steel furnaces; for magnesium oxychloride (Sorel) cement (*q.v.*), used mainly in flooring; for preparing magnesium chemicals, including those used as a component of fertilizer; and as a catalyst and filler in making synthetic rubber. The formula of magnesite is $MgCO_3$. Extensive substitution of iron, as well as lesser amounts of calcium and manganese, may occur in place of magnesium. It is rarely found in good single crystals, occurring either as crystalline aggregates or as earthy to compact masses. When pure it is white, with a hardness of 3.75 to 4.25 depending on direction, and a specific gravity of 3.0. Although found in some beds deposited from saline lakes, it more commonly occurs either as a replacement of limestones and dolomites or as a breakdown product of serpentine attacked by hot carbonate solutions. In the latter, it usually contains admixed opaline silica and magnesium silicates. (D. L. G.)

MAGNESIUM is a metallic chemical element of silvery white appearance with a specific gravity of 1.74. The sulfate, or Epsom salt, was isolated in 1695 by N. Grew, while in 1707 M. B. valentine prepared magnesia alba from the mother liquors obtained in the manufacture of nitre. Magnesia was confused with lime until 1755, when J. Black showed that the two substances were entirely different. Sir Humphry Davy in 1808 produced the amalgams of magnesium and isolated the metal by distilling off the mercury. In 1828 the metal was prepared (in a state approximating to purity) by A. Bussy who fused the anhydrous chloride with potassium. Michael Faraday in 1833 was the first to succeed in producing metallic magnesium by electrolysis of molten magnesium chloride, using a voltaic cell. Robert Bunsen achieved the same result in 1852, his electrolytic cell corresponding in construction to the principle of the modern cell. In France, H. Sainte Claire Deville and H. Caron in 1857 accomplished the reduction of anhydrous magnesium chloride with sodium. In 1886 the electrolytic process was further developed by F. Fischer and R. Graetzel in Germany. Electrolytic methods entirely superseded the older ones until about 1941 when the carbothermic and ferrosilicon techniques, employing a thermal process, came into use for a small proportion of magnesium production.

Occurrence.—It is estimated that magnesium forms about 2.1% of the earth's crust, being the third most abundant of the engineering metals. It is found widely distributed in nature in a variety of forms. The carbonate, oxide and chloride are the ones most widely used and occur as dolomite, magnesite, brucite and carnallite. Magnesium also occurs in silicate minerals of which the most important are olivine, serpentine and asbestos. Although the silicate minerals are of world-wide occurrence, they are not suitable raw materials for magnesium metal manufacture because of the difficulties in separation.

Magnesium is found as chloride in sea water and in certain deep brines, such as those of Michigan, these being important commercial sources, especially in the U.S. Magnesite, $MgCO_3$, is the most important solid source of magnesium and is widely distributed throughout the world, the largest deposits being in Austria, the U.S.S.R., Greece, Czechoslovakia, Manchuria and the Pacific coast of North America. Dolomite, $MgCO_3.CaCO_3$, is also widely distributed, there being abundant deposits in the United Kingdom, Austria, Hungary, Germany, Switzerland, Italy, Spain and the United States. Carnallite, $MgCl_2.KCl.6H_2O$, forms a layer of the great salt beds at Stassfurt, Germany, and provided the raw material for the first electrolytic production of magnesium on a commercial basis, although it is not now an important raw material. Large deposits of the hydroxide, brucite, $Mg(OH)_2$, are found in Quebec and in Nevada. Although brucite is richer in magnesium than any other ore, it is extremely local in occurrence.

Magnesium Minerals

Name	Nominal formula	% Mg contained
Magnesite	$MgCO_3$	28.7
Dolomite	$MgCO_3.CaCO_3$	13.8
Brucite	$Mg(OH)_2$	41.6
Serpentine	$3MgO.2SiO_2.2H_2O$	25.9
Olivine	$(MgFe)_2\ SiO_4$	28.4
Talc	$3MgO.4SiO_2.H_2O$	20.7–26.9

Other magnesium minerals found in salt deposits from evaporation of ancient seas, include:

Carnallite	$MgCl_2.KCl.6H_2O$
Schoenite	$MgSO_4.K_2SO_4.6H_2O$
Polyhalite	$MgSO_4.2CaSO_4.K_2SO_4.2H_2O$
Kieserite	$MgSO_4.H_2O$
Epsomite	$MgSO_4.7H_2O$
Kainite	$MgSO_4.KCl.3H_2O$
Langbeinite	$2MgSO_4.K_2SO_4$

Extraction and Production.—Two chief methods were in use by mid-20th century for the commercial production of magnesium, one electrolytic, the other thermal, the former accounting for the bulk of industrial production. In Germany, where the magnesium industry was first developed on a large scale, the process is based on the electrolysis of molten magnesium chloride. a by-product from the potash and carnallite operations at Stassfurt, or the chlorination of magnesite. Magnesium chloride may be produced from brines, sea water, processed dolomite or by chlorinating magnesite. The electrolytic method accounted for approximately 85% of the magnesium output of the U.S. during World War II. The sea water electrolytic process was then the newest method (1941) of producing magnesium, and the bulk of production in the U.S. was derived in this manner. A brief description of the process follows.

Sea water, which contains about 0.13% magnesium, is pumped into huge settling tanks where it is mixed with lime. The calcium from the lime is exchanged with the magnesium in the sea water which precipitates as insoluble magnesium hydroxide, settles to the bottom of the tank and is filtered off. The magnesium hydroxide is then converted to magnesium chloride by reaction with hydrochloric acid prepared from natural gas and chlorine, $Mg(OH)_2+2HCl=MgCl_2+2H_2O$.

After thorough drying, which may be accomplished by means of spray or shelf driers or a combination of the two, the magnesium chloride or cell feed is fed to the electrolytic cells where electricity breaks it down into magnesium metal and chlorine gas, $MgCl_2 = Mg + Cl_2$. A typical cell is a large rectangular steel pot about 6 ft. deep. 5 ft. wide and 11 ft. long which holds the fused salt bath, conducts the current to the internal cathodes and contains approximately 10 tons of molten salts. This stands in a gas-fired refractory brick furnace. The pot and its internal parts act as the cathode while graphite anodes, 8 in. in diameter and 9 ft. long, are suspended in the top of the cell. Granular $MgCl_2$ cell feed is continuously fed into the top of the cell except when dipping metal or servicing the cell. The cell bath is a mixture of molten salts held at 700° C. During electrolysis the magnesium metal is liberated at the cathode and rises to the surface of the bath where it is guided by inverted troughs to the metal wells in the front of the cell. Metal of 99.9% purity is dipped out of the cell at 4-hr. intervals and poured into ingot moulds. Each pot produces approximately 1,100 lb. of metal per day.

The thermal process may also be employed, obtaining magnesium by the direct reduction of its compounds with suitable reducing agents. In this process the reaction takes place above the boiling point of magnesium, permitting the metal to be separated from the residue by distillation and to be condensed in solid or liquid form.

The Pidgeon ferrosilicon process, an example of the thermal technique, was developed in Canada during 1941. It makes use of ferrosilicon and calcined dolomite which is fed into red-hot retorts, yielding a magnesium vapour which condenses in crystals on a water-cooled sleeve. $2(MgO.CaO) + Si = 2Mg\uparrow + 2CaO.SiO_2$ (the iron does not react). The crystals are melted and poured into ingots.

Another thermal method, the carbothermic process, was invented in 1928 in Austria. The process centres around the reduction of magnesium oxide obtained by crushing and calcining magnesite. In the original process, the oxide after being mixed with anthracite was pressed into pellets and charged into electric-arc furnaces where the magnesium vapourized, $MgO + C = Mg\uparrow + CO$. A chilling blast of hydrogen turned the vapour into a highly inflammable magnesium dust. The dust was tableted in a press, fed into retorts and vapourized again, yielding magnesium crystals which in turn were melted and poured into ingots. The process was modified in various ways after it was first designed, including the substitution of natural gas for hydrogen and petroleum coke for anthracite. As a safety measure, the dust is mixed with oil before being loaded into the retorts.

Physical Properties. — The principal physical properties of magnesium (99.9% pure) are as follows:

Symbol	Mg
Atomic number	12
Atomic weight	24.32
Atomic volume—cu.cm./gram atom	14.0
Crystal structure	Close-packed hexagonal
Lattice parameters	$a_0 = 3.203$Å
	$c_0 = 5.199$Å
Axial ratio (c/a)	1.624
Electron arrangement in free atoms	$1s^2, 2s^2, 2p^6, 3s^2$
Mass numbers of the stable isotopes	24 25 26
Relative frequency of the isotopes—%	78.8 10.1 11.1
Mass numbers of radioactive isotopes	23, 27
Melting point	650° C. (1,202° F.)
Boiling point	1103° C. (2,017° F.)
Modulus of elasticity—	
Kg /mm.²	4,570
lb./sq in.	6.5 x 10^6
Modulus of rigidity—	
Kg /mm.²	1,700
lb./sq in.	a.42 x 10^6
Poisson's ratio	0.35

Chemical Properties and Compounds. — Magnesium is a member of group II of the periodic system and has a valence of 2, forming magnesium ion (Mg^{++}). In a finely divided form, it may be ignited in air and burns with an intense white light which is rich in the ultra-violet rays. The products are magnesium oxide (MgO) and the nitride (Mg_3N_2). Larger pieces must be heated above the melting point of the metal before they ignite.

Magnesium is a very strong reducing agent and reacts with most acids liberating hydrogen, $Mg + 2H^+ = Mg^{++} + H_2$. With nitric acid it reduces both the nitrogen and the hydrogen, $4Mg + 10HNO_3 = 4Mg(NO_3)_2 + NH_4NO_3 + 3H_2O$ and, $Mg + 2HNO_3 = Mg(NO_3)_2 + H_2$. It displaces hydrogen from boiling water but is not attacked by alkalies.

The important magnesium compounds, their properties and uses are:

Magnesium oxide, MgO, prepared by calcining magnesite

$$MgCO_3 = MgO + CO_2\uparrow$$

or by calcining magnesium hydroxide

$$Mg(OH)_2 = MgO + H_2O\uparrow.$$

MgO is a white powder and is sold in various grades: light (caustic burned) magnesia, calcined at about 6j0° C., and heavy (dead burned) magnesia, calcined at 1,650 ° C.

Uses: refractory brick, oxychloride cement, fertilizer, in rubber and plastics.

Magnesium hydroxide, $Mg(OH)_2$, a white powder. This compound is the key to recovery of magnesium from sea water. It is precipitated from sea water and Mg-containing brines by the simple addition of milk of lime:

$$Mg^{++} + Ca(OH)_2 = Mg(OH)_2\downarrow + Ca^{++}$$

It is used in medicine as an antiacid and laxative and in the manufacture of other magnesium compounds.

Magnesium carbonate: The commercial product is a basic magnesium carbonate $4MgCO_3.Mg(OH)_2.4H_2O$ and is made by heating the normal carbonate, obtained by carbonating $Mg(OH)_2$:

$$Mg(OH)_2 + CO_2 + 2H_2O = MgCO_3.3H_2O$$

$$5[MgCo_3.3H_2O] = 4MgCO_3.Mg(OH)_2.4H_2O + CO_2 + 10H_2O$$

It is also made from dolomite by the Pattinson process. The rock is calcined, hydrated and then treated with carbon dioxide or kiln gas at several atmospheres' pressure. Magnesium bicarbonate goes into solution. After filtration the pressure is released and on boiling, basic magnesium carbonate is precipitated.

It is used as an insulator for boilers and pipes, in table salt to prevent caking, in rubber and ink industries and in pharmaceutical and cosmetic preparations.

Magnesium sulphate, colourless crystals, is sold as Epsom salt, $MgSO_4.7H_2O$ and Kieserite, $MgSO_4.H_2O$. Kieserite comes from the Stassfurt deposits and from British Columbia, Canada. while Epsom salt is made by treating olivine with sulphuric acid or by the reaction of magnesium hydroxide, sulphur dioxide and air:

$$Mg(OH)_2 + SO_2 + \tfrac{1}{2}O_2 \text{ (air)} = MgSO_4 + H_2O.$$

It is a constituent of cements and is used in the leather industry, flotation, medicine, fertiliser and in the textile industry.

Magnesium chloride, colourless deliquescent crystals, prepared by crystallization from brines and bitterns decomposition of carnallite and by the action of HCl on $Mg(OH)_2$

$$Mg(OH)_2 + 2HCl = MgCl_2 + 2H_2O.$$

It is used in magnesium metal production, in oxychloride cements and in textiles. Magnesium oxychloride cements are made by adding a strong solution of magnesium chloride to light (caustic', magnesium oxide. The resulting paste is magnesium oxychloride (approx. $3MgO.MgCl_2 11H_2O$). Fillers such as sand and limestone fines are added. The cement, which can be coloured, takes a high wax polish It is used for heavy-duty flooring. An increasing use for magnesium oxide and magnesium sulphate is as a fertilizer in Mg-deficient soils. giving increased yields especially with citrus fruits and potatoes.

Medicine. — The salts of magnesium may be regarded as typical saline purgatives. Their aperient action is dependent upon the minimum of irritation of the bowel. and is exercised by their abstraction from the blood of water, which passes into the bowel to act as a diluent of the salt. Magnesium salts have a powerful depressant action, especially on nervous tissue. They have been useful in controlling the epileptiform seizures nhich occur in children folloning the hypertensive encephalopathies which are secondary to nephritis. Hypertonic solutions of magnesium sulphnte (6%–10%) have proved their value over a long period of time for net dressings on open wounds.

Organic Compounds. — Important organic compounds of magnesium are knonn as Grignard reagents (*q.v.*). They are of the composition RMgX (where R=an alkyl or aryl group and

X = a halogen). One large-scale use is in the production of silicones:

$$SiCl_4 + CH_3MgCl \rightarrow \begin{array}{c} CH_3 \\ | \\ ClSiCl \\ | \\ CH_3 \end{array} + \begin{array}{c} CH_3 \\ | \\ ClSiCl \\ | \\ Cl \end{array} \xrightarrow{H_2O}$$

$$\left[\begin{array}{ccc} CH_3 & & CH_3 \\ | & & | \\ -\,Si - O - & & Si - O \\ | & & | \\ CH_3 & & O \end{array} \right]_n \quad \text{Silicone Resin.}$$

Magnesium is a constituent of chlorophyll, $C_{55}H_{70}MgN_4O_6$, and apparently plays a role similar to that of iron in haemoglobin.

Detection. — Magnesium salts can be detected by precipitating magnesium hydroxide with a solution of sodium hydroxide. It is not soluble in an excess of sodium hydroxide, but readily soluble upon addition of a saturated ammonium chloride solution.

Magnesium is determined quantitatively by precipitation as magnesium ammonium phosphate by means of dibasic ammonium phosphate from an ammonical solution from which interfering elements have been removed. It is ignited and weighed as magnesium pyrophosphate.

MAGNESIUM AS A STRUCTURAL METAL

Magnesium (specific gravity 1.74) is the lightest of the commercially used structural metals. Its basic crystal structure is different from those of iron, copper, or aluminum but similar to those of zinc and cadmium. The modulus of elasticity of magnesium and its alloys is relatively low, resulting in a comparatively high capacity for elastic energy absorption

Distortion or slipping in a magnesium crystal can take place on only one series of atomic planes at temperatures up to about 400° F. The material therefore tends to harden when worked at room temperature. More atomic planes become available for slipping above 400° F. and the metal can be readily worked without hardening. Magnesium is thus well adapted to hot forming methods. It is quite stable in ordinary inland atmospheres Brightly polished metal will gradually assume a thin gray film after about one month's exposure. Magnesium is resistant to most alkalies, many organic chemicals, chromic and concentrated hydrofluoric acids, alkali metal fluorides, arsenates, chromates and dichromates. It is attacked to varying degrees by other acids and water solutions of salts. Being high in the electromotive series, magnesium is somewhat more susceptible to galvanic corrosion than other structural metals. Protective atmospheres and fluxes are employed during melting, heat treating and casting of the alloys in order to reduce oxidation and provide clean metal.

Alloys. — Pure magnesium has low structural strength; however alloys have been developed to meet increased property demands, to improve corrosion resistance and to facilitate production and fabrication, the first commercial ones having been placed on the market by the Germans in 1909. The principal constituents of the majority of the commercial alloys of magnesium are aluminum, zinc and manganese. The proportions in which they are used vary from 3% to 10% for aluminum, 0.1% to 1.5% for manganese, and 0 5% to 3% for zinc. The use of aluminum, the most important alloying constituent of magnesium, imparts hardness and also increases the tensile strength.

Zinc, the second most important alloying element, is usually combined with aluminum to form a ternary alloy and is used chiefly to give a general improvement in properties and to facilitate foundry work. It also improves elongation, especially in the wrought alloys, and is useful for nullifying the detrimental effects of such impurities as iron and nickel, which tend to increase the salt water corrosion rate of magnesium and its alloys.

Manganese, in small proportions, is used in practically all commercial alloys of magnesium because it greatly improves the resistance to salt water corrosion without materially affecting the other properties. Seldom used in a greater proportion than 2.5%, it has a small effect on the mechanical properties in the cast state. In the rolled condition, however, manganese increases strength. Improved tensile properties particularly at elevated temperatures can be obtained with magnesium-manganese wrought alloys, especially if small amounts of cerium or calcium have been added to produce fine grain. Magnesium-manganese alloys are of value also because of their good welding properties.

Cerium, calcium, zirconium, cadmium, silver, silicon, beryllium, thorium and tin are sometimes used as alloying ingredients for special purposes. Table I gives the chemical composition of the most frequently used magnesium alloys.

Mechanical Properties. — Pure magnesium in the sand cast state has a tensile strength of 14,000 p.s.i. (7 tons/in.^{2}) and in the extruded condition about 26,000 p.s.i. (13 tons/in.^{2}). The addition of suitable alloying elements doubles these values for cast and wrought alloys. When aluminum is used as an alloying constituent, casting alloys attaih their maximum value for tensile strength and elongation in the cast state at approximately 6% aluminum. A substantial further increase in strength is possible by heat treating cast alloys containing 6% to 12% aluminum. Wrought alloys attain maximum strength with approximately 10% aluminum, although alloys with aluminum content as high as this are limited to simple shapes. Those with the lower aluminum contents of 3% to 7% are in more common use.

The typical mechanical properties of common magnesium alloys appear in Table II.

USES OF MAGNESIUM

Magnesium was formerly associated in the minds of many people almost exclusively with pyrotechnics, and for many years the chief production was used for this purpose, as well as for ribbon and powder in photography. But the increasing emphasis upon weight reduction, both in industrial applications and in consumer goods, gave magnesium as a structural material an importance far beyond these earlier uses. Since alloys, rather than pure magnesium, are used for structural purposes, mention of magnesium in this section will refer to the alloys.

Aircraft. — Because of their low specific gravity, magnesium alloys are widely used in the aircraft industry, this being especially true during World War II. Typical applications included: housings for camshafts, timing gears, superchargers, oil filters and pumps; landing wheels; forged radial engine crankcases; propeller blades; floor beams; frames for seats and many small parts such as die-cast instrument housings. Increased use has been made of magnesium sheet in the monocoque or stressed skin type of wing construction and it has been used on a considerable scale for fairings, cowlings and tanks About zoo to 400 lb. of magnesium castings were used in many aircraft engines during World War II, and it has been estimated that approximately 95% of all military planes were equipped with cast-magnesium landing wheels. As much as 1,000 lb. of magnesium were used in many combat planes, while more than a ton was used on some of the large bombers.

Transportation. — Although in this field magnesium has found its greatest use in aircraft, there is a growing interest in applying its advantages to other types of transportation. This trend has found greatest practical expression thus far in Europe, and especially in Germany, where magnesium alloys are used in such applications as superstructures for motor buses and trucks, cast wheels for tramways and buses and in a variety of small parts. In the U.S , magnesium has also been used in the construction of truck bodies and auto-transport trailers. Its projected use in railroad equipment includes frames for seating, partitions in Pullman cars and instrument panels and housings.

Portable Equipment. — Magnesium is increasingly used for various types of portable goods such as tools, being employed in the housings and handles. Portable conveyor systems, dockboards, hand trucks, milk crates and similar items are examples of other uses in this field. It is also utilized for office equipment, such as typewriter and adding machine frames, and various types of instrument housings.

Industrial Equipment. — Both because of their light weight and their ability to absorb dynamic energy, magnesium alloys are being used in parts of high-speed and reciprocating machinery. Examples are warp beams, bobbins, spools and knitting bars used in textile machinery. Cast magnesium foundry flasks and moulding and core boxes are used in foundries.

Consumer Goods. — Because of the distinct trend toward streamlining and weight reduction, the use of magnesium in consumer goods of many different types is constantly expanding. This field includes such items as domestic vacuum cleaners, griddles, wheel toys, lawn mowers and photographic and motion picture cameras. It has also been successfully used in ski, baseball catcher's masks and rowboats.

Miscellaneous. — Magnesium is used as an important alloying element in aluminum alloys, its chief function being to increase the mechanical and corrosion-resisting properties. It also facilitates heat

TABLE I. — Chemical Composition of *Magnesium* Alloys

Dow-metal Alloy	Chemical Compositions — Per Cent											
	Aluminum	Manganese min.	Zinc	Zirconium	Rare earths	Calcium	Silicon max.	Copper max.	Nickel max.	Iron max.	Other imp. mar.	Magnesium
AZ91C	8.1–9.3	0.13	0 4–1.0	—	—	—	0.3	0.10	0.01	—	0.3	Bal.
C	8.3–9.7	0.10	1.6–2.4	—	—	—	0.3	0.10	0.01	—	0.3	Bal.
EK30A	—		0.3 max.	0.2 min.	2.5–4.4	—	—	—	—	—	0.3	Bal.
EK41A	—	—	0.3 max.	0.40–1.0	3.wj.o	—	—	—	—	—	0.3	Bal.
EZ33A	—	—	2.0–3.5	0.5 min.	2.5–4.0	—	—	—	—	—	0.3	Bal.
FS	2.5–3.5	0.20	0.6–1.4	—		0.04 max.	0.3	0.10	0.03	—	0.3	Bal.
FS1*	2.5–3.5	0.20	0.7–1.3	—	—	0.04 max.	0.3	0.05	0.005	0.005	0.3	Bal.
H	5.3–6.7	0.15	2.5–3.5	—	—		0.3	0.10	0.01	—	0.3	Bal.
J1	5.8–7.2	0.15	0.4–1.5	—	—	—	0.3	0.05	0.005	0.005	0.3	Bal.
M	—	1.20		—	—	0.08–0.14	0.3	0.05	0.01	—	0.3	Bal.
O1	7.8–9.2	0.15	0.2–0.8	—	—	—	0.3	0.05	0.005	0.005	0.3	Bal.
R	8.3–9.7	0.13	0.4–1.0	—	—	—	0.5	0.10	0.01	—	0.3	Bal.
RC	8.3–9.7	0.13	0.4–1.0	—	—	—	0.5	0.3	0.01	—	0.3	Bal.
ZK60A	—	—	4.8–6.2	0.45 min.	—	—	—	—	—	—	0.3	Bal.

*Standard composition for extrusions. When used for sheet, it is designated FS1W for weldable grade. Regular FS1 sheet contains 0.10–0.16% Ca for better formability.

Source: The Dow Chemical Company.

TABLE 11.—Properties and Forms of Magnesium Alloys

Form	Dowmetal Alloy	Condition*	Physical properties: Specific gravity (75° F.)	Density lb. per cu. in.	Melting point ° F.	Thermal conductivity C.G.S. units (212°–570° F.)	Electrical resistivity microhm-centimetres (68° F.)	Mechanical properties†: Tensile strength (in 000 p.s.i.) typ.	Tensile strength min	Tensile yield strength‡ (in 000 p.s.i.) typ.	Tensile yield strength min.	Elongation in 2″—per cent typ.	Elongation min.	Compressive yield strength (in 000 p.s.i.) typ.	Compressive yield strength min.	Shear strength (in 000 p.s.i.)	Rearing strength (in 000 p.s.i.) ult.	Rearing strength yield	Hardness Brinell	Hardness Rockwell E
Sand and permanent mould casting alloys	C	–F	1.82	0.066	1,110	0.16	16.0	24	20	14	10	2	1	14	—	19	50	46	65	77
		–T4						40	34	14	10	10	6	14	—	19	68	46	63	75
		–T5						24	20	14	11	2	—	—	—	20	50	46	—	—
		–T6						40	34	23	18	2	1	23	—	22	80	65	84	90
	G¶	–F	1.81	0.066	1,100	0.17	15.0	22	20	12	10	2	—	12	—	17	—	—	54	65
		–T4						40	34	13	10	10	6	13	—	19	—	—	52	62
		–T6						40	34	16	15	4	2	16	—	21	—	—	69	80
		–T61						40	34	22	17	1	—	22	—	—	—	—	—	—
	H	–F	1.83	0.067	1,135	0.18	11.5	29	24	14	10	6	4	14	—	18	60	40	50	59
		–T4						40	34	14	10	12	7	14	—	18	60	44	55	66
		–T5						29	24	14	10	5	2	—	—	19	60	40	—	—
		–T6						40	34	19	16	5	2	19	—	21	75	52	73	83
	AZ91C	–F	1.81	0.066	1,120	0.17	17.0	24	18	14	10	2	—	14	—	18	50	30	52	62
		–T4						40	34	14	10	11	7	14	—	18	50	36	55	66
		–T6						40	34	19	16	4	3	19	—	21	65	45	73	83
	EK30A	–T6	1.79	0.065	—	0.27	5.9	23	20	16	14	3	2	16	—	—	—	—	45	49
	EK41A	–T5	1.81	0.066	—	—	6.9	23	20	16	14	1	—	16	—	—	—	—	50	59
		–T6						25	22	18	16	2	1	18	—	—	—	—	50	59
	EZ33A	–T5	1.82	0.067	—	—	6.6	23	20	16	14	—	2	16	—	—	—	—	50	59
Die casting alloys	R & RC	–F	1.81	0.066	1,120	0.17	17.0	33	—	22	—	3	—	22	—	20	—	—	60	72
Sheet§	FS1 & FS1W	–F	1.77	0.064	1,160	0.23	10.0	37	32	22	—	21	12	13	—	21	—	—	—	—
		–H24						42	39	32	29	15	4	26	24	23	72	47	73	83
		–O						37	32	22	15	21	12	16	12♀	21	70	42	56	67
	M	–F	1.76	0.064	1,200	0.30	5.0	33	28	—	—	—	8	—	—	—	—	—	—	—
		–H24						36	32	27	22	7	3	18	—	17	—	—	56	67
		–O						34	28	17	—	16	12	11	—	18	56	28	48	55
Extruded bars, rods and solid shapes‖	FS & FS1	–F	1.77	0.064	1,160	0.23	10.0	38	35	29	22	15	10	14	12	19	56	33	49	57
	J1	–F	1.80	0.065	1,145	0.19	12.5	45	40	33	24	16	10	19	14	20	68	41	60	72
	M	–F	1.76	0.064	1,200	0.30	5.0	37	32	26	—	11	3	12	—	18	51	28	44	45
	O1	–F	1.80	0.065	1,130	0.18	14.5	49	43	36	28	11	9	—	17	22	68	48	60	77
		–T5						55	48	40	33	7	4	35	28	24	—	—	82	88
	ZK60A	–F	1.83	0.066	1,175	—	—	49	43	38	31	14	5	33	27	27	80	57	75	84
		–T5						53	45	44	36	11	4	36	30	26	83	60	82	88
Extruded hollow shapes and tubing	FS & FS1	–F	1.77	0.064	1,160	0.23	10.0	36	32	24	16	16	8	12	10	—	—	—	46	51
	J1	–F	1.80	0.065	1,145	0.19	12.5	41	36	24	16	14	7	16	11	—	—	—	50	60
	M	–F	1.76	0.064	1,200	0.30	5.0	35	28	21	—	10	2	9	—	—	—	—	42	41
	ZK60A	–F	1.83	0.066	1,175	—	—	46	40	34	28	12	5	25	20	—	—	—	75	84
		–T5						50	46	40	38	11	4	29	26	—	—	—	82	88

*Condition –T4=solution heat-treated. –T6 –T61=solution heat-treated and artificially aged. –O=annealed. –H24=hard rolled. –F=as fabricated. –T5=artificially aged. †Unless otherwise indicated, values are typical. ‡Yield strength is defined as the stress at which the stress-strain curve deviates 0.2% from the modulus line. §Properties apply to following thickness ranges: FS1-F and M-F=0.080—0.500″; FS1-H24=0.065—0.250″; FS1-O=0.064—0.250″; M-H24 and M-O=0.020—0.250″. ‖The properties for bars, rods and solid shapes apply to extrusions with a minimum dimension of ¼″ to a 1½″ maximum. ZK60A properties are based on sections less than 2 sq.in. in cross sectional area. ¶Permanent mould casting alloy only. ♀FS1W has minimum CYS of 10,000 p.s.i.

Source: The Dow Chemical Company.

treatment. A new and promising use of magnesium is as an expendable galvanic anode for the cathodic protection of buried metal structures such as pipe lines, as well as for ship hulls and tanker compartments. Its high position in the electromotive series of metals enables it to perform this function.

Because of its high affinity for oxygen, magnesium is used as a deoxidizer in the manuiacture of metals lower in the electromotive force series of metals, such as nickel and nickel alloys.

*TABLE 111.—World Production of Magnesium Metal, 1945–51, in Metric Tons**

Country*	1945	1946	1947	1948	1949	1950	1951
Canada	3,338	145	136	†	†	†	†
China, Manchuria	200	...	...	...	†	†	†
France	279	704	1,043	546‡	492‡	446‡	875
Germany, West	†	...	...	17§	...	†	†
Italy	346	1,005	...	...	...	...	†
Japan	1,104	...	...	...	...	...	...
Korea	1,014	...	...	...	...	...	...
Norway	...	...	...	...	...	†	†
Switzerland (est.)	500	300	500	...	...	...	†
Taiwan (Formosa)	21	...	...	...	†	†	†
United Kingdom‖	6,900	1,700	2,500	3,500	5,000	4,900	7,700¶♀
United States	29,748	4,823	11,198	9,075	10,521	14,266	37,086
Total (est.)	62,000	24,000	32,000	31,000‡	35,000	41,000‡	80,000

*Magnesium is also produced in Australia, East Germany, and U.S.S.R., but production data are not available; estimates included in total. †Data not available; estimates included in total. ‡Revised figure. §British and American zones only. ‖Includes secondary metal. ¶Estimated figure. ♀Includes magnesium alloys.

Source: U.S. Bureau of Mines, *1951 Minerals* Yearbook.

Economic Importance of Magnesium.— After World War *I*, intensive research and development work produced strong, light alloys which have established magnesium as the world's lightest structural metal. The world-wide and rapid development of the aircraft industry played an important part in advancing the use of magnesium alloys for structural purposes, where their unusual advantages were quickly utilized. Perfection of allovs which could be fabricated successfullv by casting, extruding, rolling and forging opened up many new fields of use to magnesium. It possesses special properties which make it particularly desirable for certain types of applications which include exceptional machining qualities and good fatigue resistance and damping capacity under impact stress. The attainment of high standards in pressure die casting technique has presented new spheres of application in the instrument, tool, optical and other industries where designers are often able to substitute a single casting for parts formerly built up from sheet and sections, the die casting being stronger and more rigid but not heavier. Sand castings are being made which weigh as much as 1,000 lb. Even forgings of considerable size have been fabricated from magnesium.

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MAGNETIC INSPECTION. Magnetic inspection is the use of magnetism to detect surface and subsurface defects in magnetizable materials. In 1905 the magazine Revue de Met on page 421 mentioned for the first time the possibility of detecting defects such as cracks, lamination~,etc., in ferromagnetic materials by means of magnetic fields. In 1919 E. W. Hoke applied for the first patent in the U.S. on a magnetic inspection method, which was granted in 1922 under 1426384.

The material to be inspected is subjected to the action of a magnetic field. When the magnetic flux lines encounter a surface break or internal discontinuities they are deflected and create a distortion of the magnetic field. Not only minute cracks invisible even to the microscope, but changes in the crystal structure because of heat treating, welding or other physical operations can be detected by the experienced metallurgist.

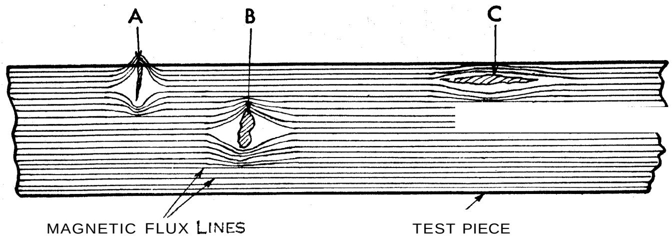


FIG. 1.— DISTRIBUTION OF MAGNETIC FLUX LINES

Fig. 1 demonstrates various kinds of defects and their effect in creating leakage flux lines. Defect *A* is a fine surface crack or lamination and causes a maximum magnetic deflection. Defect *B* is a subsurface discontinuity, which creates only a slight surface distortion of the magnetic path, the indication of which decreases with increasing depths of the defect. *C* is a flaw parallel to the magnetic flux lines which causes a minimum of magnetic deflection and in most cases can not be detected. From this last phenomenon, it is evident that the sensitivity of this testing method depends not only upon the depth of the discontinuity, but upon the necessity that at least one dimension of the flaw is approximately at a go° angle to the direction of the magnetic force lines. In order to detect flaw C, a magnetic field at right angles to C has to be produced in the test piece. To increase the sensitivity, the test piece should be magnetized near, but not above, the saturation point whenever possible. For example, to examine satisfactorily the crankshaft of an aeroplane engine, a longitudinal magnetic field has to be created to detect circumferential defects like fatigue cracks, injurious tool marks, etc. Then the part is magnetized with a circular field and longitudinal flaws like laminations, forging laps, etc., are found. Fig. 2 shows a machine for longitudinal and circular magnetization.

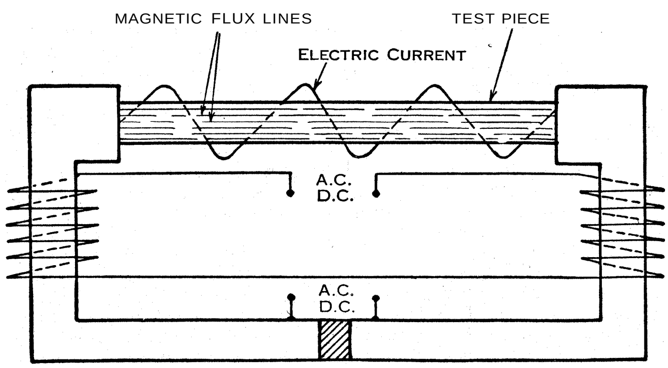


FIG. 2.— PRINCIPLE OF LONGITUDINAL AND CIRCULAR MAGNETIZATION WITH A.C. OR D.C.

To induce a magnetic field in the test piece, various methods are employed. Alternating current as well as direct current can be used; however, direct current is favoured and specified by army and navy agencies. Circular magnetism can be produced: (1) by passing a heavy current through the test piece; (2) if hollow, by inserting a rod through the test piece to carry the current; (3) by induction. Longitudinal magnetism is created: (1) by inserting the test piece in a coil carrying a heavy current; (2) by placing the test piece between the yokes of electromagnets.

Many ingenious methods have been devised to observe and record these distortions of the magnetic field, termed stray fields or leakage fields. In 1932 the Electrotechnical institute in Moscow developed a detector coil consisting of a small horseshoe magnet and compensating coil. This instrument recorded stray fields graphically. A similar method, the Sperry rail test, uses a search coil to measure current density variations in railroad tracks. Materials for highly stressed parts are tested by passing between the yokes of strong D.C. magnets on which search coils are mounted, to measure variations of the magnetic reluctance. The most simple and general application of magnetic testing uses the magnetic stray field to attract paramagnetic particles and collects these around the defective area, thus making microscopic flaws visible. These particles are brought to the piece to be tested through the medium of air or liquid. The paramagnetic substance can be iron filing, or powder, iron dust or iron oxides such as Fe_2O_3 and Fe_3O_4. The use of iron powder is called the dry process, while the wet process employs a solution of iron dust or Fe_3O_4 suspended in a light petroleum distillate.

The dry process is generally applied on large castings, forgings and welded structures, which are magnetized whole or in sections of about 5-in. diameter. or in the case of welded seams. in 6-in. to 8-in. lengths. A standard 500-amp. welding generator or a hand electromagnet with approximately 15,000-amp. turns furnishes a sufficiently strong magnetic field. These tests, if made on U.S. army ordnance matériels such as welded gun mounts, are subject to the army procedure specifications WXS-158 dated Feb. 17, 1942, if made on army and navy aeronautical materials, specifications AN-1-30/31/32 as of Jan. 1945 apply.

Small parts, as used in the automotive and the aeroplane industry, are tested by the wet process. The solution consists of paramagnetic particles suspended in kerosene of such concentration as to provide a mixture of approximately one ounce of solid to one gallon of liquid. The continuous wet method applies the magnetic substance while the material is being magnetized. The residual method immerses the test piece in the paramagnetic liquid after magnetization. The continuous wet method is most frequently used.

Any material conducting electricity can be tested magnetically, provided the magnetic stray fields are observed while the electric current is flowing. The characteristic of surface concentration when using A.C. magnetization decreases its sensitivity for revealing internal flaws, as compared to D.C. magnetization. It should be borne in mind that maximum indications are obtained by magnetization nearly to the saturation point. Most magnetic inspection machines use low voltage of approximately 6 volts, and high currents up to 6,000 amp. The maximum current used for a part under inspection is usually restricted by the heating effect in the part itself. To avoid burning the contact points of test pieces when conducting heavy currents, it is advisable to use metal braiding, steel wool or lead contact plates to increase the contact area. (W. W. O.)

MAGNETIC RECORDING: see TAPE RECORDING, MAGNETIC; PHONOGRAPH.

MAGNETISM. This article is divided into the following sections:

- I. History
  1. Magnetostatics and the Nature of Magnetism
  2. Electromagnetism
  3. Modern Theory
- II. General Description of Magnetism
  1. Magnetic Field
  2. Intensity of Magnetization and Magnetic Induction
  3. Magnetization and Permeability Curves

This subject may be divided into three parts: (1) ferromagnetism, a property possessed by iron and a few other metals and compounds and characterized by strong attraction of one magnetized body to another; (2) paramagnetism, a quality of many substances which causes them to be attracted less strongly by the poles of an electromagnet or magnetized body; and (3) diamagnetism, by virtue of which materials possessing this property are repelled by an electromagnet. Ferromagnetism is sometimes considered to be a branch of paramagnetism, and then ferromagnetic bodies are differentiatedfrom other paramagnetic bodies by the magnitude of their reaction with a magnetic field and in other ways described in detail in the following paragraphs.

For practical purposes, ferromagnetism is much the most important kind of magnetism.

After a historical introduction, ferromagnetic phenomena and materials will be described, and the effect of various factors on magnetic properties discussed. Following this, diamagnetism and paramagnetism and the theory of ferromagnetism will be considered, and finally an account of methods used for measuring magnetic quantities will be given.

I. HISTORY

Centuries before the Christian era the Greeks knew that the mineral lodestone, a magnetic oxide of iron (magnetite, Fe_3O_4), had the ability to attract iron and other pieces of the same mineral. This natural magnet was mentioned by Thales of Miletus (640–546 B.C.); and according to Plato in the *Ion,* Socrates states that it will support a chain of iron rings, each held to the one above it by magnetic attraction.

The Roman Lucretius Carus states in his De *rerum natura,* in the 1st century B.C., that ". . . iron can be drawn by that stone which the Greeks call Magnet by its native name, because it has its origin in the hereditary bounds of the Magnetes," the inhabitants of Magnesia, in Thessaly. The Romans knew also of the repulsive action of magnetism, as shown by a quotation from the same passage: "Sometimes, too, iron draws back from this stone; for it is wont to flee from and follow it in turn." No reference to the directive property of the magnet, as used in the compass, is found in old Greek and Roman literature. To account for magnetic attraction some in this period believed that there were hooks on the surface of the magnet and little rings on the surface of the iron to catch them; others that particles were emitted by the magnet and created an empty space toward which the iron would move.

Beginning in the period A.D. 1000–1200 the history of magnetism is closely connected with the compass and its use in navigation. According to G. Sarton, the first clear mention in any literature of a magnetic needle for indicating direction appears to have been made by Shen Kua (1030–93), a Chinese mathematician and instrument maker, who, however, mentions only its use on land.

Soon after 1100, the Chinese Chu Yu reported that in the period 1086–99 the compass was used for navigation by "foreign" sailors going between Canton and Sumatra. Since the trade in this region was practically a Moslem monopoly it is concluded that they were the first to use the compass for directing ships.

The earliest known European reference to the compass is by Alexander Neckam (1157–1217), an English cyclopaedist. In 1269 Petrus Peregrinus de Maricourt, a French crusader, gave the first detailed description as an instrument of navigation. He wrote of the floating compass as an instrument in common use and described a new pivoted compass in some detail. He fashioned a sphere of lodestone and explored its surface with bits of iron, and applied the term pole to the places in which the magnetic power appeared to be concentrated. He believed that the magnet derived its power from the sky.

After his time little progress was made for almost 300 years. In 1600 William Gilbert of Colchester, Eng., published his *De magnete* which summarizes the knoll-ledge of magnetism at the time of Queen Elizabeth, whose court physician he was, and reports some of his own experiments. He mentions the dip and declination of the compass and propounds his own great contribution. the discovery that the earth itself is a magnet. He showed that magnetized iron lost its magnetism when heated to a bright red heat and regained it when cooled again to room temperature. His chapter xii of book v is entitled "Magnetick force is animate, or imitates life; and in many things surpasses human life, while this is bound up in the organick body."

After the time of Gilbert, during the period when Isaac Newton was formulating the law of gravitation and Robert Boyle was investigating the laws of gases, little of importance for magnetism was recorded.

1. Magnetostatics and the Nature of Magnetism. — In 1785 Charles Augustin Coulomb established with some precision the inverse square law of attraction (and repulsion) between unlike (and like) magnetic poles, a proposition that had been favoured or opposed by many before him. This was made the basis of Poisson's mathematical theory giving the forces between magnetized bodies in terms of their intensities of magnetization. Simeon Denis Poisson (1781–1840) assumed magnetization to be a molecular phenomenon, but believed that a molecule became magnetic when the two fluids which it contained became separated. In 1852 Wilhelm Weber proposed that each molecule is a permanent magnet, subject to a frictional force that tends to maintain it in its established orientation. This explained the limit of magnetization (saturation) and gave a rather unsatisfactory explanation of residual magnetization; the magnetization remaining after the removal of the magnetizing field. Later James Clerk Maxwell (1831–79) improved upon Weber's explanation of residual magnetization by suggesting that the molecular magnet had no friction but had more than one fixed position of equilibrium.

Before the time of Weber, Hans Christian Oersted made the important discovery (1820) that an electric current would affect a magnetic needle. Quickly following up this lead. André Marie Ampère investigated experimentally and mathematically the mutual forces between currents and showed (182 j) that a current in a circuit is equivalent to a "magnetic sheli" of calculable strength. He considered a magnet to be due primarily to electric currents circulating within the molecules, and this concept, though not accepted immediately because there was no way either to prove or to disprove it, stood the test of time and was elaborated only by the advent of electron theory and the modern era.

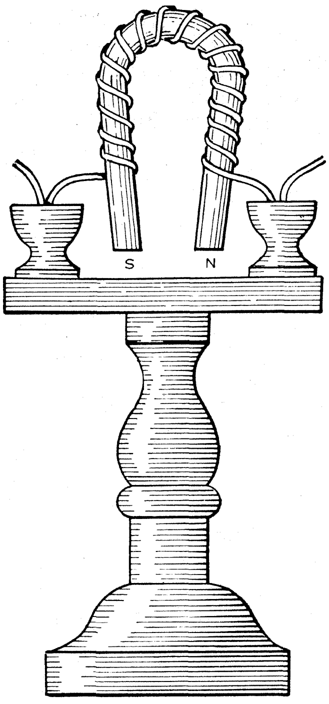


FIG. I. — THE FIRST TRUE ELECTROMAGNET

Constructed by William Sturgeon in 1825, the soft iron horseshoe is five inches high and is magnetized by the copper wire connected to a battery not shown in the drawing

2. Electromagnetism. — Using Oersted's discovery, both Ampére and Dominique Arago (1786–1853) magnetized steel needles by placing them in a helix of wire carrying an electric current. This was the prelude to the construction in 1825 of the first electromagnet which could be so called. by William Sturgeon (1 783–1850) of Lancashire (fig. 1). This was made of soft iron bent in the form of a horseshoe and mound with a loose helix of 18 turns of wire. When excited by a wet battery it could lift 20 times its own weight.

Several years later Joseph Henry in the United States built a much improved electromagnet with many turns of wire efficiently applied. While experimenting with this in 1829 he noticed the spark that occurred when the circuit was broken and he was led to the discovery of self-induction. a treatise on which he published in 18.32. The same phenomenon was independently discovered and published several years later by Michael Faraday (1791–1867). This great English experimentalist also shared with Henry the important discoverv of electromagnetic induction, the "conversion" of magnetism into electricity. Although Henry is believed to have performed the experiment first and understood its significance, his results were unknown to Faraday who likewise made the crucial experiment and was the first to publish the results. Faraday and Henry made the first transformers (fig. 2) and prepared the way for the construction of the dynamo and motor and the age of electricity.

The laws of electricity and magnetism were formulated systematically in mathematical language by Maxwell: and his famous treatise was published in 1873. (See ELECTRICITY: *Electromagnetic Waves.*)

3. Modern Theory. — One difficulty with Weber's theory was that it gave no satisfactory explanation of residual induction and hysteresis. Maxwell's suggestion of multiple fixed positions for the molecular magnet left unexplained the fact that hysteresis (*see* below) is found when a magnetizing force. after being once applied. is removed and reapplied. J. A. Ewing proposed (1890) that the constraints on the orientations of the molecular magnets were imposed by the magnetic forces of the surrounding molecules, and showed by means of calculations and models that such forces can account qualitatively for the shape of the magnetization curve and the major and minor hysteresis loops. He first used the word hysteresis. J. Swinburne predicted on the basis of Ewing's theory that in a rotating magnetic field the hysteresis should disappear, and F. G. Baily's experiment (1896) confirmed this in a striking way (see fig. 25 below).

The first important influence of modern concepts on the theory of magnetism came when P Langevin (1905) used statistical theory to explain the variation of paramagnetic susceptibility with temperature. He assumed each molecule to have a definite magnetic moment that tended to be oriented by the applied field and at the same time disturbed by thermal agitation. In 1907 this was seized upon by P. Weiss who postulated that the molecules are exposed both to the applied field and to a so-called molecular field proportional to the intensity of magnetizstion: thus he developed the first important quantitative theory of ferromagnetism. This molecular field is co-operative in nature, in that it depends on the mutual action of many atoms. and is now attributed to the "exchange forces" derived from quantum theory by W. Heisenberg.

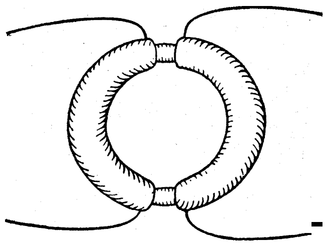


FIG 2 — FARADAY'S FIRST TRANSFORMER

This transformer has two windings of copper wire on an iron core. Connection of one winding to a battery causes mornentarv flow of electricitv in the other winbing connected to 'a galvanometer

It is a consequence of the Weiss theory that ferromagnetic materials must be spontaneously magnetized, that is. small regions or "domains" of the material are magnetized to saturation even when the specimen as a whole has zero intensity of magnetization; in this latter condition the magnetic moments of the regions are oriented at random. Previously such regions were considered identical with the molecules or atoms of the substance, but Weiss's deduction was later supported by many experiments (*e.g.,* those on the Barkhausen effect) and is the basis of the domain theory now used in the interpretation of many magnetic phenomena.

The quantum theory by its clarification of atomic structure has had a great influence of magnetic theories. W. Pauli in 1920 showed that there is a natural unit of magnetic moment, the Bohr magneton, and in 1926 S. Goudsmit and G. E. Uhlenbeck proposed the spinning electron as the fundamental magnetic particle having a moment of one Bohr magneton. The quantum theory of paramagnetism and ferromagnetism was developed rapidly by the contributions of Heisenberg. J. H. Van Vleck, E. C. Stoner. H. Bethe, F. Bloch, J. C. Slater and others. The temperature dependence of saturation magnetization, as calculated by P. Debye (1912), was a notable success of the quantum theory of ferromagnetism. Advances in the theory of diamagnetism were also made after Langevin's pioneering work of 1905. The advances in useful materials, and in methods of measurement of magnetic quantities, are mentioned in appropriate places in the body of the article.

II. GENERAL DESCRIPTION OF MAGNETISM

The quality of magnetism first apparent to the ancients. and to us today. is the attractive force that exists between a natural magnet (lodestone) or an artificial magnet (a "permanent magnet") and a piece of soft iron. When a magnet is dipped into iron filings they cling to it, especially in certain places called poles that are usually near the ends of the magnet (fig. 3). Such poles always occur in pairs. and in a magnet used as a compass needle the pole that points to the north is the north-seeking pole. or simply the north pole, and the other the south pole. When a magnet is broken new poles appear near the break so that each piece contains the same number of poles of each kind.

1. Magnetic Field. — A magnet will attract a piece of iron even though the two are not in contact. and this action at a distance is said to be due to the magnetic field, or field of force around the magnet. This field may be explored by sprinkling iron filings around a magnet, whereupon they form in lines that converge on the poles and indicate also the direction a small compass needle would take if placed at any point (fig. 4).

Poles exert forces on each other, north and south poles attract each other and like poles repel with a force that varies inversely as the square of the distance between them. A unit pole is a convenient concept defined so that two unit poles of like kind, one

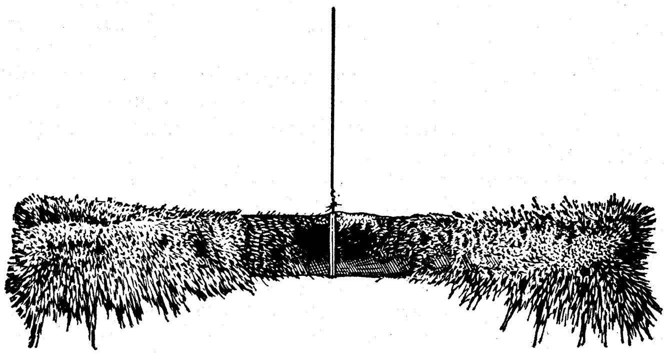


FIG. 3.— A MAGNETIZED BAR ATTRACTS IRON FILINGS THAT CLING MOST STRONGLY NEAR THE POLES OF THE BAR

centimetre apart, repel each other with a force of one dyne. The strength of the field of force, or simply the magnetic field strength or magnetizing force, may be defined in terms of magnetic poles: at one centimetre from a unit pole the field strength is one oersted. A magnetic field may be produced by a current of electricity as well as by a magnet and the unit of field strength can also be defined in terms of current. A magnetic field has direction as well as strength; the direction is that in which a north pole. subjected to it, tends to move. or that indicated by a small compass placed at the point. The field strength is represented by the symbol H, and the unit defined above is the oersted.

2. Intensity of Magnetization and Magnetic Induction.— In order to describe the magnetic properties of materials, one must have a quantitative measure of magnetization. Such a measure is the intensity of magnetization, defined in terms of the number of unit poles in a piece of given cross-sectional area. Suppose that a uniformly magnetized bar, of length l and cross-sectional area a, has m unit north poles at one end and m unit south poles at the other (fig. 5). The intensity of magnetization is then m/a, and is represented by the symbol I. It may easily be shown that I is also the magnetic moment per unit volume; for the magnetic moment is pole strength times interpolar distance ($M=ml$), and $I=M/v$, if v is the volume al.

Maxwell showed that some of the properties of magnetism may be likened to a flow, and conceived endless lines of induction that represent the direction and, by their concentration, the flow at any point. The lines pass from a magnetized material

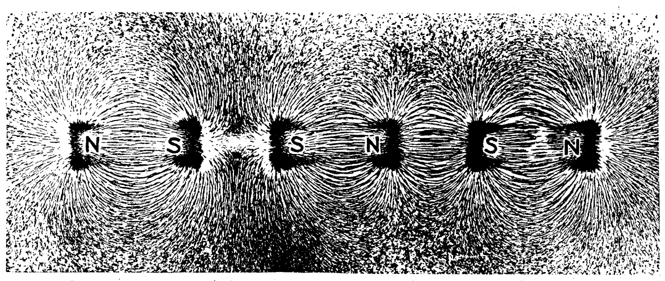


FIG. 4.— IRON FILINGS INDICATE THE DIRECTION OF THE MAGNETIC FIELD NEAR A GROUP OF BAR MAGNETS AND SHOW THE LINES OF FORCE EMANATING FROM SOUTH POLES AND CONVERGING ON NORTH POLES

into the air at the north pole, and enter again at a south pole, and pass through the material from the south pole back to the north to form a closed loop.

The total number of lines crossing a given area at right angles is the flux in that area. The flux per unit area is called the flux density or magnetic induction, and is represented by the symbol B. The lines of induction are due to both H and I, but in magnetic materials they are due mainly to the magnetization, **I**. The magnetic induction is defined by the relation

$$B=H+4\pi I,$$

the unit of induction being the gauss. The occurrence of the factor 4π is due to the fact that a unit pole gives rise to a unit field everywhere on the surface of a sphere of unit radius enclosing the pole, and this sphere has an area of 4π. The lines of induction may be visualized with the aid of fig. 4 showing the pattern obtained with iron filings.

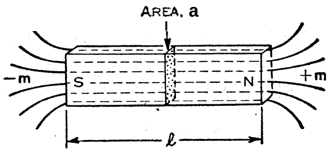


FIG. 5.— UNIFORMLY MAGNETIZED BAR

A pole of strength m and area a corresponds to an intensity of magnetization I=m/a, equal also to magnetic moment per unit volume ml/v. Lines of induction are endless, pass into the magnet at the south pole and leave at the north pole

3. Magnetization and Permeability Curves.— When a piece of iron is brought near a magnet, or subjected to the magnetic field of an electric current, the magnetization induced in the iron by the field is described by a magnetization curve obtained by plotting the intensity of magnetization, I, or the magnetic induction, B, against the field strength, H. Such curves are of fundamental importance for describing the magnetic properties of materials, and many of them are shown on the following pages. A magnetization curve for iron is shown as the solid line of fig. 6 (left).

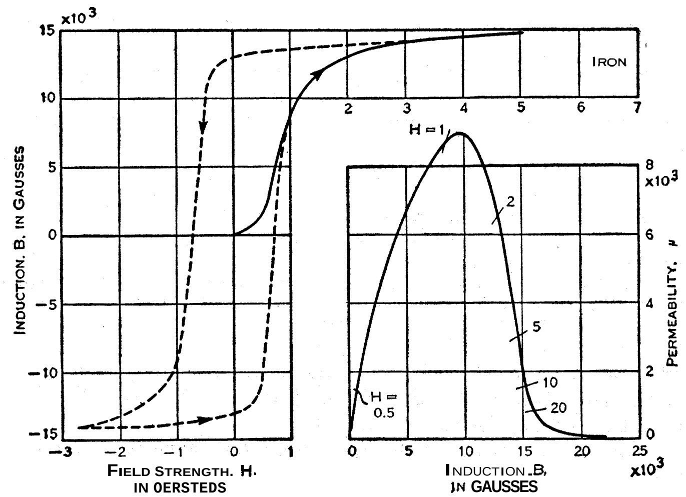
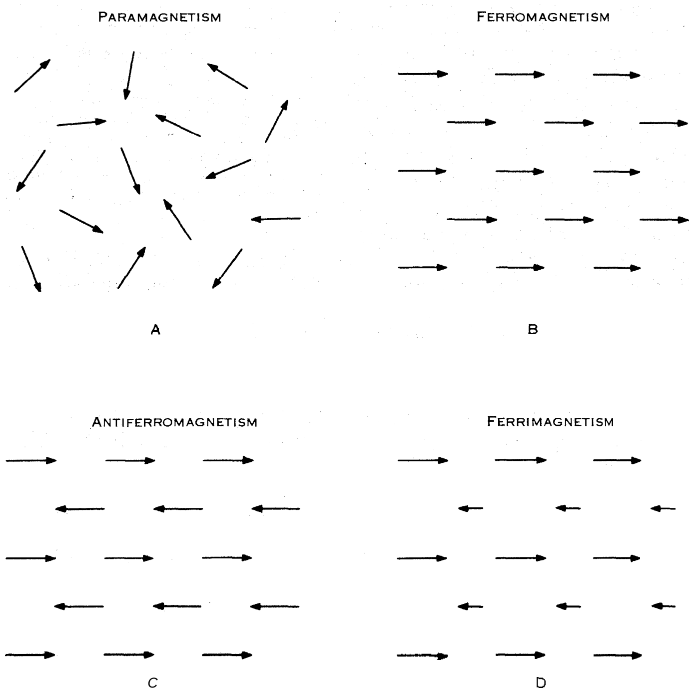


FIG. 6.— PROPERTIES OF MATERIALS ARE DESCRIBED BY MAGNETIZATION CURVES (SOLID LINE) AND HYSTERESIS LOOPS (BROKEN LINE) OBTAINED BY PLOTTING I OR B AGAINST H; THEY MAY ALSO BE DESCRIBED BY PERMEABILITY CURVES (μ v. B)

The behaviour of a material is also described by its permeability curve and hysteresis loop. The ratio B/H is called the permeability. μ, and this represents the relative increase in flux due to the presence of the magnetic material. The permeability curve is obtained by plotting the permeability, μ, against either **I**, B, B-H or H. In any case the curve rises from a point on the μ axis above the origin (the "initial permeability") to a maximum (the "maximum permeability") and falls off rapidly and then more slowly toward a value of one (not zero). When plotted against B-H the curve ends at a definite point; *i.e.,* when B-H reaches its highest possible value, the saturation (fig. 6).

If the field strength is first increased from zero to a high value and then decreased again, as indicated by the arrows of fig. 6, it is observed that the original curve is not retraced; the change of induction "lags behind" the change in field and follows the characteristic curve shown by the broken line. This phenomenon was named hysteresis by Ewing, and the characteristic curve is called a hysteresis loop. On this loop, the value of H for which $B=0$ is called the coercive force, H_c, and this is often used as a measure of quality of the material. Sometimes it is desirable to have H_c large, sometimes small; for different materials H, may be higher than 1,000 or lower than 0.01 oersted. The value of B for which $H=0$ is called the residual induction, B_r.

4. Kinds of Magnetism. — Materials which have magnetic properties similar to iron are ferromagnetic. They have permeabilities of considerable magnitude that vary with the field, they exhibit hysteresis and they lose these properties rather abruptly when heated to a temperature called the Curie point of the material. They usually contain iron, cobalt or other elements of the



BY COURTESY OF "ELECTRICAL ENGINEERING"

FIG. 7.— KINDS OF MAGNETISM ASSOCIATED WITH VARIOUS KINDS OF INTERATOMIC INTERACTION
(A) Paramagnetism, weak interaction; (B) ferromagnetism, "positive" interaction; (C) antiferromagnetism, negative interaction; (D) ferrimagnetisrn, negative interaction between unequal moments

first transition series of the elements (titanium through nickel) or of the later transition series (rare earths). They are all solids. *(See* ELEMENTS, CHEMICAL.)

Another class of materials, more numerous, have permeabilities only slightly greater than one, usually between one and 1.001. These do not show hysteresis. The permeability is generally independent of field strength, except at the lowest temperatures, and as a rule is either independent of temperature or decreases with increasing temperature. These materials are paramagnetic. Among them are many of the salts of the iron and the rare earth families and the palladium and platinum metals, the elements sodium, potassium and oxygen and the ferromagnetic materials when heated above their Curie points. The substances may be solids, liquids or gases.

In diamagnetic substances the magnetization is directed oppositely to the field; *i.e.,* they have permeabilities somewhat less than one. They are, therefore, repelled from the poles of an electromagnet, and move toward a weaker field. Many of the metals and most of the nonmetals are diamagnetic.

Paramagnetic and diamagnetic substances are described more conveniently by their susceptibilities than by their permeabilities. The susceptibility is a measure of the increase in magnetic moment caused by the application of a field and is defined as

$$\kappa = I/H,$$

or the equivalent,

$$\kappa = \frac{\mu - 1}{4\pi}.$$

For diamagnetic materials the susceptibility is negative, and for bismuth has a relatively large value of -0.000013. For substances like iron the susceptibility may be as high as 500, or higher.

The kinds of magnetism denoted antiferromagnetism and ferrimagnetism are defined in terms of the arrangement of magnetic dipoles in the material. A simple paramagnetic material can be represented by fig. 7(A), the magnetism of the separate atoms being represented by arrows arranged in random directions with little or no correlation between the directions of the arrows in neighbouring atoms. In ferromagnetic materials neighbouring atoms are arranged so that neighbouring atomic moments are parallel (fig. 7[B]). In antiferromagnetic materials neighbouring atoms are antiparallel (fig. 7[C]) and the moments are equal; the material then has the low permeability of a paramagnetic substance.

If neighbouring moments are antiparallel but unequal (fig. 7[D]) there will be a net moment in a group of atoms, and the substance is ferrimagnetic; this is both antiferromagnetic in nature and ferromagnetic in properties (large permeability).

5. Spontaneous Magnetization. — A ferromagnetic substance has long been regarded as an assemblage of small magnets, each magnet a group of atoms—when the material is unmagnetized the groups are arranged with haphazard orientations; when it is magnetized they are lined up with their axes approximately parallel. The nature of this small magnet, or domain, has been the subject of much consideration over a period of years, and now it is known that all ferromagnetic materials are composed of such domains, each of which consists of many atoms. Within a domain all of the atoms are aligned parallel, even when no field is applied, and they are therefore said to be "spontaneously magnetized." When the magnetization of the material is changed, the atoms turn together in groups, or the sizes of the groups change (the atoms in each group remaining parallel to each other), so that they are aligned more nearly with the magnetic field applied to the material. The domain theory is discussed in more detail later.

The magnetic properties of materials depend mainly on the chemical composition and on the heat treatment they receive after fabrication, and sometimes these properties are influenced in an important way by the kind of fabrication used. Some ferromagnetic properties, such as saturation induction and Curie point, change but slowly with chemical composition, and are usually quite insensitive to methods of fabrication and heat treatment. On the other hand properties like permeability and hysteresis are highly sensitive to small amounts of impurities and to heat treatment—they are extremely "structure sensitive." In some cases the permeability (*e.g.,* of iron) will increase a thousandfold when 0.1% of an impurity is removed by heat treatment, and an equal change in the reverse direction will be caused by bending the material or stretching it so that its form is permanently changed or strained. The susceptibilities of paramagnetic and diamagnetic substances are not usually affected to any considerable extent by fabrication and heat treatment.

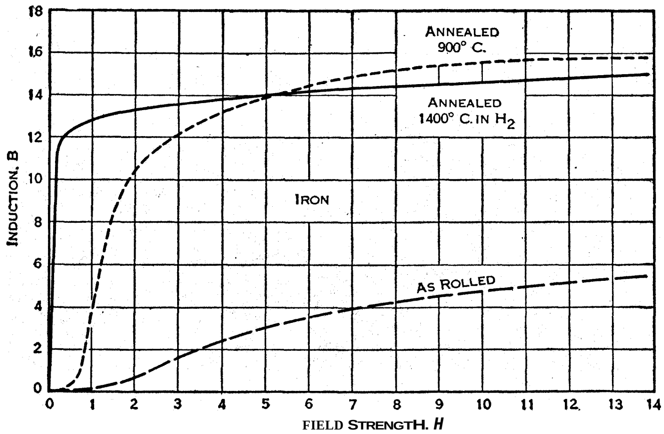


FIG. 8.— MAGNETIZATION CURVES OF IRON IN VARIOUS CONDITIONS (P. P. CIOFFI). B IS EXPRESSED IN KILOGAUSSES

III. PERMEABLE MATERIALS

Magnetic materials are essential for the operation of many of the devices and machines used in modern industry. Without them the production, distribution and use of electricity, and also communication by wire and radio, would be seriously limited or even impossible. After the use of iron in the compass became commonplace, the important new uses of magnetic materials were first in the transformer and electric motor and generator, and later in electromagnetic devices such as relays, telephone receivers, loading coils, loud-speakers, indicating instruments and many other devices upon which all of our industries depend. It is estimated that several million tons of metal are produced annually for use as magnetic material.

Most useful magnetic materials either have high permeability and are magnetized and demagnetized easily, or are permanent

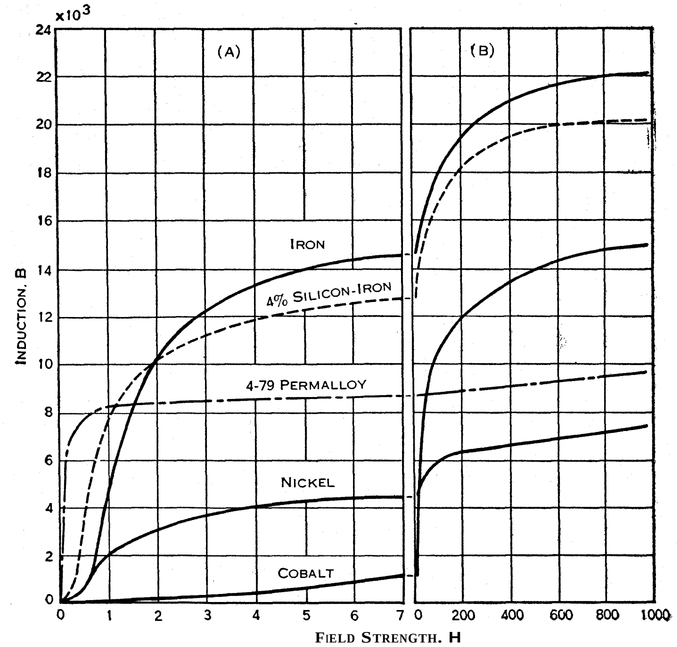


FIG. 9.— MAGNETIZATION CURVES OF SOME COMMON MATERIALS IN THE ANNEALED CONDITION IN LOW (A) AND HIGH (B) FIELDS

magnets and magnetize with difficulty but retain their magnetism tenaciously. The latter will be discussed in the next section headed *IV*. Permanent Magnets.

As stated above. the magnetic properties depend mainly on the chemical composition and heat treatment. Permeable materials are usually processed, or annealed, by heating to some temperature between 800° and 1,400° C., often about 1,000° C., and cooling at any specified rate to room temperature. Because the permeability will be lowered if they are deformed beyond the elastic limit. materials are made in final size and shape and are then heat treated and assembled directly in apparatus for use or for test. without bending. For each material there is a specific heat treatment that must be used to develop the desired property to the greatest extent. Magnetization curves of iron as rolled, after a conventional anneal. and after a special anneal in which harmful impurities are removed, are shown in fig. 8.

1. Elements. Iron-Silicon Alloys. — Iron, cobalt and nickel are the common ferromagnetic elements and were the only ones known until 193j when gadolinium was also shown to be ferromagnetic. The magnetism of iron. as well as steel and lodestone, was known to antiquity, while cobalt and nickel were first investigated about the middle of the 18th century. Most of the ferromagnetic substances are alloys containing one or more of the elements iron, cobalt and nickel; some are nonmetallic compounds of iron, cobait, nickel or (rarely) manganese or chromium; and some are alloys containing no iron, cobalt or nickel but composed of manganese and certain other elements such as aluminum and copper (Heusler alloys).

Magnetization curves for iron, cobalt and nickel are shown in fig. 9. In iron one observes the highest magnetization and also the highest permeability. Cobalt has a lower magnetization and the lowest value of maximum permeability. Of these materials iron is by far the most important and is the only one used to any considerable extent in industry as a magnetic material in elementary form. The most used material of all, however, is an alloy of iron and silicon, sometimes called silicon steel or electrical sheet steel, even though it is not a steel in the strict sense of the word because it contains no essential carbon. The iron-nickel alloys are used for many purposes when very high permeability is desired and cost is not too important.

Iron-silicon alloys containing a few per cent of silicon were invented by Sir Robert Hadfield, and came into use in the period 1900–10, mainly through the efforts of E. Gumlich in Germany. These alloys usually contain 3% to 4% silicon, but any amounts up to 6% silicon are occasionally used. They are made from pig iron and ferrosilicon melted and refined in the basic open hearth (see IRON AND STEEL), or from ingot iron remelted with ferrosilicon in the electric furnace. Ingots are poured and rolled to slabs and the latter rolled either hot or cold to sheets of the required thickness, usually 0.014 in. These are then cut to the appropriate size for use in transformers or other apparatus and are preferably annealed by heating to some temperature lying between 800° and 1,200° C., usually nearer 800° C.; or they may be annealed before cutting. A later development is the production of grain-oriented silicon iron in which a direction of easy magnetization is obtained in material by orienting the crystals of which the material is composed. This orientation is obtained in the purified alloy by cold reduction of the sheet and subsequent annealing to produce the desired recrystallization texture. The material then has an especially high permeability when magnetized in one direction — that in which the material passed through the rolls during fabrication.

Some magnetic and physical characteristics of commercial silicon-iron alloys are given in Table I. The watt loss there referred to is the power dissipated in the alloy when it is magnetized to a maximum induction of $B=15{,}000$ by an alternating field of frequency 60 cycles per second. Such losses dissipate power and objectionably raise the temperature of a transformer core in operation (see TRANSFORMER). They are due partly to hysteresis and partly to eddy currents, the nature of which latter will be discussed below under X. Magnetization in Alternating Fields.

2. Iron-Nickel Alloys **(Permalloys)**.—These alloys have properties that are unusual and interesting from both a scientific and a commercial point of view. It became generally recognized about 1920, as a result of the work of G. W. Elmen, that the alloys containing from 35% to 90% nickel have permeabilities very much greater than those of iron. These alloys were named permalloys. A magnetization curve and hysteresis loop for 78 permalloy are shown in fig. 10, and curves for iron are given for comparison.

An iron-nickel alloy containing 50% nickel was investigated by T. D. Yensen and named hipernik. As distinguished from 78 permalloy, which is suitable for transformers transmitting the weak signals of communication apparatus, hipernik has high permeabilities and low losses in the higher magnetic fields used in the transmission of power.

These commercial alloys, 78 permalloy and hipernik, have the compositions that are scientifically the most interesting of the binary iron-nickel series. This is illustrated in part (a) of fig. 11 showing the induction of the alloys at low, intermediate and high field strengths.

The induction in high fields has a minimum at 30% nickel and a

TABLE *I.—Some Propertks of Commercial Silicon-Iron Alloys in 0.014-In. Sheet, Annealed*
($B_m=15{,}000$, $f=60$ cycles/sec.)

Grade	Silicon (per cent)	Power loss (watts/lb.)	μ_m (gausses/oersted)	μ for $B=100$	H_c (oersteds)	Resistivity (microhm-cm.)	Density (g./cm.³)
Armature	0.7	3.9	3,500	500	1.2	21	7.82
Electrical	1.5	3.3	5,500	700	1.0	30	7.77
Motor	2.4	2.5	6,500	900	0.8	41	7.71
Transformer 82	3.3	2.0	7,000	950	0.6	51	7.65
Transformer 72	3.6	1.8	7,500	1,000	0.5	54	7.63
Transformer 52	4.7	1.3	13,000	1,800	0.3	66	7.56
Oriented grain*	3.1	0.7	55,000	7,500	0.1	47	7.67

*Properties as measured in direction of rolling.

maximum at 45% to 50% nickel. The maximum occurs not only when the field strengths are large but persists and is even more marked in low fields. A second maximum appears for low fields

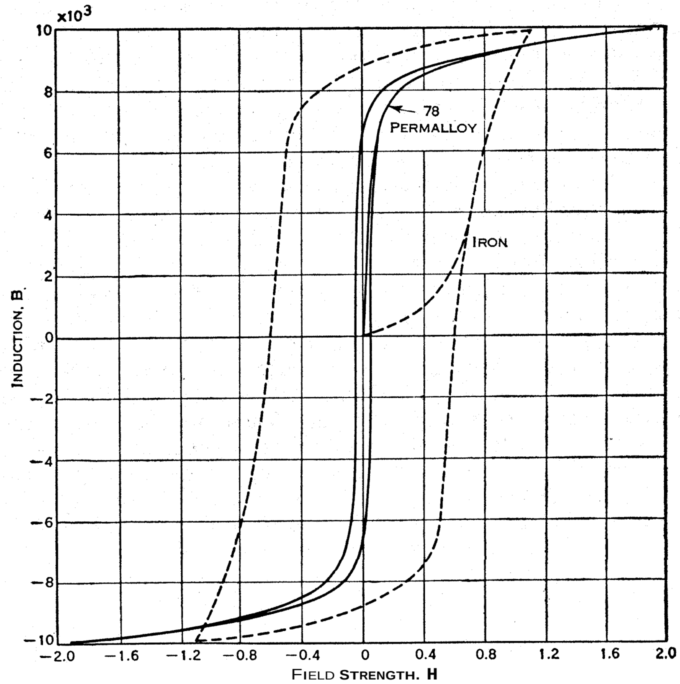


FIG. 10.— COMPARISON OF PROPERTIES OF PERMALLOY AND IRON

when the nickel content is about 80%, and this corresponds to the commercially useful alloy, 78 permalloy. The high initial permeability (permeability for very low values of B) of 78 permalloy (fig. 11[b]) is associated with its very low magnetostriction (see *VI. Stress and Magnetostriction* below).

Molybdenum, chromium and copper have been added to permalloy to advantage. The most used alloys of this kind are 4-79 permalloy, containing 4% molybdenum. 79% nickel and 17% iron! and mumetal. containing usually 5% copper, 2% chromium, 75% nickel and 18% iron. These are both used in transformers operating at high frequencies and are meritorious primarily on account of their high initial permeabilities. but also because they have higher resistivities and can be prepared with a simple heat treatment. Their permeabilities at various inductions are indicated by the curves of fig. 12. Initial permeabilities of 10,000 to 30,000 are usually attained.

During World War II a great improvement was made in the permalloys by heat treating them in pure hydrogen at 1,200° to 1,300° C. The most useful of these alloys, called supermalloy, contains 5% molybdenum and 79% nickel, the balance mainly iron. Initial permeabilities as high as 125,000 and maximum permeabilities of more than 1,000,000 can be attained commercially even in thin sheet (fig. 12). The technical progress in magnetic materials may be measured by comparing these magnitudes with the permeabilities of the best materials available in the first decade of the 20th century—silicon steel made at that time had initial and maximum permeabilities about ·,-& those of supermalloy.

Remarkable magnetic properties are exhibited by iron-nickel alloys given a still different kind of heat treatment. After heating at a higher temperature the material is maintained for a short time at 400° to 600° C. in the presence of a magnetic field of several oersteds. After cooling to room temperature the maximum permeability is found to be greatly increased and the coercive force diminished. This effect. often called magnetic anneal. depends on the composition and is most pronounced when the nickel content is 65% to 70%, as illustrated in fig. 11(c). The hysteresis loops of material given the magnetic anneal have the characteristic rectangular shape illustrated in fig. 13. The sides are vertical and the corners often perfectly square, and the coercive force much smaller than that of the same material heat treated in the absence of a field. Such "square-loop" materials of various compositions are useful as elements for the storage of information in electronic computers.

3. Iron-Cobalt Alloys.—It is a fact for which there is no satisfactory explanation that some alloys of iron and cobalt can attain greater intensities of magnetization than either of these elements alone. The saturation magnetization is highest for the alloys containing 35% to 40% cobalt, and then is 10% to 15% higher than for pure iron. When the field strength is 1,000 or below. the highest inductions are attained in the alloy containing equal proportions of the two elements, except that in fields weaker than two oersteds pure iron has the highest permeability

As a material the 50% alloy, under the name of permendur, is a useful component of the magnetic circuits of electromagnets and permanent magnets, where it is used for yokes and pole pieces. Since it is rather brittle and cannot be rolled to thin sheets, 2% vanadium is sometimes added and this permits the fabrication of sheets a few thousandths of an inch thick. The latter material is used in quantity in the thin diaphragms of telephone receivers. Some alloys contain 35% cobalt and other elements added to increase ductility.

Some alloys containing iron, cobalt and nickel are interesting because they have permeabilities that are independent of field strength over a relatively large range. The same alloys have

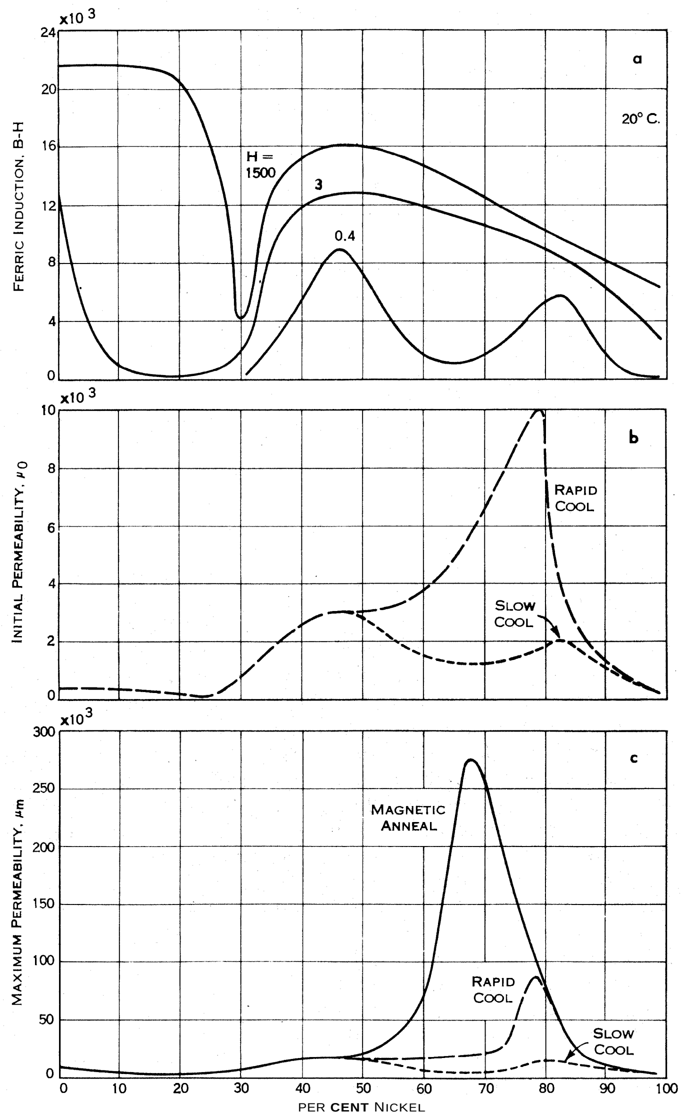


FIG 11 — SOME MAGNETIC PROPERTIES OF IRON-NICKEL ALLOYS

hysteresis loops of peculiar shape with low residual induction and a constricted middle portion.

A representative alloy, called perminvar, contains 30% iron, 25% cobalt and 45% nickel. The constancy of permeability uith field strength at low fields is brought out by annealing in the usual nay at about 1,000° C. and then heat treating for several

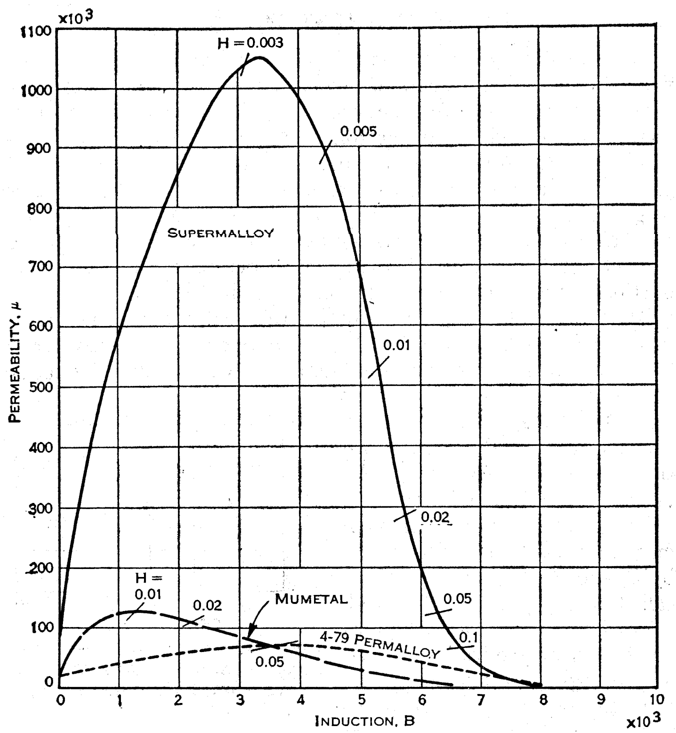


FIG. 12.— COMPARISON OF SUPERMALLOY WITH OTHER HIGH-PERMEABILITY ALLOYS (O. L. BOOTHBY AND R. M. BOZORTH)

hours at a relatively low temperature, 350° to 500° C. The hysteresis loss is then extremely small. A μ v. H curve and a hysteresis loop for an alloy of the above composition, heat treated for 24 hours at 400° C., are shown in fig. 14. This material responds

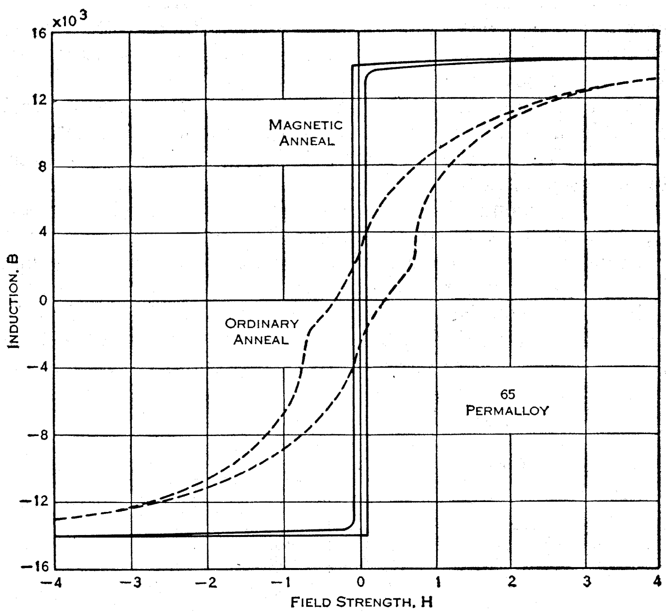


FIG. 13.—EFFECT OF ANNEALING IN PRESENCE OF MAGNETIC FIELD (J. F. DILLINGER AND R. M. BOZORTH)

to heat treatment in a magnetic field, and a loop for a specimen so treated is also shown in the figure.

4. Ferrites.—After World War II a number of nonmetallic substances were investigated and subsequently found many applications in industry. The most important among these are the ferrites. which were developed largely as the result of the work of J. L. Snoek. Examples of important ferrites are nickel ferrite ($NiFe_2O_4$), manganese ferrite ($MnFe_2O_4$) and their combinations with zinc ferrite ($ZnFe_2O_4$).

The ferrites are nonmetallic refractory materials composed of the oxides of iron-and other metals, usually manganese. cobalt, nickel. copper, zinc or magnesium. The proper proportions of the oxides are pressed in powder form to the required shape and fired at temperatures of 1,000° to 1,300° C. During the firing, chemical reaction occurs, and when the materials are cooled to room temperature they are hard, strong and brittle.

The maximum induction attainable in the ferrites is generally lower than in metallic materials, as shown by the hysteresis loops of fig. Ij. The permeability is also below that of the best alloys.

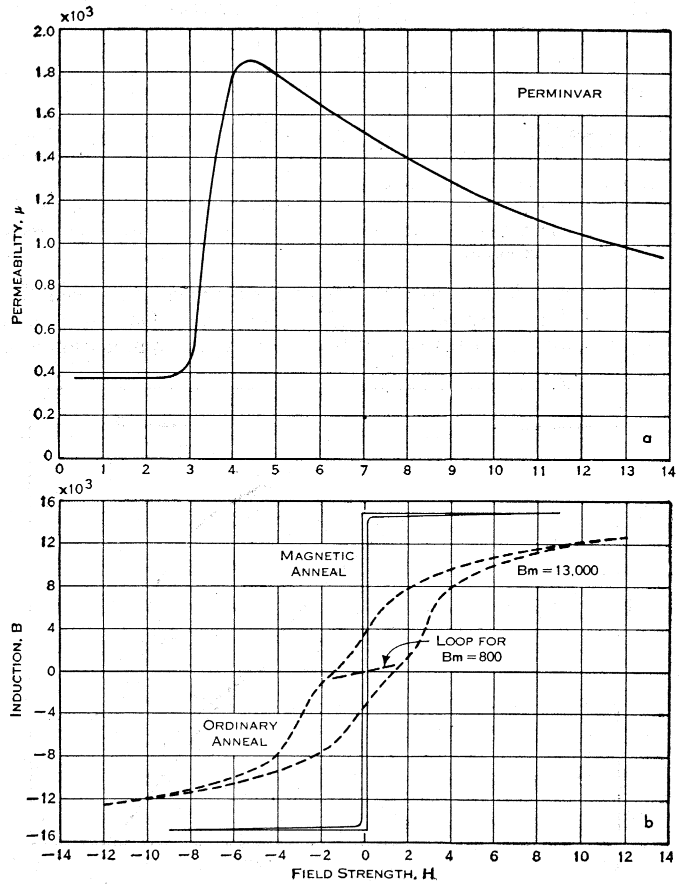


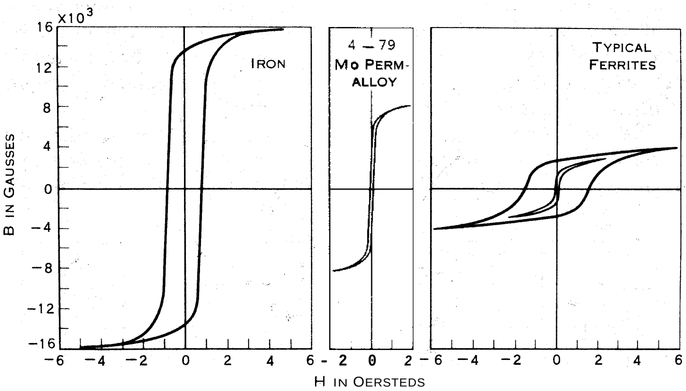
FIG. 14.— PROPERTIES OF PERMINVAR

Perminvar (45% Ni, 25% Co, 30% Fe) has remarkably constant permeability in low fields (a). It has extremely low hysteresis at low induction (b) and a characteristic wasp-waisted hysteresis loop at high inductions, and is affected strongly by magnetic anneal (G. W. Elmen and G. A. Kelsall)

However, the resistivities of the ferrites are a million (10^6) to a billion (10^9) times higher than for metallic materials, and this quality brings about a great reduction in the losses associated with changes in magnetization at high frequencies. For many applications especially in communications engineering. the merit of a magnetic material is measured by the product μQ, μ being the permeability in weak fields and Q inversely proportional to the energy loss per cycle. The variation of μ and μQ with frequency is shown in fig. 16, nhere it is noted that the μQ of manganese-zinc ferrite becomes increasingly valuable at frequencies up to one megacycle.

A number of materials of high permeability are described in Table II. The fabrication and heat treatment are given in outline only; in practice well-controlled procedures must be used.

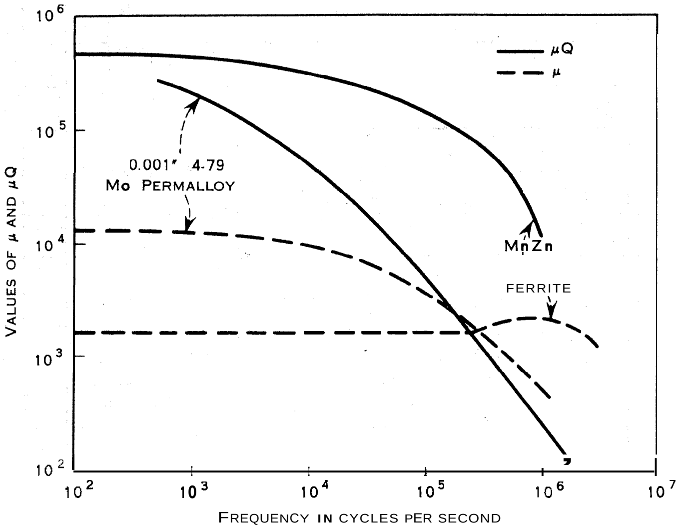
5. Magnetic Compounds. — There are a large number of other compounds and alloys that are ferromagnetic. As early as 1903, C. Heusler discovered that alloys near in composition to the compound Cu_2MnAl mere ferromagnetic, with a saturation (B_s) of about 5,500, nearly as high as for nickel. Similar alloys are known in which the aluminum (Al) is replaced by samarium, arsenic, antimony. bismuth, indium or gallium, or copper may be replaced by a larger amount of silver. Later many intermetallic and nonmetallic compounds of iron, cobalt, nickel, manganese and chromium were discovered.



BY COURTESY OF ELECTRICAL ENGINEERING'

FIG 15.— HYSTERESIS LOOPS OF NICKEL FERRITE AND ZINC MANGANESE FERRITE (SMALLEST LOOP) AS COMPARED WITH LOOPS OF METALLIC IRON AND MOLYBDENUM PERMALLOY

Ferrites in addition to those mentioned above have been the subject of increasing research and development. One such class of ferrites (orthoferrite) is typified by $GdFeO_3$, a combination of a



BY COURTESY OF THE AMERICAN JOURNAL OF PHYSICS

FIG 16— EFFECTIVE LOW-FIELD PERMEABILITY μ AND PRODUCT WITH QUALITY FACTOR Q (RECIPROCAL OF ENERGY LOSS) AS DEPENDENT ON FREQUENCY

rare earth oxide and an iron-group oxide. Different structure (garnet type) and properties are obtained if the component oxides are combined in the ratio $3Gd_2O_3.5Fe_2O_3$. Also, many cyanides, of which $Fe(FeC_6N_6)$ is an example, are found to be strongly magnetic at very low temperatures.

IV. PERMANENT MAGNETS

Permanent magnets, like electromagnets, are used to produce magnetic fields of considerable strength and constancy. Many devices depend on them for operation; *e.g.*, loud-speakers, magnetos, meters of many kinds, magnetrons, telephone receivers and a host of others. In all of these the magnet necessarily contains an air gap; consequently it always operates under the influence of a demagnetizing field (see *XIV.* Measurement of Magnetic Quantities below), such as that existing at the middle of a short bar of magnetized material. Thus the magnet operates not at residual induction but at some lower value of the induction, *B*.

The important curve for evaluating the quality and behaviour of material for permanent magnets is that portion of the hysteresis loop that lies in the second quadrant, between residual induction, B,, and coercive force, H_c, and is called the demagnetization curve. Magnetization and demagnetization curves for Alnico 5 (Alcomax) are shown in fig. 17.

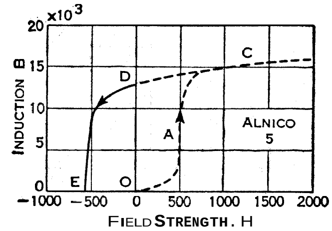


FIG. 17.— MAGNETIZATION CURVE (OAC) AND DEMAGNETIZATION CURVE (DE) O, ALNICO 5 (ALCOMAX)

The quality of a permanent magnet is characterized not only by B_r and H,, but also by the so-called energy product, the product of *B* and *H* for various points on the demagnetization curve. The energy product curve (fig. 18), showing this product as dependent on *B*, has a characteristic shape, and its greatest product, the maximum energy product, is the best single criterion of magnetic quality for these materials. The reason for this, and its importance in the design of permanent magnets. will be discussed after the most-used materials have been described.

1. Alloy Magnets.—From ancient times until about 1930 materials used as magnets were carbon steels. After 1855 alloying elements were added, especially tungsten. to improve the quality. In 1916–17 chromium began to displace tungsten, and cobalt was added up to 40% with very beneficial effect.

From the standpoint of magnetic quality the best materials available in the late 1950s for permanent magnets were not steels but dispersion-hardened (precipitation-hardened) alloys containing no essential carbon (see ALLOYS). The first materials of this kind to find commercial use were the iron-cobalt-molybdenum and iron-nickel-aluminum alloys (Table III). Their high coercivities are caused by the presence of very small particles of one kind highly dispersed in a matrix of another composition.

Important materials for magnets are listed in Table III, which indicates in outline the mechanical operations required in preparation and the heat treatment used to bring out the best magnetic

TABLE 11.—Some Properties of High-Permeability Materials

Name	Composition* (per cent)	Heat treatment (° C.)	Initial Permeability μ_0	Maximum Permeability μ_m	Coercive force H_c (oersteds)	Saturation induction B_s (gausses)	Curie point θ (° C.)	Electrical resistivity ρ (microhm-cm.)	Density δ (g./cm.³)
Iron	—	900	200	5,000	1.0	21,500	770	10	7.87
p rain-oriented Fe-Si	3 Si	1,200†	7,000	50,000	0.1	20,000	740	47	7.67
Hot-rolled Fe-Si	4 Si	800	1,500‡	7,000	0.3	19,500	730	55	7.61
45 permalloy	45 Ni	1,050	2,500	25,000	0.2	16,000	400	55	8.17
Hipernik	50 Xi	1,200†	4,000	70,000	0.05	16,000	500	50	8.25
Monimax	3 Mo, 47 Ni	1,125†	2,000	35,000	0.1	14,500	—	80	8.27
Radio metal	5 Cu, 45 Ni	1,050	2,000	20,000	0.4	15,600	—	55	8.3
4-79 permalloy	4 Mo, 79 Ni	1,100§	20,000	100,000	0.05	8,700	460	55	8.72
Supermalloy	5 Mo, 79 Xi	1,300†§	100,000	1,000,000	0.002	7,900	400	60	8 77
Mumetal	5 Cu, 2 Cr, 77 Ni	1,175†	20,000	100,000	0.05	6,500	430	62	8.58
Permendur	50 Co	800	800	5,000	2.0	24,500	980	7	8.3
Vanadium permendur	1.8 V, 49 Co	800	800	4,500	2.0	24,000	980	26	8.2
45-25 perminvar	25 Co, 45 Ni	1,000, 400	400	2,000	1.2	15,500	715	19	8.7
Alperm	16 Al	600‖	3,000	55,000	0.04	8,000	400	140	6.5
Sendust	5 Al, 10 Si	Cast	20,000	120,000	0.05	10,000	500	60	7.0
Mn-Zn ferrite	11 Mn, 14 Zn, 27 O	Sintered	1,400	2,joo	0.2	3,300	100	$20(10)^6$	4.9
Ni-Zn ferrite	9 Ni, 17 Zn, 26 O	Sintered	650	2,joo	0.4	3,600	125	10^{11}	4.9

*Remainder iron †Annealed in hydrogen atmosphere. ‡Measured at B-20 rather than B-0.
§Controlled cooling rate. ‖Quenched from indicated temperature.

properties. Demagnetization curves for some of these alloys are reproduced in bg. 19. Special attention is called to the alloy called Alnico 5 in the United States and Alcomax in England. In order to develop its remarkable properties it must be cooled at a definite rate in a strong magnetic field (about 1,000 oersteds) so directed in the specimen that it is parallel to the field required in use. At right angles to the direction of the field applied during treatment the properties are not so good, the energy product being then only about one-tenth as high. Although Alnico j is not forgeable and must be cast and ground to final form, its magnetic properties are outstanding and its uses numerous.

TABLE 111.—*Some Properties of Permanent Magnet Materials*

Name	Typical composition* (per cent)	Coercive force H_c (oersteds)	Retentivity B_r (gausses)	Energy product $(BH)_m \times 10^{-6}$	Fabrication	Heat treatment (° C.)
Cobalt steel	0.7 C, 36 Co, 4 Cr, 5 W	240	10,000	1.0	Forged	930†
Alnico 5	24 Co, 14 Ni, 8 Al, 3 Cu	600	12,500	5.0	Cart	1,300‡, 600§
Alnico 5 DG	24 Co, 14 Ni, 8 Al, 3 Cu	660	13,100	6 0	Cast	1,300‡, 600§
Alnico 6	24 Co, 15 Ni, 8 Al, 3 Cu, 1.25 Ti	750	10,100	3.8	Cast	1,300‡, 600§
Alcomax III	24 Co, 14 Ni, 8 Al, 3 Cu, 1 Nb	670	12,500	5.0	Cast	1,300‡, 600§
Platinum cobalt	77 Pt, 23 Co	4,000	6,000	9.0	Cast	—
Vectolite	16 Co, 38 O‖	900	1,600	0.j	Sinter	1,000‡
Ferroxdure	$BaFe_{12}O_{19}$	2,000	3,500	3.0	Sinter	—
Fine-powder	30 Co	1,000	9,000	5.0	Press	—
Bismanol	MnBi	3,400	4,300	4.3	Sinter	—

*Remainder iron. +Quenched from temperature indicated. ‡Must be cooled in strong magnetic field. §Baked. ‖Raw material composition.

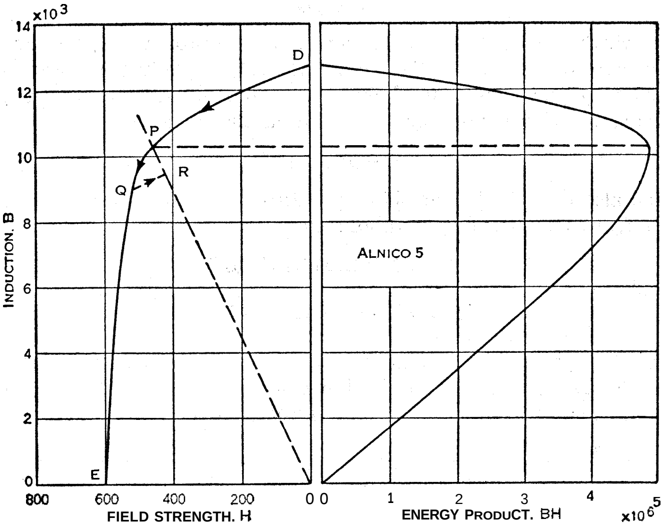


FIG. 18.— DEMAGNETIZATION CURVE (DE) AND CORRESPONDING ENERGY PRODUCT CURVE (BH v. B), SHOWING DESIRABLE POINT OF OPERATION. P, WHERE ENERGY PRODUCT IS MAXIMUM

2. Fine-Particle Magnets.—Among the other materials used or contemplated for use in permanent magnets the most interesting are in the class of fine-particle magnets. Theory indicates that

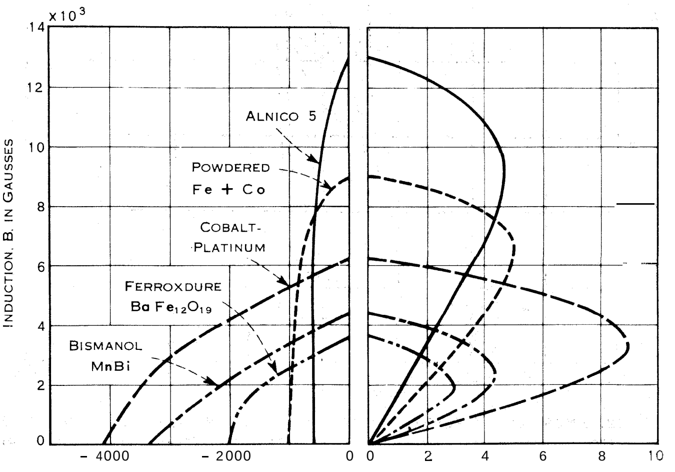


FIG. 19.— DEMAGNETIZATION AND ENERGY PRODUCT CURVES FOR SEVERAL MATERIALS IMPORTANT FOR PERMANENT MAGNETS

when particles are small enough, of the order of one micron (10^{-4} cm.) or less in diameter, they are comprised of single domains (see I'. *The Magnetization Curve: j. Domain Theory of Magnetization* below). This means that it is more difiicult to reverse the magnetization in them than in larger particles of the same material and that therefore they will make good permanent magnets.

Permanent magnets have been made of finely divided powder of barium ferrite ($BaFe_{12}O_{19}$, Ferroxdure). of iron, of manganese bismuthide (MnBi) and of iron-cobalt ferrite ($CoFe_5O_8$). In 1956 magnets of a finely powdered iron-cobalt alloy were prepared by T. O. Paine and his associates with an energy product of $j \times 10^6$ (*see* fig. 19). In this material the shape of the particle is important (the length is several times the diameter) and the long directions of the particles are all aligned parallel to the direction in which the material is to be magnetized.

It has been proposed that materials like Alnico j, although cast, fall into the category of fine-particle magnets because they are composed of particles of the requisite fineness embedded in a matrix of different magnetic quality.

3. Design of Permanent Magnets.— In the design of permanent magnets it is important to use the appropriate material and to shape it so that the minimum amount is used to produce the desired field strength in a given gap. As already pointed out. this result is accomplished when the product of B and H everywhere in the material has its maximum product, (BH),. The magnet of fig. 20 is designed with that in mind. The material is Alnico 5. The length of the material along the curved path, in relation to the length of the gap, determines the position of the line OP of fig. 18, and this should be placed so that it cuts the demagnetization curve at $B = 10{,}000$, corresponding to (BH),. The cross-sectional area of the magnet is adjusted to take account of leakage; a heavier section is necessary at the lower part because all of the leakage flux must pass through this, and B must at the same time be maintained at its proper value.

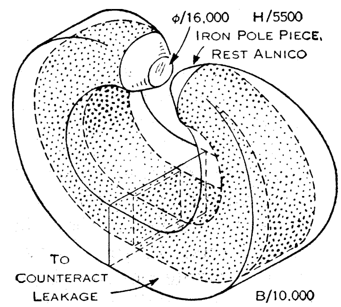


FIG. 2.0.— PRACTICAL DESIGN OF A PERMANENT MAGNET

The magnet operates at H=5,500, with B_0=10,000 almost everywhere in material. Unshaded portion is part of magnet necessary to carry "leakage flux" (P. P. Cioffi)

After a permanent magnet is designed and constructed it is magnetized with a high field. After removal of this magnetizing field it is usually desirable to apply momentarily a relatively weak field in the opposite direction. whereupon the magnetic state of the material changes as indicated by the points PQR of fig. 18. This stabilizes the magnet against the effect of stray fields or mechanical shocks or changes in temperature, so that the field in the gap is less likely to change.

V. THE MAGNETIZATION CURVE

1. Three Portions of Curve.— A typical magnetization curve, showing the relation between B and H in a specimen initially unmagnetized! may be divided into three main parts separated from each other by the "knee" and the "instep" (fig. 21). These three regions are identified with different physical mechanisms of change of magnetization; and also with different engineering uses of the materials. The initial portion of the curve; the "toe," is not horizontal at the origin but has a definite slope called the initial permeability. μ_0, equal to B/H for $H = 0$. For low inductions Lord Rayleigh found that the relation

$$B=\mu_0 H+aH^2$$

was obeyed, and when the permeability μ is plotted against the field strength H the points usually lie on a straight line corresponding to the equation

$$\mu=\mu_0+aH\ .$$

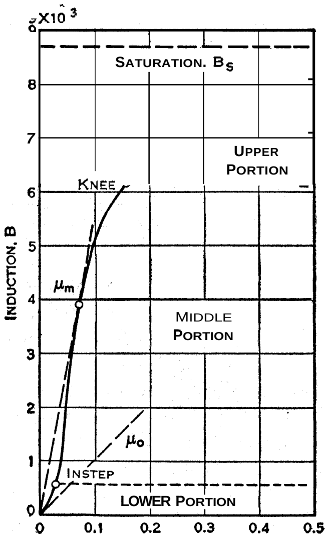


FIG. 21.—THREE SECTIONS OF NORMAL MAGNETIZATION CURVE
The sections are separated by "knee" and "instep." μ_m is largest value of B/H, μ_0 initial slope of curve

Curves of this kind are used to determine the value of μ_0 by extrapolation.

The upper portion of the magnetization curve (fig. 21) bends over and approaches the horizontal line marked B_s. In high fields, however, it is found that B approaches no definite limit but B-H does approach a limit, called the saturation induction or simply saturation. designated B_s. Since $B-H=4\pi I$, I approaches the limit I_s, the saturation magnetization.

The upper part of the curve may be represented fairly well by O. Frohlich's equation:

$$B-H=H/(a+bH)$$

in which $b=1/B_s$ and a is a constant which measures the magnetic hardness and is larger the stronger the field necessary to attain any given fraction of saturation. When H is small enough to be neglected in comparison with B, this equation may be expressed in the equivalent form used by A. E. Kennelly:

$$1/\mu=a+bH$$

and so a linear relation is found when $1/\mu$ is plotted against H. From a graph of this kind one can easily determine the constants a and b, and interpolate to find the value of μ for intermediate values of H. The slope of the line, b, may be used to estimate the saturation induction ($b=1/B_s$), but this method cannot be depended on for accuracy for in some materials such as iron the slope changes markedly at inductions close to saturation. The ratio $1/\mu$ is termed the reluctivity.

In its middle portion the magnetization curve is the steepest, and the permeability has its greatest value. It is here that irreversible changes in magnetization are a maximum, as indicated by the fact that curves for increasing and decreasing field strength differ markedly. These irreversible changes and the consequent losses in energy will now be discussed.

2. Hysteresis Loops.—A set of normal hysteresis loops is shown in fig. 22. In forming one of these the field strength is first increased from zero and the induction follows the magnetization curve OAC. H is then decreased, and the induction decreases slowly so that the hysteresis loop passes successively through the points D, E and F; then the field is reversed and the loop passes through G and back to C. At D the induction is called residual induction (B_r) and at E, when $B=0$, the field strength is the coercive force (H_c). The induction at the tip of a loop, as at C, is commonly designated B_m.

When the tip of the hysteresis loop lies on the first portion of the magnetization curve (OP in fig. 22), the loop is relatively narrow and the slope of the upper part of the loop, after it has just receded from the tip, is not greatly different from the slope of the magnetization curve at that point. If the tip lies in the middle portion of the magnetization curve, however. the slope of the loop (*e.g.*, at C, going toward D) is markedly different from the slope of the magnetization curve. These loops are relatively wide and the energy losses large. In the upper portion of the curve, above the knee, the losses are again small and the process of magnetization reversible.

The area enclosed by a hysteresis loop is proportional to the energy liberated as heat during traversal of the loop. When the area is in the units gausses × oersteds the energy loss due to hysteresis (Warburg's law) is

$$W_h=\frac{\text{area}}{4\pi}=\frac{1}{4\pi}\oint HdB$$

ergs/cm.³ for each traversal of the loop, or cycle. In high fields the hysteresis loss in iron, about 10,000 ergs/cm.³/cycle, is sufficient to raise its temperature about 0.0003° C. for each cycle, and therefore if the field is alternated 50 or 60 times a second, about one minute is required for the iron to heat one degree.

The hysteresis loss rises rapidly as the maximum induction of the loop, B_m, increases. The curve of fig. 23 shows the relation between W_h and B_m for ordinary iron having a maximum permeability of 4,500. When B_m is very small W_h varies as B^3, and in the range $B_m=1{,}000$ to $15{,}000$, of special interest for work on power transformers, it varies approximately as the 1.6 power of B_m in accordance with the empirical law of Steinmetz:

$$W_h=\eta B_m^{1.6}$$

in which the Steinmetz coefficient, η, is approximately constant for any one material. The B3 relation at low inductions was derived by Rayleigh. He showed, as noted above, that the magnetization curve near the toe followed the equation

$$B=\mu_0 H+aH^2$$

and also that the hysteresis loop with tips at B_m, H_m and $-B_m$, $-H_m$ was described by parabolic equations

$$B=\mu H+(a/2)(H_m^2-H^2)$$

and

$$B=\mu H-(a/2)(H_m^2-H^2)$$

for the upper and lower halves of the loop, respectively. (Here $\mu=B_m/H_m$). Such a loop is shown with the corresponding magnetization curve in fig. 24. Measurements have been made for

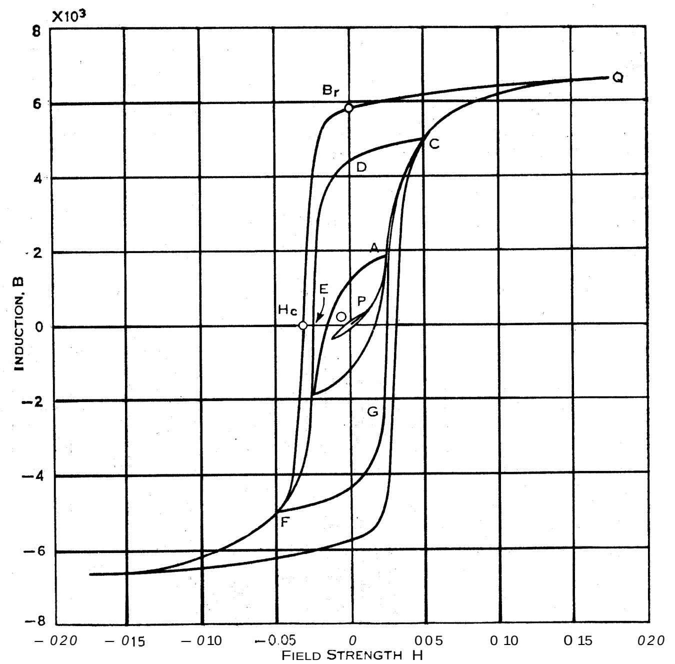


FIG 22 — NORMAL HYSTERESIS LOOPS FOR LOW, INTERMEDIATE AND HIGH INDUCTIONS. RESIDUAL INDUCTION, B_r, AND COERCIVE FORCE, H_c, ARE VALUES OF B AND H WHERE CURVES CROSS AXES

values of B_m as low as two gausses, and only slight deviations from the Rayleigh form observed. The area of a Rayleigh loop may be calculated from the above equations, and the corresponding hysteresis loss, expressed in ergs/cm.³/cycle, is

$$W_h=\frac{aH_m^3}{3\pi}=\frac{aB_m^3}{3\pi\mu^3}.$$

This equation corresponds to the lower part of the long curve of fig. 23, and is valid in iron when B_m is below about 500 gausses.

The hysteresis losses of various materials vary over a wide range. Losses of some of the common permeable materials are indicated by curves in fig. 23, and one of these has about $\frac{1}{200}$ the loss of iron at the same value of B_m. Materials used for permanent magnets, on the other hand, have hysteresis losses enormously larger than iron, sometimes by a factor of 500. Thus the over-all range in loss in various materials is approximately 100,000 times; *i.e.*, the coefficient η of Steinmetz' equation varies from 0.6×10^{-5} to 0.6.

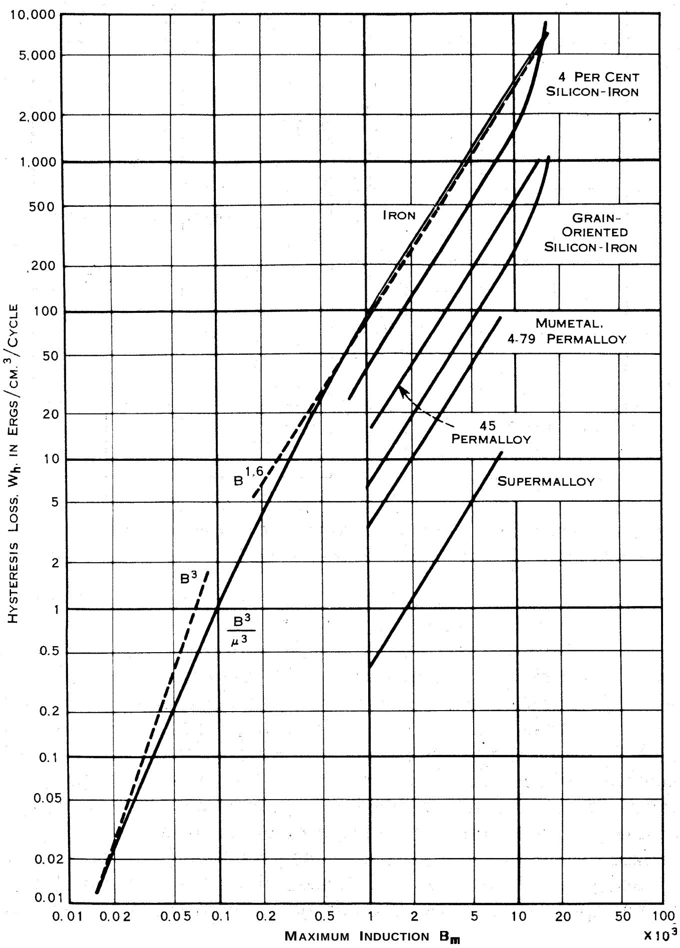


FIG. 23.— HYSTERESIS LOSS AS DEPENDENT ON MAXIMUM INDUCTION FOR SOME IMPORTANT MATERIALS

3. Distribution of Hysteresis Loss Over Cycle.—The energy loss and the attendant rise in temperature can be calculated satisfactorily as described above for a complete hysteresis loop. But in what part of the loop does most of the rise in temperature take place? This question has been answered by direct experiment, measurements having been made of the very small rise in temperature that occurs when the induction is changed by only a small fraction of the total. Changes of about $\frac{1}{1,000,000}°$ C. have been measured in these experiments. The results of such investigations show that the energy losses are largest where the hysteresis loop is steepest. In addition to this irreversible loss, there is a heating of the specimen in strong fields as the field is increased, and an equal cooling as the field is decreased. This reversible heat does not, therefore, contribute to the hysteresis loss over a complete cycle.

4. Hysteresis in Rotating Fields.—The hysteresis loops mentioned so far have been measured with B and H either parallel or antiparallel to each other. A different result is obtained if the field acting on a specimen is maintained constant in strength and varied continually in direction. This is usually called simply rotational hysteresis as compared with the usual alternating hysteresis. Measurement of rotational hysteresis is accomplished by placing a disk of the material to be examined between the poles of an electromagnet and rotating the disk so that H always lies in its plane. The force necessary to turn the disk is then a measure of the rotational hysteresis loss.

As the field strength increases from zero the rotational hysteresis first increases rapidly (fig. 25), more rapidly than the alternating hysteresis, but when the induction is half to three-quarters of saturation the alternating hysteresis goes through a maximum and decreases rapidly, approaching zero at saturation. The disappearance of hysteresis in a high rotating field was predicted as a result of Ewing's theory, and its confirmation in 1896 indicated the fundamental soundness of the theory. Rotational hysteresis is of practical importance in the magnetic material forming the segments or teeth of rotating dynamo-electric machinery.

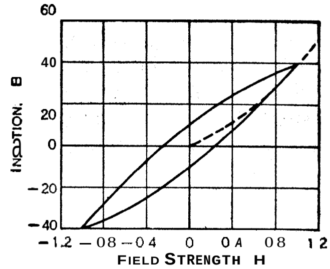


FIG. 24.—FORM OF HYSTERESIS LOOP FOR LOW INDUCTIONS (LORD RAYLEIGH)

5. Domain Theory of Magnetization.— Many of the phenomena of the magnetization curve and hysteresis loop can be described to advantage in terms of the domain theory. The theory that a ferromagnetic material is composed of many small regions, each magnetized to saturation in some direction, was first stated by Weiss in 1907, and the description he gave at that time is accepted with but slight modification. The existence of such domains is evident from H. Barkhausen's experiments and even more definitely from the study of powder patterns (see below). In the unmagnetized state the directions in which the domains are saturated (the directions of easy magnetization) are distributed either at random or in some other way such that the resultant magnetization of the specimen as a whole is zero. Application of a field changes only the direction of magnetization in a given volume. The three main parts of the magnetization curve are distinguished from each other by the nature of this change in direction, which may take place in any of several ways.

The magnetic moment of any one domain is specified by the magnitude and direction of its magnetization and by its volume. Ordinarily at constant temperature the moment of a domain, and therefore the magnetization of the ferromagnetic body of which it is a part, is changed by: (1) a change in the direction of magnetization of the domain ("rotation"); or (2) a change in the volume of the domain ("moving boundary"). These processes are indicated graphically in fig. 26. It has been shown by R. Becker that the moving boundary is particularly important for changes occurring in low and medium fields. Processes may be classified also as reversible or irreversible accordingly as the energy dissipated in heat is a relatively small or large fraction of the potential energy.

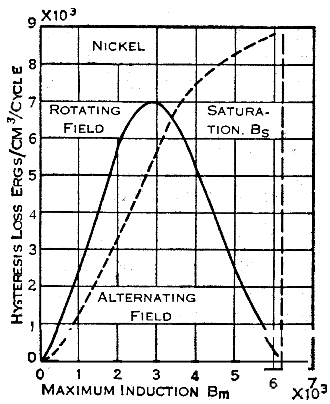


FIG. 25.— ROTATIONAL HYSTERESIS LOSS GOES THROUGH MAXIMUM, APPROACHES ZERO AT SATURATION (A. PERRIER)

In each of these portions of the magnetization curve, one type of process preponderates as indicated here: (1) initial portion—reversible boundary displacement; (2) middle portion—irreversible boundary displacement; (3) upper portion—reversible rotation. Fig. 27 shows the three important processes in relation to the magnetization curve and hysteresis loops, and the corresponding energy losses due to hysteresis, for a specimen of a high-permeability alloy.

The domain boundaries are not sharp on an atomic scale; as shown in fig. 28 the orientations of the atoms change progressively across the "wall." In iron the wall is about 1,000 atoms thick instead of the four indicated in the schematic drawing.

If the dimensions of a magnetic particle are about the same as the wall thickness it is apparent that there can be no change in magnetization by wall displacement. Change in magnetization must then occur by domain rotation, and higher fields are necessary to produce a given change in magnetization, provided the particles are magnetically anisotropic. Consequently an agglomerate of fine particles will make a good permanent magnet.

The factors which determine the direction of magnetization in a single domain of a specimen are the crystal structure, the state of strain and, of course, the direction and strength of the magnetic field. The effect of crystal structure and of strain will be

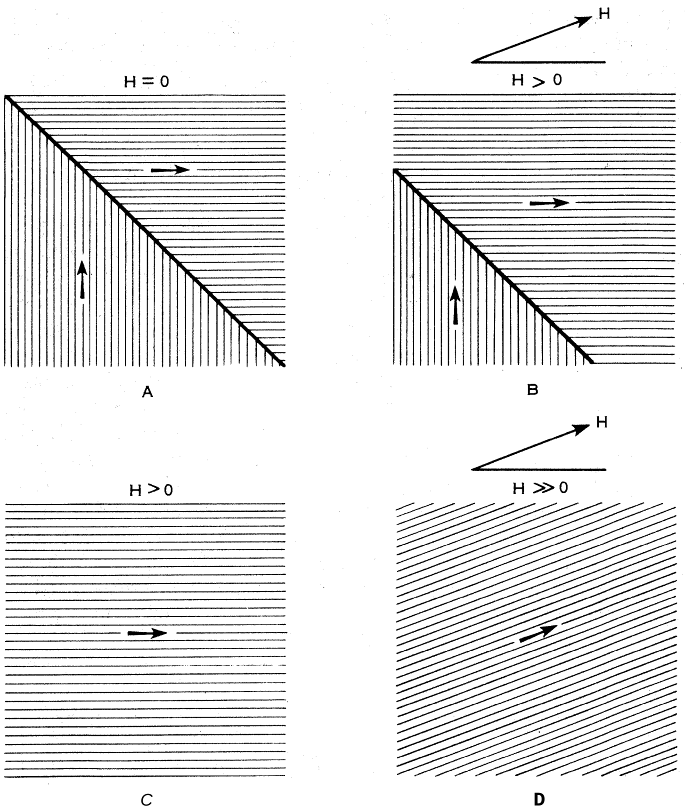


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FIG. 26.— MECHANISM OF CHANGE OF MAGNETIZATION. DOMAIN WALL MOTION IN WEAK FIELDS (A, B), DOMAIN ROTATION IN STRONG FIELDS (C, D)

discussed in some detail in later sections of this article. It may be mentioned here in a preliminary way that the nature of the crystal structure affects mainly the upper part of the magnetization curve of a permeable material. In iron, for example, the crystal structure is such that the magnetic properties of a single crystal vary considerably with direction, and as a result of this variation exceptionally high fields are necessary to approach saturation in ordinary polycrystalline iron. The rotation of the domain by the field must be made against relatively powerful forces. and so the magnetization curve above the knee rises slowly over a considerable distance. This behaviour may be contrasted with that of permalloy containing 60% to 80% nickel and 40% to 20% iron —here the magnetic properties vary but little with the direction in the crystal, the domains therefore rotate easily and the magnetization curve flattens out quickly above the knee, attaining saturation in relatively weak fields (fig. 9).

Just as strain affects magnetic properties, so magnetization changes the dimensions of a ferromagnetic body, or the body is said to exhibit magnetostriction. If the length of a material changes by a relatively large amount when magnetized to saturation, this material will be relatively sensitive to strain; *i.e.*, magnetostriction and strain sensitivity are reciprocal properties. Strain affects mainly the lower and middle portions of the magnetization curve, and the strain and magnetostriction together determine the ease with which the interdomain boundary is moved by a change in the magnetic field. Thus the highest initial perme-

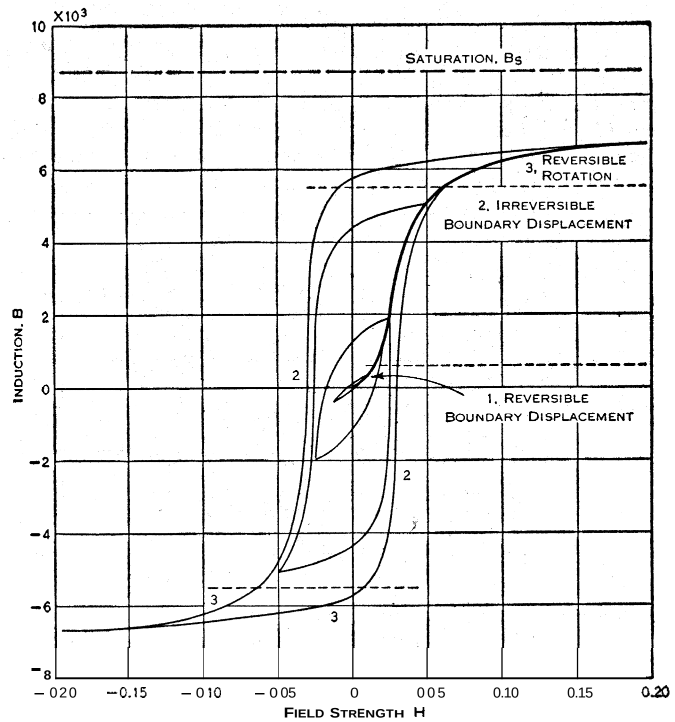

FIG. 27.— NATUREOF CHANGE IN MAGNETIZATION IN RELATION TO POSITION ON MAGNETIZATION CURVE AND HYSTERESIS LOOP

abilities are found in materials having very small magnetostriction; *e.g.*, permalloy containing about 80% nickel.

6. Powder Patterns. — For many decades iron filings have been used to portray the directions of lines of magnetic force in air and to detect flaws or inhomogeneities in magnetic materials. (See MAGNETIC INSPECTION.) In 1931 it occurred to L. von Hàmos and P. A. Thiessen to use fine magnetic powder to detect the local inhomogeneities in magnetization that the domain theory predicts. Independently F. Bitter applied a suspension of siderac (Fe_2O_3), having particles about 10^{-4} cm. in diameter, to a polished magnetized surface and observed under the microscope that the powder formed parallel lines regularly spaced about 0.1 mm. apart and aligned approximately perpendicularly to the direction of magnetization. The technique and interpretation of such patterns were then the subjects of study by a number of workers. A notable advance was made by H. J. Williams, R. M. Bozorth and W. Shockley, who used carefully prepared surfaces of single crystals of silicon

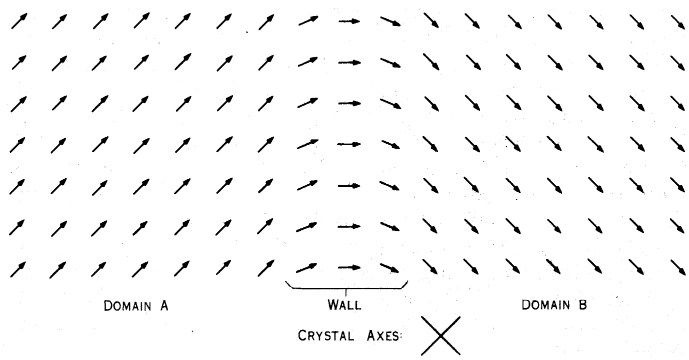

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FIG. 26.— SCHEMATICOF DOMAIN WALL AS TRANSITION BETWEEN DOMAINS. ACTUAL WALLS MAY BE 1.000 ATOMS THICK

iron and other substances. Many of the processes predicted by domain theory were confirmed by them and other experimenters. Fig. 29 shows a domain pattern on a single cobalt crystal; one sees here the motion of the boundaries with change in direction of applied field. In fig. 30, a domain pattern near the edge of a crystal of iron, both 180° and 90° walls (between domains magnetized in opposite directions and at right angles) are observed. The small domains at the bottom are "domains of closure" and permit the flux to flow easily in the directions of easy magnetization indicated by the arrows. A discussion of the easy directions of magnetization is given in *VII. Properties of Single Crystals* below.

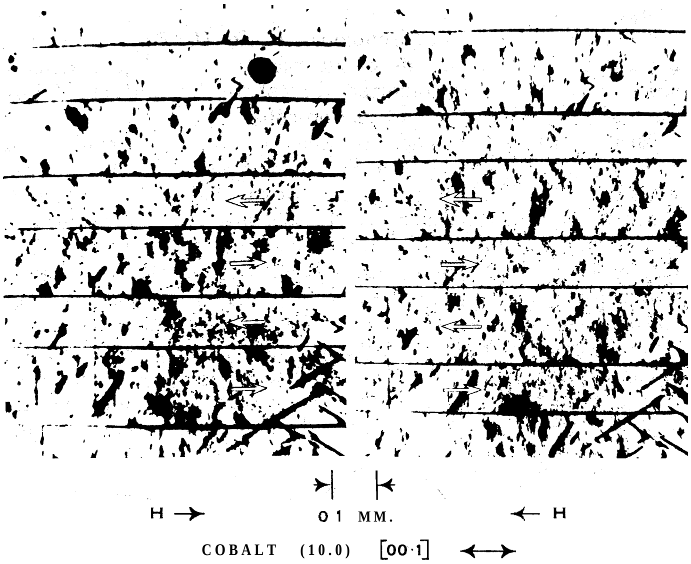

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FIG. 29.— POWDER PATTERN OF DOMAIN WALL MOTION IN COBALT (H. J. WILLIAMS)

The effect of imperfections on wall movement is illustrated by the two parts of fig. 31. In (A) the imperfection is near a principal wall which moves under the influence of a field, and from the imperfection there are subordinate walls stretching from the principal wall. But when this wall moves too far from the imperfection the subordinate walls are stretched too far and ultimately break, thus releasing the energy stored in the subordinate walls and causing the principal wall to move forward suddenly.

The structures of some powder patterns are simple and well understood. It is believed that the more complicated patterns are controlled by the same factors, illustrated in fig. 32.

The energies involved are: (1) magnetostatic energy, associated with magnetic charge or poles; (2) magnetostrictive energy, associated with the spontaneous change in dimensions of a domain when it is formed as a magnetic unit; and (3) the energy associated with the domain wall. In the various configurations of fig. 32, (A) shows a single isolated domain with a large amount of magnetostatic energy; in (B) this is reduced but some wall energy is added; in (C) the magnetostatic energy is further reduced but magnetostrictive energy, associated with nonparallel domains, is added; and in (D) the latter is reduced and some domain wall energy is added. The stable configuration is that for which the total energy is a minimum. The amounts of energy can be evaluated for simple configurations such as the one shown, and quantitative agreement with experiment is found. The resemblance between fig. 32(D) and fig. 30 is easy to see. Complex structures presumably are subject to the same principles.

7. Barkhausen Effect.—In 1919 Barkhausen discovered the effect known by his name, and interpreted it as demonstrating that the magnetization of iron proceeds by steps and not in a continuous manner. This effect may be demonstrated simply with the aid of amplifier and phones. As the field is changed slowly the succession of clicks heard in the phones, or in a loud-speaker, persists only when the magnetization is changing along the steep part of the magnetization curve or hysteresis loop. The clicks are identified with irreversible changes in magnetization (process [2] above) and are direct evidence of the existence of domains.

It is now known that the discontinuities of the Barkhausen effect are caused by the sudden movement of a portion of a domain wall from one stable position to another. the positions of stability being determined by the location of crystal imperfections of one kind or another. During one discontinuity in magnetization the volume of the material swept over by the wall is on the average about 10^{-6} mm.^{3}, whereas the volume of a single domain is of the order of 10^{-3} mm.^{3}

VI. STRESS AND MAGNETOSTRICTION

The magnetic properties of many ferromagnetic materials are sensitive to the application of stress, to such an extent that stress may be ranked with field strength and temperature as one of the primary factors affecting magnetic change. Stresses of two kinds should be distinguished: large stresses, that cause a permanent deformation of the material. almost invariably cause a decrease in permeability; stresses within the elastic limit may cause either an increase or a decrease in the permeability, depending on the nature of the material.

When a moderate tension is applied to a specimen of nickel, its permeability is decreased. The magnetization curve taken with tension applied always lies below that-for the unstrained material (fig. 33), and the curve is always lower the greater the tension. The effect of stress on the magnetization curve is greatest in the middle portion of the curve, and approaches zero when the specimen is either unmagnetized or saturated.

With some materials, on the other hand, the effect of tension is to increase the permeability. For example, in permalloy containing **68%** nickel and 32% iron the maximum permeability is higher by a factor of 8 when the tension is 2 kg./mm.^{2} and by a factor of about 30 when the tension is 11 kg./mm.^{2} (15,600 lb./in.^{2}), the elastic limit of this material. As the stress exceeds the elastic limit the permeability of permalloy, and indeed that of any material. decreases rapidly.

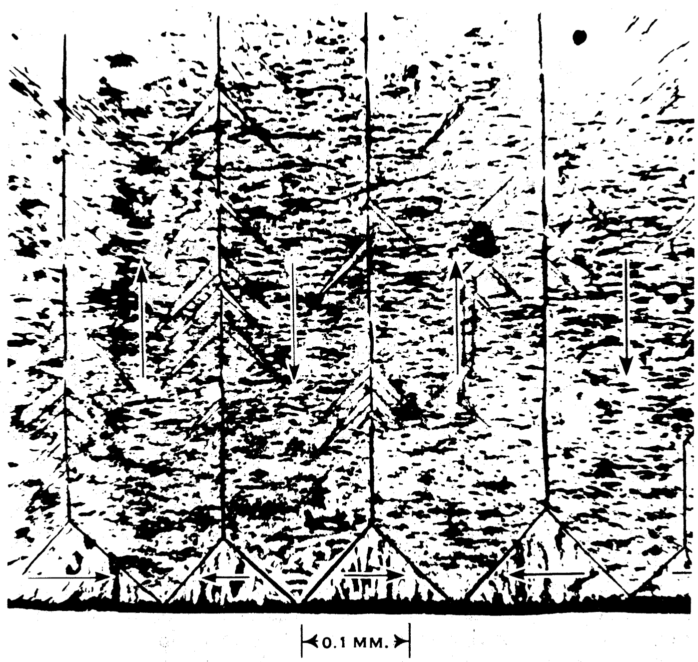

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FIG. 80.— DOMAIN STRUCTURE IN [100] PLANE OF IRON, SHOWING TRIANGULAR DOMAINS OF CLOSURE AT EDGE OF CRYSTAL. UNMAGNETIZED (H. J. WILLIAMS)

The effect of stress on magnetization is closely related to the change of dimensions that occurs when a magnetic body is magnetized (magnetostriction); that is, the effect of strain on magnetization and the effect of magnetization on strain are interdependent. When nickel is magnetized it contracts a small fraction of its original length, at most 40 parts per 1,000,000. The fractional change of length, $\Delta l/l$, with field strength, H (fig. 34), is first slow, then rapid, then again slow as it approaches a finite limit called "saturation magnetostriction" $(\Delta l/l)_s$. When 68 permalloy is magnetized it increases in length as shown.

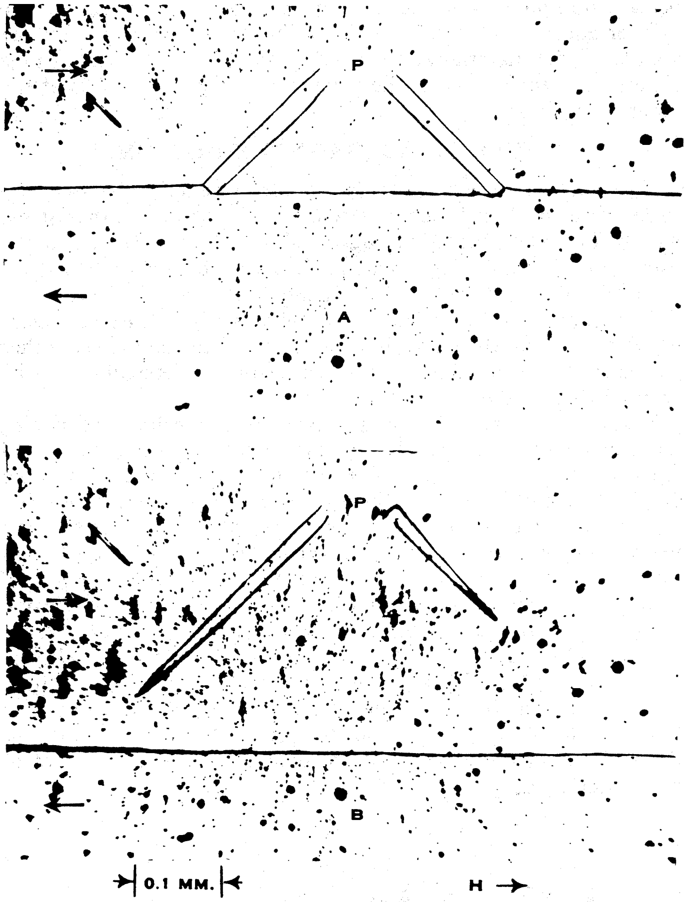

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FIG. 31.— SECONDARY WALLS FROM SUBSURFACE CRYSTAL IMPERFECTION RESTRICT PRIMARY WALL AS IT MOVES DOWNWARD UNDER INFLUENCE OF APPLIED FIELD (R. C. SHERWOOD)

Nickel and 68 permalloy are representative of materials with negative and positive magnetostriction. respectively. Tension increases the magnetization of a body having positive magnetostriction, decreases the magnetization if it has negative magnetostriction. The effect of compression is opposite to that of tension, consequently the magnetization of magnetostrictively positive materials is decreased by pressure. In referring to tension and compression it has been assumed that they are applied along a line parallel to the direction of the magnetic field; if pressure is applied in a direction at right angles to the field the effect on magnetization is opposite to the effect of compression applied parallel to the field; *i.e.,* compression applied to nickel at right angles to the field will decrease the magnetization measured parallel to the field.

Iron and some other materials have magnetostriction that is sometimes positive and sometimes negative. The magnetostriction of iron is positive in weak fields, negative in strong fields; and the effect of tension is, as expected, to increase magnetization in low fields, decrease it in high fields.

Generally the magnetostriction begins to increase rapidly with field strength at about the knee of the magnetization curve. The magnetization attains one-half to two-thirds of its saturation value while the magnetostriction is still only one-fourth to one-third of its final value $(\Delta l/l)_s$.

Both the strain sensitivity and magnetostriction of the iron-nickel alloys are of special interest. The saturation magnetostriction (the greatest change in length) goes through zero at about 81% nickel, a composition close to that of the permalloys having the highest permeability, and L. W. McKeehan pointed out the close theoretical connection between the low magnetostriction and high permeability of these alloys. The strain sensitivity of the permalloys is also zero at about 81% nickel, as would be expected.

The magnetostriction of iron-cobalt ferrite ($CoFe_2O_4.Fe_3O_4$) is the largest so far reported—about 750×10^{-6}. High magnetostriction has also been reported for cobalt, for manganese bismuthide (MnBi) and for some iron-cobalt alloys.

Measurements of magnetostriction are commonly made with strain gauges, as proposed by J. E. Goldman. These consist of fine wires cemented firmly to the surface of the body to be measured. When the body expands or contracts, the wire expands or contracts with it and the resistance of the wire changes accordingly. The resistance can be measured with high accuracy so that the change in dimensions can be determined to 1 part in 10,000,000 to 100,000,000 (10^{-8}).

1. Changes in Volume.—When iron is magnetized in not too strong a field its length increases and its cross-sectional area decreases in about the same proportion, so that the volume remains approximately constant. However, there is a small change in vol-

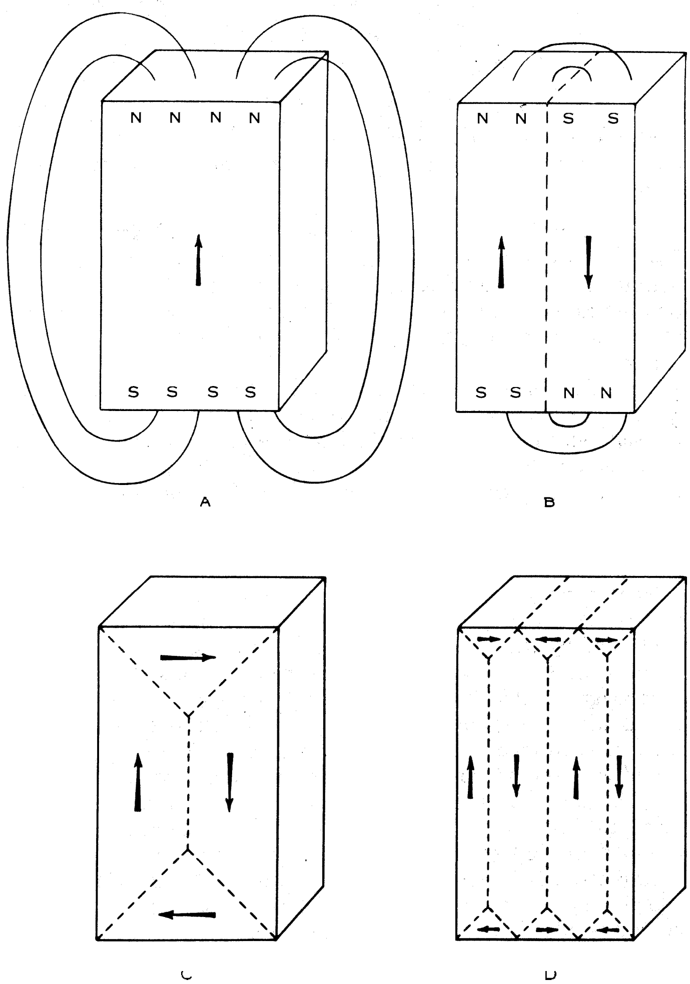

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FIG. 32.— POSSIBLEDOMAIN STRUCTURES

Diagrams show large magnetostatic energy in (A), and successively lower energy in other structures in which there is wall energy (B) and magnetostrictive energy (C); (D) represents the kind of structure actually observed (fig. 30)

ume, usually an expansion, that can be detected with sensitive apparatus. When a field of about 2,000 oersteds is applied. the fractional change in volume in iron is about 10^{-6}, and in nickel about one-third of this amount. It is especially large in the iron-nickel alloys containing about 30% nickel, and here amounts to about 40×10^{-6}.

Closely connected with the change in volume with field strength is the change of magnetization with hydrostatic pressure. As indicated by the magnitude of the volume magnetostriction, this change is small.

2. Domain Interpretation of Stress.—According to the domain theory, when tension is applied to a material with positive magnetostriction, the magnetization of a single domain will tend to be aligned parallel to the direction of the tension. In an unmagnetized material with domains oriented initially at random the domains are rotated by a sufficiently large tension, as shown in fig. 35(A) and (B), because the directions of easy magnetization in the various domains have been changed by the stress. If a field is then applied, half of the domains reverse in direction and the material is saturated. (No magnetostrictive change in length accompanies such domain reversals.)

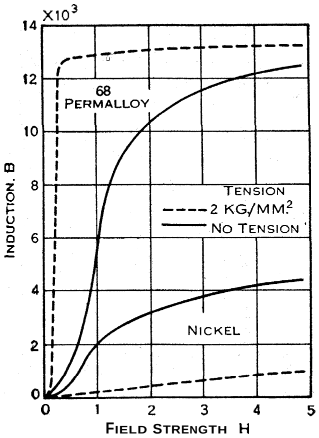

FIG. 33.—EFFECT OF TENSION ON MAGNETIZATION

The effect on 68 permalloy and nickel is opposite in direction. Tension is held constant while field is increased from zero

Compression causes the domains to orient transversely (fig. 35[D]). If a material has negative magnetostriction, tension will effect the same result, and a field subsequently applied will rotate the domains toward saturation.

The domain theory has been successful in predicting the highest value of the initial permeability that can be attained when impurities have been reduced to a minimum and internal strains relieved as much as possible by annealing. The small strain then remaining is due to the magnetostriction of the separate domains and is proportional to the saturation magnetostrictions; and the smaller the magnetostriction the larger the initial permeability according to the relation derived by M. Kersten:

$$\mu_o = \frac{4I_s^2}{(\Delta l/l)_s^2 E}$$

in which E is Young's modulus of elasticity and **I,** the saturation magnetization. This equation, although by no means exact, is in agreement with the fact that μ_o is large when $(\Delta l/l)_s$ is small. as it is in the iron-nickel alloys containing about 80% nickel; and the equation holds with fair accuracy for a series of iron-nickel alloys. For $(\Delta l/l)_s$ one can usually use the magnetostriction for polycrystalline material, but more accurately it is the magnetostriction measured in the direction of easy magnetization in a single crystal.

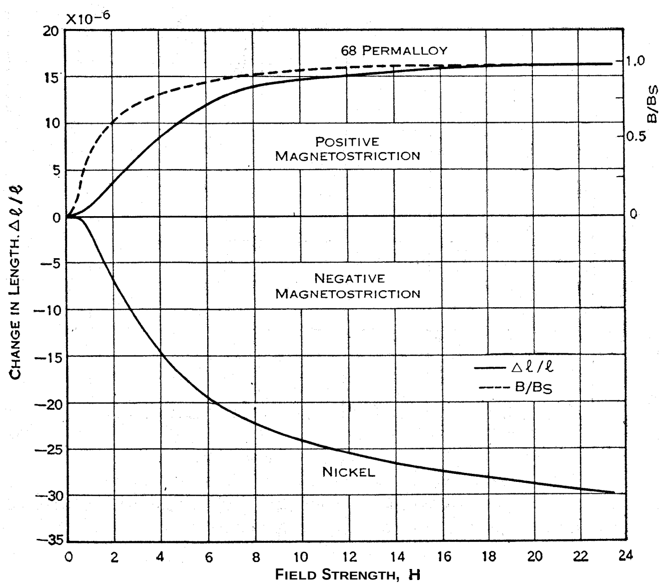

FIG. 34.— APPLICATION OF FIELD CAUSES INCREASE IN LENGTH OF 68 PERMALLOY (POSITIVE MAGNETOSTRICTION), AND A DECREASE IN NICKEL (NEGATIVE MAGNETOSTRICTION). COMPARE WITH RECIPROCAL EFFECT OF FIG. 33

VII. PROPERTIES OF SINGLE CRYSTALS

Improvements in the technique of growing large metallic crystals have opened to investigation the magnetic properties of single crystals of iron. cobalt. nickel and many alloys of these elements, and the nonmetallic ferrites. Crystals of some metals. such as nickel and nickel-iron alloys, are grown by slow freezing of a melt of pure material. This method is not adapted to iron. because of its phase transformation at about 900° C.; single crystals of this element are grown by stretching a pure specimen a definite amount and then heating it for a long time just below the transformation temperature.

In the cubic crystals of iron and nickel the magnetic properties depend on the direction, with respect to the crystal axes. in which these properties are measured. Fig. 36 shows the magnetization curves for iron and for nickel, taken nith B and H measured in the three principal directions, namely: (1) parallel to an edge of the cube—the [100] direction; (2) parallel to a diagonal of a cube face—the [110] direction; and (3) parallel to the space diagonal—the [111] direction. The direction for nhich the magnetization curve lies highest is the direction in which magnetization is most easily acquired, and is called the direction of easy magnetization. In iron this directipn is parallel to a cube edge; in nickel it is parallel to a cube diagonal.

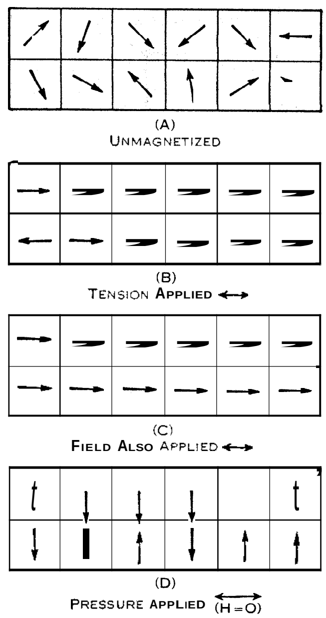

FIG. 35.—EFFECT OF STRESS AND MAGNETIC FIELD

Schematic domain interoretation of the effect of stress and magnetic field applied to material with positive magnetostriction

According to the domain theory the direction of easy magnetization in a crystal determines the actual direction of magnetization in a single domain not subjected to magnetic field or strain. and in unmagnetized iron the domains are oriented in each of the six directions parallel to a cube edge so that the net magnetization is zero. In nickel there are eight such easy directions.

Magnetization curves of single crystals of a silicon-iron alloy (3.8% silicon) have a special interest because this is the first case in which measurements mere extended to very low inductions, and because the high permeabilities obtained in these crystals are enormous compared with the permeabilities found in commercial silicon-iron sheet having the same silicon content These data nere made available by cutting a single crystal in the form of a hollow parallelogram so that all sides were parallel to equivalent directions in the crystal. *e.g.,* parallel to diagonals of cube faces and so forming a closed magnetic circuit and measuring in the usual way. The highest permeability observed is about 100 times that of commercial transformer sheet.

1. Calculation of **Magnetization Curves.**—A theoretical study of the properties of crystals has made it possible to calculate the magnetization curve for any direction in a single cubic crystal like iron or nickel, provided a single constant of the crystal, the anisotropy constant. K, is knonn. This constant is a measure of the difference between the magnetization curves in different directions, and is numerically equal to four times the area between the **I** v. H curves for the [100] and [110] directions. The constant is positive for iron and negative for nickel, and is approximately zero for iron-nickel alloys containing 65% to 80% nickel.

Comparison of theory and experiment is made in fig. 37 using Williams' data for a single crystal containing 3.8% silicon, for which $K = 280\ 000$ ergs/cm.^{3}; the theory does not take account of the energy associated with the lower and middle portions of the magnetization curve; therefore, the calculated curves do not correspond to the true magnetization curve below its knee. In a polycrystalline material the magnetization curve is a combination of the separate curves for the many small single crystals of which it is composed. The calculation of such a composite curve has been made to show in what manner the magnetization curve approaches saturation, and fair agreement with observation has been found.

In iron and nickel the anisotropy constants decrease as the temperature increases, so that these metals are isotropic over a considerable range of temperature before they become nonmagnetic at

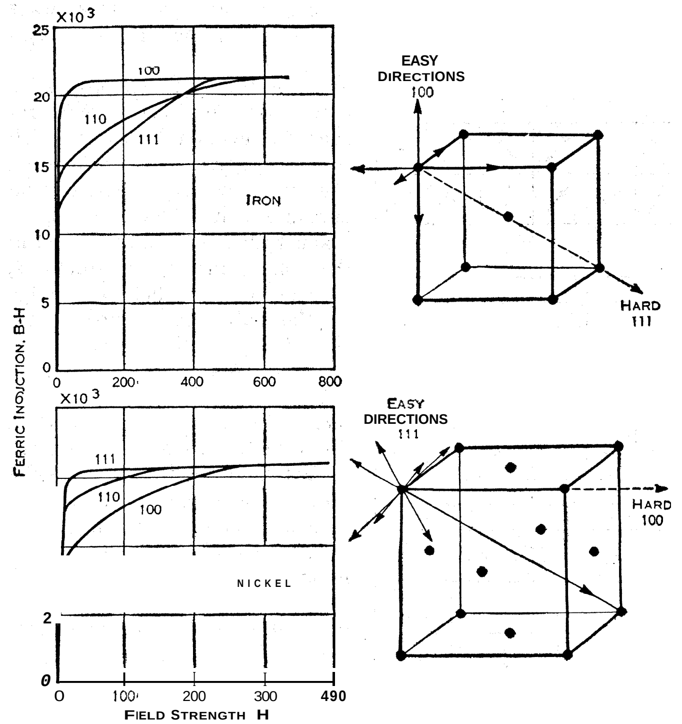

FIG. 36.— MAGNETIC PROPERTIES AND CRYSTAL STRUCTURES OF SINGLE CRYSTALS OF IRON AND NICKEL

The groups of arrows at the corners of the cubes—six for iron and eight for nickel — indicate the directions of easy magnetization (K. Honda and S. Kaya, W. L. Webster)

the Curie point. At very low temperature, 20° K., the constant for nickel is 10 to 15 times that it is at room temperature, while for iron the corresponding ratio is only 1.5.

2. Anisotropy.—Unusual magnetic properties are found in alloys having small values of the anisotropy constant. Such alloys are the permalloys having nickel contents between 60% and 80%, in which range of composition the constant goes from positive to negative (fig. 38). When the anisotropy is small, and the orientation of the domain therefore controlled only weakly by the crystal structure, the material responds easily to either magnetic field or to mechanical stress and therefore saturates in relatively low fields and is unusually strain sensitive.

The small anisotropy of the permalloys containing 60% to 80% nickel is associated with the fact that these alloys show unusual properties when heat treated in a magnetic field. A hysteresis loop of material so treated, and the high values of maximum permeability associated with the permalloys (fig. 12), have already been mentioned.

Cobalt differs from the other ferromagnetic elements, iron and nickel, by having a hexagonal crystal structure instead of a cubic one. At room temperature the direction of easy magnetization is parallel to the hexagonal axis of the crystal, and when unmagnetized the domains therefore lie in one of the two orientations parallel to this axis.

This small number of easy directions, compared with the six or eight in a cubic crystal, means that the domains are needlelike and that the whole magnetic structure may be regarded as a bundle of needles magnetized initially in either direction at random. This picture is supported by powder patterns (see fig. 29) and by the measurements made by L. H. Germer of magnetic fields close to the surfaces of a single crystal of cobalt.

The crystal anisotropy of cobalt is large, and consequently a

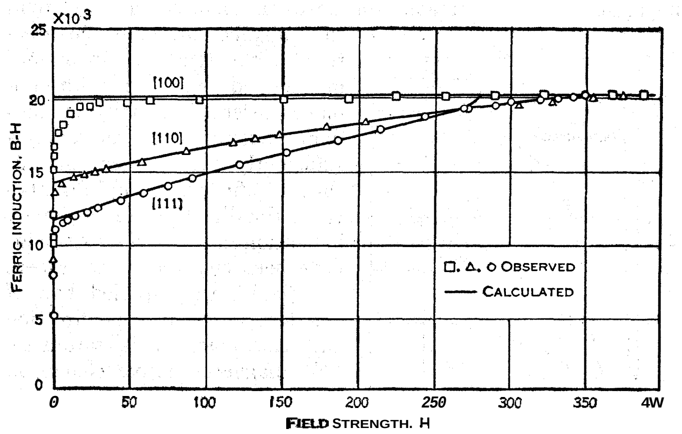

FIG. 37.— COMPARISON OF THEORY AND EXPERIMENT FOR MAGNETIZATION OF IRON-SILICON CRYSTAL IN THREE PRINCIPAL DIRECTIONS (H. J. WILLIAMS)

strong field is necessary to saturate a crystal in the direction of most difficult magnetization. More than 10,000 oersteds are required for this purpose at room temperature (fig. 39), compared with 600 oersteds for iron and 300 for nickel.

At higher temperatures cobalt becomes isotropic, and above 300° C. the hexagonal axis is the direction of most difficult magnetization. all directions at right angles to the axis being equally easy. Magnetization curves for the principal directions at room temperature and at 390° C. are shown in fig. 39.

3. Magnetostriction in Single Crystals.— The magnetostric-

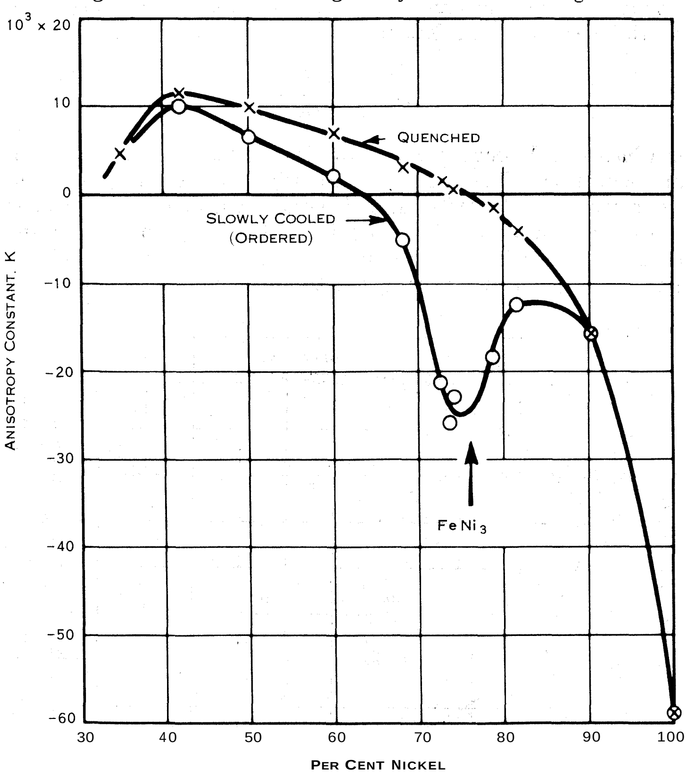

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FIG. 38.— CRYSTAL ANISOTROPY CONSTANTS OF IRON-NICKEL ALLOYS AFTER QUENCHING OR SLOWLY COOLING (R. M. BOZORTH AND J. G. WALKER)

tive change in length of a single crystal is not the same in all crystallographic directions. Especially is this true in iron which expands when the field is applied parallel to a crystal axis [100], contracts when it is applied parallel to a cube diagonal [111] (fig. 40). In the direction of the face diagonal [110] the crystal expands in low fields and contracts in high fields. Nickel contracts in all field strengths in all directions.

VIII. TEMPERATURE AND THE CURIE POINT

It bas been known for many years that when iron is heated to a high temperature it loses its ferromagnetism and is no longer

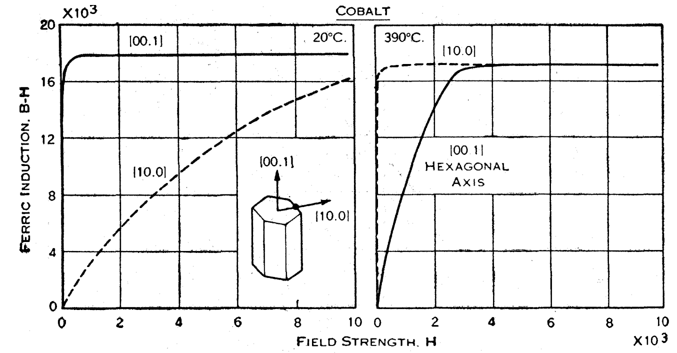

FIG. 39.— CRYSTAL ANISOTROPY OF COBALT REVERSES SIGN AT ABOUT 270" C., DIRECTION OF EASY MAGNETIZATION CHANGING FROM HEXAGONAL AXIS [00.1] BY 90" TO [10.0] (K. HONDA AND H. MASUMOTO)

strongly attracted by a magnet. The temperature at which any ferromagnetic material loses its magnetism is known as the Curie point; it is 770° C. for iron and 358" C. for nickel. The highest knonn Curie point is 1,120° C., for cobalt. For some materials the Curie point lies near the absolute zero of temperature.

When a magnetic material is subjected to a high constant field, an increase in temperature brings about a continuously accelerating decrease in induction. The induction comes down abruptly, almost to zero, at the Curie point (fig. 41), and the curve is retraced when the temperature is lowered again. On the other hand when the iron is subjected to a weak field the induction will first increase with increase in temperature and after passing through a maximum will drop to a low value at the Curie point as before.

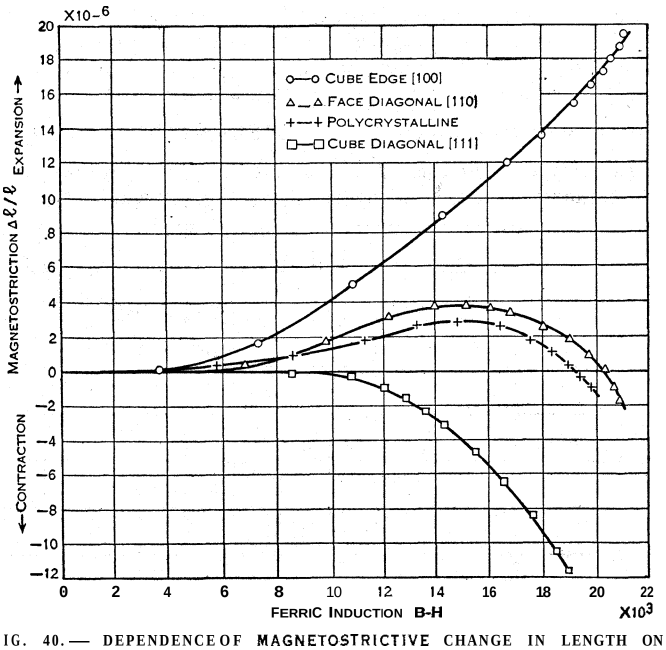

FIG. 40.— DEPENDENCE OF MAGNETOSTRICTIVE CHANGE IN LENGTH ON CRYSTAL DIRECTION IN IRON (W. L. WEBSTER)

In iron and in other materials which may be called "normal," the initial and maximum permeabilities first increase and then decrease with increasing temperature, and the coercive force and hysteresis loss continually decrease. The characteristic maximum in the initial and maximum permeabilities, just below the Curie point. is associated with the low magnetic anisotropy at this temperature. The way in which the size and shape of the hysteresis loop of iron change as the temperature approaches the Curie point is shown in fig. 42.

Iron and nickel are normal as to their magnetic behaviour with change of temperature. No changes in their crystal structures occur between room temperature and the Curie point. On the other hand such changes in structure do occur in many alloys, among which the so-called irreversible alloys of iron and nickel (5% to 30% nickel), investigated by J. Hopkinson. and some of the iron-cobalt alloys may be considered as examples. In the 60% cobalt-iron alloy a change in phase, due to a rearrangement of the atoms in the crystal. from a body-centred cubic (a) to a face-centred cubic (γ) form, occurs when the alloy is heated above 980° C. The α phase is ferromagnetic, the γ phase is nonmagnetic (*i.e.*, paramagnetic), consequently the material loses its ferromagnetism when heated through the temperature of change of phase, 980° C., and the magnetization (measured in a high field) drops toward zero precipitously (fig. 43) instead of in the normal fashion as it does for iron (fig. 41).

IX. EFFECT OF MAGNETIZATION ON OTHER PROPERTIES

Preceding paragraphs have described the magnetostriction that occurs during magnetization. Magnetization also effects changes in many other physical properties; and a ferromagnetic material, even though unmagnetized, possesses certain physical properties that are characteristic of its ferromagnetism. The more important of these properties are the following: (1) electrical resistance; (2) thermal expansion; (3) Young's modulus and other elastic constants; (4) magnetocaloric effect; (5) specific heat. The resistivity of magnetic materials is affected also by stress— tension may either increase or decrease the resistivity, depending on whether the material has positive or negative magnetostriction.

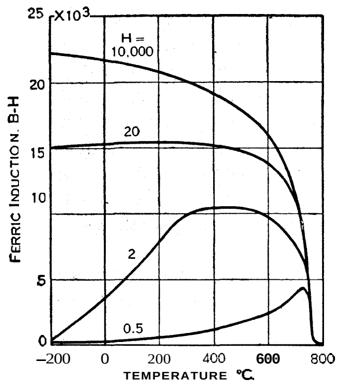

FIG. 41.— EFFECT OF TEMPERATURE

Effect of temperature on magnetization of iron subjected to fields of various strength. Magnetization drops to low value at Curie temperature, 770° C. (E. M. Terry)

1. Magnetism and **Resistivity.**—When nickel is magnetized in a high field. its electrical resistivity is increased by about 2%, and a similar but smaller effect is found in iron. Such changes were first reported by W. Thomson (Lord Kelvin) in 1851. A larger change in resistivity, as high as 4% to 5%, is shown by the iron-nickel alloys having 70% to 85% nickel. The increase in resistivity with field strength for the 84% permalloy (fig. 44) illustrates the general rule that most of the change occurs when the magnetization is well beyond the knee of the magnetization curve. and suggests that the change in resistivity, like the magnetostrictive change in length. is associated with domain rotations and not with domain reversals. There is a close relation between changes in length and changes in resistivity, and these quantities usually have a constant ratio.

The resistivity of a ferromagnetic material is abnormally low by virtue of the fact that it is ferromagnetic. This may be illustrated by comparison of the resistivities of nickel and palladium, elements occupying similar positions in the periodic table. The resistivity-temperature curves (fig. 45) are drawn so that they coincide at a temperature just above the Curie point of nickel, when both metals are nonmagnetic, and the separation of the curves below this temperature indicates the lowering of the resistivity due to the ferromagnetism. The ferromagnetism becomes progressively weaker as the Curie point is approached, and the separation of the curves in the figure correspondingly less.

2. Magnetism and Thermal Expansion.— The thermal expansion of magnetic materials is abnormal to such an extent that occasionally such a material will contract instead of expand as the temperature is raised in the vicinity of the Curie point. In some alloys, such as invar, the expansion is very small over a range of temperatures that includes room temperature, and this property is of great technical importance.

The origin of the abnormal expansion lies in the change in the forces between atoms that occurs when the material becomes ferro-

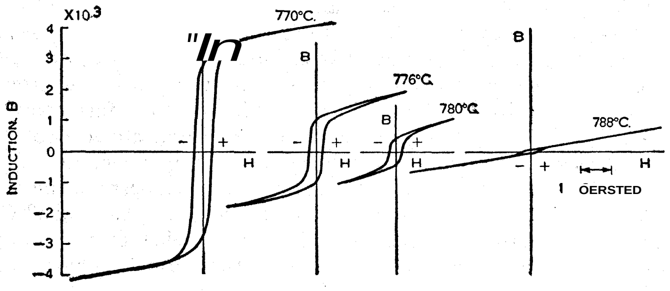

FIG. 42.—CHANGE IN FORM OF HYSTERESIS LOOP OF IRON NEAR THE CURIE POINT (H. KÜHLEWEIN)

magnetic. The iron-nickel alloys show these changes in a striking way (fig. 46). As nickel and the alloys containing more than 70% nickel cool through the Curie point, the expansion coefficients first increase and then decrease rapidly. In contrary fashion. the coefficients of alloys with 30% to 70% nickel first decrease sharply and then increase. These changes may be regarded as the result of the superposition of a "magnetic" expansion or contraction on the normal; in invar, containing about 36% nickel, the anomalous and normal expansion neutralize each other at room temperature. When the nickel content is about 70%, there is no anomalous magnetic expansion or contraction at any temperature; this is associated with the fact that at this composition the Curie point of these iron-nickel alloys is a maximum and independent of composition.

3. Abnormal Stress-Strain Relation.—In almost all substances a small mechanical stress, σ (tension), will produce a strain, ϵ (expansion), that is proportional to the stress, as required by Hooke's law

$$\epsilon=\sigma/E$$

in which Young's modulus, E, is constant. In an unmagnetized magnetic material, however, a tension will change the direction of local magnetization (fig. 35), and with such changes is bound a change in length equal to the magnetostriction of the material. Therefore, when tension is applied to a magnetic material, the whole expansion will be the sum of the normal expansion and the magnetostrictive expansion, consequently Young's modulus will vary with stress and deviations from Hooke's law occur.

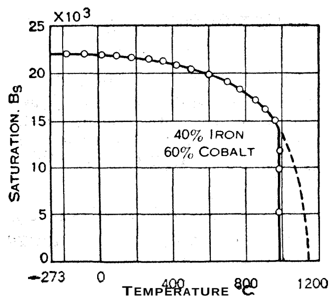

FIG. 43.—CURIE POINT DETERMINED BY CHANGE IN PHASE, AT 980° C., OF IRON-COBALT ALLOY (60% COBALT) (A. PREUSS)

In a magnetic material Young's modulus will therefore vary both with the amount of strain and with the intensity of magnetization. The change of E with magnetization has been studied in a variety of materials and may be 10% or larger.

4. Specific Heat and Magnetocaloric Effect.—In comparing the specific heats of nickel and copper at various temperatures (fig. 47) it is apparent that there is an unusual effect in nickel in the neighbourhood of the Curie point. Such a rapid rise and still more rapid drop in the curve, occurring aith rising temperature, is characteristic of a ferromagnetic material and is accounted for qualitatively and to a considerable extent quantitatively by theory. The heat necessary to raise the temperature of a magnetic material like nickel is equal to that necessary for a similar but nonmagnetic material (*e.g.*, copper), plus the heat necessary to overcome the mutual interatomic forces that hold the magnetic moments of neighbouring atoms parallel.

This characteristic specific heat of ferromagnetic bodies occurs whether or not the substance under examination is magnetized in the usual sense of the word. The existence of this phenomenon is strong evidence in favour of the existence of spontaneous

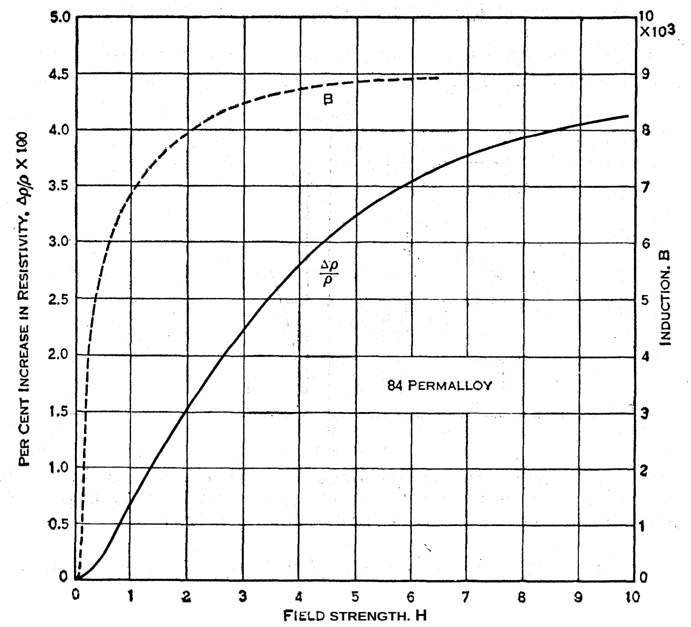

FIG. 44.— RESISTIVITY (ρ) OF MAGNETIC MATERIAL (PERMALLOY) INCREASES SLIGHTLY WITH MAGNETIZATION. MOST OF INCREASE OCCURS AFTER MAGNETIZATION IS WELL BEYOND KNEE OF MAGNETIZATION CURVE (L. W. MC KEEHAN)

magnetization in certain regions or domains in ferromagnetic materials.

Similar evidence for spontaneous magnetization is supplied by the magnetocaloric effect. According to theory, at temperatures near the Curie point high fields should increase the spontaneous magnetization, and with this increase there should be a rise in temperature of the material. Experimentally. Weiss and R. Forrer observed increases in temperature of more than 1° C. when a field of 18.000 oersteds was applied to nickel just below its Curie point. The change of spontaneous magnetization with temperature, derived from the data, is in good accord with the theory.

X. MAGNETIZATION IN ALTERNATING FIELDS

In many of their uses magnetic materials are subjected to an alternating field, produced by an alternating current in the mire

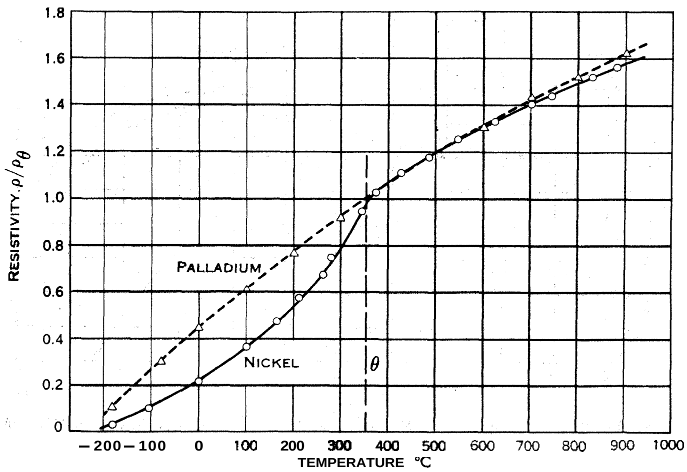

FIG. 45.— RESISTIVITY OF MAGNETIC MATERIAL IS ABNORMALLY LOW AS LONG AS IT IS FERROMAGNETIC (H. H. POTTER AND J. G. G. CONYBEARE)

associated with the material. The effects of the frequency of alternation on the magnetic properties of the material are primarily of four kinds: (1) the effective permeability of the material is reduced; (2) the energy loss in the material is increased; (3) there is a time lag between the field strength and the corresponding induction; and (4) at ultrahigh frequencies true permeability is less than at low frequencies. The distinction between effective and true permeability is discussed below.

1. Effect of Eddy Currents.—When the magnetic flux in a conducting medium changes with time, an electromotive force is generated, and there is a resulting flow of currents within the material. These Foucault currents, or eddy currents, depend on the geometry of the material specimen and on its resistivity and permeability; their direction is always such as to counteract the change in field that produced them (fig 48). The effect of eddy currents is to prevent the field from penetrating immediately to the interior of the material, and when the applied field is varying continually, as it is in much of the apparatus in which magnetic material is used, the field strength in the interior of the material may never be more than a small fraction of the field strength at the surface. The magnetic induction, therefore, decreases from the surface toward the interior.

To avoid this reduction in field strength, and resultant decrease in alternating flux, the magnetic cores of transformers and other apparatus are laminated, each lamination being insulated electrically from its neighbour. The flux-carrying capacity of such a lamination depends on the thickness (t in cm.), permeability (ρ) and resistivity (ρ in ohm-cm.$\times 10^9$) of the material and on the frequency (f in cycles/sec.) of alternation of the magnetic field. It can be calculated accurately provided the permeability does not vary with field strength, and can be expressed in terms of the effective permeability, $\bar{\mu}$, defined as the ratio of the amplitude of the induction, $\overline{B}$ (averaged over the section of the lamination), to the amplitude of the applied field strength, H_a. When H_a varies sinusoidally with time, $\bar{\mu}/\mu$ varies with frequency as is shown graphically in fig. 49.

In laminations as commonly used in power transformers, the reduction in permeability is only a fraction of 1%, and therefore negligible. When the frequency is high, $\bar{\mu}/\mu$ is inversely proportional to $\sqrt{f}$, or

$$\bar{\mu}=\frac{\sqrt{\mu\rho}}{2\pi t}\cdot\frac{1}{\sqrt{f}}.$$

In a transformer working at radio frequencies the constants of the materials used are such that 95% of the true permeability

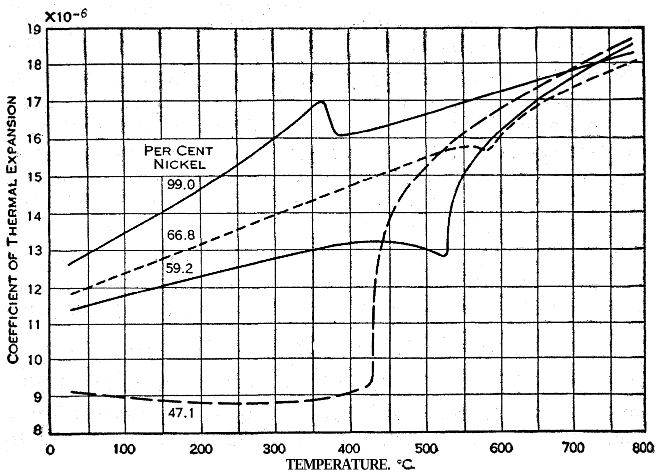

FIG. 46.— THERMAL EXPANSION CURVES OF MAGNETIC MATERIALS SHOW ANOMALIES NEAR AND BELOW CURIE POINTS (P. CHÉVENARD)

is lost. At these high frequencies the flux-carrying power or value of a material of given resistivity and thickness is directly proportional to the square root of its permeability.

2. Energy Losses in Alternating Fields.—Eddy currents in a magnetic material consume power and raise the temperature of the material. The power loss, W_e, may be calculated with some precision provided μ does not vary with B. At low frequencies it is proportional to f^2. At high frequencies it is proportional to $f^{3/2}$, if the material is always magnetized to the same value of $\overline{B}$:

$$W_e=\frac{\pi t\overline{B}^2}{\sqrt{\mu\rho}}\cdot f^{3/2}.$$

If the amplitude of the magnetizing current is held constant, the loss is proportional to $f^{1/2}$. The hysteresis loss of a magnetic

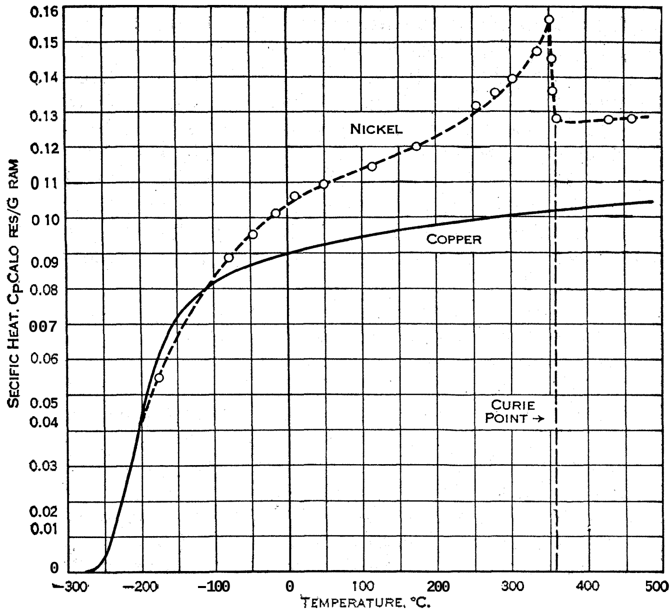

FIG. 47.— SPECIFIC HEAT OF A MAGNETIC SUBSTANCE IS UNUSUALLY HIGH. CURVES FOR NICKEL (E. LAPP) AND COPPER (H. KLINKHART) ARE COMPARED

material at intermediate and high inductions is given approximately by Steinmetz' relation (*see* above)

$$W_h=\eta B^{1.6}f.$$

The total loss due to hysteresis and eddy currents at low frequencies may then be written

$$W=W_h+W_e=\eta B^{1.6}f+AB^2f^2$$

where A can be calculated theoretically under certain conditions, as shown above. This relation is sometimes used for the separation of the total loss (as measured with a wattmeter at a given value of B) into its hysteresis and eddy components.

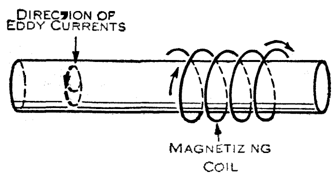

FIG. 48.—DIRECTION OF EDDY CURRENTS IN SOLID BAR

The direction is opposite to that of applied magnetizing current giving rise to them

When apparatus operates at low inductions, as it often does for transmission of the feeble signals used in communication, the energy losses incurred are usually measured with a Maxwell bridge, as described below under *XIV. Measurement of Magnetic Quantities.* The data obtained are the A.C. resistance. R, in ohms, and the inductance, L, in henries, of a coil surrounding the material under test. The ratio R/L is characteristic of the magnetic material and is related to the energy losses in ergs/cm.^{3} by the equation

$$\frac{R}{2\pi fL}=\frac{8\pi\bar{\mu}W}{B^2}.$$

The reciprocal of $R/(2\pi fL)$ is often called the quality factor, Q. When the frequency is low, the losses due to eddy currents and hysteresis may now be separated by plotting $R/(2\pi fL)$ or $R/(\mu Lf)$ against frequency. W_h varies as B^3f (see V. *The Magnetization Curve: 2. Hysteresis Loops* above) and W_e as B^2f^2, and

$$\frac{R}{\mu Lf}=aB+c+ef,$$

a relation in which a and e are called the hysteresis and eddy current constants, respectively, and c is a constant representing an energy loss of unknown origin, important only at very low inductions.

At moderately high frequencies and low inductions the losses in a material of high permeability are usually due predominantly to eddy currents. These can be calculated as described above and for them $R/(2\pi fL)$, or Q, is shown by the curve of fig. 49.

3. Effects at High Frequencies. — In considering the effect of frequency on permeability it has been assumed that the permeability, ~is independent of frequency and that only the effective permeability, $\bar{\mu}$, diminishes as the frequency increases. However, at very high frequencies, of the order of 10^9 to 10^{10} cycles/sec., the permeability decreases to a small fraction of its value at low frequency. This decrease is due primarily to the energy losses associated with rapid changes in magnetization. The losses are due to various inherent properties of the material other than eddy currents, and may be associated, for example, with the bending of domain walls.

Experiments on ferromagnetic resonance at high frequencies have yielded much information about the nature of the magnetic carriers and the forces between them, and have led to important applications of magnetic materials, especially the ferrites. The principle of the experiments and the experimental arrangements are as follows:

Imagine an electron travelling in an orbit and suspended in space as shown in fig. 50. The magnetic moment caused by the orbital motion of the electron and also by its spin can be represented by the vector M. Antiparallel to M is the vector J, which represents the angular momentum of the electron. If a magnetic field, H, is applied as indicated, the vectors M and J will precess with the frequency $MHI(2\pi J)$.

Now let us apply a small-amplitude alternating field. H_{rf}, having a direction perpendicular to H and a frequency equal to or near the precession frequency. The amplitude of the precessing magnetic moment will become larger and larger, because it is continually pulled by the alternating field, until a final amplitude is reached which depends on the internal damping or energy loss as-

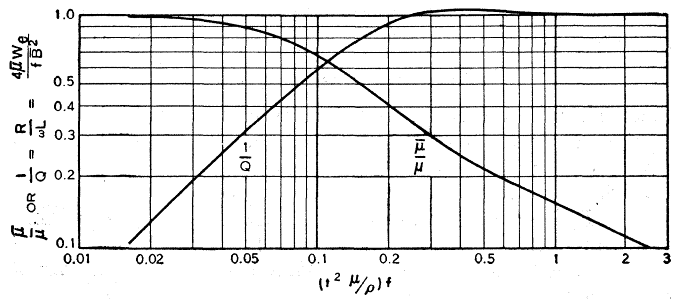

FIG. 49.— THEORETICAL CHANGE OF APPARENT PERMEABILITY. $\bar{\mu}$, AND ENERGY LOSS, W_e, DUE TO EDDY CURRENTS. WITH FREQUENCY, F, FOR SHEETS OF GIVEN THICKNESS. T(CM.), PERMEABILITY, μ, AND RESISTIVITY. ρ (OHM-CM. X 10^9)

sociated with the precession. The amplitude of the magnetic moment obtained with a given alternating field is measured, and by varying the frequency of H_{rf} until the amplitude is a maximum (at resonance) we can determine the natural frequency of precession and so the ratio M/J. The results of the experiments give fundamental information concerning the nature of the magnetic dipoles and the forces acting on them in the solid state.

In an actual material, one way of observing resonance at microwave frequencies is indicated in fig. 51. A wave guide is terminated at one end by a cavity one wave length long, and a small spherical specimen is supported at the centre of the cavity by a polystyrene rod, as shown. Under these conditions the alternating field, obtained by excitation of the wave guide, is perpendicular to the constant field, H, of several thousands of oersteds, which is supplied by an electromagnet. By measurement of the standing wave pattern in the wave guide the effective permeability of the specimen, and in particular the maximum permeability at resonance, can be determined. The results of an experiment in which the material supermalloy was excited at 24,000 mc./sec. is shown in fig. 52. The position and sharpness of the peak give basic information about the gyromagnetic properties of the atoms and the interaction between them.

F. F. Roberts observed that if a piece of magnetized magnesium ferrite is placed in a microwave transmission line the plane of polarization of the electromagnetic wave is rotated through a large angle, *e.g.*, 90° or 180°, the amount of rotation ("Faraday rotation") being governed by the intensity of magnetization of the ferrite. In manganese ferrite rotations of 90° to 180° can readily be observed. A device constructed on this principle by C. L. Hogan permits microwave transmission in one direction without appreciable loss but prevents to a high degree the transmission in the opposite direction. Such a device can be used to prevent unwanted reflections in a transmission line, and similar devices can be adapted for many kinds of microwave switching.

4. Time Lag in **Magnetization.**—As already mentioned, eddy currents cause a delay in magnetization so that after a sudden change in H from one value to another, a perceptible time elapses before B acquires its final corresponding value. There are other reasons, too, why B continues to change with time after H has become constant. One well-known cause of such change is metallurgical aging. This is usually observed in permanent magnets, the induction in h can be l l t change over a period of years, and this change is attributed to the slow precipitation of metallic phases from supersaturated solution at room temperature. Similar changes occur also in ordinary annealed iron to such an extent that the coercive force may eventually be doubled even though the material has not been heated above 100° C. Materials that have been severely cold worked sometimes become magnetically softer on account of the slow relief of the internal strains caused by the working.

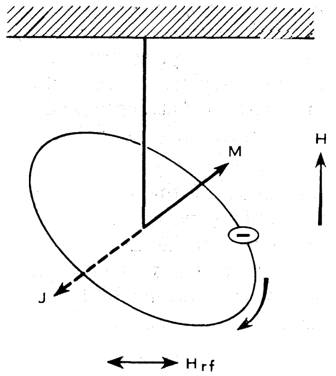

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FIG. 50.— SPINNING ELECTRON IN ORBIT

Magnetic moment M, and angular momentum J, precess under influence of applied field H. Radio-frequency field H_{rf} is applied perpendicular to H for resonance

A more rapid change of induction with time has been observed repeatedly since Ewing's experiments of **1885**. One method of experimenting is to change H suddenly, then observe the change in B as dependent on time. A second way of observing a change of magnetic state with time is to measure the permeability at very low inductions, at various times after demagnetizing and after the measuring current has been applied. Such changes are associated in some way with the impurities present, for they disappear when these are removed by heat treatment at a high temperature in hydrogen. It has been suggested that the diffusion of small traces of nitrogen or oxygen in iron will impede the movement of domain boundaries in such a way as to account for the observed changes of permeability with time.

XI. DIAMAGNETISM

Faraday showed in **1845** that all substances may be classified as diamagnetic and paramagnetic (he considered ferromagnetism to be one kind of paramagnetism). He distinguished between the paramagnetism and diamagnetism of feebly magnetic substances by suspending them in a strong inhomogeneous field and noting whether they were drawn into or repelled from the strongest part of the field.

The force with which a diamagnetic material is repelled by a field is proportional to the strength H and gradient dH/dx of the field and to the susceptibility, κ, and volume, v, of the material:

$$f=\kappa vHdH/dx.$$

The susceptibilities of solid diamagnetic substances are usually about -1×10^{-6} or -2×10^{-6}, and are normally independent of field strength. Bismuth has the exceptionally large value of -13×10^{-6}, but even in this substance the numerical value of the susceptibility is millions of times less than that of the ferromagnetic metals. Bismuth is also exceptional in that its suscep-

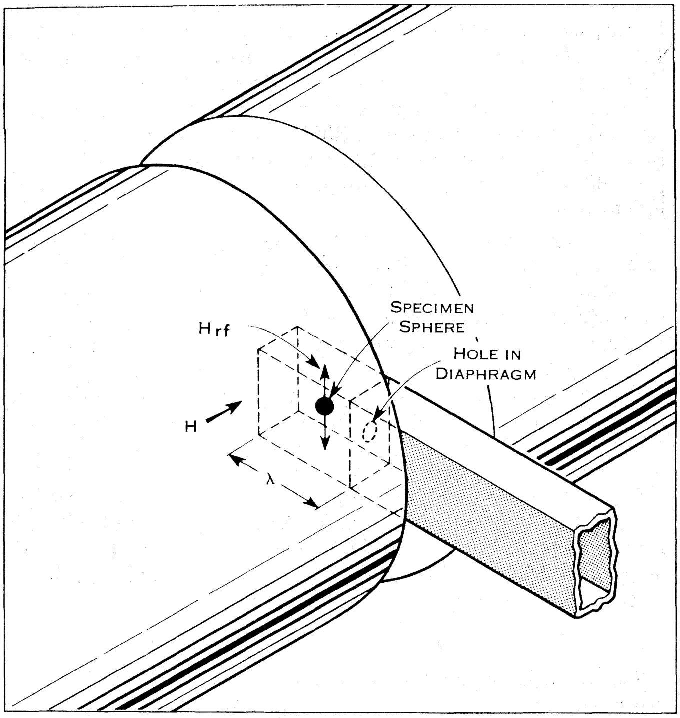

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FIG. 51.— ELECTROMAGNET WITH SECTION OF WAVE GUIDE SHOWING CAVITY USED FOR FERROMAGNETIC RESONANCE

tibility varies somewhat with the field at low temperatures (jo° K.).

While diamagnetic and paramagnetic materials are not often of technical use, as such, a study of their behaviour is very important for our scientific knowledge of the nature of matter. Diamagnetism is an atomic property, and usually occurs when the atom has a symmetrical electronic structure and no permanent magnetic moment. In discussing diamagnetism it is appropriate to use the term atomic susceptibility defined as $\chi_A=\kappa A/d$, A being the atomic weight and d the density. Then $\chi_A H$ is the magnetic moment of one gram atomic weight: and when divided by Avogadro's number is the average magnetic moment per atom resolved parallel to the magnetic field. Similarly $\chi_M=\kappa M/d$ is the molecular susceptibility. M being the molecular weight.

As P. Curie shoved in his classical researches (1895), diamagnetism is usually independent of temperature. and so is not disturbed markedly by atomic collisions or the positions of nearby atoms. However. some change in the diamagnetic susceptibility is generally noted when a substance changes from the solid to the liquid state.

Following the work of Curie, in 1910 and 1912 K. Honda and M. Owen reported measurements of the susceptibilities of many elements. Fig. 53 shows the atomic susceptibilities as dependent on atomic number according to more recent data summarized by P. W. Selwood. Here it is apparent that the rare earth metals are strongly paramagnetic, that the metals of the transition groups containing palladium and platinum are rather strongly paramagnetic and that most good metallic conductors of electricity are weakly paramagnetic. This implies what is in fact the case. that in a metal the conducting electrons are paramagnetic. The other metals and the nonmetals are usually weakly paramagnetic or diamagnetic.

Most ionic and molecular compounds are also diamagnetic because their electrons are paired and their permanent moments tend to cancel each other; however. gaseous oxygen, 0,. is paramagnetic. Fig. 54 shows the atomic or molecular susceptibilities of some typical materials and the way they change with temperature.

1. Theory.— Our understanding of the origin of diamagnetism is due largely to Langevin, who published his celebrated paper on magnetism and electron theory in 1905. He considered an atom nith a single electron of charge, e, and mass. m, travelling with velocity, v, in a circular orbit of radius, r (fig 55). This "current" gives rise to a magnetic moment, M, proportional to the current and the area of the orbit:

$$M=\frac{ve/c}{2\pi r}\cdot\pi r^2=\frac{ver}{2c},$$

where c is the velocity of light. As pointed out by Sir Joseph Larmor. application of a magnetic field H will create an electromagnetic force in the orbit, as a result of the flux threading it, and this will cause the electron to change its velocity by an amount

$$\Delta v=-\frac{eHr}{2mc}$$

in such a direction as to change the moment, M, by the amount

$$\Delta M=\frac{er\Delta v}{2}=\frac{e^2Hr^2}{4mc^2}.$$

The susceptibility of this "atom" is then $-\delta M/H$, and the susceptibility of one gram atomic weight is

$$\chi_A=-\frac{Ne^2\,r^2}{4mc^2},$$

where N is the number of molecules in a gram molecular weight. If an atom contains many electron orbits, oriented in all directions with respect to the field, the expression for atomic susceptibility becomes

$$\chi_A=\frac{Ne^2\Sigma\overline{r^2}}{6mc^2}=-2.83\times10^{10}\,\Sigma\overline{r^2}$$

in which the mean square orbital radius is summed over all the orbits in the atom.

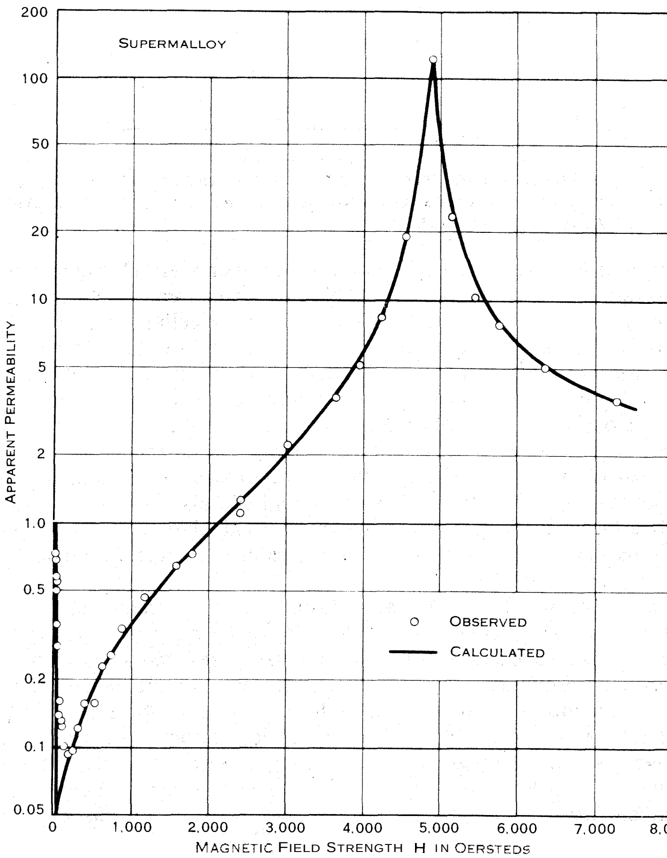

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FIG. 52.— PEAKIN PERMEABILITY AT RESONANCE (W. A. YAGER)

The equation above, known as Langevin's equation of diamagnetism, is applicable to every substance, whether it be diamagnetic or paramagnetic. If an atom has a permanent moment and the material is consequently paramagnetic or ferromagnetic, it is still true that its susceptibility has the diamagnetic component given by this equation.

Knowing the number of electrons in the atom. one may calculate from the diamagnetic susceptibility the average (root mean square) radius of an atom and compare this with the radius determined by other means. Values so obtained are consistent with our other knowledge of atomic structure.

In quantum mechanics (*q.v.*) the Langevin formula still holds when the field of the nucleus is spherically symmetrical, as it is in atoms or ions. The meaning of the orbital radius, r, however, is somewhat different. since the electrons are assumed to be distributed in less localized orbits. Calculation of diamagnetic susceptibilities by wave mechanics has been attempted for a number of the

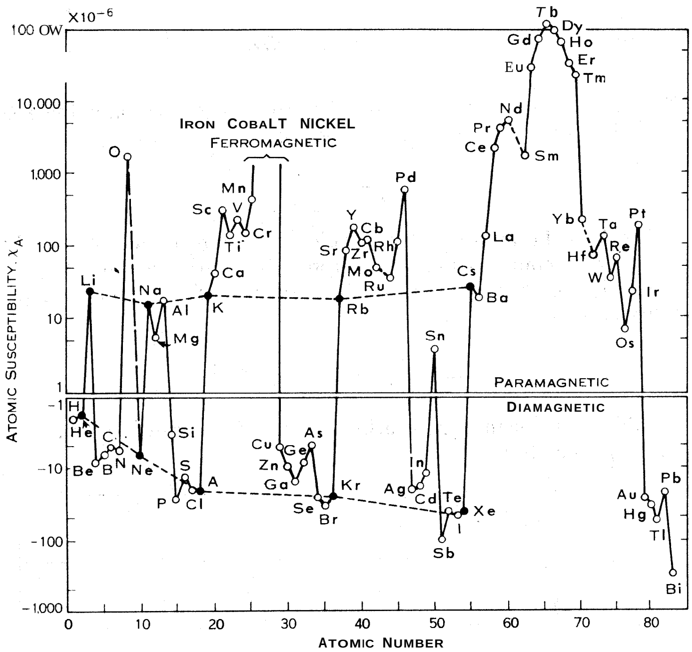

FIG 53.— ATOMIC SUSCEPTIBILITIES OF THE ELEMENTS AT ROOM TEMPERATURE. DOTTED LINES CONNECT ALKALI METALS (PARAMAGNETIC) AND RARE GASES (DIAMAGNETIC)

simple atoms and molecules and has been moderately successful for the rare monatomic gases helium, neon. argon, krypton and xenon. and for molecular hydrogen, H,. For helium. theory indicates an atomic susceptibility ($\times$ 10⁶) of 1.65 to 1.90, depending on the method of calculation; G. G. Havens' measured value is 1 9 1 For hydrogen the calculated and observed values are 2.10 and 2.01. For the other elements listed, both theoretical and measured susceptibilities vary over a greater range.

Positive ions of the alkali and alkaline earth metals and of the halogens have the rare gas structure and can also be treated theoretically. The lack of precision in the calculation arises in the approximate nature of wave functions and the effective molecular charge assumed.

2. Compounds.— Most salts are diamagnetic because the ions of which they are composed (*e.g.,* Na^+ and Cl^-) have the completed electron shells characteristic of the rare gases and consequently have no permanent magnetic moment. Measurements are made either on solid salts or on solutions, and the susceptibilities of the separate ions can be deduced from a series of such measurements. There is some ambiguity in separating the susceptibility of the salt into its component parts, and there is also some change with concentration and state of aggregation, but each ion has a value of χ_A that is approximately constant. The observed increase of χ_A with the number of electrons. n, is to be expected according to simple theory. In ions having the same number of electrons but a different nuclear charge. as in the series I-. Xe, Cs^+ and Ba^{++}, the diamagnetic susceptibility decreases numerically with increasing charge because the larger charge draws the electrons closer to the nucleus and so diminishes the value of $\Sigma\overline{r^2}$ of Langevin's equation.

The principle of additivity of the diamagnetism of ions may be extended to include also the more complex ions NO_3^-, SO_4^{--}, PO,---, NH_4^+ and others. Values for these are less certain than those for the simple ions already considered.

In his early comprehensive experiments (1908–13) P. Pascal found that the molecular susceptibility of many organic compounds is the sum of the susceptibilities of the atoms composing them, plus additional terms characteristic of the various bonds occurring in the molecule.

While the Langevin theory is not very illuminating when applied to a simple diatomic molecule like H_2, quantum mechanics can be called upon provided the wave functions are known with sufficient accuracy. In the expression for χ_M there is a term, always positive. added to the negative term of the Langevin equation.

Van Vleck and N. H. Frank have used the wave functions of molecular hydrogen to calculate both terms of the expression, and found them to be -4.66×10^{-6} and $+\ 0.51 \times 10^{-6}$. The net result of $-4.1j \times 10^{-6}$ may be compared favourably with the experimental values ranging from about -3.9 to -4.0×10^{-6}.

Calculation of heavier diatomic molecules cannot be carried out so rigorously, and the approximate wave functions generally used for these substances give too high a value of χ_M. Our knowledge of gases is also limited by the fact that measurements are difficult to make with accuracy.

XII. PARAMAGNETISM

The paramagnetism of the materials examined by Curie was dependent on temperature. the susceptibility decreasing with increasing temperature. Subsequently it was found that there is a large class of weakly paramagnetic substances for which the susceptibility is practically independent of temperature (fig. 54); this class includes many of the metallic elements when, and only when, they are in the solid conducting state. and the paramagnetism of these materials is due to the conduction electrons. This kind of paramagnetism is referred to as meak paramagnetism, whereas the former class has strong paramagnetism and is due to a permanent magnetic moment of the component atoms or molecules.

The origin of the two kinds of paramagnetism is shown schematically in fig. 56, where the curved lines represent electron shells in an atom. The outer line is broken to indicate that the electrons in this shell are loosely bound and become conduction electrons in a solid metal or valence electrons in a compound. In a metal the spins of a portion of these electrons can be changed by an applied field in a way that can be explained by quantum mechanics, and therefore give rise to weak paramagnetism as shown, for example, by metallic sodium. Most of the other shells have their full complement of electrons! and the magnetic moments due to their orbital and spin motions are self-neutralizing so that they contribute only diamagnetism to the atom. On the other hand some of the shells in some atoms are incomplete and therefore have a resultant moment that is large compared with the spin of the conduction electrons or the diamagnetic moment of the closed shells. Such incomplete shells occur notably in the iron group and rare earth group of elements, also in the palladium and platinum groups, and all of these show strong paramagnetism. In the extreme cases of the rare earth elements dysprosium and holmium, the fourth shell (fig. 56) contains electrons whose spin and orbital moments combine to give the largest magnetic moment of any atoms.

Before discussing the experimental results further it is desirable to outline the classical and quantum theories of strong paramagnetism, and the quantum theory of meak paramagnetism.

1. Langevin Theory.— Curie found that his measurements at various temperatures could be expressed by the law now known by his name:

$$\chi_M = C_M/T,$$

in which T is the absolute temperature and C_M the Curie constant characteristic of the substance. The classical theory of this kind of paramagnetism was developed by Langevin who investigated mathematically the behaviour of an ensemble of magnetic

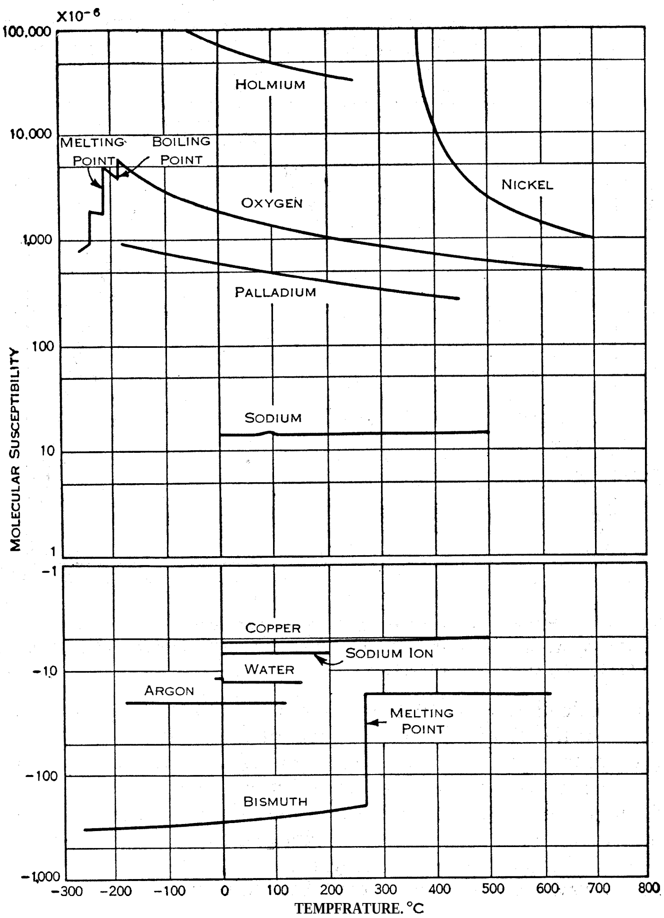

FIG. 54.— VARIATION OF ATOMIC OR MOLECULAR SUSCEPTIBILITY WITH TEMPERATURE FOR SOME REPRESENTATIVE MATERIALS

Susceptibilities of diamagnetic and weakly paramagnetic substances are normally independent of temperature, those of strongly paramagnetic substances decrease with increasing temperature

dipoles, each of moment μ_M, in a field of strength H. The effect of the field is to cause alignment, the thermal agitation to destroy this alignment. Assuming that the molecules are far enough apart so that their mutual forces can be neglected, the energy due to the field is

$$W=\mu_M H \cos \theta$$

for each dipole oriented so that its moment μ_M makes the angle θ with H. If the ensemble is subject to thermal agitation, the principles of statistical mechanics (Boltzman's equation) show that at any temperature, T, the number of dipoles oriented in the solid angle $d\omega$ about the direction θ, is proportional to

$$e^{-W/kT}d\omega=e^{(\mu_M H \cos\theta)/kT}d\omega.$$

For all the molecules the average value of the moment in the direction of the field. $\bar{\mu}_M$, is calculated, and the ratio of this to the total moment, or the moment when all magnets lie parallel, is found to be

$$\frac{\bar{\mu}_M}{\mu_M}=\operatorname{ctnh}\frac{\mu_M H}{kT}-\frac{kT}{\mu_M H}.$$

This is Langevin's equation of paramagnetism. At ordinary temperatures $\mu H << kT$, and this equation may be expanded in series form:

$$\frac{\bar{\mu}_M}{\mu_M}=\frac{\mu_M H}{3kT}-\frac{1}{45}\left(\frac{\mu_M H}{kT}\right)^3+.$$

Now the moment of a gram molecule is $N\bar{\mu}_M$ and the molecular susceptibility is then $\chi_M=N\bar{\mu}_M/H$, so that at ordinary temperatures, where the first term of this equation is sufficient, we have

$$\chi_M=\frac{N\bar{\mu}_M}{H}=\frac{N\mu_M^2}{3kT}=\frac{C_M}{T}.$$

This is Curie's law, with the Curie constant given by

$$C_M=N\mu_M^2/3k.$$

Thus Langevin's work explained Curie's law and showed how the moment per molecule could be determined from the results of experiment.

2. Quantum Theory. — The advent of quantum theory has changed our notions of atomic structure in fundamental ways, and our interpretation of paramagnetic phenomena in several particular ways now to be discussed under four headings.

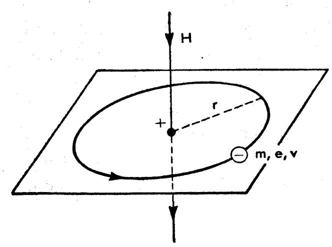

FIG. 55.— ELECTRON VELOCITY

Velocity of electron is changed by application of field **H** so that induced magnetic moment is in direction opposite to that of field

1. Langevin assumed that any orientation of magnetic moment with respect to an applied field is possible; quantum theory requires that only discrete changes of angular momentum are possible, and this imposes restrictions on the orientations of magnetic moment, As a result the Langevin equation of paramagnetism is replaced by a more complicated expression. In the simplest case, when an atom contains a single electron free to change its direction of spin. there are just two possible orientations — those parallel and antiparallel to the field—and the function becomes

$$\bar{\mu}_M/\mu_M=\tanh(\mu_M H/kT)=\mu_M H/kT+\ldots,$$

the last part being applicable when HIT is not too large. When many orientations are possible the function approaches Langevin's as a limit.

2. There is a natural unit for magnetic moment, the Bohr magneton, substantially equal to the moment of one electron spinning about its own centre. Its value is

$$\beta=eh/4\pi mc=9.27\times10^{-21}\text{ erg/gauss.}$$

Here e is the charge and m the mass of the electron, h is Planck's constant and c the velocity of light. It is convenient to convert susceptibility data to the apparent number of Bohr magnetons per atom, by dividing the moment per atom, determined from Langevin's expression for the Curie constant, by β.

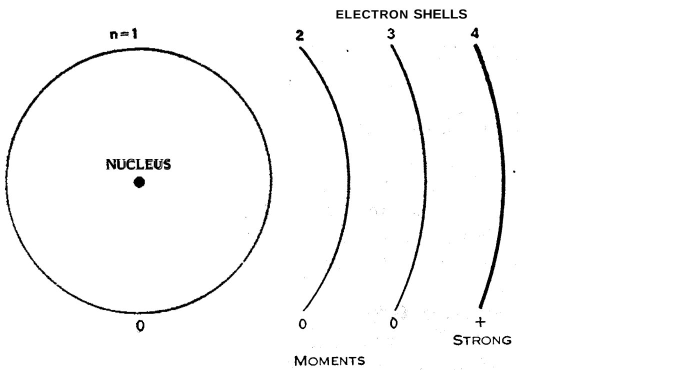

FIG. 56.— PARAMAGNETISM OCCURS WHEN INNER SHELL IS INCOMPLETE (HEAVY LINE) AND THEREFORE HAS PERMANENT MOMENT (STRONG PARAMAGNETISM), OR WHEN ELECTRONS OF OUTER SHELL (BROKEN LINE) BECOME CONDUCTION ELECTRONS IN METAL (WEAK PARAMAGNETISM)

This number is called the effective Bohr magneton number: $\mu_{eff}=\mu_M/\beta$. In terms of the Langevin theory it may be expressed

$$\mu_{eff}=\frac{\mu_M}{\beta}=\sqrt{\frac{3k\chi_M T}{N\beta^2}}=2.83\sqrt{\chi_M T}=2.83\sqrt{C_M}$$

and can be calculated provided enough is known of the structure of the atom.

3. The effective moment of an atom may change with temperature or field strength in a calculable way, and Curie's law will not then be obeyed. Under certain conditions χ_M will be of the form

$$\chi_M = \frac{N\mu_M^2}{3kT} + N\alpha.$$

Such an expression. with the constant a included, accounts quantitatively for the behaviour of some of the rare earth ions, and is applicable in principle in other cases where, however, it cannot often be worked out in detail.

4. The temperature-independent or weak paramagnetism of many metals (fig. 54) and of some conducting oxides and salts was quite inexplicable on classical theory. Quantum theory. however, provides an explanation by showing that conduction electrons, behaving as an electron gas, have just this observed character, as previously stated. Comparison of theory with experiment is discussed below.

The applications of these items to substances of various types will now be considered.

3. Rare Earths. — The ions of the rare earth elements cerium (58) to .ytterbium (70) are good examples of strongly paramagnetic substances. The permanent magnetic moment is due to the 4f subshell of the 4th electron shell in the usually trivalent ions. This inner shell is protected by the outer shells from the influence of neighbouring atoms and so the assumptions underlying the theory are fairly well satisfied.

Ionic susceptibilities are deduced from measurements on solutions and on solid salts and oxides, by subtracting the contributions of water and other ions. The susceptibilities decrease with increasing temperature, as expected. except that χ_M for the samarium ion Sm^{+++} is almost constant above room temperature and Eu^{+++} shows an almost constant susceptibility at low temperatures.

Calculation of the susceptibilities of the rare earth ions by quantum mechanics is one of the important successes of the Van Vleck theory (fig. 57), based on the earlier work of F. Hund. Both terms of the last equations above, those dependent on and independent of temperature. were derived quantitatively from theory. and the unusual change of χ_M with temperature for samarium and europium satisfactorily explained.

Rare earths in metallic form have large susceptibilities, and gadolinium and dysprosium are ferromagnetic at low temperatures. Values of $\chi_A \times 10^6$ are more than 100.000 for terbium and dysprosium at room temperature. Important deviations from Curie's law are observed, and a law of the form

$$\chi_A = C/(T-\theta)$$

is closely followed. This is the Curie-Weiss law applicable to many solid paramagnetics. particularly those in which the magnetic cores of the atoms are under the influence of magnetic or electric fields of nearby atoms: and the Langevin assumptions, therefore. not satisfied. For gadolinium, as for the other ferromagnetic elements. 0 is approximately the Curie point (see *XIII. Theory* of *Ferromagnetism* below), but the existence of θ in the Curie-Weiss equation does not mean necessarily that the material will be ferromagnetic below the temperature $T=0$; rather, the law breaks down before this point is reached.

4. Ions of the Iron Group.——Strong paramagnetism occurs also in the ions of the elements lying between scandium and copper, and is most marked in the ions of manganese. iron and cobalt. The moments of the ions are generally less than those of rare earth ions, because the shell responsible for the paramagnetism is smaller and has only 10 instead of 14 electrons when filled.

In calculating the moments from quantum theory the method used for the rare earths is not at all successful, as shown by the broken line of fig. 58. Results of calculations made with other assumptions are shown by the solid lines (a) and (b), and it is seen that the observed values lie between these curves. Stoner has indicated the reason for this. The shell responsible for the moment is the outermost shell of the ion and so is subject to the influence of surrounding ions. These affect the orbital motions in a way difficult to calculate, but if the effect is severe only the spin moments will be influenced by the magnetic field and curve (a) results. On the other hand if the interaction between neighbouring ions is weak, the orbital motions will be affected and curve

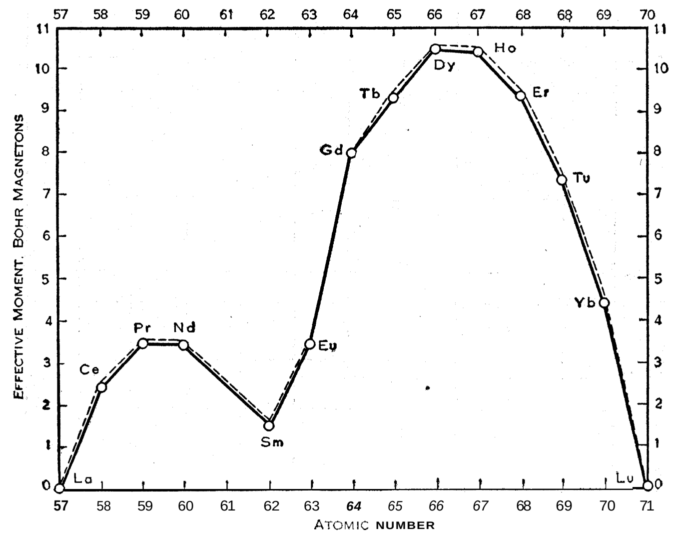

FIG 57 — EFFECTIVE MOMENT OF THE TRIVALENT IONS OF THE RARE EARTH ELEMENTS AT ROOM TEMPERATURE. BROKEN LINE SHOWS VALUES CALCULATED BY VAN VLECK THEORY

(b) is calculated; the further assumption is here made that the energy of thermal agitation is capable of changing the distribution of electron spins in the unfilled shell, an assumption cbnsistent with known facts concerning the structures of these ions. When the influence of surrounding ions on the unfilled shell is moderate, the actual ionic moments may be expected to lie between the two theoretical limits, as in fact they do.

5. Paramagnetism at Low Temperatures. — At ordinary

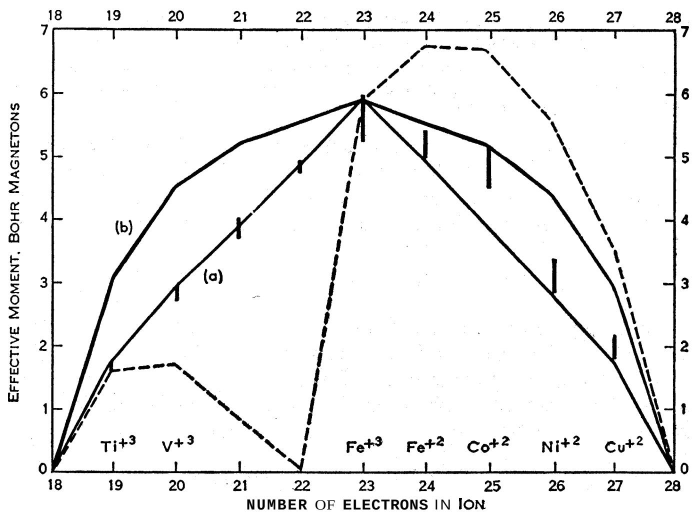

FIG. 58.— EFFECTIVE MOMENT OF IONS OF IRON GROUP OF ELEMENTS. PLOTTED AGAINST NUMBER OF ELECTRONS IN ION. VERTICAL LINES INDICATE RANGE OF OBSERVED VALUES. CONNECTING LINES THEORETICAL VALUES BASED ON DIFFERENT ASSUMPTIONS

temperatures the Langevin equation may be represented with sufficient accuracy by the first term of the series expansion, as noted above. However, at low temperatures and in strong fields $\mu_M H/kT$ may be so large that the complete equation. or its quantum equivalent, must be used. Under these conditions the susceptibility is no longer independent of the field strength, and the magnetic moment of the material approaches a limiting value corresponding to alignment of the molecular magnets parallel to the field.

The first experimental test of this phenomenon was carried out at temperatures down to 1.3° K. and field strengths up to 22,000 oersteds, and the results confirmed the theory in a satisfactory manner. A slightly different relation was predicted by quantum theory, and this agrees with experiment entirely within the limits of accuracy of the experiments.

The magnetic behaviour of certain paramagnetic salts is important in the attainment of very low temperatures. A temperature just 0.0014° above absolute zero was attained in 1951 using the paramagnetic salt chrome aluminum alum.

6. Paramagnetic Gases.—>lost monatomic gases. such as those in the eighth column of the periodic table, are diamagnetic because they have complete electron shells and. therefore, no residual magnetic moments. Metal vapours, however, have monatomic molecules in which the single electron in the outer shell should give rise to paramagnetism. Measurements on such vapours are difficult, but potassium and thallium are reported to be paramagnetic and the former obeys Curie's law over a limited range of temperatures and has a susceptibility, according to the rather inaccurate measurements, corresponding approximately to a single uncompensated electron ($\chi_M = 0.375/T$).

Molecules containing more than one atom are generally diamagnetic because they contain an even number of electrons whose moments neutralize each other. A well-known exception to this rule is oxygen (O_2). This gas follows Curie's lam ($C_M = 1.00$) except at high pressures when the Curie-Weiss law is obeyed, with the constant θ·small and negative. Liquid oxygen also follows the Curie-Weiss law, and the susceptibility increases with decreasing temperature through the solidification point.

The molecular susceptibility of nitric oxide has been measured from 20 to −160° C. (below its normal boiling point) and the effective Bohr magneton number, μ_{eff}, found to vary by about 15% over this range of temperature. Accurate calculation of μ_{eff} and its variation with temperature was carried out by Van Vleck, who based his work on the electronic structure derived from spectroscopic data. The close agreement found between calculated and observed values is a tribute to the adequacy of the theory.

7. Paramagnetism of Free Electrons.— The weak temperature-independent paramagnetism of many of the metals (fig. 53 and 54) was inexplicable on the Langevin theory, according to which all paramagnetism should decrease with increase in temperature. According to modern theory the conduction electrons of a metal have spin moments that can be oriented slightly by a magnetic field. In the simplest case, with one free electron per atom, quantum theory predicts an atomic susceptibility of $1.88 \times 10^{-6} (A/d)^{2/3}$, where A is the atomic weight and d the density in g./cm.^{3}; there is also a smaller diamagnetism predicted by quantum theory, equal to one-third the paramagnetic contribution when the electrons are free.

In actual metals the electrons are not wholly free but are partially bound to the atoms, and are influenced by the so-called correlation and exchange forces, quantum mechanical in nature. Also, the ionic core of the atom has an important diamagnetic contribution to the susceptibility. These various components have been calculated for sodium, and when summed they come within about 10% of the observed susceptibility. For other elements the calculations are less satisfactory.

The paramagnetic contributions of the electrons will vary with the nature of the metal and the diamagnetism of the ionic cores will be different for different atoms, and it is easy to see qualitatively that these and other factors will cause some metals to be weakly paramagnetic. others weakly diamagnetic. The order of magnitude of the susceptibility is explained by theory; more exact calculations must await further quantitative development of atomic theory.

8. Ferromagnetic Materials Above the Curie Point.—A11 materials that exhibit ferromagnetism are paramagnetic when they are heated above the Curie temperature. As the temperature continues to increase. the susceptibility decreases continually according to the Curie-Weiss law for strongly paramagnetic substances, unless there is a change in the phase structure of the material. If the Curie-Weiss law were followed exactly, a straight line would be obtained when $1/\chi_A$ is plotted against the temperature. The data for iron, cobalt and nickel show some variations from the expected linear relations. Definite breaks in the curve for iron are caused by changes in its crystal structure at temperatures of 910° and 1,400° C.

One should be able to calculate from the slope of each of these lines the magnetic moment per atom. and compare this with the moment calculated from the saturation magnetization determined at lower temperatures when the material is ferromagnetic. For nickel the ferromagnetic moment is 0.61 Bohr magnetons per atom. and the moment calculated from the Curie constant is 1.6 in the same units. Similar discrepancies occur for iron and cobalt. These results show that there is not an integral number of electron spins per atom; therefore the atoms will not all have the same moment at any instant. This means that the calculation of magnetic moment from the Curie constant cannot properly be made by the relation used. Modifications of the theory are necessary.

9. Paramagnetic Resonance.— Experiments on resonance at high (microwave) frequencies are carried out in the same way for paramagnetic substances as for ferromagnetic materials! as described above (X. *Magnetization in Alternating* Fields: fig. jo–jz). Resonance occurs when the frequency of the high-frequency field is

$$f = MH/(2\pi J),$$

H being the strength of thesteady magnetic field and M and J the magnetic and mechanical moments of the atom (see fig. 50). This may also be written:

$$f = g\beta H/h,$$

β being the Bohr magneton, h Planck's constant, and g the spectroscopic splitting factor which is 2.00 for electron spin and 1.00 for the orbital motion of the electron.

In solids the electron orbits in a given atom are generally fixed by the strong electrostatic fields of neighbouring atoms so that only the spin moments of the electrons are able to precess in an applied magnetic field. However, the coupling between spin and orbital motion prevents the spin from being perfectly free, and the value of g departs from the value 2.00. The amount of departure gives information about atomic forces and interactions in the solid state, and is a specific property of the material.

In a crystal the spin-orbit coupling depends on the direction in which the steady magnetic field is applied with respect to the crystal areas. Consequently the g values determined with differently oriented fields give additional valuable information about the fields of force in solids.

The nucleus of an atom may itself have a magnetic moment. This is expressed in nuclear magnetons, which are smaller than Bohr magnetons by a factor of 1,840. Nuclear moments precess in a magnetic field, and nuclear magnetic resonance is quite analogous to paramagnetic resonance. The data obtained are useful in studying nuclear structure.

10. Antiferrornagnetism.— Thereis a class of materials that are paramagnetic as judged by their small positive susceptibility, whose behaviour is interpreted in terms of a negative molecular field, or the tendency of neighbouring atomic magnets to be arranged antiparallel. This is illustrated in fig. 7(C). A typical member of this class is manganous oxide. MnO. for which the susceptibility is plotted against temperature in fig. 59. The temperature of the susceptibility maximum is called the antiferromagnetic Curie point or the Néel point; below this temperature there is antiparallel arrangement but above it the thermal agitation destroys the regular arrangement of atomic moments and the material behaves like a normal paramagnetic substance (fig. 7[A]).

The spatial orientations of the atomic moments have been determined for a number of antiferromagnetic substances with the aid of neutron diffraction. Some of the best known antiferromagnetic materials are chromium. copper chloride, ferrous fluoride, manganous oxide and nickel oxide; about jo were known in the late 1950s. Néel points are known to vary from less than 1° to 800° above absolute zero.

Generally in these materials the force bringing about the antiparallel arrangement between the atomic moments (*e.g.*, between Mn ions in MnO) is the quantum mechanical force of exchange, acting from one magnetic atom (Mn) through the intermediate nonmagnetic oxygen atom to the next magnetic atom. Such indi-

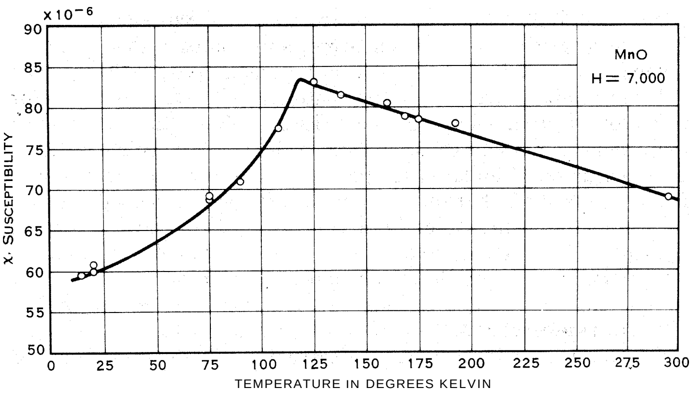

FIG. 59.— SUSCEPTIBILITY OF MnO AS DEPENDENT ON TEMPERATURE. TYPICAL OF ANTIFERROMAGNETIC SUBSTANCE. TEMPERATURE OF MAXIMUM IS NÉEL POINT (H. BIZETTE. C. F. SQUIRE. B. TSAI)

rect action has been designated by H. A. Kramers as superexchange.

It is supposed that antiferromagnetic materials form domains in much the same way as ferromagnetic materials. Such a formation, including one "wall." is shown schematically in fig. 60.

XIII. THEORY OF FERROMAGNETISM

The first requirement of a ferromagnetic material is that the atoms of which it is composed have permanent magnetic moments. The magnetic moment of an atom is due to the electrons which it contains, since the nuclear contribution is negligible. An electron possesses a magnetic moment because of its spin, and may have an additional moment by virtue of its orbital motion.

A second requirement of ferromagnetism is the existence of some kind of interatomic force that maintains the magnetic moments of many atoms parallel to each other. Without such forces the atoms would be disordered by thermal agitation and the moments of neighbouring atoms would neutralize each other, and the large magnetic moment characteristic of ferromagnetic material would not exist. The material would then be merely paramagnetic.

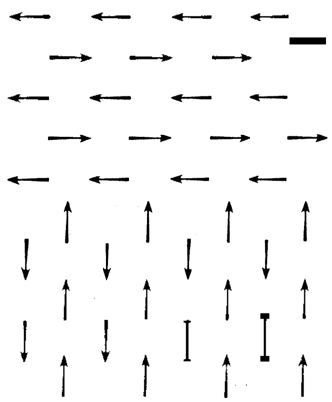

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FIG 60 —DOMAIN STRUCTURE OF ANTIFERROMAGNETIC MATERIAL DOMAIN WALL IS NOT AS SHARP AS INDICATED

Our knowledge of these interatomic forces and of the structure of the atom now permits a general description of the origin of ferromagnetism. The following steps in the theory may be enumerated: (1) the ultimate magnetic particle is the spinning electron, and a change in magnetization is fundamentally due to a change in the directions of spin of certain electrons, not to any appreciable extent to a change in their orbital motions; (2) in iron, cobalt and nickel the electrons responsible for ferromagnetism lie in the incomplete third shell of these atoms. In complete shells the electrons are arranged symmetrically so that the spins neutralize one another and the combined moment is zero; (3) in ferromagnetic materials the spins of neighbouring atoms are held parallel by strong quantum mechanical forces. whereas in the atoms of other substances the forces usually tend to make the spins of neighbouring atoms antiparallel and self-neutralizing. The circumstances under which these quantum forces effect parallel orientations and form ferromagnetic domains, or antiparallel orientations that lead to paramagnetism or antiferromagnetism, will be discussed in the following paragraphs. Before considering these steps in modern theory in detail, however, it is appropriate to recall the earlier theories and their development.

1. Early **Theories.**—Ewing was one of the first to attempt to explain ferromagnetic phenomena in terms of the forces between atoms. He assumed with Weber that each atom was a permanent magnet free to turn in any direction about its centre. The interatomic forces holding neighbouring atoms parallel were assumed to be the usual magnetic forces known to act between large-scale bar magnets. The **I,** H curve and hysteresis loop were calculated for a linear group of such magnets and were determined experimentally using models having as many as 130 magnets arranged at the points of a plane square lattice. The calculations for a linear chain show that as the field is gradually increased in magnitude from zero there is at first a slow continuous rotation of all the magnets together, then sudden change in orientation and finally a further continuous rotation until the magnets lie parallel to the field. The **I,** H curves calculated for such a group of magnets resemble in general form the actual curves of iron; they show a permeability first increasing. then decreasing, and saturation and hysteresis.

G. S. Mahajani calculated the magnetic potential energy of a group of magnets arranged in space in the same way that the iron atoms are arranged in a crystal. In agreement with Ewing's theory the magnets tend to be parallel, and some directions in the space array are more stable or preferred than others. On the other hand our present knowledge of the structure of atoms and crystals makes it clear that such magnetic furces between atoms are not large enough to maintain the magnetic moments of neighbouring atoms parallel, as they must be if ferromagnetism is to exist. Such weak forces would readily be disturbed by the thermal motion of atoms at room temperature and even at temperatures a few degrees above absolute zero.

It is now well established that there are very powerful forces, not contemplated when Ewing made his model and proposed his theory, which maintain the dipole moments of neighbouring atoms parallel. These are the electrostatic forces of exchange which will be discussed in connection with the quantum theory.

2. Molecular Field Theory.—In order to understand how atomic forces give rise to ferromagnetism it is desirable to review briefly Weiss's theory of ferromagnetism, which introduces a so-called molecular field that presently will be identified with the nature of these forces. Using an approach different from Ewing's, Weiss did not attempt to explain the nature of the interatomic forces but treated them empirically by assuming that they exerted a powerful effect which aided the applied field in lining up the atomic moments. This is an extension of Langevin's theory of a paramagnetic gas, which culminated in a formula relating the magnetization, **I,** to the field strength, H, and the temperature, T—the hyperbolic cotangent law,

$$\frac{I}{I_0}=\operatorname{ctnh}\frac{\mu_A H}{kT}-\frac{kT}{\mu_A H},$$

referred to in XII. Paramagnetism above. In deriving this, the assumptions are made that the elementary magnets, each of moment μ_A, are subject to thermal agitation and momentarily may have any orientation with respect to the direction of the field, and that they are too far apart to influence each other. Quantum theory alters the first of those assumptions by stating that in such an ensemble of elementary magnets (atoms) there will be only a limited number of possible orientations, in the simplest case only two, one parallel and the other antiparallel to the direction of the field. In this case the equation corresponding to Langevin's is

$$\frac{I}{I_0}=\tanh\frac{\mu_A H}{kT}.$$

Weiss assumed that there exists in a ferromagnetic material a molecular field, proportional to the intensity of magnetization, that aids the magnetic field already present. He therefore replaced the H of Langevin's equation by $H+NI$, calling N the molecular field constant. The resulting equation,

$$\frac{I}{I_0}=\tanh\frac{\mu_A(H+NI)}{kT},$$

is perhaps the most important in the theory of ferromagnetism. It indicates that even in zero field there is still a magnetization of considerable magnitude, provided the temperature is not too high. Putting $H=0$ and $\theta=\mu_A NI_0/k$, this equation reduces to

$$\frac{I}{I_0}=\tanh\frac{I/I_0}{T/\theta}.$$

This purports to specify the magnetization at zero applied field by a function that is the same for all materials, when the mag-

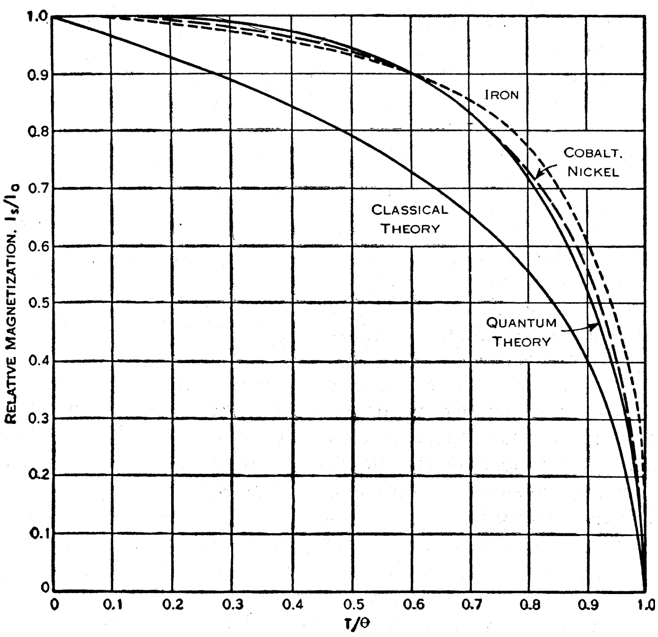

FIG. 61.— SATURATION MAGNETIZATION AS DEPENDENT ON ABSOLUTE TEMPERATURE IN RELATIVE UNITS. SOLID CURVES ARE THEORETICAL. FOR CLASSICAL (WEISS) AND QUANTUM THEORIES

netization is expressed as a fraction of its value at absolute zero (I,) and the temperature as a fraction of the Curie temperature (θ) on the absolute scale. This magnetization v. temperature relation, plotted as the upper solid line of fig. 61, means that at all temperatures below 0 the intensity of magnetization has a definite value even when no field is applied.

According to this conception the I of the last equation represents the magnetization of a domain, and is determined experimentally by measuring the magnetization of a specimen when all domains are parallel; *i.e.,* at saturation (I= I,). This equation should then be written

$$\frac{I_s}{I_0}=\tanh\frac{I_s/I_0}{T/\theta}.$$

It is well known, however. that a piece of iron may be apparently unmagnetized at room temperature. Weiss explained this by formulating the domain theory, already described above, according to which each part of a ferromagnetic material is magnetized to saturation, the magnetic moments of the separate parts being oriented in different directions so that the over-all effect is zero.

These relations are also important for ferromagnetic materials above the Curie point, when they are paramagnetic. Then I is small compared to I_0 and we may write

$$\frac{I}{I_0}=\frac{\mu_A(H+NI)}{kT}.$$

If we put $\theta=\mu_A NI_0/k$ as before, and $C=I_0\mu_A/k$, this becomes

$$I=\frac{CH}{T-\theta},$$

the Curie-Weiss law. Thus θ is explained by the existence of the molecular field, *NI,* that aids the applied field, H, in orienting the elementary magnets. However, as pointed out above, the fact that a paramagnetic substance follows this law does not mean necessarily that it will become ferromagnetic at temperatures below $T=\theta$.

3. Quantum Theory.— The nature of the molecular field was unknonn to Weiss when he developed his theory; he knew only that its power in orienting the elementary magnets was equal to that of a magnetic field of millions of oersteds (in iron, NI is as high as 7×10^6 oersteds). A rational explanation of this was first proposed in 1928 by Heisenberg who showed that it can be explained in terms of the quantum mechanical forces of exchange (see QUANTUM MECHANICS) acting between electrons in neighbouring atoms. Imagine two atoms some distance apart. each atom having a magnetic moment of one Bohr magneton due to the spin moment of one electron. **A** force of interaction, the exchange force already referred to, has been shown to exist between them in addition to the better-known electrostatic and (much weaker) magnetic forces. It is known that such quantum forces are negligible, as one would expect, when the atoms are two or three times as far apart as they are in crystals. It is supposed also, on the basis of discussions by Slater and by Bethe, that as two atoms are brought near to each other from a distance, these forces at first cause the electron spins in the two atoms to become parallel (positive interaction). As the atoms are brought nearer, the spin moments are held parallel more firmly until at a certain distance the force diminishes and then becomes zero; and with still closer approach, the spins set themselves antiparallel with relatively strong forces (negative interaction). In the curve of fig. 62 the energies corresponding to these forces are shown as a function of the distances between atoms.

The interaction curve was drawn originally for atoms with definite shell radii and varying distances from atom to atom. It may equally well be used for a series of elements if we take account of the different radii of the shell in which the magnetic moment resides. The criterion of interaction for the metals of the iron group is the radius, R, of the atom (half the internuclear distance in the crystal) divided by the radius, *r,* of the 3d shell, in which the magnetic moment resides. In fig. 62 this ratio R/r has been used as abscissa and the elements chromium to nickel have been given appropriate positions on the curve. Slater showed that the ratio R/r is larger in the ferromagnetic elements than in other elements having incomplete inner shells, and that the point at which the curve crosses from the nonferromagnetic to the ferromagnetic region is near $R/r=1.5$. This also explains why manganese becomes ferromagnetic when the atoms are separated by abnormally large distances as they are in the Heusler alloys and some compounds.

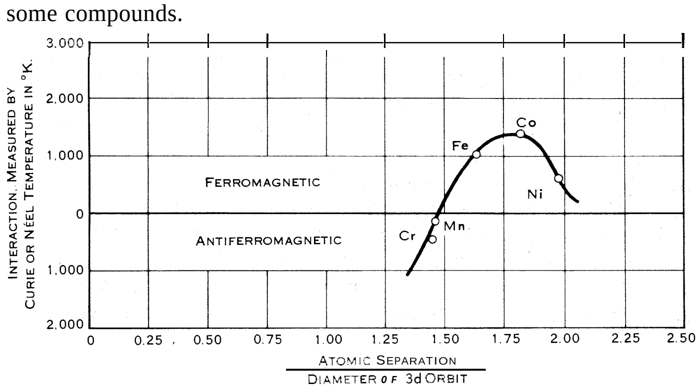

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FIG. 62.—FORM OF INTERACTION CURVE. INTERACTION MEASURED AS CURIE (OR NÉEL) POINT, θ, IN ° K.

4. Atomic Structure of Ferromagnetic Substances.— It has already been pointed out that the fundamental magnetic particle is the spinning electron. One might think that the orbital motions of the electrons in the atom would also contribute to ferromagnetism, as a result of their magnetic moments, but it

has been established that when the magnetization is altered all that changes is the direction of the spin of certain of the electrons in the atoms—the orbital motions remain practically unchanged. The experimental basis for this conclusion is the determination of the ratio of angular momentum to magnetic moment; this ratio is found, in the experiments of S. J. Barnett and others, to be appropriate to the electron spin and definitely not to the orbital moment.

The electrons that are responsible for the magnetic properties of iron, cobalt! nickel and their alloys lie in a definite shell in the atom. As shown in fig. 63, there are four shells or regions, more or less well defined, into which all the electrons circulating about the nuclei of these atoms may be divided when the atom is separated from its neighbouring atoms, as it is, for example, in a gas. Two of these shells are subdivided as shown. When the atoms come closer together to form the solid metal, the fourth or outermost shell of each becomes disrupted, and the two elec-

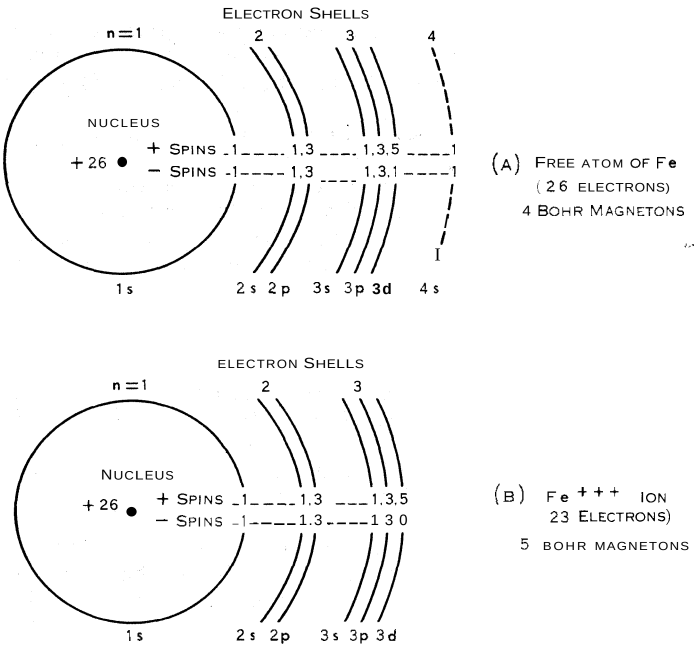

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FIG. 63.— ELECTRONSHELLS

Shells in (A) free iron atom, (B) Fe^{+++} ion. Unfilled third shell is responsible for magnetic moment. Electrons of outer 4s shell of isolated atoms become "free" electrons in the metallic state

trons which comprised it wander easily from atom to atom and are the "free" electrons responsible for electrical conduction. The electrons in the outer part of the third shell are those responsible for the ferromagnetic moment. Some of these electrons spin in one direction and some in the opposite, as indicated, so that their magnetic moments neutralize each other partially but not wholly, and the excess of those spinning in one direction (+) over those spinning in the other (−) causes each atom as a whole to behave as a small permanent magnet.

The average moment of the atom in a ferromagnetic material may be determined from the saturation magnetization. I_0, at the absolute zero of temperature by dividing I_0 by the number of atoms in a cubic centimetre. Expressed in Bohr magnetons, β, this number is

$$n_B = \frac{I_0 A}{N\beta d},$$

A being the average atomic weight, N Xvogadro's number and d the density. Moments of iron, cobalt and nickel atoms, so calculated, are

Fe	2.22 Bohr magnetons
Co	1.70
Ni	0.61

The meaning of these nonintegral values may be discussed in either of two different ways used for many problems of the solid state. In the Heisenberg method of approach the atoms have their own electrons (some atoms necessarily more than others), and the disturbing effect of the interaction between neighbours is estimated as well as possible. The other approach, followed by Bloch, Stoner and others, is to consider the metal as composed initially of ions and free electrons, and to calculate the way in which the ionic fields modify the behaviour of the electrons, making them less free. According to the latter or "collective electron" description both the 3d and 4s shells of iron, cobalt and nickel atoms are incomplete and there is a distribution of electrons between them determined by the specific nature of the atomic fields. The calculations indicate that in iron the electrons in these shells are distributed (on the average) about the nuclei as indicated in fig. 64. The 3d shell is a rather dense ring of electrons, as contrasted with the 4s shell which extends farther from the nucleus, so far that in the solid the shells of neighbouring atoms overlap considerably.

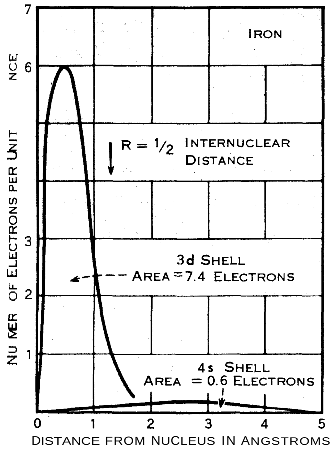

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FIG. 64.—DISTRIBUTION OF ELECTRONS IN THE 3d AND 4s SHELLS IN IRON

The above description of electron distributions in their relation to ferromagnetism is supported by experiments on the alloying of nickel with copper, zinc and other elements. The substitution of one copper for one nickel atom in the lattice is equivalent to adding one electron to the alloy. This electron seeks the place of lowest energy in the alloy and finds it in the 3d− shell of a nickel atom rather than in the copper atom to which it originally belonged. This lowers the magnetic saturation of the alloy by one Bohr unit, since the added electron in the 3d− shell just neutralizes the moment of one in the 3d+ shell. Addition of more copper to nickel decreases the average moment until the empty spaces in the 3d− shell are just full; this should occur when 60% of the atoms are copper, and then the magnetic saturation at 0° K. should be just zero. The theory is well confirmed by the data (fig. 65). When divalent zinc, having two available electrons per atom, is added to nickel the 3d shell is filled twice as fast as when monovalent copper is added, again in accordance with theory, and metals of higher valences behave accordingly.

5. Theory of Ferrites.—The relation of the atomic moments and interaction to atomic structure and interatomic distance are well illustrated by the properties of the ferrites. Nickel ferrite, for example, has the chemical composition represented by $NiO.Fe_2O_3$ or $Ni^{++}Fe_2^{+++}O_4^{--}$. The crystal structure is determined mainly by the oxygen ions, which are much larger than the metal ions and form a close-packed cubic array. Among the oxygen ions there are two kinds of openings in which the metal ions lie. In one kind of position (the A position) the metal ions are equidistant from four oxygen ions arranged at the corners of a tetrahedron; in the other kind (B position) the metal ions are surrounded by six equidistant oxygen ions placed at the corners of an octahedron. In the magnetic ferrites $NiFe_2O_4$, half of the iron ions, Fe^{+++}, are in the A sites. the other half and all of the divalent ions. Ni^{++}, are in the B sites.

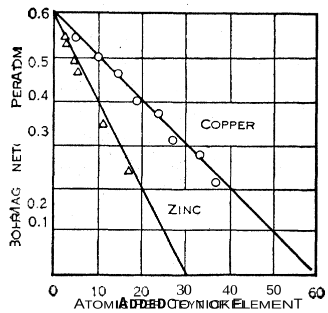

FIG. 65.—REDUCTION IN MAGNETIC MOMENT PER ATOM OF NICKEL

Reduction is caused by adding copper (with one extra electron per atom) or zinc (two per atom). Extra electrons go into unfilled shell and therefore decrease its moment (V. Marian)

The magnetic moments of the metal ions can be deduced from the number of electrons in the atom, as shown in the diagram of fig. 63. The spin moment of Fe^{+++} is five Bohr magnetons, that of Ni^{++} is two.

L. Néel showed that in the magnetic ferrites the interactions between the ions in the A and B sites are antiferromagnetic in nature so that the moments of A ions are antiparallel to those of the B ions. Since the moments are not equal the material is ferromagnetic (*see* fig. 7[D]). In the nonmagnetic zinc ferrites it is knonn that the Zn^{++} ions are on the A sites and all of the Fe^{+++} on the B sites. In magnetic $NiFe_2O_4$ and nonmagnetic $ZnFe_2O_4$ we can represent the situation as follows:

	Tetrahedral A sites	Octahedral B sites		Net moment (n_B)
Fe (NiFe)O_4:	Fe^{+++}	Ni^{++}, Fe^{+++}	O_4^{--}	
Moments:	$\overrightarrow{5}$	$\overleftarrow{2}$ $\overleftarrow{5}$		2
Zn(FeFe)O_4:	Zn^{++}	Fe^{+++} Fe^{+++}	O_4^{--}	
Rloments:	o	$\overleftarrow{5}$ $\overrightarrow{5}$		o

the moments being expressed in Bohr magnetons per molecule. The net moment of $NiFe_2O_4$ is then expected to be two Bohr magnetons. Experimentally E. W. Gorter found 2.3. At room temperature $ZnFe_2O_4$ has random directions of the Fe^{+++} moments, but below 10° K. the Fe^{+++} ions go into an antiparallel arrangement and so show a weak antiparallel or negative interaction.

Similarly one can estimate the moments for the other ferrites in the series Mn, Fe, Co, Ni, Cu, Zn with increasing atomic number. One expects the molecular moments to be just those of the divalent ions of these elements, because the two Fe^{+++} ions in the A and B positions cancel each other. Using the known moments of the divalent ions and plotting the molecular moments of the corresponding ferrites, we obtain the straight line of fig. 66. The observed moments, derived from the saturation magnetization at 0° K., are shown as points. The small discrepancy between calculated and observed moments has been attributed to the moments resulting from the orbital motions of the electrons.

The agreement betneen theory and observation shows that we have a good understanding of the atomic structure and interatomic interactions in simple ferrites.

An interesting and useful material is made by combining a small amount of nonmagnetic zinc ferrite with magnetic manganese

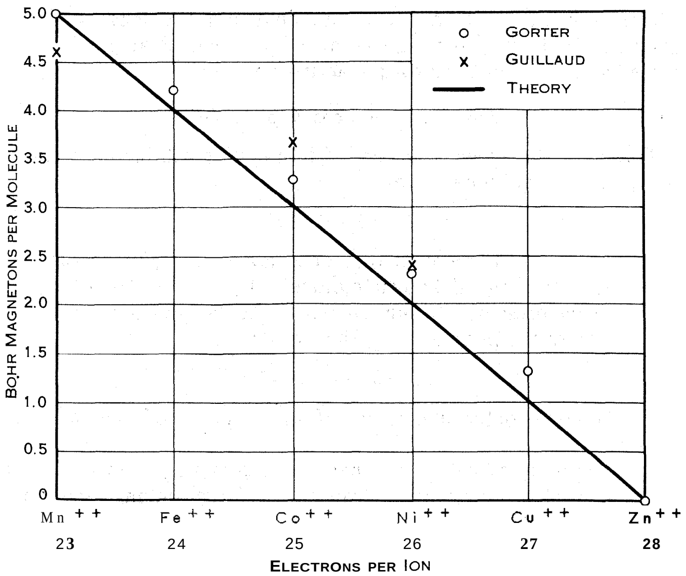

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FIG 66 — THEORETICAL AND MEASURED MOLECULAR MOMENTS OF FERRITES OF IRON-GROUP ELEMENTS

ferrite. One can calculate the magnetic moment of a mixture of 90% $MnFe_2O_4$ and 10% $ZnFe_2O_4$ as follows:

	Tetrahedral A sites	Octahedral B sites		Net moment (n_B)
$MnFe_2O_4$:	Mn^{++}	Fe^{+++},Fe^{+++}	O_4^{--}	
Moments:	$\overrightarrow{5}$	$\overleftarrow{5}$ $\overleftarrow{5}$		5
$ZnFe_2O_4$:	Zn^{++}	Fe^{+++},Fe^{+++}	O_4^{--}	
Moments:	o	5 random 5		o
0.9 $MnFe_2O_4$ 0.1 $ZnFe_2O_4$	$Zn^{++}_{0.1}$, $Mn^{++}_{0.9}$	$Fe^{+++}_{0.9}$, $Fe^{+++}_{1.1}$	O_4^{--}	
Moments: o	$\overrightarrow{4.5}$	$\overleftarrow{4.5}$ $\overrightarrow{5.5}$		5.5

If, therefore, some $ZnFe_2O_4$ is added to $MnFe_2O_4$, the Zn^{++} ions will go in the A positions and the Fe^{+++} will remain in the B

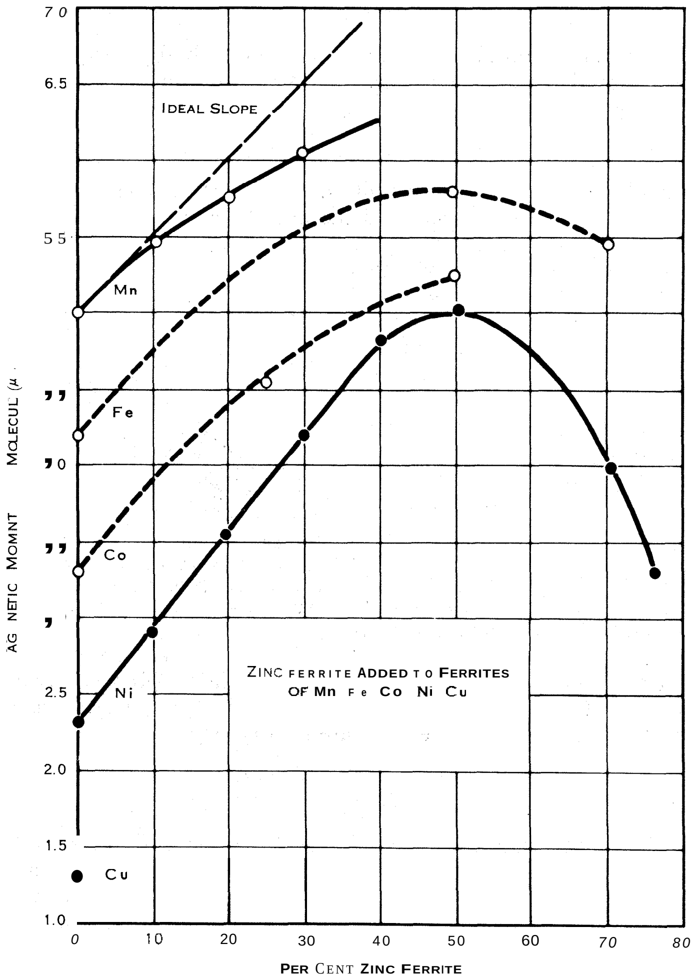

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FIG 67 — OBSERVED CHANGE IN MOMENT OF SEVERAL FERRITES BY ADDITION OF ZINC FERRITE. IDEAL THEORETICAL INCREASE IS APPROACHED FOR SMALL ADDITIONS

positions. The net moment of the chemical mixture is found to be 5.5, an increase of 0.5 over that for $MnFe_2O_4$. As long as added Zn^{++} ions go into the A positions we should expect the moment to rise as indicated by the upper broken line of fig. 6; (ideal slope), which has this same increase of 0.5 Bohr magneton for each addition of 10% of $ZnFe_2O_4$. Actually the experiments of E. W. Gorter and C. Guillaud give the data of fig. 67 for additions of $ZnFe_2O_4$ to several of the simple ferrites. The first additions give curves starting with the ideal slope. Eventually the moments of ions in the A positions are too weak to influence the moments of ions in the B positions and the mixture becomes nonmagnetic like pure $ZnFe_2O_4$.

XIV. MEASUREMENT OF MAGNETIC QUANTITIES

1. Basic Relations.—As a prelude to a discussion of the production and measurement of magnetic fields, and the measurement of magnetization, it is desirable to consider quantitatively the fields and forces excited by currents and magnets. These may be discussed according to the following list: (1) the fields produced by magnets; (2) the fields produced by currents; (3) the force on a magnet in a field; (4) the force on a current in a field; (5) the electromotive forces produced in coils by changes in induction within them. It is on these relations that most of the measurements of induction and field strength are based.

Field of a *Magnet*—Consider a bar magnet NS (fig. 68) of pole strength m and interpolar distance l and therefore magnetic moment $M=lm$. Using the fundamental relation according to which the field strength varies inversely as the square of the distance, d, from a pole,[1]

$$H=m/d^2, \qquad (1)$$

and adding vectorially the fields produced by both poles it may be shown that the field strength at distance r from the centre of the magnet is given by

$$H=(M/r^3)\sqrt{1+3\cos^2\theta}$$

provided r is large compared with l. Here θ is the angle between the axis SN of the magnet and the line OP drawn from its centre to the point. P, at which the field is observed. The direction of the field at this point is defined by φ, the angle it makes with OP prolonged. and is determined by

$$2\tan\varphi=\tan\theta.$$

A graphical construction based on this relation may be made easily by trisecting OP so that OC$=\frac{1}{2}$ CP. drawing CD at right angles to OP to cut SN produced at D. Then DP is the direction of the field at P. Here. as elsewhere in this article. H is expressed in oersteds, B in gausses, dimensions in centimetres, forces in dynes and currents in amperes.

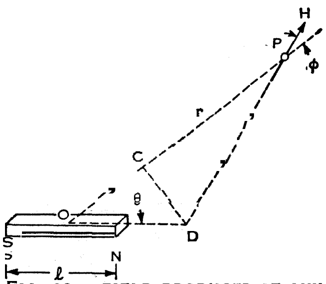

FIG. 68.—FIELD PRODUCED AT ANY POINT P BY PRESENCE OF BAR MAGNET NS DEPENDS ON DISTANCE R AND ANGLE θ

Important special cases are the end-on position (first Gaussian position) for $\theta=0$, and the broadside position (second Gaussian) for θ =go°. For these the fields are respectively

$$H_1=(2M/r^3)(1+l^2/2r^2),$$
$$H_2=(M/r^3)(1-3l^2/4r^2).$$

When two magnets are placed very close together end to end, with opposite poles m_1 and m_2 separated by a distance. d, small romnared mith the extent of the surfaces. the two magnets are attracted with a force that may be very strong. For each portion of one of the nearby surfaces the corresponding part of the other has an attraction given by the fundamental relation

$$F=\frac{m_1 m_2}{d^2}.$$

Summing for the effect of all parts of one surface on all parts of the other one can obtain

$$F=AH^2/8\pi$$

proportional to the pole area, A, but independent of the distance betneen as long as this is small.

Fields Produced by *Currents*.—The simplest way of producing a magnetic field of known strength and direction is by the use of a long coil or solenoid of wire. The field is parallel to the axis of the coil, and when a current of i amperes flows in the windings (having n turns per centimetre) the field strength within the coil is

$$H=4\pi ni/10. \qquad (2)$$

When many layers of wire are used in a solenoid that is not very long in comparison mith its diameter. the field strength varies mith the position. and can be calculated with the help of the appropriate formula.

When a field is produced by the current in a long straight wire of radius a, the direction of the field is everywhere at right angles to the wire axis, and at distance x from the axis the field strength is

$$H=\frac{2i}{10x}$$

outside the wire, while inside it the field strength is

$$a=\frac{2ix}{10a^2}.$$

To create a relatively uniform field in a large volume Hermann von Helmholtz proposed the arrangement of two thin circular coaxial coils of diameter $2a$ and axial separation a. At the centre of symmetry, 0, the field strength is

$$H=0.899\ Ni/a.$$

N is the total number of turns of wire in each coil.

Other forms of coils may be used. and the strength and direction of the field calculated by summing the fields due to each current element. The magnitude of the field dH caused by a current i flowing in an element of mire dl cm. long, at a point r cm. from the current, is given by the equation

$$dH=(i/10r^2)\ dl\ \sin\theta,$$

θ being the angle between the direction of the current and that of the line, r, connecting dl to the point. The direction of the field is at right angles to both the current and r.

Force *on Magnet* in Field.—The force on a single magnetic pole of strength m in a field of strength H is

$$F=Hm$$

dynes acting parallel to the field. In a uniform field a magnet of moment dl' is acted on by a torque tending to turn the magnet upon an axis at right angles to its length and to the field so that it will lie parallel to the field. The magnitude of this torque is

$$L=M'H\sin\alpha$$

where a is the angle between the field and the length of the magnet. If the field is produced at P by a magnet of moment M placed at O (fig. 68), the torque acting on M' is

$$L=MM'\sqrt{1+3\cos^2\theta}\ (\sin\alpha)/r^3.$$

If a pivoted magnet is suspended in a field it will have a natural period of oscillation equal to

$$T=2\pi\sqrt{K/MH}$$

seconds, if K is the moment of inertia about its point of suspension. If an additional known moment of inertia. k, is added to that already present. without changing the magnet moment, and this increases the period to T_1, the expression

$$MH=4\pi^2k/(T_1^2-T^2)$$

can be used to determine either H or M provided the other is known.

In a nonuniform field a magnet will experience a translational force as well as a torque, because the force pulling one pole parallel to the field will be opposed by a larger force caused by a larger field acting on the other pole. If the gradient of the field is dH/dx, the force on a magnet of moment M is

$$F=MdH/dx.$$

This may be expressed more accurately by the relation

$$F_x=M_x\frac{\partial H_x}{\partial x}+M_y\frac{\partial H_y}{\partial x}+M_z\frac{\partial H_z}{\partial x}$$

[1]This relation applies exactly when the magnet is surrounded hy a vacuum; when the surrounding medium is air a very small modification may be necessary. When surrounded by a medium of permeability μ the law is $H=m/\mu d^2$.

in terms of the x, y and z components of H and M. When the moment is induced by the field and is therefore

$$M = Iv = \kappa Hv,$$

the force acting on the volume, v, is

$$F = \kappa vH dH/dx. \tag{3}$$

Force on Current in Field.—When a current i flows in an element of wire of length dl in a field of strength H, a force acts on the wire of magnitude

$$F = Hidl(\sin\theta)/10. \tag{4}$$

Here θ is the angle between dl and H, and the direction of the force is at right angles to both. In two long parallel straight wires carrying currents the field of each acts on the current in the other to produce an attractive force if the currents are in the same direction, a repulsive force if they are antiparallel, of magnitude

$$F = 2ii'/(100a)$$

dynes per centimetre length of wire.

Electromotive Force Due to Changing Flux.—When an electric circuit encloses a changing magnetic flux, φ, an electromotive force is generated in the circuit proportional to the time rate of change of flux, $d\varphi/dt$, and to the number of times, N, the circuit threads the flux. Thus if N turns of wire are wrapped around a piece of iron of cross-sectional area A, and a change in the induction, B, is produced in the iron, a voltage is produced at the ends of the wire equal to 10^{-8} NA times the rate of change of induction in gausses per second:

$$E = 10^{-8}\, NA\, dB/dt.$$

The total change in B that has occurred in a specified time may be evaluated by integrating this equation with the result

$$B = 10^{8}\int E\, dt/NA. \tag{5}$$

2. Common Methods.—Ballistic *Method* With Ring.—In determining magnetization curves and hysteresis loops the ballistic method, employing a ring specimen, is generally the most satisfactory. H. A. Rowland used this method in 1873, and was the first to express the results of measurement in an absolute system. A ring is cut with a radial thickness small compared with its diameter and two uindings of wire are applied (fig. 69) ; a secondary winding (S), usually consisting of many turns of fine wire, is wound close to the specimen and connected to a ballistic galvanometer or fluxmeter (G), and a primary winding (P) of turns evenly spaced is applied and connected to a current source.

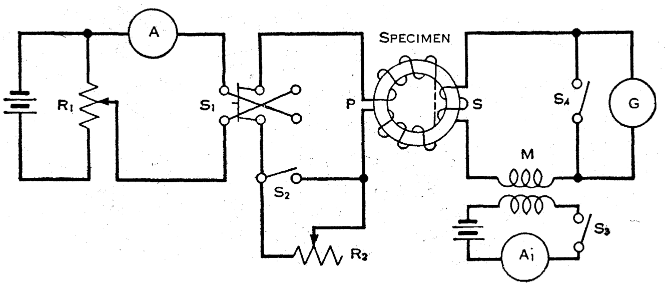

FIG. 69.— DIAGRAM OF METHOD OF MEASUREMENT OF B AND H IN RING SPECIMEN

Current in primary winding P is controlled by resistances R_1 and R_2 and switches S_1 and S_2 and is read on meter A. Secondary winding S is connected through mutual inductance M to ballistic galvanometer G. A_1 and S_3 are used for calibration

In the primary circuit means are provided for adjusting the current and for changing it rapidly from one value to another in the same or opposite direction. In the secondary circuit a mutual inductance (M) with an air core is provided for calibration and a switch for short circuiting the galvanometer. The field strength, H, is calculated according to equation (2) from the number of turns and the dimensions of the coil and the current indicated by the ammeter (A).

When H is changed suddenly from one value to another the resulting change in B induces a voltage in the coil S and causes

TABLE IV.—*Demagnetizing Factors, $N/4\pi$, for Rods and Ellipsoids Magnetized Parallel to Long Axis*

Dimensional ratio (length/diameter)	Rod	Prolate ellipsoid	Oblate ellipsoid
0	1.0	1.0	1.0
1	.27	.3333	.3333
2	.14	.1735	.2364
5	.040	.0558	.1248
10	.0172	.0203	.0696
20	.00617	.00675	.0369
50	.00129	.00144	.01472
100	.00036	.000430	.00776
200	.000090	.000125	.00390
joo	.000014	.0000236	.001567
1,000	.0000036	.0000066	.000784
2,000	.0000009	.0000019	.000392

a deflection of the galvanometer that is proportional to the change in B, according to equation (5) above (the ballistic galvanometer has a deflection proportional to $\int$Edt provided the voltage impulse occurs in an interval of time short compared with the natural period of oscillation of the galvanometer coil and mirror). Since ballistic measurements always involve differences one must start with a known value of B. The most common procedure for accomplishing this is first to reduce the magnetization to zero, or demagnetize the core, by subjecting it to an alternating field of high strength and gradually reducing the amplitude to zero. To determine a point such as M in fig. 70, current corresponding to H_1 is applied and reversed several times with the galvanometer short-circuited. to establish a steady cyclic state, and then the galvanometer is connected in and the deflection for reversal of H_1 noted. This deflection then corresponds to a change in B of $2B_1$, and B_1 can easily be calculated from the constant obtained by calibration. The point M on the normal magnetization curve is thus established and other points on the curve are determined similarly.

To determine a point, N, on a hysteresis loop the field is alternated several times between the points of the loop (*e.g.*, MM'), then H, is changed suddenly to $-H_2$ and the deflection noted and the corresponding change in B is subtracted from B_1, already determined, to give the value of $-B_2$ at N. By varying H_2, a sufficient number of points on the whole loop can be obtained.

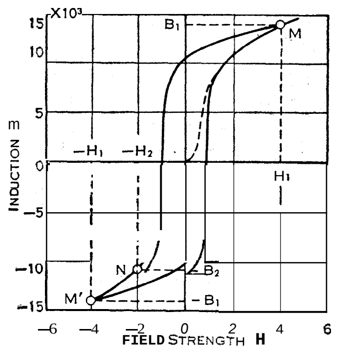

FIG. 70.— HYSTERESIS LOOP ILLUSTRATING BALLISTIC METHOD OF MEASUREMENT OF B

When field strength is changed from H_1 to $-H_1$, B changes from B_1 to $-B_1$, and galvanometer deflection measures this change in B

The ring specimen is not adapted to rapid testing, for some time is consumed in machining the ring and in winding it with wire. However, several methods are available for the rapid application of turns. Stiff wires may be held in fixed positions and arranged so that the ring will slip over many of them at once, the nires being connected together by a plug-and-socket arrangement or with mercury contacts to make a single circuit. Also, toroidal winding machines are made that apply more than 25 turns a second to a closed ring.

Ordinarily the ballistic galvanometer and ring specimen are used for fields of intermediate strength. When the field strength is high, *e.g.*, 1,000 oersteds, the number of turns in the primary winding, or the current through it, must be large and the consequent heat generated interferes with the measurements. If the field strength is too low many turns must be wound on the secondary in order to obtain a sufficiently large galvanometer deflection, and this process is tedious and under some circumstances there may not be enough space available inside the ring. In very low fields A.C. methods should be considered.

Rod *Specimens;* Demagnetizing *Factors*.—The ballistic method may be used with a straight specimen in the form of a rod, this being magnetized with the same procedure as that used for a ring. The specimen may easily be slipped into a long solenoid previously prepared. and the secondary winding or search coil should be placed around a small central portion of the specimen. Under these circumstances the more difficult quantity to determine is the field strength, because the field created by the solenoid will be disturbed by the magnetic poles of the specimen. The field created by the specimen itself is called the demagnetizing field, δH, and is proportional to the intensity of magnetization. It is usually specified by the. demagnetizing factor, N, which depends on the ratio length/diameter of the rod:

$$AH = NI.$$

The field acting on the middle of the rod is then the resultant of the field in the solenoid. H,. and the demagnetizing field, δH, and (when I is replaced by $(B-H)/4\pi$) is

$$H = H_0 - \frac{N}{4\pi}(B-H).$$

Values of $N/4\pi$ have been determined by a number of experiments and selected values are given in Table IV.

The term effective permeability, μ', is often applied to the ratio B/H_0, and its relation to the (true) permeability, μ, can be derived from the above equation:

$$1/\mu = 1/\mu' - N/4\pi$$

by considering $N/4\pi$ to be negligibly small compared with one. The relation between μ and μ' for rods of various dimensional ratios m = length/diameter is shown graphically in fig. 71. It is apparent that rods having dimensional ratios as large as 1,000 must be used to determine accurately the value of the permeability when it is more than 100,000.

In rods the induction varies from place to place in the bar, decreasing from the middle toward the ends. It is only when the specimen is in the form of an ellipsoid that the induction is uniform throughout. In specimens of such form the demagnetizing factor may be calculated accurately from the lengths of the three axes of the ellipsoid, and the direction of the induction determined. Equations are given below for the two most useful cases: (1) the prolate ellipsoid having the major axis m times the two equal minor axes, and magnetized parallel to its major axis; and (2) the oblate ellipsoid or ellipsoidal disk having two long axes each m times the short axis, the specimen being magnetized parallel to a long axis.

$$\text{Prolate: } \frac{N}{4\pi} = \frac{1}{m^2-1}\left[\frac{m}{\sqrt{m^2-1}}\log_e\left(m+\sqrt{m^2-1}\right)-1\right],$$

$$\text{Oblate: } \frac{N}{4\pi} = \frac{1}{2}\left[\frac{m^2}{(m^2-1)^{3/2}}\arcsin\frac{\sqrt{m^2-1}}{m} - \frac{1}{m^2-1}\right].$$

Values of $N/4\pi$ for various values of m are given in Table IV.

Yokes and Permeameters.—When the specimen is in the form of a straight rod or tube or tape the demagnetizing field may be partially or completely annulled by connecting the tao ends, outside the magnetizing solenoid. nith magnetic material of high permeability and large cross-sectional area. Such a yoke may be used for specimens of high dimensional ratio, and measurements made with considerable accuracy.

More often, in the testing of permanent magnets or commercial materials in the form of bars or strips. it is desirable to use a yoke with a relatively short specimen and in this case the demagnetizing field must be taken into account or annulled in some way. One way that has been satisfactorily used to accomplish both of these things is to measure the field with a ballistic galvanometer connected to a coil (H-coil) of many turns placed in the magnetizing coil near the middle of the specimen but not surrounding it (fig. 72), and at the same time to magnetize the yoke nith the current that passes through the magnetizing coil. The turns through which this current passes are adjusted to overcome the reluctance of the yoke and the air gaps that exist at each end of the specimen no matter how much care is taken to obtain good joints at these points. The search coil used in determining B is wound on the middle of the specimen as usual.

A further step toward increased accuracy was taken in the

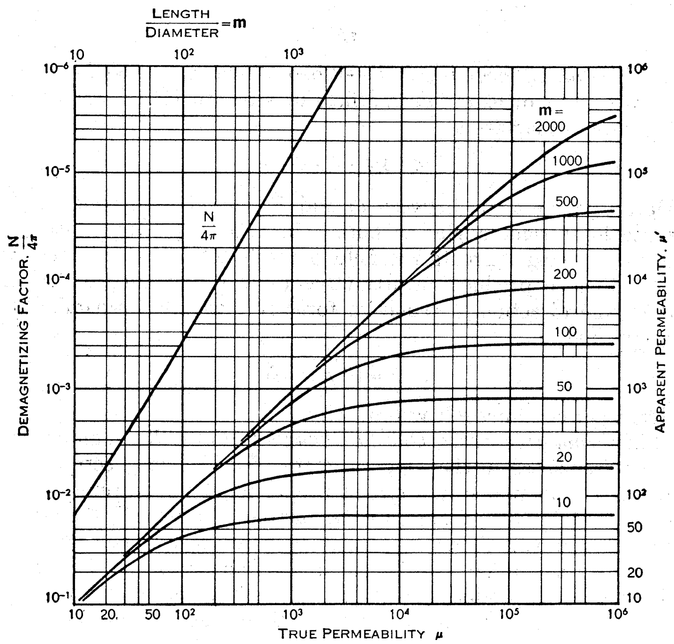

FIG. 71.— CHART FOR CONVERTING APPARENT TO TRUE PERMEABILITY. μ' TO μ, OF CYLINDERS OF GIVEN RATIO M OF LENGTH TO DIAMETER. ALSO DEMAGNETIZING FACTORS. $N/4\pi$

construction of the Burrows and the Niwa permeameters. These use auxiliary magnetizing and search coils to effect a uniform magnetization of the specimen by compensating for the air gaps that must be present. The induction is determined with a ballistic galvanometer.

Other methods of testing with a yoke mere proposed by F. P. Fahy and by **A.** Koepsel and these have been used extensively for routine testing of samples of standardized materials of moderate or low permeability. In the Fahy permeameter B and H are determined with the help of coils extending the full length

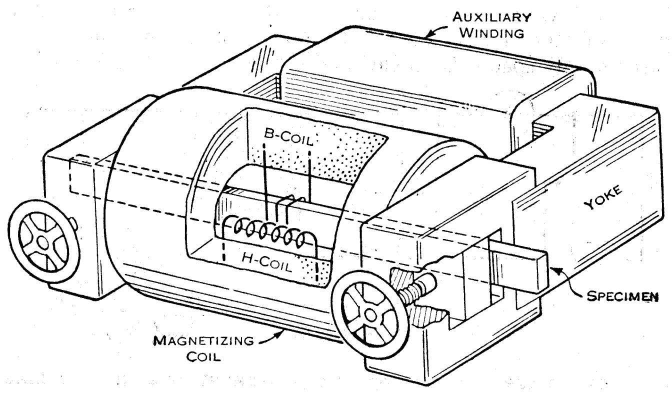

FIG. 72.— SIMPLE YOKE METHOD OF COMPENSATING DEMAGNETIZING EFFECT OF ENDS OF SHORT SPECIMEN

of the specimen and connected to a galvanometer. An auxiliary magnetizing coil is used on the yoke. The Koepsel permeameter has the advantage of being a direct-reading instrument since it requires no galvanometer. To indicate the induction in the specimen a coil of wire is placed on a delicate bearing in an air gap in the yoke. and when a constant current is passed through this coil it deflects in accordance with equation (4) by an amount proportional to the field strength in the gap, which in turn depends on the flux in the specimen.

In determining the magnetic properties of materials in high fields, of the order of *300* to 10,000 or more! it is usually desirable to use some kind of an electromagnet (*q.v.*) to create the field. One good method for determining B and H is shown in fig. *73*. The specimen S is placed in the air gap of an electromagnet EM and surrounded by a small coil B, preferably a short single layer of fine wire. This is connected to a sensitive fluxmeter G_B, the deflection of which is a measure of the flux change when the field of the electromagnet is changed.

The field strength acting on the specimen is measured by a Chattock potentiometer; this is made of many turns of fine wire, C, wound evenly on a flexible nonmagnetic form which is bent into a semicircular shape and placed against the specimen near the ends of the coil B. The deflection of the fluxmeter G_B measures the change of field strength as the coil C is brought from zero field into its place against the specimen.

A high-H permeameter was also designed by R. L. Sanford and E. G. Bennett for measurements of B in high fields.

Alternating Current *Methods.*—The principal uses of A.C. testing methods are for determining (1) permeability and energy losses of thin sheet at low inductions, usually not more than a few hundred gausses, using an inductance bridge; and (2) energy losses at high inductions, usually $B=15{,}000$, using the Epstein method.

A diagram of the inductance bridge is shown in fig. *74*. Current of the desired frequency, f, is supplied by an oscillator and fed to opposite corners of the bridge through a transformer and a thermal ammeter, A. Two equal fixed resistances R_1 constitute two arms of the bridge, and in the others are the specimen, S, and variable inductance L and resistance R. When the bridge is balanced by adjusting L and R until no voltage is detected by the phones P or other instrument connected as shown through a transformer and amplifier, then L and R are equal to the inductance and A.C. resistance of the winding enclosing the specimen. The permeability can be calculated from L and the dimensions of the specimen, the field strength from the current through the core winding and the energy loss in the specimen from the resistance R, correction being made for the losses in the copper wire. In another common modification of the Maxwell bridge the variable inductance L is removed and a variable condenser is connected in parallel with the variable resistor.

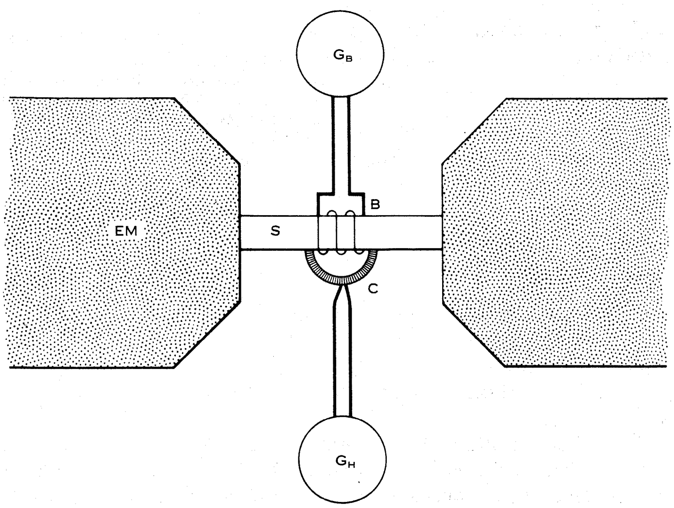

FIG. 73 — MEASUREMENT OF SPECIMEN S AT HIGH VALUES OF H
Induction is measured with coil B connected to fluxmeter G_B, H is measured with Chattock coil C. H is changed with current through electromagnet EM

To save the application of many turns of wire to the specimen, necessary nhen low inductions are measured. G. E. Kelsall has used a device indicated schematically at K in fig. 74. Instead of connecting the windings of a specimen directly to one arm of the bridge, in the usual way, there is substituted a transformer having a many-turn primary and a single-turn secondary. This turn is wound on the specimen also, and the bridge is balanced as before. The core of the transformer is made of high quality laminated material and has low losses which, however, must be taken into account and subtracted from the bridge measurement to obtain the loss in the specimen. This instrument has been adapted for use at high temperatures as well as at ordinary temperatures.

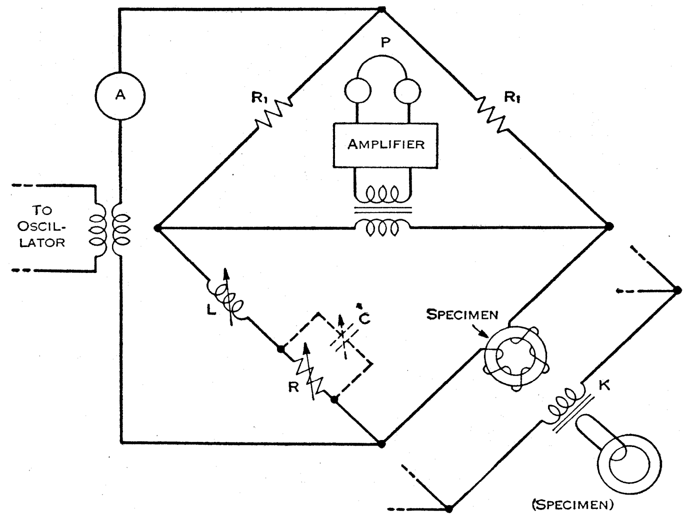

FIG. 74. — INDUCTANCE BRIDGE
The bridge measures resistance and inductance of winding surrounding specimen. Alternatively, L may be omitted and a variable condenser, C, inserted in parallel with R. Specimen may be connected through transformer K having single-turn secondary looped with specimen

In interpreting the permeability and energy losses measured by A. C. methods one must consider the apparent reduction of permeability due to skin effect or shielding caused by eddy currents. and the separable losses attributable to eddy currents and hysteresis. These data obtained with the A.C. bridge are especially important in the study of materials used in communication engineering where small magnetic fields are important in the transmission of weak or undistorted signals.

The Epstein or Lloyd-Fisher apparatus is used primarily for measuring magnetic losses in material for power and other transformers operating at high inductions. The material in the form of strips is built into a hollow square. An alternating field is applied. in one winding, to magnetize it to a high induction measured by the voltage induced in a second winding, and the loss is indicated by a wattmeter connected to the circuits of both windings (fig. 75). Both windings are placed evenly on forms with square sections. and four such forms are placed to form a hollow, square. The strips are slipped into the forms and carefully clamped at the corners after being abutted or overlapped there. Standard specifications control the manner of cutting and stacking the specimens, of correcting for the air flux in the coils and of taking into account the wave form of the exciting current. Measurements are commonly made at $B=15{,}000$ and at a frequency of 60 cycles/sec. in the U.S. and 50 cycles/sec. in England.

In principle a simple method of testing a specimen by A.C. is by determining the current-voltage characteristics of a specimen having tuo uindings. the current being a measure of H and the voltage a measure of *B*. Several ways have been used for accomplishing this. involving potentiometric measurements or rectification. From the results one can determine not only *B* and H, but also by taking account of the phase can determine the total energy loss in the material.

3. Special Methods. — Methods other than those described may be used advahtageously for special investigations.

Measurements of very small quantities of materials, of single crystals in definite directions, of paramagnetic or diamagnetic solids, liquids or gases all require specific arrangements for obtaining results of high accuracy with a minimum of effort.

Years ago the intensity of magnetization of a specimen was usually measured by the torque it exerted on a small magnetic needle of known moment suspended nearby. The deflection of a light beam by a mirror attached to the delicate suspended system is still a very sensitive indicator of the state of magnetization of a specimen under investigation, but for most purposes the uncertainty in the positions of the magnetic poles of the specimen makes the magnetometer an instrument of low precision.

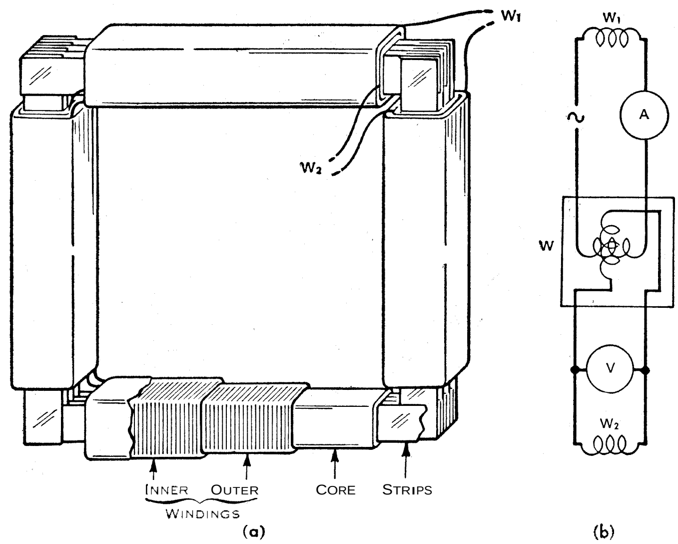

FIG. 75.— EPSTEINOR LLOYD-FISHER APPARATUS
This apparatus measures power dissipated in a specimen formed from strips. Coils, form wound as shown in (a), are connected as shown at (b) to voltmeter V and wattmeter W. Same coils are also used for ballistic measurements

In principle the magnetometer measures field strength at a known distance from the poles of the specimen. in accordance nith equation (1), $H=m/d^2$. It has been used recently for measuring, with not too great accuracy, the magnetic properties of very small specimens in the form of fine wires or thin films deposited by evaporation or electrodeposition.

Measurements of weakly magnetic substances usually depend on the translational force exerted on a magnetized body in a nonuniform magnetic field. Faraday suspended the material to be measured between the poles of an electromagnet, displaced from the central position so that the field gradient was large, and used a torsion balance to measure the force pulling the material toward the stronger part of the field or repelling it therefrom. This method was developed by P. Curie and used in his classical researches on the effect of temperature on paramagnetic and diamagnetic materials.

When the field gradient is dH/dx, the force on material of magnetic moment M is MdH/dx dynes, and when expressed in terms of susceptibility and volume (equation [3]) the force is

$$F=\kappa vHdH/dx.$$

The force is zero at the central position between the poles of the magnet because here dH/dx is zero, and the force is a maximum at some point and falls off again toward zero at points distant from the magnet.

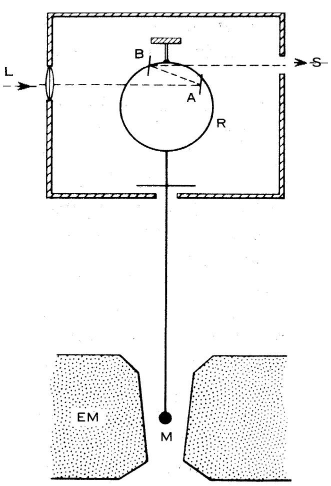

FIG. 76.—SUCKSMITH BALANCE
Specimen M is pulled into electromagnet and strains ring R by amount measured by deflection of light beam LS after reflection from mirrors AB

To avoid the laborious mapping of the field to determine the product HdH/dx, and the careful setting of the sample at a given position, C. Chéveneau proposed that the magnet be moved until the sample deviates a maximum amount from its zero position against the restoring force of a torsion balance. The deflection is then proportional to the susceptibility and to the maximum value of HdH/dx, and the proportionality factor is determined by calibration with a substance of known susceptibility.

An ingenious quick-reading device was designed by W. Sucksmith and is shown schematically in fig. 76. The specimen M is suspended from a ring R which is made of a flexible strip of metal that deforms when the specimen is pulled into the inhomogeneous field of the electromagnet EM. The deformation of the ring is measured with a beam of light L reflected from two mirrors AB to a scale S. The force that deforms the ring is proportional to the intensity of magnetization of the specimen; the constant of calibration is obtained using a magnetic material of known magnetization. The method is applicable to ferromagnetic and paramagnetic substances.

A further method of measuring magnetization in high fields is the method of extraction. used first by Weiss and R. Forrer. The specimen is placed in the field of an electromagnet and then suddenly removed. During removal it induces a voltage in a coil that is fixed to the magnet, and the integrated voltage. proportional to the magnetization of the specimen, is measured by a ballistic galvanometer.

The force exerted upon a magnetic material in an inhomogeneous magnetic field is also the basis of the methods of L. Gouy and G. Quincke for measuring the susceptibilities of liquids. There are numerous modifications of the original methods and adaptation has been made to the measurement of gases. The force on the liquid in the field is measured by its rise in a capillary tube, against the force of gravity. A simple modification is shown diagrammatically in fig. 77 which shows the poles of an electromagnet producing a high field at the surface of the liquid, the movement of which is measured by a microscope when the field is applied or removed. In using the method for gases a standard liquid of known susceptibility is employed and the gas fills the remainder of the tube. The force on the gas, caused by the field. adds vectorially to that on the liquid and the displacement of the meniscus is a measure of the resultant.

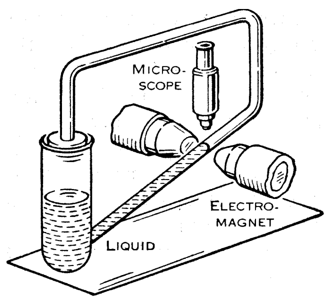

FIG. 77.— DETERMINATION OF SUSCEPTIBILITY OF LIQUID
Displacement of the liquid's meniscus in a capillary tube when the field of an electromagnet is applied in direction at right angles to tube is noted (with microscope) (L. Gouy, G. Quincke)

The force on a column of liquid (or gas) extending from a place where the field is H_1 to where it is H_0 may be obtained by integration of equation (3) to give

$$F=\kappa A(H_1^2-H_0^2)/2,$$

A being the cross-sectional area of the column. If a column of liquid (susceptibility κ_1) is opposed by a column of gas (susceptibility κ_2), the relation becomes

$$F=(\kappa_1-\kappa_2)A(H_1^2-H_0^2)/2.$$

Usually H_1 is the field strength directly between the poles of the magnet at the boundary between liquid and gas, and H_0 at the other end of the column is negligibly small. The susceptibility of gases has also been measured with the aid of a sensitive torsion balance.

The measurements of the saturetion induction of ferromagnetic materials were made with great accuracy by Weiss and his students in fields up to 20.000 oersteds, at temperatures ranging from about $-250°$ to $+800°$ C. For this purpose they used some modification of the scheme shown in fig. 78, in which the force is produced by a field gradient as in the Faraday method, but is measured as a translation instead of a torsion. Such a pendulum magnetometer has a light horizontal beam with the specimen mounted at one end in a region of high field gradient. The force due to the field is annulled by adjusting a current in a solenoid in which is a plunger attached to the other end of the beam, and the point of zero deflection is indicated by a tilting mirror.

Other methods of measurement in strong fields deserve brief mention. H. DuBois measured the intensity of magnetization by observing the rotation of the polarization of light reflecting from a magnetized surface (Kerr effect). The strength of a field can be measured by noting the change in the electrical resistance of

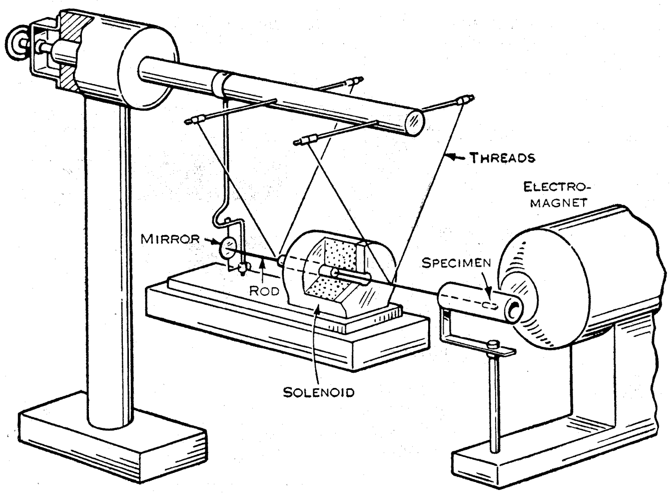

FIG. 78.—PENDULUM MAGNETOMETER

Specimen is hung from threads on light frame. Inhomogeneous field of electromagnet (half of which is shown) causes horizontal motion of frame, detected by tilting of mirror. Motion is compensated by magnetic plunger in solenoid, current through which is measure of magnetization of specimen (P. Weiss and G. Foex)

a bismuth wire immersed in the field or by observing the force (opposing gravity) produced on a conductor carrying a known current (equation [4]). Special methods have been devised for measuring the magnetic properties of materials in which these vary with direction. as in single crystals.

In weak fields, such as that of the earth. the methods of geomagnetism can be used (see GEOMAGNETISM). In 1936 an apparatus was constructed for measuring and recording rapid changes in fields as small as one gamma (10^{-5} oersted), and during and after World War II this method was developed to even higher sensitivity (10^{-7} oersted). A piece of high-permeability material is subjected to an alternating field of moderate amplitude, and if an additional steady field (that to be measured) is also present an alternating voltage of twice the exciting frequency will be produced and can be amplified and recorded. Its amplitude is proportional to the field strength to be determined.

The strength of high fields is now measured with high accuracy with the use of nuclear resonance. In principle this is the same as ferromagnetic resonance described above (X. *Magnetization* in Alternating Fields) except that the magnetic moment of the nucleus is much smaller than that of the electron so that the frequency of resonance is correspondingly lower, and for the nuclei of the hydrogen and lithium atoms. which are most used for measurement, this frequency lies in the radio-frequency range. The measurement of the field strength is then reduced to the measurement of a radio frequency, and this can readily be done with a precision of a few parts in 1,000,000. 4 material containing hydrogen or other nuclei, whose constants are known with high accuracy, is placed in the field to be measured, the weak radio-frequency field is applied at right angles to the principal field and the frequency is varied until resonance occurs.

A number of curve tracers have been made for taking magnetization curves and hysteresis loops so that a permanent accurate record may be obtained in a short time. Among the more accurate and convenient of these is the device of P. P. Cioffi. For the investigation of magnetic properties at high frequencies special techniques of some complexity must be used. (See also ELECTRICITY; ELECTROMAGNET; GEOMAGNETISM.)

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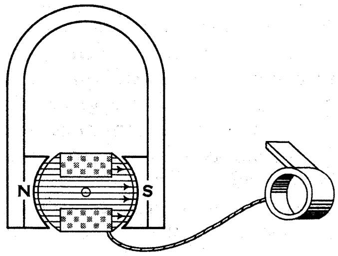
(R. M. B.)

MAGNETITE or MAGNETIC IRON ORE, a member of the spinel group of minerals with the formula Fe_3O_4 (or $FeFe_2O_4$), is an important ore of iron found in commercial quantities in northern Sweden, Norway and Rumania and in the Ural mountains; in the United States—New York, New Jersey, Pennsylvania and Utah (and in some of the ores of the Lake Superior district). It is a black, opaque mineral with metallic lustre. Hardness, about 6. Specific gravity, 4.9 to 5.2. Streak, black. Magnetite, also known as the loadstone, is strongly magnetic and frequently polar and has been known from very early times for this remarkable property which was described by Pliny (see also MAGNETISM: History). It crystallizes in the cubic system, in which it occurs usually in octahedra, and is frequently twinned. There is no distinct cleavage.

Magnetite is a mineral of wide distribution, especially as a constituent of igneous rocks, both intrusive and volcanic. It appears to have crystallized from the magma at an early period of consolidation, and marginal segregation has led in many cases to the formation of ore deposits. Being a mineral not prone to decomposition, it is also found in detrital deposits, sometimes in a concentrated form, as magnetite sand. The existence of pseudomorphs of magnetite after hematite (*q.v.*) and vice versa, however, prove that these minerals may be converted into one another by a change in the state of oxidation. Oxidation and hydration in the zone of weathering lead to limonite (*q.v.*). Titaniferous magnetite or titanomagnetite is a variety containing titanium. It consists of an intergrowth in various proportions of the minerals magnetite and ilmenite (*q.v.*).

See also IRON: Compounds of Iron; NATURAL RESOURCES: Minerals.

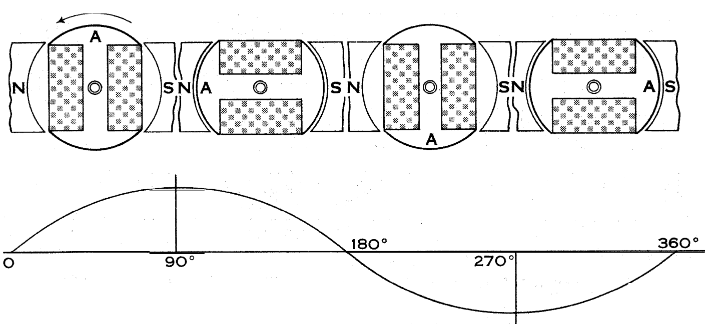
MAGNETO, HIGH-TENSION. The magneto is a special application of the electric generator employed where the output of energy required is very small. It is used to furnish energy for ignition of compressed gases in various types of internal-combustion engines. The elements of construction comprise a permanent magnetic field, an armature rotated within that field, a circuit breaker and a distributing mechanism which serves to convey the generated voltage to a desired point. The low-tension magneto consists merely of a permanent magnet of inverted U form and, rotating between its poles, a shuttle-wound armature containing a number of turns of comparatively coarse wire, as shown in fig. 1.



BY COURTESY OF J H CROWNE

FIG. 1.—SIMPLE MAGNETO SHOWING MAGNET PRIMARY WINDING

The changes of flux in the armature core, caused by its rotation in the permanent field, generate in the armature winding an electromotive force, the magnitude of which is proportional to the field strength, the speed of rotation and the number of turns of wire on the armature. As the armature core rotates into a position in a plane nith the flux lines, the flux in the core increases to a maxi-



BY COURTESY OF J H CROWNE

FIG. 2.—SIMPLE ELECTRIC WAVE FORMED IN A MAGNETO, SHOWING POSITION OF THE ARMATURE AND THE CURRENT PHASE FOR EACH POSITION

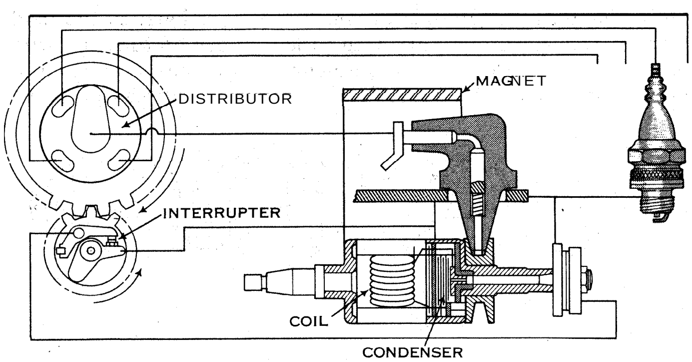
mum. As the rotation progresses, the flux in the core decreases for one-half cycle. In the second half cycle, the coil direction is reversed with relation to the flux.

The generated electromotive force, consequently, is alternating in direction and magnitude and follows the variation of flux in the core. The change of electromotive force with change of position of the armature is shown in fig. 2. The low-tension magneto has been used in conjunction with an induction coil as an ignition source, the coil serving to transform the voltage to a value sufficient to cause a spark across the terminals of a spark plug.

High-Tension Magneto Construction.—The high-tension magneto has a secondary winding, comprising a great many turns of fine wire superimposed upon the primary winding. The primary winding is short-circuited by means of an auxiliary device during the building up of the field in the armature core. When the energy in the primary circuit has reached a maximum, this circuit is opened, and at the same instant, as a result of the rotation of the armature, the magnetic field is removed. The energy of the primary winding is discharged through the secondary, and as a result of the ratio of primary to secondary turns, a considerable increase in voltage is effected. This value may vary between 7,500 and 18,000 v. The high-tension magneto when employed as a source of ignition for gas engines is operated synchronously with the engine by direct connection.

Fig. 3 shows the construction of a shuttle-armature type of high-tension magneto. The circuit breaker is operated by means of a cam, upon which the bumper, or cam follower on the breaker bar, bears. Since the armature is directly connected to the engine, the frequency of the discharges through the secondary circuit is thus determined. (A shuttle armature, having two poles, can generate two spark discharges per revolution.) The distributor serves to convey the voltage to each of the spark-plug cables, in a desired sequence. Operating in synchronism with the armature, from which it is driven by means of a gear and pinion, the brush or firing pin of the distributor arm makes contact with a segment in the distributor block each time the secondary discharge occurs. By this means, the high-tension energy is carried to each spark plug in order. For a four-cylinder engine, the distributor block carries four segments, and since the shuttle armature generates two sparks per revolution, the gear ratio between armature and distributor is 2:1. The primary and secondary windings are common at one point and are there connected to the frame of the magneto. The return circuit of the secondary is thus completed through the body of the engine. The contact points of the circuit breaker, or interrupter, are made of an arc-resistant alloy.

An improvement in magneto design was offered in the inductor-type instrument in which the coil is stationary and the flux changes are brought about by means of magnetic shunt segments which rotate between the magnet poles and bridge between them and the coil core. A cross-sectional drawing of this type is shown in fig. 4. By the use of four rotor segments, spaced 90° apart, four

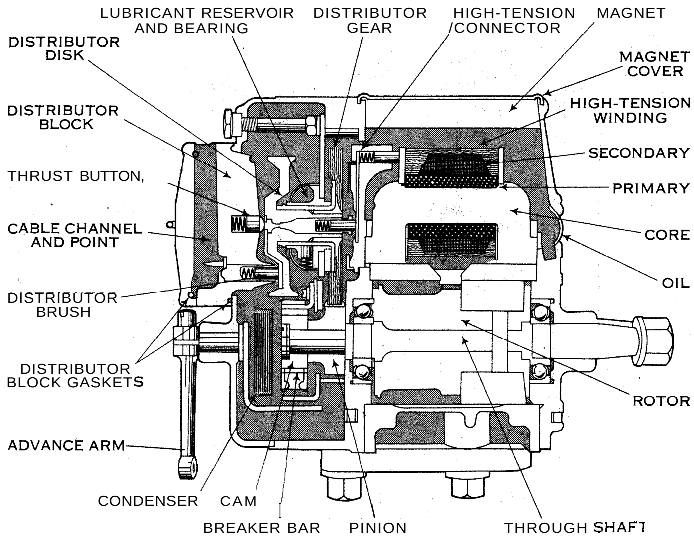


BY COURTESY OF J H. CROWNE

FIG. 3.—UNIT COIL FOR GASOLINE MOTOR IGNITION SYSTEM

sparks per revolution may be generated. In addition, the flux direction through the coil core is reversed each quarter revolution. The direction of current through the contact points of the interrupter is thus alternated, and the excessive point pitting, caused by a unidirectional arc is eliminated.

In order to vary the time of occurrence of the spark in the engine cylinder, the magneto cam, or the circuit breaker, is made



BY COURTESY OF J H CROWNE

FIG. 4.—CROSS SECTION OF INDUCTOR MAGNETO

rotatable through part of a revolution, and is connected, by means of a linkage, to a convenient advance-retard lever. This makes it possible to alter the relationship between the engine crankshaft and the magneto, and to ignite the charge either before or after the piston has reached its dead centre position. Since the spark intensity of a magneto varies directly with engine speed, there is available an increase of energy at high speed when the requirements for ignition are most severe. At low speeds of rotation such as accompany the cranking or starting of automotive engines, the magneto will sometimes fail to produce a voltage sufficient to spark across the gap. There have been in use various impulse devices, such as "impulse couplings," which serve to couple the magneto to the engine and to accelerate its rotation in starting.

The magneto is employed on aircraft engines, where the highest engine efficiency must be maintained; on tractor engines, motorcycles, marine engines and to a great extent on motorbuses and motor trucks. Stationary engines are also magneto equipped. Minor commercial uses are found in the igniting of blasting charges (detonafors), in igniters, for oil or gas burners; and, in conjunction with neon lamps, as stroboscopic indicating instruments.

See also AUTOMOBILE; INDUCTION COIL. (I. H. C.)

MAGNETOCHEMISTRY. Iron is strongly attracted by a magnet; the iron is said to be ferromagnetic. There are few ferromagnetic materials, but all other substances experience either a weak attraction or a very weak repulsion by a magnet. Substances thus weakly attracted to a magnet are said to be paramagnetic, those repelled are diamagnetic. The measure of the attraction or repulsion is called the magnetic susceptibility. Magnetochemistry is the application of magnetic susceptibilities, and of closely related quantities, to the solution of chemical problems.

There are four major applications of magnetism to chemistry. These are (1) testing for traces of certain kinds of impurities in various substances; (2) the study of free radicals; (3) examination of inorganic solids with a view to finding their structures; and (4) the study of complex compounds. These four applications will be described more fully in the following paragraphs.

Magnetic susceptibility balances may be made very sensitive for the detection of paramagnetic impurities in diamagnetic substances, and especially so for ferromagnetic impurities. Three examples will be cited. The sand used for making glass must often be as free as possible from iron. Use of the magnetic balance will often detect a very small trace of such impurity and the measurements may be made in such a routine fashion as to be simpler and cheaper than any other method of detection. Similarly, traces of iron or of other ferromagnetic substances may be detected in metals such as magnesium. A third analytical application is in measuring the concentration of oxygen in mixtures of gases. The magnetic method is a convenient analytical tool for a variety of chemical and metallurgical operations.

The second use of magnetic measurements is in the study of free radicals. These substances, of which triphenylmethyl is an example, are of very considerable theoretical interest to chemists. Most chemical substances have an even number of electrons, and are diamagnetic, but free radicals have an odd number of electrons, and are paramagnetic. Magnetic susceptibility measurements may be used to establish the presence of free radicals, to estimate their amount and to follow the chemical changes which they undergo, all in a very satisfactory manner.

A field of much interest and promise is the application of magnetic methods to the study of inorganic solids, particularly those solids of interest in catalysis. The possibility of relationships between catalytic activity on the one hand and magnetic properties on the other has interested many workers. It cannot be denied that those chemical elements, such as chromium and nickel, which show the most pronounced catalytic activity are the elements which show the most interesting magnetic effects. This is not to say that all catalytic activity is caused by magnetism, but rather that catalysis and magnetism may, in some cases at least, have some common underlying basis.

In a few cases it is possible to predict whether or not a substance will sho catalytic activity, solely on the basis of magnetic measurements. Superactive catalysts, and catalysts showing undesirable side effects, may not infrequently be identified through use of the magnetic method.

The final application which mill be mentioned is to complicated compounds, of which hemoglobin will serve as an example. Hemoglobin is the red matter in blood. It serves in the blood as the carrier of oxygen. Hemoglobin is composed in part of a complex compound containing iron. This substance is paramagnetic. When hemoglobin takes up oxygen, as it does in passing through the lung tissues, it becomes diamagnetic. From this change it is possible to draw conclusions concerning the spatial arrangement of the various atoms which make up the molecule of hemoglobin. Conclusions may also be drawn as to the mode of linkage between the hemoglobin and the oxygen. Similar studies have been made on a very wide range of complex compounds containing iron, nickel, cobalt and many other elements. See MAGNETISM; CATALYSIS.

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(P. W. S.)

MAGNETOMETER, an instrument for measuring a magnetic force. Although the term is often applied to any instrument for measuring the external field caused by a magnet, it has become attached more specifically to instruments for measuring the earth's magnetism. Such instruments can be used for measuring the intensity of one or more components. the direction of the total field vector or one of its components. In practice, usually one of the intensity components is measured together with the direction of the total field vector, and the field or other components are then computed.

Magnetometers can be classified as (1) absolute magnetometers; (2) relative magnetometers; and (3) variometers. Absolute magnetometers measure the magnetic force without reference to any other standards except those of mass. length and time. Relative magnetometers require comparison with absolute instruments to determine certain fundamental constants that can be determined only with great difficulty, or occasionally not at all; or involve the use of standards of electric current, resistance or voltage. Variometers are used for measuring the variations in the force from time to time between two points in space. A set of variometers for recording time variations of the magnetic field is called a magnetograph.

The absolute magnetometers in use at the majority of magnetic observatories are those that measure the horizontal intensity of the earth's magnetic field by the classical method of C. F. Gauss. Gauss's method permits the measurement of the intensity through two experiments. The first observation is the determination of the period of oscillation of a magnet. The magnet is suspended on a fibre of negligible torsion in a closed housing free from air currents. The period of oscillation is measured, and is a function of the strength of the magnet, its magnetic moment and the strength of the horizontal component of the field. In the second experiment, this magnet is used to deflect a second magnet suspended in a similar manner. Gauss made these deflection observations by keeping the magnet in a fixed position at right angles to the magnetic meridian. Johann von Lamont later revised this procedure, and by means of a theodolite magnetometer could keep the two magnets at right angles during the experiment. In the first experiment, ihe relationship between the values of the horizontal field and the magnet are expressed as:

$$MH = \frac{4\pi^2 I}{T^2}$$

where H is the horizontal intensity of the earth's field; M is the moment of the magnet; I is the moment of inertia of the magnet and supporting holder; and T is the time of one oscillation.

The moment of inertia of the magnet and its support cannot be computed readily because the shape is irregular and dissimilar materials are used. It is therefore determined experimentally by attaching a cylindrical bar or ring whose moment of inertia can be computed from its dimensions and mass.

In the second experiment, folloning Lamont's method. the relationship between the field and the deflection angle is:

$$\frac{H}{M} - \frac{2}{r^3 \sin \delta}$$

where H and M are as above; r is the distance between the centres of the two magnets; and δ is the deflection angle. By combining these two equations, the final value is:

$$H^2 = \frac{87r^2 1}{T^2 r^3 \text{ sins}}$$

In practice. various corrections are applied to allow for the effects of torsion in the fibre. induction in the magnets, coefficients of distribution of magnetism in the magnets, temperature coefficients of the magnet and the deflection bar, etc. Errors are kept down to 0.00008 gauss.' where one gamma (y) is $\frac{1}{100.000}$ gauss.

Relative magnetometers are finding increased usefulness for magnetic survey work and as control instruments at magnetic observatories. The reliability of these instruments has been greatly enhanced by virtue of the new magnetic steels and by the use of modern techniques in measuring electrical quantities on some instruments that operate on electromagnetic principles.

One of the most nidely used relative magnetometers, known as the QHM (quartz horizontal magnetometer), was developed by D. La Cour of the Danish Meteorological institute. It consists of a magnet with an attached mirror suspended by a quartz fibre. It operates on the principle of balancing the torque exerted on the magnet by the earth's horizontal magnetic field against the torque exerted by the fibre when twisted through exactly 2π (360°) radians. The torsion coefficient of the fibre and the moment of the magnet are so related that for the value of horizontal intensity in most latitudes. $HM > 2\pi\phi$ (H is horizontal intensity; M, the moment of the magnet: ϕ, the coefficient of torsion). The suspended system is so arranged that when the magnet is in the magnetic meridian, the mirror is perpendicular to the axis of the telescope attached to the instrument. The image of the scale in the Gaussian eyepiece of the telescope may be viewed through the mirror. and the telescope set perpendicular. To make a measurement, the instrument is first set in the magnetic meridian by bringing the central mark on the scale into coincidence with its image as seen in the mirror. The magnet is left unclamped and the instrument is then rotated slowly through an angle $2\pi + \delta$ to coincidence of the two lines. The instrument is then rotated in the opposite direction through an angle $4\pi + \delta$ to coincidence. The horizontal intensity is then given by:

$$H = \frac{2\phi}{M \sin 6} = \frac{C}{\sin \delta}$$

C is a constant determined by comparison with standard instruments. Corrections must be applied for the temperature coefficients of the magnet and the quartz fibre.

The QHM is also widely used at fixed observatories for the determination of the magnetic declination by sighting at a mark whose azimuth is known.

A companion instrument of the QHM is the BMZ (magnetometric zero balance) for measuring the vertical intensity. It is similar to the local vertical intensity variometer in principle. The instrument is equipped with two auxiliary magnets, the upper one for establishing the mean value at which the instrument will operate, and a lower magnet used to reach a balanced condition. The indicating or balanced magnet is made from one piece of magnet steel and consists of the magnet, mirror and steel knife-edges. The knife-edges of the magnet rest on cylindrical quartz bearings. A small telescope with Gaussian eyepiece similar to that used in the QHM is used to determine the balanced or horizontal position of the magnet. The observation is made by freeing the balanced magnet and rotating, about a horizontal axis, the lower or turn magnet. The angle through which this lower magnet must be turned to reach a balance is a measure of the vertical intensity. The constants of the instrument must also be determined by comparison with standard instruments. Corrections are applied for the temperature coefficients of the two magnets.

Electromagnetic Magnetometers.—Electromagnetic instruments constitute a large class of relative magnetometers. They all depend upon the comparison of the magnetic field of the earth with the magnetic field produced by a coil through which a measured electric current is flowing. As the electrical standards are accurate to about 1 part in 100,000, they are inferior to the accuracy of standards of length and time. These electromagnetic types of instruments are gradually replacing the older magnetometers and are becoming increasingly important.

The sine galvanometer designed by S. J. Barnett consists of a Helmholtz coil (a system of circular coils giving a uniform field near the axis between them) with the windings in spirals upon a marble cylinder. The dimensions of the coil are accurately measured so that the field produced by this coil can be computed. A small magnet is suspended at the centre of the coil for determining the magnetic meridian as well as the resultant direction after the field from the coil is applied.

In making the measurement, a fixed current is applied and the sine galvanometer is rotated about its vertical axis until the resultant field (*i.e.*, between the coil and the horizontal component of the earth's field) is perpendicular to the axis of the coil. The sine of the angle (6) between the axis of the coil and the direction of the earth's field is a measure of the horizontal intensity and is given by:

$$H = \frac{Ci}{\sin 6}$$

in which i is the current and C is the coil constant which has been accurately calculated from the measurements of the dimensions of the coil.

The Schuster-Smith coil magnetometer, used extensively in England and Canada, is similar to the sine galvanometer except that the current applied to the coil is adjusted so that the field produced by the coil is slightly greater than the horizontal component of the earth's magnetic field. The coil is then turned on its vertical axis nearly 180° with the direction of the earth's magnetic field until the suspended magnet is at right angles to the magnetic meridian. Then $H = H_c \cos \propto$, where H is the value of the horizontal component of the earth's field, H_c is the field produced by the coil and $\propto$ is the angle between the magnetic meridian and the axis of the coil.

Other electromagnetic instruments have been designed for the measurement of the vertical intensity, such as the instrument designed by D. W. Dye, a counterpart of the Schuster-Smith magnetometer. The coil is a Helmholtz system on a precision-ground marble form, similar to the coils of the instruments mentioned above. The current in the coil is adjusted till the magnetic field at the centre just nulls the vertical intensity. Then: $Z = Ci$, where Z is the vertical intensity of the earth's magnetic field; C is the coil constant determined from measurements of the dimensions of the coil; and i is the current. A number of devices have been applied for determining the condition of neutralization of the component being measured. In the Dye coil magnetometer, a small flat coil free to swing about a horizontal axis is used. A comparatively strong alternating current, of frequency equal to that of the mechanical resonance vibration of the coil, is applied to the coil through the suspension wires. This coil acts as a small magnet except that the axis is being continually reversed by the alternating current. The coil will vibrate about the suspension under the action of the vertical magnetic field, except when the earth's vertical component has been exactly nulled by the field of the Helmholtz coil.

Another type of null indicator for the electromagnetic instruments is a small coil rotating about a suitable axis within the fixed coil. The output from this coil is usually amplified and the output from this amplifier fed into a suitable detector. This method is capable of high accuracy, since the coupling between the fixed coil and the rotating coil may be calculated accurately to correct for their finite dimensions.

Military requirements of World War II led to the development of a number of devices usable as null detectors which employed a new principle. These detectors depend upon the ability of very weak fields to produce magnetic saturation of certain alloys of iron, nickel and cobalt. If an alternating and symmetrical magnetic force is applied lengthwise to a rod of suitable dimensions and composition, the magnetic flux changes in the rod will be symmetrical. But if there is a small ambient magnetic field parallel to the rod, the flux changes will exhibit pronounced asymmetry. The sensitivity of this effect is sufficiently great that it may be used for the detection of extremely small fields.

Several different methods have been devised for applying this principle to the measurement of magnetic fields. In one of these methods, an alternating magnetomotive force is applied to the permeable material through a coil. Asymmetrical flux changes in the material are revealed by the appearance of voltages in the exciting coil at twice the frequency of the exciting current, voltages which may be filtered out and measured. Another device employs two such units with the axes parallel, side by side or in line, the exciting coils being connected in series opposition. A connection is made between the bridge connecting the two coils and the transformer winding which energizes the coils. When there is no ambient magnetic field, there is no voltage across this bridge, but if there is an ambient field, the flux changes in one element lead those in the other in phase so that sharp voltage peaks occur on each half cycle. In another type of detector, the two elements have a secondary coil wound about them which, when the proper adjustments are made, picks up only the asymmetrical flux changes which appear as voltages across the secondary. Electronic circuits are used with all these types of instruments to amplify and detect the output voltages, although the last type of instrument has been used successfully with a conventional galvanometer as the detecting member.

Although the greatest sensitivity may be realized when these devices are used as null detectors, they may be used as direct reading instruments to measure the intensity of any component of the field. In most cases, however, the major part of the components of the field to be measured is neutralized by electric currents or balanced out by application of biasing voltages applied to the detecting circuit.

These detectors possess several advantageous characteristics: they comprise no moving parts which are subject to errors resulting from accelerations; they may be mounted in one place and the readings taken in another; they are fast in operation and response; and their outputs may be readily applied to operate various control devices. Electronic control circuits employed to excite the elements and to amplify and detect their outputs are rugged. By suitable amplification' small changes in the ambient magnetic field may be made to produce large deflections of rugged recording meters. These characteristics make the induction-type detectors particularly suitable for use on aircraft.

Originally intended for the detection of submarines during World War II, these devices later found extensive application in geophysical prospecting. The great mobility of aircraft and their ability to fly over areas which are accessible for ground surveys only with great difficulty encouraged the use of these induction-type instruments for geophysical surveys. To escape magnetic effects of the plane, the measuring and orienting mechanism is sometimes mounted in a "bird" which is trailed well beneath the plane, the control circuits and indicating meters being mounted within the plane and connected to the bird by electric cables.

In most geophysical surveys conducted on the ground, the vertical component of the intensity is measured since that component uniquely defines the magnetic potential over the area being investigated, subject to certain limitations. Measurements of total intensity do not uniquely define a magnetic potential. However, if the variations in total intensity caused by the magnetic anomaly being surveyed are small relative to the total intensity of the earth's uniform field. a satisfactory solution can be derived.

Nuclear Resonance Magnetometer. — After the end of World War II there was considerable work accomplished on the various nuclear resonance phenomena that are associated with a magnetic field. One of the first instruments developed using these new methods was a nuclear resonance magnetometer, frequently termed a proton precessional magnetometer. The instrument consists essentially of a means of initiating precession of protons having gyromagnetic properties in a magnetic field. Nuclei may have spin or angular momentum. and will act like small gyroscopes. In a constant magnetic field the nucleus. having a magnetic moment, may be expected to behave like a compass needle. But because of the spin. the behaviour of the nucleus is slightly more complex. The system has angular momentum and a torque caused by the interaction between the nuclear magnetic moment and the external field Since the value of the angular momentum of the nucleus is fixed, the only possible change caused by the torque is a change in orientation. This orientation of the angular momentum vector changes steadily. but always maintains a constant angle with the magnetic field, so that the momentum vector moves on the surface of a cone with axis parallel to the magnetic field. This motion is commonly called precession, and is exactly similar to that of a gyroscope acted on by gravity, the axis making a constant angle with the vertical as it precesses. Just as friction or other damping causes the gyroscope to assume a position of lowest potential energy in the gravitational field, so the damping forces acting on the nucleus eventually suppress the precession and allow the nuclear magnetic moments to line up nith the magnetic field. The time required for these damping forces to act has been called the relaxation time and may be of the order of microseconds or minutes depending on the material used for the sample.

In the nuclear precession magnetometer. the nucleus is polarized in a direction at an angle to the earth's magnetic field. When this polarizing current is suddenly cut off, the protons precess back to the normal (ambient) magnetic field. The frequency of precession is directly related to the strength of the magnetic field being measured. The instrument consists essentially of a sample containing protons and a coil of wire wound around this sample. The sample may be nater or a hydrocarbon such as kerosene. When a strong direct current is applied to the coil, the protons are magnetized or oriented in this new direction. The current is then cut off rapidly, and the protons start precessing back to their normal direction The coil previously used for polarizing the sample is now connected to an amplifier and suitable electronic counter, and the frequency of precession is measured. This frequency is directly related to the strength of the magnetic field.

$$H = Cf$$

where H is the value of the magnetic field; f is the frequency of precession; and C is a constant.

In 1950 A. Kastler, in Paris, suggested the technique of optical pumping for orienting nuclei and for detecting nuclear magnetic resonance signals in gases at low pressures. This technique has been developed and expanded and is the basis of a type of magnetometer capable of measuring extremely low fields of the order of a few gammas.

The magnetometer consists in its simplest form of a light source, a filter to pass only one of the strong optical lines in the spectrum of the alkali metal being used, a device to circularly polarize the light, an absorption cell and a photocell to monitor the light transmitted through the cell. The light beam is oriented roughly parallel to the magnetic field. Under proper conditions, the atoms will tend to line up with their magnetic moments along the direction of the magnetic field. In this condition, the atoms will absorb less light than normally, and the amount of transmitted light will be greater than if the atoms were randomly oriented. If a radio-frequency field is now applied at right angles to the magnetic field, and at a frequency corresponding to the Zeeman transitions, the atoms will become disoriented, and the amount of light transmitted will decrease. If the applied radio frequency is swept through the resonance value, the resonant frequency will be observed as a dip in the output of the photocell. The above instrument has been used successfully to measure the earth's magnetic field and the results have been of the same order of accuracy as the proton precessional magnetometer or the electromagnetic types of instruments.

See also GEOMAGNETISM: *Elements* of *the Geomagnetic Field.*

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(A. G. McN.; R. E. GT.)

MAGNIFICAT, the *Canticum beatae Mariae Virginis,* the song of praise of Mary in the house of Zacharias, with which she answered the greeting of Elizabeth: "Magnificat anima meum Dominum."

It constitutes the most important canticle of the vesper service in the Roman Catholic Church and of the evening office in the Anglican Church. Besides having been set to plain song melodies in all the eight church modes, it has received countless settings by later composers.

MAGNITUDE of a star is the measure of its brightness adopted in astronomy. The higher the number expressing the magnitude the fainter the star. A step of one magnitude corresponds to a decrease in light intensity in the ratio 2.512:1, so that five magnitudes correspond to a decrease in the ratio 100:1. The absolute magnitude of a star is the apparent magnitude it would have if placed at a standard distance of ten parsecs or about 33 light-years.

The bolometric magnitude is an analogous measure of the heat intensity of a star.

See PHOTOMETRY. CELESTIAL; STAR.

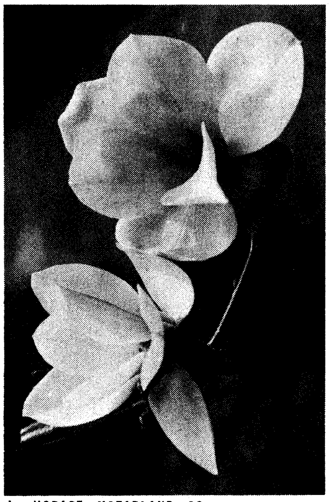
MAGNOLIA, the type genus and one of nine genera of the botanical family Magnoliaceae, named for Pierre Magnol (1638–1715), professor of botany at Montpellier, France. It includes about 75–80 species. in two centres. about 50 in the old world (Japan to the eastern Himalayas, south to Java) and about 25 in the new world (southern Ontario, the eastern United States, the Greater Antilles and Mexico to Venezuela).

Magnolias are trees or shrubs with persistent or deciduous simple leaves with stipules. Most magnolias bear showy, fragrant, white to pink or purple or green to yellow flowers singly at the tips of the branches. The perianth is composed of 9–15 petallike tepals in series of 3 each; the 3 outermost are differentiated as sepals in some species. The numerous stamens and carpels are borne spirally on the elongated floral axis. The conelike fruit is composed of the many carpels. each of which splits along the outer side releasing two scarlet to pink seeds which dangle by slender threads. Essential-oil cells give most tissues of the plant a spicy fragrance when crushed.

Eight species, cultivated as ornamentals in both the United

States and England, are native to eastern North America. Five are closely related trees or shrubs with rather large deciduous leaves clustered near the tips of the branches (whence the name umbrella tree) and large white flowers: *Magnolia fraseri,* of the southern Appalachians; M. *pyramidata,* with a Gulf coast distribution; M. *tripetala,* the original umbrella tree; the spectacular *M. macrophylla,* with leaves up to three feet long (the largest in the genus); and *M. ashei,* restricted to western Florida. Closely related to these are three Asian species, all in cultivation: *M. obovata* (Japan), *M. officinalis* (eastern China) and *M. rostrata* (northwestern Yünnan and adjacent areas). The best-known American magnolia is *M. grandijlora* (bull bay), a handsome evergreen tree bearing large white flowers, native to the southeastern coastal plain but cultivated in other warm temperate areas. Excepting the tenderer *M. delavayi* (from Yünnan), *M. grandijlora* is the only hardy evergreen species. *M. virginiana* (sweet bay), with small, white, very fragrant flowers and leaves whitened beneath, has a wide range along the coastal plain (Massachusetts to southernmost Florida and Texas), and was the first magnolia to be grown in England (1688). M. *acuminata* (called cucumber tree, from the appearance of the young fruits) is a large deciduous tree which occurs from Ontario and New York to Florida, Missouri and Arkansas. Its green to yellow flowers are in striking contrast with those of its only close relative, the purple-flowered *M. liliflora* of China.

More than half of the Asian magnolias are evergreen trees and shrubs of the tropics, and only about 20 are suitable for cultivation in temperate areas. Among the hardy and showy ornamental species are the Chinese *M. denudata* and *M. liliflora* and the Japanese M. *stellata,* M. *kobus* and *M. salicifolia.* Unfortunately, *M. sprengeri, M. sargentiana* and *M. campbellii,* among the most beautiful trees in the genus, are far less hardy. In all of these species, flowering occurs before the leaves appear, in contrast with the American species which flower with or after the unfolding of the leaves.



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LARGE WAXY BLOSSOMS OF A HYBRID MAGNOLIA (MAGNOLIA SOULANGIANA)

No wild hybrids of *Magnolia* have been found, although a number of garden hybrids are known. Probably' the most widely cultivated of any of the Asian group is *M. soulangiana,* a hardy and vigorous hybrid (originated near Paris, 1820) of the white-flowered *M. denudata* and the purple M. *liliflora.*

Magnolias prefer well-drained but moist, rather loamy, slightly acid (pH 6) soil. Propagation is by layers, cuttings, grafts or seeds. The seeds have a short period of viability, especially if allowed to dry out, and usually a period of moist cold is necessary to promote germination. Attempts to send seeds from Asia to England were mostly unsuccessful until the practice of coating the seeds with paraffin was tried; the storage and transport of seeds in bags of polyethylene film is a more modern development.

Much attention has been focused on *Magnolia* as one of the most primitive of living flowering plants, particularly on account of the woody habit, the numerous, free and spirally arranged floral parts, the primitive stamens and the single-grooved pollen grains. Although the group is undoubtedly ancient (more than 80 fossil "species" have been described) and formerly had a much wider distribution in the northern hemisphere, a number of other extant flowering plants show evolutionarily much more primitive structures. Some of the species of the genus *Drimys* (of the family Winteraceae) appear to combine more numerous primitive features than any other known group of flowering plants.

BIBLIOGRAPHY.—For a description of the principal species under cultivation *see* L. H. Bailey, *Standard Cyclopedia of Horticulture* (1943), *et al, Manual of Cultivated Plants,* rev. ed. (1949); G. H. Johnstone, *Asiatic Magnolias in Cultivation* (1955). *See* also J. G. Millais, *Magnolias* (1926); A. Rehder, *Manual of Cultivated Trees and Shrubs,* 2nd ed. (1940). For classification see *Camellias and Magnolias,* Royal Horticultural Society Conference, 1950 (1950).

(C. E. W.)

MAGNUS, OLAUS (Swedish OLAF MANSSON) (1490–1557), Swedish ecclesiastic and author of an influential history of Scandinavia, was born at Linkoping in Oct. 1490. A Catholic priest, he went to Rome in 1523, during the Swedish reformation, and thereafter lived in exile, first in Danzig and later in Italy, with his brother Archbishop Johannes Magnus (1488–1544), on whose death he was appointed Catholic archbishop of Sweden. After 1549 he was also director of St. Brigitta's, a religious house in Rome.

Magnus died in Rome, Aug. 1, 1557.

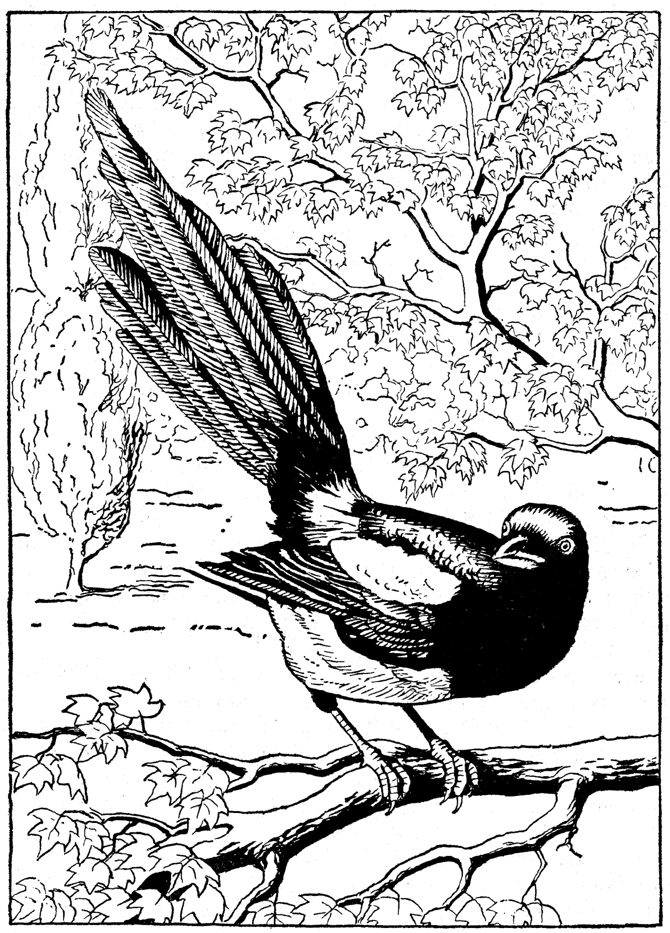
Olaus Magnus' *Carta marina* (1539) was the first detailed map of Scandinavia with any pretensions to accuracy. His foremost work, however, is the *Historia de gentibus septentrionalibus* (1555), a history of the northern peoples inspired by humanist historiography and imbued with patriotic warmth, which gives a picture of the countryside and people of Sweden on the threshold of a new era. It appeared in many editions and translations during the 17th century—the first English translation being the *History of the Goths, Swedes and Vandals* (1658)—and for long influenced the European idea of the Scandinavian people. (S. H. L.)

MAGNUSSON, ARNI (1663–1730), Icelandic historian and antiquarian. was born in Vestland, Ice., on Nov. 13, 1663, and died at Copenhagen, Den., on Jan. 6, 1730. He studied theology at Copenhagen, and in 1696, on his return from a visit to Germany, was appointed to the post of secretary of the secret archives. In 1701 he was elected professor of Danish antiquities and the next year was sent on a royal mission to Iceland, where he stayed ten years. collecting documents relative to the history of that country which he bequeathed to the university of Copenhagen. Magnusson's most important works are: *Incerti auctoris Chronica Danorunz, et praecipue Islandiae* (Leipzig. 1695); and *Testamentum Magni regis Norvegiae* (Copenhagen, 1719). *See* also his letters, *Arne Magnusson's Private Brevveksling* (Copenhagen, 1920).

MAGO, the name of several Carthaginians. (1) The reputed founder of the military power of Carthage, fl. 550–500 B.C. (Justin xviii. 7; xix. 1). (2) The youngest of the three sons of Hamilcar Barca. He accompanied Hannibal into Italy, and held important commands in the great victories of the first three years. After the battle of Cannae (216 B.C.) he sailed to Carthage to report the successes gained. He was about to return to Italy with strong reinforcements for Hannibal when the government ordered him to go to the aid of his other brother. Hasdrubal, who was hard pressed in Spain. He carried on the war there with varying success in concert with the two Hasdrubals until, in 209, his brother marched into Italy to help Hannibal. Mago remained in Spain with Hasdrubal, the son of Gisco. In 207 he was defeated by M. Iunius Silanus, and in 206 the combined forces of Mago and Hasdrubal were scattered by Scipio Africanus in the decisive battle of Silpia. Mago maintained himself for some time in Gades, but afterward received orders to carry the war into Liguria. He wintered in the Balearic Isles, where the harbour Portus Magonis (Port Mahon) still bears his name. Early in 204 he landed in Liguria, where he maintained a desultory warfare till in 203 he was defeated in Cisalpine Gaul by the Roman forces. Shortly afterward he was ordered to return to Carthage, but on the voyage home he died of wounds received in battle. (3) The name of Mago is also attached to a great work on agriculture brought to Rome and translated by order of the senate after the destruction of Carthage. The book was regarded as a standard authority, and is often referred to by later writers.

MAGOON, CHARLES EDWARD (1861–1920), U.S. lawyer and government official, was born in Steele county, Minn., on Dec. 5, 1861. He had one year of college education at the University of Nebraska, Lincoln, and then studied law in Lincoln, where he subsequently practised from 1882 to 1899. From 1899 to 1904 he was legal adviser to the bureau of insular affairs of the war department, during which time he compiled the valuable and detailed *Report on the Legal Status of the Territovy . . . Acquired by the United States during the War with Spain* (1900). Two years later his interpretations of U.S. law, as it affected possessions acquired after the Spanish-American War, uere gathered and published as *The* Law *of Civil Government in Territory Subject to Military Occupation* (1902). This work became of value to administrative personnel in the Philippine Islands. From 1905 to 1906 Magoon was governor of the Panama Canal Zone as well as U.S. envoy to the Republic of Panamá. He served as provisional governor of Cuba from 1906 to 1909 at a critical period in the history of the island. Among other changes which took place during his administration. the scourge of yellow fever was almost entirely eliminated. He died in Washington on Jan 14, 1920.

MAGPIE or **Pie,** a bird once abundant throughout Great Britain. but later much scarcer, though after World War I its numbers increased. It did not reach Ireland until the 15th century, but is no common enough in that country. This species is extending its range where not molested.



BY COURTESY OF THE AMERICAN MUSEUM OF NATURAL HISTORY

THE MAGPIE (PICA PICA OR PICA RUSTICA)

In Norway, the magpie is very tame, nesting in the gardens even of town houses. but in Britain persecution has made it shy, and most people know it only as a captive in a wicker cage. where its vivacity and natural beauty are lessened or lost. At large, few European birds possess greater beauty, the pure white of its scapulars and inner web of the flight feathers contrasting vividly with the deep glossy black on the rest of its body and wings, while its long tail is lustrous nith green, bronze and purple reflections. The pie's nest is a wonderful structure, placed either in trees or bushes and massively built. Its foundation consists of stout sticks, turf and clay, wrought into a deep, hollow cup, plastered with earth and lined with fibres; around this is erected a basketlike outwork of thorny sticks, forming a dome over the nest, and leaving a hole in the side for entrance and exit. Herein are laid from six to nine eggs, of a pale bluish green freckled with brown and blotched with ash colour. The magpie, in common with the raven, the jay and many birds of prey, has a remarkable capacity, when its mate is killed, for obtaining a new mate within a day or two. In the case of the pie and the jay, a large gathering of birds of the species is said to appear on the scene, and apparently the new mate is selected from these.

The pie belongs to the crow family and is scientifically termed *Pica pica.* The typical subspecies inhabits Europe, northwest Africa and Asia, and is replaced in western North America by the subspecies *Pica pica hudsonia.* In California *P. nuttalli* is distinguishable by its yellow bill and the bare yellow skin round its eyes.

MAGSAYSAY, RAMON (1907–1955), Philippine soldier and political leader. who as secretary of defense and president reduced the communist-led Hukbalahap (Huk) movement after World War II. Born on Aug. 31, 1907, at Iba in Zambales province on Luzon, the son of a schoolteacher, blacksmith and farmer, he worked his way through the University of the Philippines at Manila (1927–31) and José Rizal college, from which he received a degree in 1933. Rising from his first job as an automotive mechanic, he became by 1941 branch manager (later general manager) of a transportation company whose buses were commandeered by U.S. forces after Japan invaded the Philippines.

He fought with U.S. forces until before the surrender of Bataan, when he joined the western Luzon guerrilla forces, becoming commanding officer of the Zambales military district in 1945. He fought with U.S. forces until the liberation and afterward was appointed military governor of Zambales province. Discharged from military service in 1946, he was elected to two terms in congress for Zambales (1946–50). In 1950 Pres. Elpidio Quirino appointed him secretary of defense. The Huks, then at the height of their power. derived much support from the peasants. who felt the local constabularies oppressed them as representatives of the landlords. Magsaysay replaced the constabulary with army units, reformed the army and fought the Huks, offering them '.complete force or complete fellowship!'; to those who surrendered he gave land and tools. In 1953 he resigned as secretary of defense and from the Liberal party and joined the Nationalist party, charging President Quirino with obstruction of his anti-Huk campaign and a corrupt administration.

The Nationalist party nominated Magsaysay to oppose Quirino for the presidency; Magsaysay won the election and was inaugurated Dec. 30. for a four-year term. He also served as secretary of defense until May 1954, when the surrender of the Huk leader Luis Taruc climaxed the anti-Huk campaign. Despite Magsaysay's great personal popularity, congressional and intraparty opposition slowed the progress of his program of land and governmental reform. His opponents considered his friendship with the United States extreme. but he held firm in foreign policy. In July 1955 congress gave the president power to break up large landed estates and carry out basic land reform; in August a Nationalist party convention completely endorsed the president's program and nominated a slate of candidates to remove the president's strongest opponents in congress. This slate won in November, but congressional opposition to his reform measures continued.

Magsaysay died in an airplane crash on March 17, 1957 while returning from Cebu City to Manila. and was succeeded by Carlos P. Garcia, vice-president and foreign minister.

See Carlos P. Romulo and Marvin M. Gray, *The Magsaysay Story* (New York, 1956).

MAGWE, a district and division of Burma. In 1941 the division included the district of Thayetmyo, Minbu, Magwe, Pakôkku and Pakôkku hill tract and the Chin hills district. The district has an area of 3,724 sq.mi.; pop. (1941) 559,926. Magwe may be divided into two portions: the low, flat country in the west. forming part of the surrounding valley, and the undulating high forested ground in the east forming part of the Pegu

Yomas, which at some parts reaches a height of 1,500 ft. In the heart of the district there is a low fertile plain which is about 45 mi. from north to south and as much as 30 mi. wide in places. The railway from Pyinmana runs through this plain and beyond. The chief streams are the Yin and the Pin, which form the northern boundary. The only perennial stream is the Yanpe. The annual rainfall averages about 27 in. The maximum temperature rises to a little over 100° F. in the hot season, and falls to an average minimum of 53° F. and 54° F. in the cold season. Rice is the staple product, and considerable quantities are exported. Sesame, maize and millet are also cultivated, as well as cotton, while an important crop in the sandy soil is peanuts.

In this district are included the well-known Yenangyaung and Chauk oil fields. A block of 80 sq.mi. was demarcated by the government as the area of the Yenangyaung oil fields but only about 2 or 3 sq.mi. were occupied by the actual field and the bulk of the production was from an area of only $1\frac{1}{4}$ sq.mi. The state lands were leased to the Burmah Oil company but two large blocks in the richest part (the Beme and Twingôn reserves) were reserved for the hereditary Burmese owners called *twinsa*. Although there were still some primitive hand-dug wells in modern times. nearly all the native owners sold their rights to companies operating with modern plant. Hence it was in these reserves that competition between the competing companies proved extraordinarily keen, though methods of working were closely supervised by government agents.

A great advance has been made by electrifying the field. The oil was sent by pipe line to the refineries at Syriam near Rangoon.

MAGYARS, the name of the people called in English Hungarians. Though they have become physically assimilated to the western peoples. linguistically they belong to the Finno-Ugrian (*q.v.*) group within the Ural-Altaic (*q.v.*) family of languages. Before World War I they formed barely half the population of Hungary, but were by far the largest and most compact of all its racial groups. Magyar was the official language of Hungary, the official name of which (*Magyarország*, or "country of the Magyars") enshrined the Magyar claim to predominance. The Magyars themselves sometimes applied the name *Magyarország* to Hungary "proper," excluding Croatia-Slavonia, the whole kingdom being called *Magyarbirodalom*, the Magyar monarchy or realm.

Hungary. as constituted now, does not include the whole of the *Magyarország*. (W. A. P.)

MAHAN, ALFRED THAYER (1840–1914), U.S. naval officer and historian, an early exponent of sea power, was born on Sept. 27, 1840, at West Point, N.Y., where his father was professor of military engineering at the U.S. Military academy. Columbia college and the U.S. Naval academy at Annapolis, Md., qualified him for the U.S. navy, in which he served 40 years. He saw active service in the Civil War and when 21 designed a "mystery ship" and volunteered to command it. After acting as lecturer on naval history and strategy at the naval war college, he became its president in 1886. An indefatigable student with a prodigious memory, he steeped himself in the strategy of Antoine Henri Jomini, Napoleon and Nelson and made critical analyses of the conclusive battles of the world on land and sea. *The Influence of Sea Power Upon History, 1660–1783*, published in 1890, was inspired by a conviction that the historic significance of the control of the sea had never been fully revealed. It was followed in 1892 by *The Influence of Sea Power Upon the French Revolution and Empire, 1793–1812*. These classic works were widely acclaimed by naval men, statesmen and scholars and have been credited with stimulating the growth of navies between 1900 and 1914. No previous writer had so convincingly argued the case for the dominating influence of sea power. The famous trilogy was completed by *The Life of Nelson* in 1897.

Mahan was recognized as an authority on naval strategy, especially in Great Britain, and his doctrines have been said to have governed the naval political thought of the world. Degrees were conferred upon him by Oxford and Cambridge universities in 1894 and later by leading U.S. universities. He commanded the cruiser "Chicago" in European waters. 1893–95, and served on the naval war board during the Spanish-American War of 1898 and as delegate to The Hague peace conference in 1899. In 1900 he was awarded the Chesney gold medal for his three works. which were translated into several foreign languages. He was president of the American Historical association in 1902 and chairman of a commission on naval affairs in 1908.

Mahan, who excelled as a strategist rather than as a tactician, attempted chiefly to make clear the paramount importance of the sea as a decisive factor in history. He analyzed the elements of sea power in all its bearings, military. national, territorial and commercial. With masterly touch he dissected the strategic features of the Caribbean. He stressed the interdependence of the military and commercial control of the sea and held that commerce dominates war. In *The Interest of America in Sea Power, Present and Fziture* (1897) and in most of his 20 volumes he sought to arouse his countrymen to a realization of their maritime responsibilities. He doubted the infallibility of arbitration in international disputes and in Anglo-U.S. naval supremacy saw the surest hope of peace.

Mahan died on Dec. 1, 1914, having foretold the defeat of the Central Powers and the surrender of the German navy. Discussion of sea power compels recourse to his works, which are invaluable to students of international affairs. *(See* SEA POWER.)

For a complete list of works and bibliography *see* Charles Carlisle Taylor, *The Life of Admiral Mahan* (1920). (C. C. TAY.; X.)

MAHANADI ("The Great River"), a river of India rising 25 mi. S. of Raipur, in Madhya Pradesh. Taking a northerly direction, it receives the Seonath above Seorinarayan. Turning east. it is augmented by drainage of the hills of Uprora, Korba and the ranges separating Sambalpur from Chota Nagpur. At Padampur it turns south past Sambalpur to Sonpur and flows toward the Orissa hills, piercing them by a gorge. It reaches the Orissa delta at Naraj and, traversing Cuttack district, falls into the Bay of Bengal. The Mahanadi drainage area is about 74,516 sq.mi., and in flood its maximum discharge exceeds 1,500,000 cu.ft. per second. In dry weather the discharge dwindles to 500 cu.ft. per second. An early (1863) project to store and use the flood waters was a financial failure. It did, however, save the lowland from threats of famine and was thus the first truly protective canal project in India. A weir at Rudri on the upper Mahanadi, supplemented by a reservoir in a tributary valley, irrigates 300,000 ac. around Raipur on the Chhattisgarh plain. (T. HER.; X.)

MAHAR, the name of a servile caste in the Deccan, India. Their special function, apart from that of scavenger, is to act as village watchman, as guardian of the village boundaries and as public messenger. In some parts they are also weavers of coarse cotton cloth.

MAHARASHTRA, a state of the Republic of India, with Bombay as its capital city. It has, according to 'the redefined boundaries laid down in the Bombay Reorganization act, 1960, an area of 118,884 sq.mi. and a population (1961) of 39,504,294. When India became independent in 1947, the province long known as Bombay Presidency became Bombay state. The following year a number of former princely states (notably Baroda) were merged into the new state, and on Nov. 1, 1956, the major reorganization of the states of peninsular India resulted in the addition of large parts of the former Hyderabad and Madhya Pradesh. From 1956 to 1960, with an area of 190,668 sq.mi. and a population of 48,265,622 (1951), Bombay was the largest state in area in the republic and second in population. In the north it comprised most of the Gujarati-speaking peoples and in the south most of the Marathi-speaking. It was on this linguistic basis that the state was split into two on May 1, 1960, with Gujarat in the north and a state that was at first named Maharashtra in the south. The latter resumed the name Bombay a few weeks later, but before the end of the year, despite opposition, the central government declared Maharashtra the official name. As now defined, with minor boundary adjustments, this comprises 26 districts, which are, in effect, all those parts of India where Marathi is the dominant language. It stretches along the west coast between the former Portuguese territories of Damão and Goa. comprising an area known as the Konkan (*q.v.*), and far inland beyond Berar and the city of Nagpur to include the districts of Bhandara and Chanda. It is bordered by Gujarat and Madhya Pradesh in the north and east and by Andhra Pradesh and Mysore on the south.

Physical **Geography.**—Maharashtra comprises the coastal strip backed by the high crest of the Western Ghats beyond which is a rolling plateau with flat-topped hills indicating the presence of the successive lava flows, almost horizontal, of the Deccan basalts, formerly known as traps. The lavas cover practically the whole surface; the underlying complex of metamorphic rocks is rarely seen. Spurs from the Western Ghats reach the coast, which renders north-south communication difficult; neither motor road nor railway has been constructed through the west coast districts south of Bombay city. The coast is rock-bound and dangerous when the southwest monsoon is blowing onshore There are havens for small vessels, but there is only one major inlet, that protected by the island on which Bombay city has been built and which is one of the most magnificent and spacious harbours of Asia.

The climate shons the typical monsoon regime of cool dry season with light northeasterly minds from the land (about November to February), the hot dry season of March, April and May followed by the rainy season when the southnest monsoon blows directly against the west coast and Western Ghats. Apart from preliminary showers (mango showers) in May and early June, the rains break suddenly about mid-June. The Konkan is very wet; no part receives less than 80 in., while Mahabaleshwar, in the Western Ghats, with an annual average of more than 250 in., has one of the highest recorded rainfalls in the world. The winds lose their moisture in rising to cross the Ghats, and eastward on the plateau the average rainfall declines rapidly so that over most of the plateau districts it is less than 40 in. a year. The coastal districts enjoy equable temperatures, monthly averages ranging, as at Bombay city, only a few degrees above or below 80° F. A range of more than 20° between day and night temperatures is unusual. Stations like Poona, high up on the plateau but sufficiently near its edge to get a good rainfall, benefit from the elevation to be cooler throughout the year but remain equable. Mahabaleshwar, at 4,534 ft., has long been used as a hill station. Eastward on the plateau, with the lower rainfall, both daily and annual ranges of temperature increase.

The wet coastal districts have swift mountain torrents, sometimes with spectacular waterfalls when in spate but greatly hindering land communication and useful mainly for floating down timber. Except in the extreme north, where it is trenched by the westward-flowing Tapti, most of the plateau is drained by seasonal, eastward-flowing tributaries of the Godavari and Krishna in broad open valleys. Many rise very close to the edge of the plateau, the crest of the Western Ghats, which varies from 2,500 to 4,500 ft. in height. with some points exceeding 5,000.

The basaltic lava flows of the plateau break down into the famous regur or black cotton soil of India. It is a heavy, dark, almost black, clayey loam, which holds moisture well and is especially suited to Indian varieties of cotton and to dry zone grains. Some irrigation is practised in the broad open valleys, but care has to be taken in the use of irrigation water as the soil easily becomes a pasty mud.

The natural vegetation of the state reflects in the main the amount of rainfall. There are evergreen rain forests of large trees on the wet western slopes of the Ghats, giving place to a somewhat narrow but valuable belt of the monsoon forests, leafless in the dry season but including teak and the useful sal tree (*Shorea* robusta), and then eastward to the scrub forests and savanna lands so typical of much of the plateau. (L. D. S.)

History. — The present state comprises more than the ancient Maharashtra, which did not include the Konkan coastal strip and did not stretch so far south as Pandharpur, the celebrated Vaishnava shrine, nor as far east into the Deccan. For the history of early dynasties who ruled over this area between the 6th and 10th centuries A.D., see CHALGKYA; RASHTRAKUTA. By the beginning of the 13th century Maharashtrians or Mahrattas, speaking the forerunner of Marathi, were infiltrating into regions occupied previously by Telugu- and, more notably, Kanarese-speaking peoples. With the exception of the Konkan, which tended to be rich and easygoing, all Maharashtra, including the Ghats, was hard and severe, and the earliest ruling families of which there is any record were occupied largely in invading and attempting to exploit wetter, easier regions, such as Gujarat, Vengi and the Tamil country. Patronage of religion, letters and architecture was virtually unknown until in the 13th century, under the Yadavas, success outside Maharashtra brought an accumulation of resources. Poona was, and remains, in the cultural heart of the country. Under the Yadavas, too, Maharashtrian schools of Vaishnavism became prominent.

After the defeat of the last Yadava by the troops of the sultan of Delhi in 1310, a period of unrest followed, during which Maharashtra was partitioned between the sultanates of Ahmednagar and Bijapur, two of the successor states of the Bahmani (*q.v.*) empire. When the sultanates were absorbed by the Moguls, some Maratha officials attempted to carve out separate fiefs and to challenge Muslim authority. For the rise of Hindu autonomy in this area and for the history of the period of Maratha ascendancy and of the Maratha Wars, see MAHRATTAS.

The essence of Maharashtra has been its possession of a common language, and an active, restless people. Participation in Hindu Sanskritic culture came rather late but was embraced the more fervently for that reason. The feelings of independence, and even superiority to the inhabitants of the easier, wealthier regions in the north, west, east and southeast, can be explained on historical grounds. The neighbours to the south were equally poor but not equally successful. Maharashtrians show no great aptitude for commerce and have no great artistic traditions, but the blending of cultures, particularly in Bombay and similar centres, has ushered in a more fruitful era. (See also INDIA: History.)

(J. D. M. D.)

Population, Administration and Social Conditions. — At the 1961 census the population was 39,504,294. There are many Adibasi communities in the state, like the Agaris, the Warlis, the Katkaris, the Thakurs of the Thana and Kolaba districts, the Bhils of West Khandesh and the Gonds of Vidarbha. who live in dense forests or on the mountain perches of the Western Ghats.

The state is divided into the following 26 districts, which are grouped in 4 divisions: Khandesh (East and West), Nasik, Thana, greater Bombay, Kolaba. Ratnagiri (Bombay division); Ahmednagar, Poona, Satara (North and South). Kolhapur, Sholapur (Poona division); Aurangabad, Parbhani, Bhir, Osmanabad, Nanded (Aurangabad division); Buldana, Akola, Amravati, Yeotmal, Wardha. Nagpur, Chanda, Bhandara (Nagpur division).

There are more than 380 towns and nearly 36,000 villages in the state. The more important cities and towns with their populations at the 1951 census, are as follows: Bombay (2,839,270; [1961] 4,146,491); Poona (480.982; [1961] 721,134); Nagpur (449,099; [1961] 643,186); Sholapur (226.050; [1961] 337,544); Kolhapur (136,835; [1961] 187,306); Nasik (97,042; [1961] 130,834); Akda (89,606); Amravati (87,099); Ahmednagar (80,873; [1961] 118,266); Ulhasnagar Camp (80,861); Jalgaon (68,412); Poona cantonment (59.011); Kalyan (58,900); Bhusawal (54,346); Sangli (50,287); Thana (50,155; [1961] 101,103). (S. CH.)

With about one-eighth of the population attending educational establishments and about 30% of the people literate, Maharashtra is one of the educationally advanced states of India. In 1958–59 there mere 45,000 schools and higher educational institutions, including five universities — Bombay, Nagpur, Poona. Marathwada and Shreemati Nathibai Damodar Thackersey Women's university. Free compulsory primary education for children between the ages of 7 and 11 is available in all villages with a population of more than 1,000 in western Maharashtra. The Marathi (*q.v.*) language and its various dialects are widely spoken.

Nearly 900 hospitals and dispensaries generally provide free medical aid. Under the contributory social insurance plan many industrial workers in greater Bombay and the Vidarbha region are protected against sickness, maternity and employment injury.

Maharashtra is one of the pioneer states in providing welfare facilities for children. including the care and rehabilitation of juvenile delinquents and destitute and neglected children. Welfare centres offer recreational, cultural and educational facilities to industrial workers. Under a Sarvodya plan, free educational facilities and medical aid are available to backward classes and tribal people. (S. B. L. N.)

The Economy.—Rice, which occupies about 10% of the cultivated area, is grown mainly in the small alluvial basins that lie between the hills of the west coast; on the plateau cotton sometimes predominates. followed by wheat on the better lands, but the great staples in the poorer parts are jowar and bajra. Oilseeds, fodder and grain occupy large areas. Sugar cane is more local, and coconuts are typical only of the coast. The Konkan is famed for its mangoes and cashew nuts. Forests of the varied types mentioned in *Physical Geography* cover large areas; products include timber, fuel, sandalwood, bamboos and grasses.

Production of manganese ore is of major importance. Other minerals include limestone and salt, which is produced in some coastal areas by evaporation.

Maharashtra can claim to be the most industrialized state in India, with about 8,000 registered factories employing two-thirds of 1,000,000 workers. Bombay city is the great centre! but the former dominance of the cotton textile industry has given place to a marked diversification. with general and electrical engineering, a considerable motion-picture industry, the making of rayon fabrics, ceramics, glassware (especially at Ogalewadi), drugs, chemicals, antibiotics (at Pimpri, near Poona). soap, sugar and agricultural implements and pumps (at Kirloskarvadi) and the refining of oil (at Thana). There are government printing works at Nasik and hydroelectric plants at Khopoli. Bhivpuri, Bhira and Koyna and a thermal power station at Trombay.

With an excellent harbour and highly developed industries: Bombay city is an important trading entrepdt for the whole of India. To the east of the city lies one of the relatively easy passes through the Ghats, which facilitated the early construction of railway links with other parts of India. Under the railway grouping of 1947 Maharashtra is served by three of the systems: the Western railway northward into Gujarat, the Central from Bombay eastward and the Southern southeastward to Madras. The state has 2,656 mi. of railway line. The use of motor transport as a feeder to the railways continues to extend with the metaling and tarring of roads. The Konkan is the only part of the state not well served with rail and road. Bombay city has an international airport, and much use is made of local air services. (L. D. S.)

MAHASARAKHAM, a province on the Khorat plateau in northeast Thailand. Area 2,224 sq.mi. Pop. (1960) 496,970. The chief crops are rice: cotton, sugar cane, tobacco. maize and beans. The province is relatively isolated from modern influences and traditional Thai-Lao folk dances, music and religious ceremonies are still widely performed. The capital, Mahasarakham town (pop. [1960] 15,680), lies in the Chi river valley, 41 mi. by motor road from Banphai located on the Khorat-Nongkhai rail line. Locally called Ban Talat, "market town," it is a trading centre for the neighbouring provinces of Kalasin and Roiet, which are still farther from the railroad. (G. W. SK.)

MAHAVAMSA, the *Great Chronicle,* a history of Ceylon from the 5th century B.C. to the middle of the 5th century A.D., written in the 6th century in Pali verse by Mahanama of the Dighasanda hermitage, shortly after the close of the period with which it deals.

In point of historical value it compares well with early European chronicles. In India proper the decipherment of early Indian inscriptions was facilitated to a great extent by the data found only in the Mahavamsa. It was composed on the basis of earlier works written in Sinhalese! which are now lost, having been supplanted by the chronicles and commentaries in which their contents were restated in Pali in the course of the 5th century. The particular one on which this Mahavamsa was mainly based was also called the Mahavamsa, and was written in Sinhalese prose with Pali memorial verse interspersed. The extant Pali work gives legends of the Buddha and the genealogy of his family; a sketch of the history of India down to Asoka; an account of Buddhism in India down to the same date; a description of the sending out of missionaries after Asoka's council, and especially of the mission of Mahinda to Ceylon; a sketch of the previous history of Ceylon; a long account of the reign of Devanam-piya Tissa. the king of Ceylon who received blahinda and established Buddhism in the island; short accounts of the kings succeeding him down to Duttha Gamani (Dadagamana or Dutegemunu); then a long account, amounting to an epic poem, of the adventures and reign of that prince. a popular hero born in adversity, who roused the people and drove the Tamil invaders from the island. Finally, there are short notices of the subsequent kings down to the author's time.

The Mahavamsa mas the first Pali book made known to Europe. It was edited in 1837 with English translation and an elaborate introduction by George Turnour. then colonial secretary in Ceylon. Its vocabulary was an important part of the material utilized in R C. Childers' *Pali Dictionary.* Its relation to the sources from which it drew was carefully discussed by various scholars and in special detail by M'ilhelm Geiger. It was agreed that it gave a reasonably fair and correct presentation of the tradition preserved in the lost Sinhalese Mahavamsa; that, except in the earliest period. its list of kings with the years of each reign was complete and trustworthy; and that it gave throughout the view, as to events in Ceylon, of a resident in the Great Minster at Anuradhapura. (T. W. R. D.; X.)

MAHAVIRA, VARDHAMANA JNATRIPUTRA (6th century B.C.), a contemporary of Buddha, was the 24th and last *tirthankara* ("prophet") of the Jains (*q.v.*) and the founder of the present form of their creed. Mahavira is an honorary title meaning "great hero." According to Jain tradition, his dates were 599–527 B.C., but the two Jain sects, Svetambaras and Digambaras, differ in their accounts of his life, which is confused with many legends. The historical facts are that he was born in Vaisali, the younger son of a king named Siddhartha and of his wife Trisala. He married a noble lady by whom he had a daughter, but at the age of 30 he renounced the world and for 12 years led a life of self-mortification as a wandering beggar, even discarding his clothes. At the end of this period he reached the state of omniscience, and for the rest of his life he taught his doctrines to his ascetic disciples and to an ever-increasing number of laymen. Although he was of a reserved nature, his personality seems to have left a deep impression.

His teaching was a systemization of that of Parsva, the 23rd *tirthankara,* who is said to have lived about 250 years previously. Recensions of some of Mahavira's discourses are extant in the sacred books of the Jains, written in Prakrit dialects, their final redaction dating probably from the 5th century AD. It is uncertain how far any of the sayings there attributed to him are genuine: the Svetambaras acknowledge their authenticity but the Digambaras deny it. As, however, the doctrines of the two sects differ only in matters of minor importance and bear the stamp of a very archaic mode of thinking, it seems not improbable that their leading ideas may go back to his teaching.

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MAHAYANA (GREAT VEHICLE) is one of the two major schools of Buddhism (*q.v.*), the other being Theravada. As a "vehicle," *i.e.,* conveyance, it is "great" because it teaches, by its cardinal doctrine, the broad path to salvation: all sentient beings possess the Buddha-nature and hence are capable of attaining enlightenment. The Mahayana aspect of Buddhism, which is followed in Tibet, China and Japan, probably developed during the two centuries before the Christian era, with its starting point very likely furnished by the speculations on the nature of the Buddha developed by the Mahasanghikas, the group of dissident monks who broke away from the orthodox community at the second great Buddhist council, at Vesali (northeast India) c. 383 B.C. According to this school, the Buddha was no longer a human teacher but a *lokottara* or supramundane being who appeared on earth in an apparitional form as Sakyamuni *(see* GAUTAMA BUDDHA).

Doctrine.—Since the Mahayana teaches the universal salvation of all sentient beings, the path leading to this salvation must be simplified. The Mahayana stresses the importance of faith and devotion to the Buddha and the Bodhisattvas, and love for all creatures, manifested by compassion and charity. According to the Lotus (Saddharma Pundarika) Sutra, one of the important Mahayana scriptures, anyone who hears the Master's teachings, who worships an image or relic of the Buddha or who makes a statue even of sand will attain enlightenment; according to the Pure Land (Sukhavativyuha) Sutra, it is necessary only to utter the name of the Buddha Amitabha in loving adoration.

The Mahayana scriptures were composed mainly in Sanskrit (in contrast to the Theravadin, in Pali) and survive largely in Tibetan and Chinese translations.

One of the notable differences between the Theravadin and Mahayana aspects lies in their conception of the Buddha. In the Mahayana there is little of the man left; he has become a transcendental being. a Supreme God above all gods, who has lived for countless ages in the past and will continue to live forever in the future. As the embodiment of the absolute and eternal truth, he is neither born nor dies but lives and works eternally. leading all his followers also to the eternal life. However, to save errant mankind. he appeared on earth as Sakyamuni to preach a doctrine of salvation; he did this not once but countless times in the past and will continue to do so in the future.

As a result of this development, the historical Buddha, Sakyamuni, receded farther and farther into the background, while speculations about the eternal Buddha began to assume increasing importance Such speculations eventually led to the formulation of the doctrine of the *Trikaya* or the triple body of the Buddha. According to this doctrine, as elucidated in its fullest form by Asanga (4th century A.D.), the triple body consists of the *Dharmakaya* (Body of Essence, or Unmanifested Body), *Sambhogakaya* (Body of Communal Enjoyment, or Subtle Body) and *Nirmanakaya* (Body of Magical Transformations, or Earthly Body). The *Dharmakaya* is the only real body of the Buddha; it connects and unites all the Buddhas of the past with those of the future. Though there are many Buddhas, there is only one *Dharmakaya,* which is devoid of all determinations, free from all opposites and embodied in all bodies. The universe becomes, but the *Dharmakaya* remains forever. When it is called upon to fulfill the vows of the Bodhisattva. it then appears as the *Sambhogakaya,* the body in which the Buddha enjoys his full majesty, virtue and knowledge and which the Bodhisattvas are privileged to witness. A marvelous symphony of light and sound, this body preaches the Mahayana *sutras* on Vulture peak, one of the hills encircling Rajagaha, capital of the ancient kingdom of Magadha in eastern India. Lastly, to explain the appearance of a Buddha like Sakyamuni on earth, there is the *Nirmanakaya,* which is a fictitious creation of the eternal Buddha made to conform to the ways of man.

Between the realm of pain which is human and the realm of beatitude which is the Buddha. a connection is established by a class of deity called Bodhisattva — literally a being destined for enlightenment — the doctrine of which is one of the distinguishing features of the Mahayana. The Bodhisattva is an ever-compassionate, warm and merciful being, always ready to assist anyone in need of help, who delays his entry into Nirvana until he has rescued all sentient beings from the sea of misery. He is able to do this by a new doctrine developed by the Mahayana, that of the transfer of merits, according to which the Bodhisattva transfers to less fortunate creatures some of the merits he has accumulated through his long career of spiritual advancement. There are a number of great Bodhisattvas, who are usually regarded as personifications of different aspects of the Buddha's virtues: Manjusri represents wisdom, Avalokitesvara the compassionate glance, Samantabhadra all-round excellence. Of these, Avalokitesvara (Kuan-yin in Chinese, Kwannon in Japanese) is the most prominent, for he abrogates the law of *karma* by going to the deepest hell to lighten the misery of creatures there, and he is ever ready to help people faced with the dangers of fire. flood, demon and the sword. For reasons not fully clear, this Bodhisattva is best known in China and Japan in a female form as the goddess of mercy, the patron deity of women who desire children.

Theravada and Mahayana also differ in their understanding of the concept of Nirvana (*q.v.*). In the Mahayana, Nirvana means the thorough comprehension of the sameness of *samsara* — that is, the phenomenal world of human experience, with its suffering and unrest — and Nirvana — that is, the experience of spiritual freedom and enlightenment. Therefore the enlightened Bodhisattva does not think of passing from *samsara* into Nirvana. The nirvanic state is present in all of us, but we do not realize it because of our ignorance. When all imaginings about the dualism of *samsara* and Nirvana cease, when there is a complete cessation of mental constructions, then the individual is said to have attained Nirvana or perfect Buddhahood.

Within the Mahayana there arose a development called Tantrayana or Mantrayana — Tantrayana because its basic literature is designated as *tantras,* meaning esoteric literature, Mantrayana because it emphasizes *mantras* or mystic syllables. In this phase, an esoteric consecration into the mystic circle or *mandala* — in which sexual symbolisms, liturgy and rites play a prominent role — is a necessary component of soteriology. Developed originally on the borders of India, the Tantrayana attained its most luxuriant growth in Tibet. For a brief period during the 8th century it gained a foothold in China, but it soon disappeared, presumably because the prevailing Confucian ritualistic principles did not countenance mixture of the sexes. (See also TIBETAN BUDDHISM.)

Schools. — The two main Mahayana schools in India were the Madhyamika (Doctrine of the Middle Path) and the Vijnanavada (Doctrine of Mere Ideation). The former, founded by Nagarjuna (2nd century A.D.), stresses the doctrine of *sunyata,* interpreted as emptiness by some and relativity by others. By this, Nagarjuna meant that a thing can be identified only by its relation to another thing; without these relations, it becomes meaningless. Therefore, a thing is said to be empty because it does not possess an independent reality, for it depends upon causes and conditions for its existence, and when these causes and conditions disappear, the thing also disappears. Thorough comprehension of the doctrine of *sunyata* leads to *prajna,* intuitive wisdom or nondual knowledge. When one achieves *prajna,* one reaches the state of absolute truth, which is beyond thought and conception, unconditioned and indeterminate. On the one hand, this absolute truth is said to transcend phenomenon, but on the other hand it is also said to be immanent and identical with it. The understanding of the phenomenal world, where *karma* prevails, is said to constitute the second or relative level of truth. The Vijnanavada holds to the dictum that this world is mere ideation. The external world is a fabrication of human consciousness, hence an illusion. The only true reality is mind or consciousness.

The Madhyamika school was introduced into China in the early 5th century by Kumarajiva; the Vijnanavada was first propagated by the Indian monk Paramartha in the middle of the 6th century, though the chief exponent of this school was Hsiian-tsang during the 7th century. Although both schools were studied, they never became so popular as the other Mahayana schools developed in China, such as the Hua-yen, T'ien-t'ai, Pure Land and Ch'an (Zen [*q.v.*] in Japanese). The Hua-yen or Wreath school, with its principles of interpenetration and intermutuality, emphasizes the relationship between one phenomenon and another and maintains that since all phenomena are manifestations of the one immutable noumenon they are in perfect harmony with one another. Followers of the T'ien-t'ai school, on the other hand, concentrate their attention on the relationship between the noumenon and phenomenon and say that the whole and the part are identical with each other in accordance with their doctrine of the threefold truth, emptiness, temporariness and the mean. All things lack reality, hence they are empty. However, a thing, though empty, enjoys a temporary existence as phenomenon. The fact that a thing is both empty and temporary at the same time constitutes the middle truth. In the Pure Land school. faith and devotion to Amitabha, presiding Buddha of the Western Paradise, accompanied by utterance of his name, are the main prerequisites for rebirth in that ideal Buddha-land. The Ch'an or Meditation school would do away with all literature and images and endeavour to attain a direct, instantaneous realization of the inner essence that is the Buddha-nature in man.

Of these four schools, the first two, being more philosophically inclined, did not gain so wide a following among the populace as did the Pure Land and Ch'an. The teachings and practices of the Pure Land were so simple that even the illiterate could understand them, hence this school became the dominant one in China from the time of the T'ang dynasty (7th–10th centuries). As for the Ch'an school, its de-emphasis of the scriptures, images, rituals and metaphysical speculations appealed to the practical tendencies of the Chinese. Its approach to enlightenment was direct, plain and concrete. The Ch'an masters spoke in the everyday colloquial language the ordinary Chinese could understand. It did not antagonize Confucian thought. for it insisted that monks do productive work. It had a close affinity to Taoism in its nonattachment to worldly objects and its mystic appreciation of nature. Being elastic and comprehensive enough to adapt itself to the Chinese environment, it prospered in China.

All these schools were in turn introduced into Japan with very little doctrinal change by Japanese monks after the beginning of the 7th century, and in their new home in that country they were to enjoy a long period of growth and development. For a study of Mahayana Buddhism as it is practised in the modern world, it is therefore necessary to go to Japan (see JAPAN: The People: *Religion*).

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MAHDI (Arab., "he who is guided aright"), a title assumed by the third Abbasid caliph (see CALIPHATE). According to Moslem traditionists Mohammed declared that one of his descendants, the imam of God. who would fill the earth with equity and justice, would bear the name of al-mahdi. The Sunnis hold that this mahdi has not yet appeared. The name of mahdi is also given by the Shi'ites to the last of the imams of the house of Ali, who disappeared mysteriously about 874. It was under the name of al-mahdi that Mokhtar proclaimed Ali's son Mohammed as the opponent of the caliph Abdalmalik and, according to Shahrastani. the doctrine of the mahdi, the hidden deliverer who is one day to appear and fill the oppressed world with righteousness, first arose in connection with a belief that this Mohammed had not died but lived concealed at Mt. Radwa, near Mecca, guarded by a lion and a panther. The belief in the appearance of the mahdi readily lent itself to imposture. Of the many pretenders to this dignity known in all periods of Moslem history the most famous was the first caliph of the Fatimite dynasty in north Africa: Obaidallah al-Mahdi, who reigned from 909 to 933. After him was named the first capital of the dynasty. the once important city of Mahdia (*q.v.*). Another great historical movement, headed by a leader who proclaimed himself the mahdi (Mohammed ibn Abdallah ibn Tumart), was that of the Almohads (*q.v.*).

In 1881 Mohammed Ahmed ibn Seyyid Abdullah (*q.v.*), a Dongolese, proclaimed himself al-mahdi and founded in the eastern Sudan the short-lived empire which was overthrown by an Anglo-Egyptian force at the battle of Omdurman in 1898. Concurrently with the claim of Mohammed Ahmed to be the mahdi the same title was claimed by, or for, the head of the Senussi, a confraternity powerful in many regions of north Africa.

MAHDIA (also spelled MEHDIA, MEHEDIA, etc.), a port of Tunisia, on the coast between the gulfs of Hammamet and Gabès. 47 mi. by rail S.S.E. of Sousse. Pop. (1956) 10.832. Mahdia is built on a rocky peninsula which projects eastward about a mile beyond the normal coast line, and is not more than a quarter of a mile wide. The extremity of the peninsula is called Ras Mahdia or Cape Africa — Africa being the name by which Mahdia was designated by Froissart and other European historians during the middle ages and the Renaissance. In the centre of the peninsula and occupying its highest point is a citadel (16th century); another castle farther west is now used as a prison and is in the centre of the native town.

The European quarter and the new port are on the southwest side of the peninsula. The small artificial harbour is available for small boats only; steamers anchor in the roadstead about a quarter of a mile from the shore. On the southeast, cut out of the rock, is the ancient harbour, or cothon. There are manufactories of olive oil.

Mahdia occupies the site of a Phoenician settlement on which grew a Roman centre, name unknown. After the Arab conquest of north Africa the town fell into decay. It was refounded in 912 by the first Fatimite caliph, Obaidallah al-Mahdi, after whom it was named. It became the port for Kairawan and was for centuries a city of considerable importance. largely because of its great natural strength and its position on the Mediterranean. It carried on an active trade with Egypt, Syria and Spain. The town was occupied by the Normans of Sicily in the 12th century, but after holding it for about 12 years they were driven out in 1159 by the Almohades. In 1390 a joint English and French force vainly besieged Mahdia for 61 days. In the early part of the 16th century the corsair Dragut seized the town and made it his capital, but in 1550 the place was captured by the Spaniards, who held it until 1574. Before evacuating the town the Spaniards dismantled the fortifications. Near to Mahdia, about 3 mi. N.E. of the lighthouse, were found in the sea in 1908 at a depth of 528 ft. the remains of an ancient galley. of Athenian construction, laden uith objects of art, and sunk in the 1st century A.D. Beautiful statues of bronze and many fragments found by divers are gathered together in the Alaoui museum at Tunis.

MAHÉ, a former French settlement within Malabar district, Kerala, India, situated in 10° 43' N. and 75° 33' E., at the mouth of the Mahé river. Area 23 sq.mi.; pop. (1955) 20,261. It was the only French possession on the west coast of India and was subordinate to the commissioner in Pondicherry. A popular movement in favour of Mahé's union with India began on April 9, 1954; after a series of disturbances the French administration withdrew on July 15 and Mahé was transferred de *jure* to the republic of India on Nov. 1, 1954.

MAHESHWAR, a town in Nimar district, Madhya Pradesh state, India, on the north bank of the Narbada (Nerbudda). Pop. (1951) 7,525.

Though of great antiquity, and also of religious sanctity, it is chiefly noted as having been the residence of Ahalya Bai, the famous queen of the Holkar dynasty during the last half of the 18th century.

MAHI, a river of western India. which rises in southwestern Madhya Pradesh and, after flowing through southern Rajasthan, enters the Gujarat and falls into the sea by a wide estuary near Cambay; total length, about 350 mi.; estimated drainage area, 17,000 sq.mi.

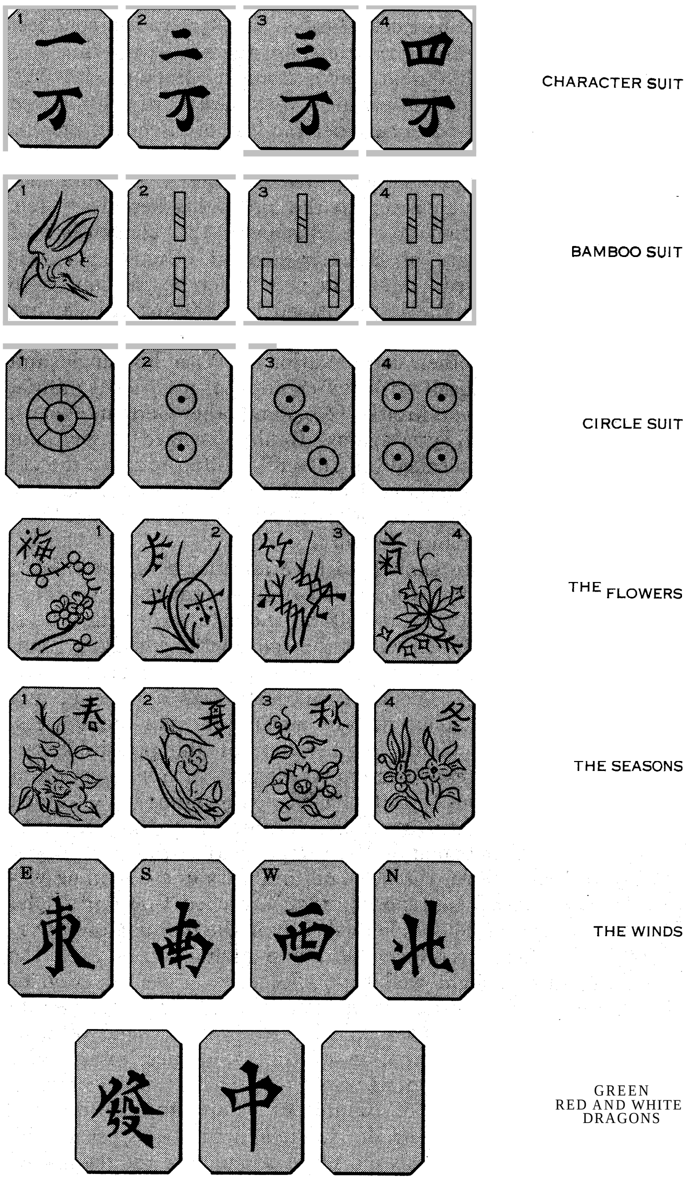
MAHILLON, VICTOR CHARLES (1841–1924), Belgian musical scholar and authority on wind instruments. The son of Charles Mahillon (1813–87), the founder of a firm of wind-instrument makers, he was born in Brussels, March 10, 1841, and entered his father's business (1865). As curator of the museum of the Brussels Conservatoire, he formed a collection of over 1.500 instruments of which he published an analytical catalogue (1880–1922), containing demonstrations of the theories of instrument construction and a methodical classification of ancient and modern instruments. He had copies made of rare instruments, and adapted some of them, notably the Bach trumpet. for modern use.

Mahillon published Les *Éléments* d'acoustique *musicale* et *instrumentale* (1874), and numerous monographs on instruments and organized concerts of historical works played on old instruments.

Mahillon died at St. Jean, near Cap-Ferrat, June 17, 1924.

See E. Closson, *La Facture des instruments de musique en Belgique* (1935).

MAH-JONGG, a western version of a Chinese game, is played with 136 or 144 tiles or *p'ais,* similar to dominoes but engraved with Chinese symbols and characters and divided into suits and honours. A fad in England, the United States and Australia in the mid-1920s, the game was revived in the U.S. after 1935 but never regained its initial popularity. The game that came to be known as mah-jongg is probably of 19th-century origin. Before World War I, each Chinese province had its own style of play and dialect name for it. Signifying "sparrow" or hemplike bird, the name has been variously transliterated as *ma tsiang, ma chiang, ma cheuk* and *ma ch'iau.* The sparrow or a mythical "bird of 100 intelligences" appears on one of the tiles. The name mah-jongg was coined and copyrighted by Joseph P. Babcock, a U.S. resident of Shanghai who is credited with introducing mah-jongg to the west after World War I. He wrote a modified set of rules,



TILES OF COMMON **SUITS** AND HONOURS USED IN MAH-JONGG

A full set contains 144 tiles, divided into 6 suits; sometimes only 5 are used

gave English titles to the tiles and added index letters and numerals familiar to western card players.

Pieces.—Modern mah-jongg sets are usually made of plastics instead of bone or ivory. A full mah-jongg set contains 136 or 144 tiles depending on whether the flowers or seasons are used. Some sets include 20 flowers. The pieces are named and numbered as follows:

1. Bamboos, numbered 1 to 9, four of each number.......36 tiles
2. Circles, numbered 1 to 9, four of each number..........36 tiles
3. Characters, numbered 1 to 9, four of each number.......36 tiles
4. Honours, 4 red dragons, 4 green, 4 white dragons.......12 tiles
5. Winds, 4 east winds, 4 south winds, 4 west winds, 4 north winds..............................16 tiles

136 tiles

In addition:

6. Flowers and seasons, 4 of each or 8 of either............8 tiles

144 tiles

The bamboos are often called sticks or bams, the circles dots, the characters cracks or craks. The set also includes two dice, a quantity of tokens or plastic chips used for scorekeeping and a rack for each player whereon he can place 14 tiles with their faces visible only to himself.

The Game.—The usual game is for four, each playing for himself (there are no partners). The object of play, similar to that of the rummy card games, is to obtain sets of tiles. There are three kinds of sets: "chow," a run or sequence of three tiles of the same suit in numerical order; (2) "pung," a sequence of three like tiles of the same suit and rank, three dragons of the same colour or three identical winds; and (3) "kong," a pung plus the fourth matching tile. The winner is the first player to hold a complete hand; *i.e.,* four sets and a pair of like tiles (14 tiles). The strategy of mah-jongg, like that of rummy, is both offensive and defensive: to complete a "woo" or winning hand as quickly as possible; to block other players by not discarding tiles useful to them; and to build a high-scoring hand. Beginning with "east wind" (who collects or pays double according to whether he or another player wins), each player draws his "hand" and places it in his tile rack, east taking a total of 14 tiles and the others 13. The flowers or seasons are not counted as part of a 13-tile hand; on drawing such a tile, the player immediately "grounds" it face up and draws another tile. East begins the play by discarding one tile, reducing his hand to 13. Thereafter, the other players, in counterclockwise rotation, each draw one tile, which may be the last discarded tile or a loose tile from the "wall" (comparable to stock in rummy). Any player, regardless of whether it is his turn, may claim the previous discard if it completes his set. (If two or more players claim the same discard, there is a detailed order of precedence.) The losing players settle with the winner and with each other according to the accepted schedule of values for the sets or combinations of sets. A concealed set held in the hand scores differently from an exposed set on the table.

Under certain rules, exceptionally complete hands or "limit hands," picturesquely named "the three scholars," "four small blessings," etc., are scored differently. In U.S. play the emphasis on limit hands eventually far exceeded that under Chinese rules until high scores were accented over playing skill. A certain school of players restricted the winning hand to a very narrow list and made the flowers wild. Various other innovations followed. One was the "clear-handed" rule: woo hand may contain only tiles of one suit plus honours. The conflict led to publication of *Laws for Mah-Jongg* (1925) by Babcock and others, giving an option between the Chinese game and the clear-handed variant. Shortly after, the Mah-Jongg fad collapsed.

In 1937 Viola Cecil organized the National Mah Jongg league in the U.S. to standardize a new version of the game. Its innovations included the "Charleston," or exchange of tiles between players before the start of play, and the use of 22 flower tiles (wild or jokers except in certain winning hands).

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MAHLER, **GUSTAV** (1860–1911), Austrian composer and conductor, was born at Kalischt, Bohemia, July 7, 1860. From 1885 onward he conducted in Prague, Budapest, Hamburg and London, becoming director of the Vienna Opera in 1897. By unremitting zeal and tireless enthusiasm he brought the Viennese opera to a high state of perfection, but the strenuous work which he exacted from all earned him the name of "the tyrant" and made him many enemies, and in 1907 he was obliged to resign his post. He immediately received the offer of a conductorship in the U.S., which he visited for three seasons, returning in 1911 to Vienna, where he died on May 18. Mahler reflected to some extent in his works the classical tradition inherited from F. Schubert and A. Bruckner. In addition to over 40 songs, he wrote nine symphonies and part of another, all planned on a gigantic scale for an orchestra nearly doubled in strength.

BIBLIOGRAPHY.—R. Specht, Gustav Mahler, etc. (1913); P. Stefan, Gustav Mahler, a *Study* of his Personality and *Work* (1913); G. Adler, Gustav Mahler (Vienna, 1916); P. Bekker, Gustav Mahler's *Sinfonien* (1921); R. Mengelberg, Gustav Mahler (Leipzig, 1923).

MAHLSTICK, a stick with a soft leather or padded head, used by painters to support the hand that holds the brush. The word is an adaptation of the Dutch *maalstok* (*i.e.,* the painter's stick), from *malen,* to paint.

MAHMUD I (1696–1754), sultan of Turkey, the son of Mustafa II, succeeded his uncle Ahmed III in 1730. A peace-loving man, he played no part in the wars of his reign. He was under the influence of his two successive chief eunuchs, both named Beshir Aga. The first died in 1746; the second was assassinated in 1752 at Mahmud's instigation to appease the janissaries and the ulema. During this reign Turkish diplomacy was conspicuously skilful, partly as a result of what had been learned from a French convert to Islam, the comte de Bonneval (called Ahmed Pasha), who also did much to westernize the army. Mahmud died of heart disease in 1754.

(See TURKEY: History.) (G. L. L.)

MAHMUD II (1785–1839), sultan of Turkey, was the son of Abdul-Hamid I, and succeeded his brother, Mustafa IV, in 1808. He had shared the captivity of his ill-fated cousin, the former sultan Selim III, whose efforts at reform had ended in his deposition by the janissaries. The reforming efforts of the grand vizier Bairaktar, to whom he had owed his life and his accession, broke down on the opposition of the janissaries, and Mahmud had to wait for more favourable times. Meanwhile the empire seemed in danger of breaking up. In 1812 the war with Russia was closed by the treaty of Bucharest, which restored Moldavia and the greater part of Walachia to the Ottoman government, but left a number of burning questions, both internal and external, unsettled. The preoccupation of the sultan with Ali (*q.v.*) of Janina gave their opportunity to the Greeks, who in 1821 began their war of independence (see GREEK ISDEPENDENCE, WAR OF). The rising in the north was easily crushed; but in the south the Ottoman power was hampered by the defection of the seafaring Greeks, who had manned the Turkish navy.

After three abortive campaigns Mahmud was compelled, infinitely against his will, to summon to his assistance the already too powerful pasha of Egypt, Mohammed Ali (*q.v.*), whom he had already employed to suppress the rebellious Wahhabis in Arabia. The disciplined Egyptian army, supported by a well-organized fleet, rapidly accomplished what the Turks had failed to do; by 1826 the Greeks were practically subdued on land, and Ibrahim was preparing to turn his attention to the islands. But for the intervention of the Powers and the battle of Navarino Mahmud's authority would have been restored in Greece. After in vain attempting to obtain an apology for "the unparalleled outrage against a friendly power" he issued on Dec. 20, 1827, a solemn *hatti* sherif summoning the faithful to a holy war. This, together with certain outstanding grievances and the pretext of enforcing the settlement of the Greek question approved by the Powers, gave Russia the excuse for declaring war against Turkey. After two hardly fought campaigns (1828, 1829) Mahmud was at length, on Sept. 14, 1829, compelled to sign the peace of Adrianople. From this moment until his death Mahmud was, to all intents and purposes, the "vassal of Russia," though not without occasional desperate efforts to break his chains. (For the political events of the period see TURKEY: History.)

The attitude of, the sultan to Mohammed Ali must now be considered. This was determined throughout by his overmastering hatred of the upstart pasha, of whom he had stooped to ask aid and who in Sept. 1832 began to defy his will (see MOHAMMED ALI); the importance of this attitude lies in the fact that, as the result of the success of Mahmud's centralizing policy and notably of the destruction of the janissaries (*q.v.*), the supreme authority, hitherto limited by the practical power of the ministers of the Porte and by the turbulence of the privileged military caste, had become concentrated in his own person.

This omnipotence of the sultan in deciding the policy of the government was in striking contrast with his impotence in enforcing his views on his subjects and in his relations with foreign powers. Mahmud, in spite of—or rather because of—his well-meant efforts at reform, was hated by his Moslem subjects and stigmatized as an "infidel" and a traitor to Islam. Of this hatred he was fully conscious; he knew that his subjects, even many of his own ministers, regarded Mohammed Ali as the champion of Islam against the "infidel sultan"; he suspected the pasha, already master of the sacred cities, of an intention to proclaim himself caliph in his stead. This, together with the weakness caused by military reforms but recently begun, drove him to rely on the aid of Russia. The long tradition of French friendship for Turkey had been broken in 1830 by the conquest of Algiers. Austria was, for the time, but the ally of the tsar.

On Aug. 9, 1832, Mahmud made, through Stratford Canning, a formal proposal for an alliance with Great Britain, which Lord Palmerston refused to consider for fear of offending France. Mahmud bitterly contrasted the fair professions of England with the offers of effective help from Russia. His old ally having deserted him, he accepted the aid of his hereditary foe. The Russian expedition to the Bosporus, the convention of Kutakia and the treaty of Hunkiar Iskelesi (Unkiar Skelessi; July 8, 1833) followed. Mahmud was under no illusion as to the position in which the latter placed him toward Russia, but his fear of Mohammed Ali and his desire to be revenged upon him outweighed all other considerations. With his single aim in view he busied himself with the creation of a national militia, with the aid of count von Moltke (*q.v.*) and other German officers. In 1834 the revolt of Syria against Ibrahim seemed to give him his opportunity. He pleaded the duty of a sultan to go to the aid of his subjects when oppressed by one of his servants; but the Powers were obdurate, even Russia, much occupied in affairs nearer home, leaving him in the lurch.

Mahmud was astute enough to take advantage of the offense given to the Powers by Mohammed Ali's system of monopolies, and in 1838 signed with Great Britain, and afterward with others, a commercial treaty which cut at the root of the pasha's system. A few months later his passionate impatience overcame his policy and his fears. The hand of death was upon him, and he felt that he must strike now or never. In vain the Powers, now united in their views, warned him of the probable consequences of any aggressive action on his part. On his sole initiative he sent instructions to Hafiz Pasha, commanding the Ottoman troops concentrated at Bir on the Euphrates, to advance into Syria. The fatal outcome of the campaign that followed he did not live to hear. When the news of Ibrahim's overwhelming victory at Nezib (Nizib) (June 24, 1839) reached Constantinople, Mahmud lay unconscious. He died early in the morning of July 1.

Mahmud's efforts to reform the whole administration after the European pattern might well have succeeded, given a period of peace and enough first-rate men to help him. He was, despite his hasty temper, a kindly man, sincere, energetic and of high intelligence. By his extirpation of the janissaries, one of the greatest obstacles to reform, he paved the way for the *tanzimat* of 1839. He set an admirable example of loyalty to subordinates, and his abolition (1826) of the sultan's right to confiscate the property of deceased officials did much to enhance the dignity of public service. (W. A. P.; X.)

MAHMUD NEDIM PASHA (c. 1818–1883), Turkish statesman, was the son of Nejib Pasha, former governor general of Baghdad. He was successively undersecretary of state for foreign affairs, governor general of Syria and Smyrna, minister of commerce and governor general of Tripoli; minister successively of justice and of marine (1869); grand vizier in 1871 and 1872 and in 187j and 1876. He was high in favour with Sultan Abd-ul Aziz and fell much under the influence of Count Nicholas Ignatiev, the forceful Russian ambassador, before the war of 1877–78, his subserviency to Russia earning for him the nickname of "Mahmudoff." His administration was most unsuccessful, and he was largely responsible for the issue of the decree suspending the interest on the Turkish funds. He was minister of the interior from 1879 to 1883.

MAHMUD OF GHAZNI (971–1030), son of Sabuktagin, Afghan conqueror, was born on Oct 2, 971. His fame rests on his repeated invasions of India. His military capacity, inherited from his father, Nasir ud-Din Sabuktagin. was strengthened by youthful experience in the field. Sabuktagin, a Turki slave of Alptagin. governor of Khurasan under 'Abd ul-Malik I ibn Nuh of the Samanid dynasty of Bukhara, early brought himself to notice. (See SAMANIDS) He was raised to high office in the state by Alptagin's successor, Abu Ishak, and in A.H. 366 (AD. 977), by the choice of the nobles of Ghazni, he became their ruler. He soon began to make conquests in the neighbouring countries, and in these wars he was accompanied by his young son Mahmud.

In 994 Mahmud was made governor of Khurasan, with the title of saif *ud-daula* ("sword of the state"), by the Samanid Nuh II. Two years later his father Sabuktagin died in the neighbourhood of Balkh, having declared his second son, Ismail, uho was then with him, to be his successor. As soon as Ismail had assumed the sovereignty at Balkh, Illahmud, who was at Nishapur, addressed him in friendly terms, proposing a division of the territories held by their father at his death. Ismail rejected the proposal and was immediately attacked by Mahmud and defeated Retreating to Ghazni, he there yielded and was imprisoned, and Mahmud obtained undisputed power as sovereign of Khurasan and Ghazni (997).

The Ghaznevid dynasty is sometimes reckoned by native historians to commence with Sabuktagin's conquest of Bost and Kosdar (978). But Sabuktagin, throughout his reign at Ghazni, continued to acknowledge the Samanid suzerainty, as did Mahmud also, until 999, when after driving the Samanid forces out of Khurasan he received from Kadir, caliph of Baghdad, a khzlat (robe of honour). with a letter recognizing his sovereignty and conferring on him the titles *yamīn* ud-daula ("right hand of the state") and *amīn ul-millat* ("guardian of the faith"). From this time it is the name of the caliph that is inscribed on Mahmud's coins. together with his own new titles.

The new honours received from the caliph gave fresh impulse to Mahmud's zeal on behalf of Islam, and he resolved on an annual expedition against the idolaters of India. He could not quite carry out this intention, but a great part of his reign mas occupied with his Indian campaigns. In 1000 he started on the first of these expeditions, but he went no farther than the hill country near Peshawar. Mahmud's army first crossed the Indus in 1001, opposed by Jaipal, raja of Lahore. Jaipal was defeated, and Mahmud, after his return from this expedition. is said to have taken the distinctive appellation of *ghāzi* ("valiant for the faith"), but he is rarely so-called. On the next occasion (1005) Mahmud advanced as far as Bhera on the Jhelum, when his adversary, Anang-pal, son and successor of Jaipal, fled to Kashmir. The following year saw Mahmud at Multan. When he was in the Punjab at this time he heard of the invasion of Khurasan by the Ilek khan Nasr I, ruler of Transoxiana, whose daughter Mahmud had married. After a rapid march back from India, Mahmud repelled the invaders. The Ilek khan, having retreated across the Oxus. returned with reinforcements and took up a position a few miles from Balkh, but was defeated by Mahmud.

Mahmud again entered the Punjab in 1008, this time for the express purpose of chastising Sukhpal, who, having become a Moslem and been left by Mahmud in charge of Multan, had relapsed to Hinduism. The Indian campaign of 1009 was notable. Near the Indus Mahmud was opposed again by Anang-pal, supported by powerful rajas from other parts of India. After a severe fight, Anang-pal's elephants nere so terror-stricken by the fire missiles flung among them by the invaders that they turned and fled, the whole army retreating in confusion and leaving Mahmud master of the field. Mahmud, after this victory, pushed on through the Punjab to Nagar-kot (Kangra) and carried off much spoil from the Hindu temples to enrich his treasury at Ghazni. In 1011, after a short campaign against the Afghans under Mohammed ibn Sur in the hill country of Ghor, he marched again into the Punjab. The next time (1014) he advanced to Thanesar, between the Sutlej and the Jumna.

Before beginning his inroad into Hindustan he had to march north into Khwarizm (Khiva) against his brother-in-law Mamun, who had refused to acknowledge Mahmud's supremacy. The result was as usual. and Nahmud, having committed Khwarizm to a new ruler, one of Mamun's chief officers, returned to his capital. Then in 1018, with a very large force, he proceeded to India again, extending his inroad this time to the great Hindu cities of Muttra on the Jumna and Ranauj on the Ganges. He reduced the one, received the submission of the other and carried back great stores of plunder. Three years later he went into India again, marching over nearly the same ground, to the support, this time, of the raja of Kanauj, who, having made friendship with the Mohammedan invader on his last visit, had been attacked by the raja of Kalinjar. But Mahmud found he had not yet sufficiently subdued the idolaters nearer his own border, between Kabul and the Indus; and the campaign of 1022 was directed against them and reached no farther than Peshawar. Another march into India the follouing year was made direct to Gwalior.

The next expedition (1025) is the most famous of all. The point to which it was directed was the temple of Somnath on the coast of the Gujarat peninsula. After an arduous journey by Multan and through part of Rajputana, he reached Somnath and met with a very vigorous but fruitless resistance on the part of the Hindus of Gujarat. Moslem feet soon trod the courts of the great temple. The chief object of worship that it contained was broken, and the fragments kept to be carried off to Ghazni. For the more recent story of the Somnath gates see SOMNATH.

After the successes at Somnath, Mahmud remained several months in India before returning to Ghazni. Then in 1026 he crossed the Indus once more into the Punjab. His brilliant military career closed with an expedition to Persia. in the third year after this, his last, visit to India. The Indian campaigns of Mahmud and his father were almost, but not altogether, unvarying successes. The Moslem historians touch lightly on reverses. And, although the annals of Rajputana tell how Sabuktagin was defeated by one raja of Ajmere and Mahmud by his successor, the course of events which followed shows how little these and other reverses affected the invader's progress. A vast cycle of legends soon grew up over blahmud's exploits in India and more especially over the expedition to Somnath. Yet Mahmud's Indian conquests, striking and important in themselves, were, after all, in great measure barren, except to the Ghazni treasury. Mahmud retained no possessions in India under his own direct rule. But after the repeated defeats, by his father and himself, of two successive rajas of Lahore, the conqueror assumed the right of nominating the governors of the Punjab as a dependency of Ghazni, a right which continued to be exercised by seven of his successors. And for a time, in the reign of Mas'ud II (1098–1114), Lahore was used as the residence of the reigning Ghaznevid sovereign.

Mahmud died at Ghazni in 1030, the year following his expedition to Persia. He is conspicuous for his military ardour, his ambition. strong will, perserverance, watchfulness and energy, combined with great courage and unbounded self-reliance. But his tastes were not exclusively military. His love of literature brought poets and men of learning to his court, and the site of the ancient city of Ghazni still has remains of his monuments.

See *Cambridge* History *of India,* vol. *3* (1928); M. Nāzim, *The Life and Times of Sultan Mahmud of Ghazna* (1931).

MAHOGANY is the foremost cabinetwood of the world and one of the most valuable timbers in tropical America. It is the product of the genus Swietenia, family Meliaceae. First discovered of the three species is West Indies mahogany (Swietenia mahagoni), native in the Bahamas, Cuba, Jamaica, Hispaniola and southern Florida. More important commercially. is Honduras mahogany (Swietenia *macrophylla)* of southern Mexico, Central America and South America, found in Colombia, Venezuela and the upper Amazonian region of Peru, Bolivia and western Brazil.

Mahogany trees are scattered through wet tropical forests and are grown in plantations and for shade and ornament around the world. The alternate pinnate leaves have 4 to 12 paired, shiny, pointed leaflets with the two sides unequal. Many small greenish-yellow 5-petaled flowers are borne in clusters. The distinctive hard, pear-shaped seed capsules split into five parts from the base upward, releasing many winged seeds. The wood characteristically is rich reddish brown, especially after exposure, though when freshly cut ranges from light pink to golden brown. It is fine-textured with scattered pores and often with a highly attractive figure. such as stripe, mottle. fiddleback and. from forks, the famous crotch and swirl. Oi uniformly high grade, it is easily worked, takes a beautiful polish, stains and glues readily and is strong and durable.

The oldest surviving use oi carved mahogany is in the cathedral at Santo Domingo, built 1514–40. Hernán Cortés in 1521 adapted it for shipbuilding. One of the first recorded uses in England was at Nottingham castle in 1680. For fine furniture, mahogany became popular in the early part of the 18th century, when cabinetmakers began to carve decorations on this strong wood. Other uses include cabinetwork, television cabinets, paneling, veneers, plywood, molded plywood boat hulls, yacht interiors, working models and foundry patterns. In World War II mahogany served for PT boats and aircraft.

The word mahogany, usually with a descriptive or geographic qualification: has been applied to nearly 200 species. Khaya, or African mahogany, is obtained from the genus Khaya (mostly Khaya iuorensis; family Meliaceae) in West Africa, mainly Ivory Coast: Ghana and Nigeria. Wood of related genera. for example sapele (*Entandrophragma cylindricum*). also has been marketed as African mahogany. The trade name Philippine mahogany has been applied to red lauans (*Shorea negrosensis, S. polyspermn*—also called tangile, and related species) irom the Philippine Islands belonging to the dipterocarp family (Dipterocarpaceae). The U.S. Federal Trade commission has approved the names African and Philippine mahogany but otherwise restricts mahogany to woods of *Swietenia.*

In western North America several species of shrubs and small trees of cercocarpus, genus *Cercocarpus* (fam. Rosaceae, *q.v.*), with hard, fine-grained, reddish wood, are known as mountain-mahogany. Lemonade sumac (*Rhus integrifolia*), a handsome evergreen shrub or small tree of southern California and Mexico, has been called mahogany sumac or mahogany. (E. L. L.)

MAHONE, WILLIAM (1826–1895), U.S. soldier and senator, was born near Monroe, Va., on Dec. 1, 1826. In 1847 he graduated at the Virginia Military academy and. having studied civil engineering, became chief engineer of the Norfolk and Petersburg railway. At the outbreak of the Civil War he became lieutenant colonel of Virginia volunteers in the Confederate army. and soon after colonel of the 6th Virginia infantry. He participated in most of the battles of the peninsula and those around Petersburg, winning a reputation for his hardy campaigning. He was commissioned brigadier general in March and major general in August 1864. He afterward commanded a division in Ambrose B. Hill's corps. After the war he again turned to railway affairs and became president of the Norfolk and Tennessee. He became the leader of the readjuster party in Virginia! was an unsuccessful candidate for governor in 1878, but in 1880 was elected U.S. senator, which position he held until his defeat in 1887. He died at Washington, D.C.. on Oct. 8, 1895.

MAHONIA, a genus of unarmed evergreen shrubs (family Berberidaceae), closely allied to the barberry (*q.v.*) and considered by some as a section of *Berberis.* The mahonias differ from the true barberries mainly in having compound leaves and a calyx of nine sepals. There are about jo species of *Mahonia,* found chiefly in Asia, western Sorth America and Central America. Several are cultivated for their ornamental ioliage, flowers and fruit, including the Oregon grape (*q.v.*); the Japanese mahonia (*M. japonica*), native to China; and *M. fortunei,* also native to China and named after the English traveller, Robert Fortune.

MAHONY, FRANCIS SYLVESTER (1804–1866), known as "Father Prout," Irish priest and author, son oi a woollen manufacturer. was born in Cork) Ire.: in 1804. His classical education was chiefly obtained at a Jesuit college at Amiens, and after studying in Paris he entered the Jesuit college at Rome and was admitted into the Society of Jesus. He served in Switzerland and at Clongoweswood, Ire.. where he was prefect of studies and subsequently master of rhetoric. There he was involved in scandals that led to his resignation. On going to Italy he was told at Florence that he was expelled from the society. He obtained priest's orders at Rome in 1832, and returned to Ireland, later officiating in the chapel of the Bavarian Legation in London. He joined William Maginn, and about 1834 began to contribute his celebrated "Prout Papers" to *Fraser's Magazine.* These consist of episodes in the life of the parish priest "Father Prout," and dialogues after the model of "Christopher North." Of his poetic writings. his "Bells of Shandon" has always been greatly admired. His verse tends to show that with all his sarcastic and cynical wit his genius had also its tender, serious and sentimental side. In 1846 Mahony became correspondent at Rome to the *Daily News,* and his letters from that capital give vivid pictures of the first years of the reign of Pius IX. He died in Paris on May 18, 1866.

An edition of his works, by Charles Kent, was published in 1881.

MAHOUT, an elephant driver. The mahout sits on the elephant's neck and directs him by voice and by the use of a goad called ankus.

MAHRATTAS or **MARATHAS.** The Mahrattas are a mixed people inhabiting Central India irom Gwalior to Goa. Their religion is Hinduism and their language is Marathi. Their origin is obscure. hut they seem to have entered India beiore Mahmud of Ghazni with his Mohammedan horde conquered Indian states in the early 11th century. The real iounder of the Mahrattas as a power was Sivaji Bhonsla (1627–80). He gradually succeeded in compelling the independent chiefs to acknowledge his suzerainty, and drawing upon their military resources he subdued much of the territory of the emperor of Delhi. In 1674 he was proclaimed maharajah of the Konkan, and he instituted a levy of a fourth of the land revenues. Sivaji was succeeded by his son; Sambaji, in 1680. and in 1689 the latter was captured and put to death by Aurangzeb (*q.v.*). Thereafter, there being no stable rule, the peshwas or chief ministers indulged their ambitions to the full and the Mahrattas began to decline, being divided among themselves.

Sivaji's successor was merely a titular monarch, the peshwa becoming the hereditary ruler. These peshwas were Brahman by faith and gradually the struggle became one between the military and religious powers. In the early 18th century the five Mahratta states of Baroda, Gwalior, Indore, Nagpur and the "dominions of the Peshwa" were constituted. Owing to internal strife the East India company was forced to intervene. When, in 1739, Nadir Shah invaded the empire of Delhi the peshwas saw an opportunity of seizing further territory from the mogul emperor. In 1761 their power was almost irretrievably destroyed in their defeat by Ahmad Shah, ruler of Afghanistan, at the battle of Panipat. In 1779 began a series of wars between the Mahrattas and the British and the names of Wellesley and Lake are famous in connection with the brilliant victories over the soldiers of Indore, Nagpur and Gwalior in the third Mahratta War (1803–05). The efforts of these officers resulted in the accession of much territory to the British flag. In 1817 the Mahratta peshwa united with Nagpur and Indore in attacking the British forces. and the result was the annexation of the peshwa's territories to the presidency of Bombay. Later. Indore and Xagpur were annexed by the British and the state of Gwalior was brought under British control in the middle of the 19th century. In modern times the rulers of the Mahratta states took special titles, the ruler of Indore being known as Holkar of Indore, Sindia of Gwalior, and Gaikwar of Baroda. These are family names.

MAHSEER (*Barbus mosal*), a large-scaled barbel of the rivers of India. attaining a weight of over 100 lb. and celebrated as a sporting fish.

MAI, ANGELO (1782–1854), Italian cardinal and philologist, was born of humble parents at Schilpario in the province of Bergamo. Lombardy. on March 7, 1782, was made a cardinal in 1838. and died at Castelgandolfo on Sept. 8, 1854. He was educated at the Collegium Romanum. and aiter teaching at Orvieto and elsewhere was made custodian of the Ambrosian library at Milan in 1813. He went to Rome in 1819 as chief keeper of the Vatican library.

It is on his skill as a reader of palimpsests that Mai's fame chiefly rests. To the period of his residence at Milan belong: Fragments of Cicero's *Pro Scauro, Pro Tullio, Pro Flacco, In Clodium et Curionem, De aere alieno Milonis, De rege Alexandrino* (1814); *M. Corn. Frontonis opera inedita, cum epistolis item ineditis, Antonini Pii, Marci Aurelii, Lucii Veri et Appiani* (181j; new ed., 1823, with more than 100 additional letters found in the Vatican library); portions of eight speeches of Quintus Aurelius Symmachus; fragments of Plautus; the oration of Isaeus *De hereditate Cleonymi;* the last nine books of the *Antiquities* of Dionysius of Halicarnassus, and a number of other works. *M. Tullii Ciceronis de republica quae supersunt* appeared at Rome in 1822; *Scriptorum veterum nova collectio, e vaticanis codicibzis edita* in 1825–38; *Classici scriptores e vaticanis codicibus editi* in 1828–38; *Spicilegium romanum* in 1839–44; and *Patrum nova bibliotheca* in 1845–53.

MAIA. (1) In Greek mythology, the eldest of the Pleiades, the seven daughters of Atlas and the Oceanid Pleïone, mother of Hermes (*q.v.*). (2) An obscure Roman goddess, also called Maiesta, the cult partner of Volcanus; commonly confused with (1) in poetry and later cult.

MAIDA, a village in the province of Catanzaro, Calabria, near the Gulf of Sant' Eufemia, It., 210 mi. S. of Naples. Pop. (1951) 4,603. The battle of Maida on July 4, 1806, is memorable as the first of many successes in the Napoleonic Wars gained by British infantry in line over French infantry attacking in column. Adm. Sidney Smith had landed Gen. Sir John Stuart with about 5,000 men to help the Calabrian guerrillas. Gen. E. Reynier swiftly brought 6,000 French; Poles and Swiss to Maida. Each general meant to fight, and each engaged his leading unit before the rest of his force could wheel into action on the flank.

The French 1st light infantry, described by the French general, Joachim hlurat, in 1802 as a "superb regiment," attacked in two columns, between which rode Gen. Compere, a noted leader of light troops, confident of breaking the English as he had broken the Neapolitans four months before. Col. J. Rempt faced them with seven companies of light infantry in line two-deep, thus able, as Sir Charles Oman observed, to fire 700 shots against 240 from the front of the 1,600 French. On the third volley, at 20 yd., the French broke; Compere was taken, wounded, in the British line; Rempt charged the fugitives, and the 1st infantry lost 430 prisoners as well as 42; killed and wounded. On their flank this disaster and the fire of Col. W. P. Acland's brigade shattered the next French column, 42nd line, as quickly, though with less loss, and Acland, advancing, took 250 prisoners from a Polish regiment. With three regiments beaten Reynier was forced to retreat; the engagement developing on his right flank between Gen. Antoine Digonet's and Gen. Sir Galbraith Cole's brigades became a rearguard action and ended when a belated British battalion appeared on the flank. Reynier fled north, having lost 2,000 men. and it was a year before he regained Reggio. The battle had no other result. as Stuart had at once turned south, cleared some posts and returned to Sicily.

See Sir C. Oman, Studies in *the Napoleonic Wars* (London, 1929; New York, 1930). (I. D. E.)

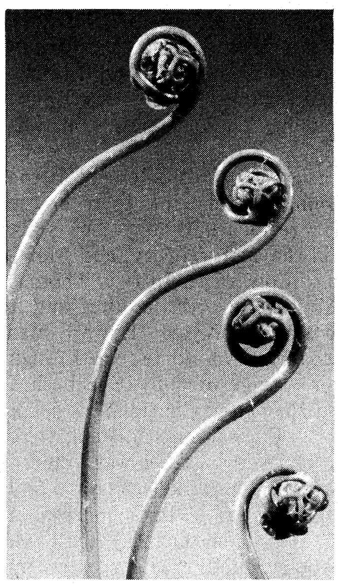
MAIDAN, a term used in Morocco and other parts of the Arabic-speaking east for an open space, usually in front of a palace. It is used generally in the middle east to signify an open plain; *e.g.,* Maidan park, Calcutta. It is a common part of place names in Afghanistan and Iran.

MAIDEN or MAID, a young unmarried girl. Maid is a shortened form of maiden. O Eng. *nzaegden,* which represents a diminutive of a Teutonic word meaning "young person," of either sex. An old English word "may," meaning a kinsman or kinswoman, and also a virgin or girl, represents the original. In early usage maiden as meaning virgin is frequently applied to the male sex, thus. in Malory's *Morte d' Arthur,* Sir Percyvale is called a "parfyte clene megden."

The title of maid of honour is given to an unmarried lady attached to the personal suite of a queen. The custom of sending young girls of noble or good birth to the court of a prince or feudal superior, for the purpose, primarily, of education, goes back to early feudal times, and is parallel with the sending of boys to act as pages and squires to the feudal castles. The regular establishment of maids of honour (*filles d'honneur*) appears first in the French court. As an institution they were suppressed in the reign of Louis XIV, at the instigation of Mme. de Montespan — who had been one of them — and their place was taken by the *dames de palais.* In the English court. this custom of attaching maids of honour to the queen's person was no doubt adopted from France. At the present day a queen regnant has eight maids of honour, a queen consort four. They take precedence next after the daughters of barons, and where they have not by right or courtesy a title of their own, they are styled "Honourable."

THE SCOTTISH MAIDEN was an instrument of capital punishment formerly in use in Scotland. It is said to have been invented by the earl of Morton, who is also said to have been its first victim. But the maiden was first used at the execution of the inferior agents in the assassination of David Rizzio (1566) and hlorton was not beheaded till 1581. The maiden was practically an early form of guillotine. A loaded blade or axe moving in grooves was fixed in a frame about 10 ft. high. The axe was raised to the full height of the frame and then released) severing the victim's head from his body. At least 120 suffered death by the maiden, including the regent Morton, Sir John Gordon of Haddo, President Spottiswood, the marquis and earl of Argyll. In 1710 it ceased to be used; it is now preserved in the museum of the Society of Antiquaries of Scotland, in Edinburgh.

MAIDENHAIR, the common name for the plants of a large genus of ferns, *Adiantum,* comprising about 200 species of dainty shade-loving forms with shiny black or purplish stipes and thin delicate fronds or leaf blades, either simple or divided icto fan-shaped segments or pinnules. Sori are marginal, short, borne on the underside at edge of the more or less altered margin of the pinnule, the margin reflexed to form a kidney-shaped indusium. The genus is largely of tropical America, nith a few species in temperate North America. *A. capillus-veneris,* Southern maidenhair or Venus' hair. occurs in temperate and tropical America, in the warmer parts of the old world and is a popular plant in greenhouses *A. pedatum,* a larger and beautiful fern. grows in woods from Nova Scotia to Alaska and southward from Florida to Texas. Adiantum is the ancient name. meaning unwetted, the foliage shedding raindrops.



ROCHE

MAIDENHAIR. UNOPENED FRONDS

Maidenhair tree is the popular name for *Ginkgo biloba,* a remarkable and handsome gymnospermous tree, the fan-shaped leaves of which with their forked veins resemble those of the maidenhair ferns. *See* GINKGO OR MAIDENHAIR TREE; GYMNOSPERMS. (J. M. BL.)

MAIDENHEAD, a municipal borough in the Windsor parliamentary division of Berkshire, Eng., on the Thames, 12 mi. N E. of Reading by road. Pop. (1951) 27,145. Area 7.8 sq.mi. Edward I gave a grant of pontage in aid of Maidenhead bridge in 1297 and in 1451 Henry VI incorporated the guild of the Brethren and Sisters of Maydenhith to keep the bridge in order; Elizabeth I in 1581 substituted for it a corporation. The present bridge is of stone and dates from 1772. It carries the London traffic over the Thames. In the 18th century a considerable river trade was done in malt, meal and timber; today Maidenhead is a residential and holiday town with much boating in the summer and with some light industries, such as engineering and the making of precision instruments, preserves and confectionery. There are research laboratories in the district. The railway bridge, designed by Isambard Brunel and built in 1838 has one of the largest brick spans in the world. The governing charter of the town until the 19th century was that of James II (1685).

MAID MARIAN, a personage incorporated in the English legend of Robin Hood (*q.v.*). She seems to have been an essential feature of the morris dance, and in the may-game was paired sometimes with Robin Hood, but oftener with Friar Tuck. The well-known pastoral play of Adam de la Hale, *Jeu de Robin et Marion,* and the many French songs on the subject, account for the association of the names. In the ballads on Robin Hood her name is only twice mentioned, but there is a late ballad, by a certain S. G. (F. J. Child, *English and Scottish Ballads,* i, 219), which tells how Maid Marian sought Robin in the forest disguised as a page, and fought with him for an hour before she recognized him by his voice. S. G. was perhaps acquainted with the two plays, written in 1598, of *The Downfall* and *The Death of Robert Earl of Huntingdon,* by Anthony Munday and Harry Chettle. In *The Downfall,* Matilda Fitz Walter escapes from the persecution of King John by following her lover to Sherwood forest, where they take the names of Robin Hood and Maid Marian. Perhaps this tale has some connection with the romance of the outlaw, Fulk Fitz Warin. Matilda or Mahaud, widow of Theobald Walter, escaped from John's solicitations by marrying the outlawed Fulk and following him to the forest. There were in semihistorical legends three Matildas pursued by King John, of whom particulars are given by H. L. D. Ward in his *Catalogue of Romances* (i. 502). Their several histories were fused by the Elizabethan dramatists, and associated with the Maid Marian of the morris dance who up to that time had probably only a vague connection with Robin Hood.

MAIDSTONE, a market town and municipal borough and the county town of Kent, Eng., in the Maidstone parliamentary division, about 41 mi. E.S.E. of London by road. Pop. (1951) 54,035. Area 9.3 sq.mi. There is evidence of Roman rural settlement, but the name Maidstone (Meddestane in Domesday Book; later Maeghan stane), probably meaning "the Maiden's stone," is presumably Saxon.

At the time of the Domesday survey the town belonged to the archbishop of Canterbury, and from the reign of John to the Reformation the archbishops had a residence there. The shire moot was held on Penenden heath in the 11th century, and Maidstone was an assize town in the reign of Edward I. In 1537 Thomas Cranmer exchanged the manor of Maidstone with the king, and it was granted by Edward VI to Sir Thomas Wyat. Edward also incorporated the town but this charter was forfeited through Wyat's rebellion. A second charter was granted by Elizabeth I (1559), others by James I (1604 and 1619) and Charles II (1682), and a new one by George II (1747). Four fairs, still held, were granted by the charter of 1559. A Thursday market was granted by Henry III to Archbishop Boniface, and a market every second Tuesday in the month by charter of George II. A cattle market on Monday and a produce and general market on Tuesday are held.

The manufacture of linen and woolen goods was increased by Walloons, who settled there in 1567, and was succeeded by papermaking, later the chief industry of the district. Maidstone is also the principal grain centre in the county. The cultivation of hops has been carried on since the 17th century, and there are large breweries and maltings. Other industries are confectionery, quarrying for Kentish ragstone, agricultural implement making, iron founding, and manufacturing hop bags, matting, sacking, etc., besides cement and lime works. The water traffic on the Medway is comparatively small.

Archbishop Boniface in about 1260 established a hospital there (Newark) for poor travelers, the chapel of which, with modern additions, is St. Peter's church. The demolition of the parish church of St. Mary. which had existed from Norman times, was begun in 1395 by Archbishop William Courtenay, who erected on the site the present church of All Saints. The remains of Courtenay's college of secular canons are interesting late 14th-century architecture. The grammar school was founded in 1549 and endowed with the estates of the local Corpus Christi fraternity, then dissolved; the medieval hall remains, but the school is in modem buildings on a new site.

A municipal museum, with public library, was opened in 1858 in a Tudor building, which is also the headquarters of the Kent Archaeological society. A museum of carriages, the only one of its kind in the British commonwealth was opened in 1946. From Saxon times down to 1830 executions and all the great county meetings took place on Penenden heath, a common enclosed in 1882 as a public recreation ground. In 1929 the corporation bought the Mote estate of 558 ac. and converted it into a public park and housing estate. A new courthouse was opened in 1937. The borough has its own courts of quarter sessions and summary jurisdiction.

MAIDU. This Indian group, of Penutian (*q.v.*) stock, lived in California east of the Sacramento river. Dialectically it comprises three divisions, northwestern, northeastern and southern or Nisinan; but a physiographically founded cultural cleavage into Maidu of the valley, foothills and mountains is more significant. The valley division was wealthiest and most advanced, and together with the Patwin west of the Sacramento had developed the Hesi form of the Kuksu cult, a spirit-impersonating religion with initiating societies, which appears to mark the culminating point of central Californian culture. The name Maidu, pronounced Mydoo, means "people." The population, which was originally from 8,000 to 10,000, had declined to 1,100 (including mixed bloods) by the end of the first decade of the 20th century.

MAIL: *see* ARMS AND ARMOUR; POST AND POSTAL SERVICES.

MAILLART, ROBERT (1872–1940), Swiss engineer, renowned for his pioneering work in reinforced-concrete flat-slab construction and the unsurpassed beauty and elegance of his bridges, was born in Bern. Switz., June 2, 1872. He was educated at the Federal Institute of Technology, Zurich (1890–94); then worked in France with François Hennebique. who had the first reinforced-concrete construction firm. In 1902 Maillart founded his own engineering firm in Zurich. He went to Russia in 1912, where he constructed factories and warehouses in Kharkov. Riga and St. Petersburg (Leningrad) for Swiss companies. After the Russian Revolution he returned to Switzerland financially ruined. In 1919 he again founded an engineering firm and continued construction until his death in Ziirich on May 4, 1940.

Among Maillart's works are bridges, spun airily over space, belonging to the purest expression that the modern era has been able to achieve. They include the Tavanasa bridge (1905), span 170 ft.; Salginatobel bridge (1929–30), span 307 ft.; Thur bridge (1933), span 240 ft.; a bridge over the Arve river near Geneva (1936–37), span 187 ft.: and bridges at Lachen (1940) and over the Simme river (1940). His was the first mushroom column, flat-slab construction, for a warehouse in Ziirich (1910).

See E. B. *Mock, The Architecture of Bridges* (1949). (S. GN.)

MAILLOL, ARISTIDE (1861–1944), French sculptor, whose primary importance rests on his monumental studies of the nude, was born at Banyuls-sur-Mer, Rousillon, on Dec. 8, 1861. At first a painter, he studied at Perpignan and, from 1882 to 1886, in Paris with Alexandre Cabanel. Like many young artists at this time, he then abandoned easel painting, taking up tapestry and wood carving and, about the turn of the century, began to work on a grand scale in clay, marble and bronze. At that time Maillol began to be influenced by the "synthesist" movement of Paul Gauguin (*q.v.*) and to some extent by his powerful wood carving, and by Maurice Denis and his concern with statuesque calm, order and unity at the expense of detail.

This equipment was strengthened in the first decade of the 20th century by a reappreciation of the archaic art of Greece (which Maillol visited in 1909); and it gave his work qualities which at once distinguished it from the intensely emotional and disrupted forms of Auguste Rodin, then powerfully influential.

Closely based on the living model, Maillol's work is nonetheless formal and he is preoccupied with over-all unity and balance. The emotional force of his work depends on disciplined relationships of mass and direction, and this control distinguishes it again from Rodin's frequent dependence on accidental effects of surface. Among Maillol's large works are the reclining figure of

"Fame" in the Tuileries gardens, Paris (a monument to' Paul Cézanne); the war memorials at Elne, Céret and Port Vendres; the standing figure of "Flora" (1911), based on a study of the Olympian sculptures; and the "Crouching Woman" made for his friend Count Kessler. There is a portrait head of Auguste Renoir (1907), between whose sculpture and Maillol's there is an affinity. He also worked in high-relief in stone and made fine terra-cotta statuettes, and his drawings and the book illustrations of his late years are of high quality. He died after a road accident near his birthplace in Oct. 1944. (D. C. T. T.)

MAILLY, LOUISE JULIE, COMTESSE DE (1710–1751), mistress of Louis XV of France, was the daughter of Louis, marquis de Nesle. She was the eldest of three sisters who succeeded one another as favourites of the king. In 1726 she married her cousin, Louis-Alexandre de Mailly. Although Louis XV had paid her attentions from 1732, she did not become titular mistress until 1738. She did not use her position to enrich herself, but she did have some influence in politics, being a patroness of Charles Fouquet, duc de Belle-Isle.

She was supplanted by her sister, the duchess of Châteauroux, and obliged to leave court in 1742.

MAIL-ORDER BUSINESS. In mail-order business, a retail commercial enterprise carried on primarily by mail, customers order from illustrated catalogues, circulars or advertisements in periodicals. Orders are placed by mail, filled from stock and usually delivered to the customer by parcel post, freight or express. In metropolitan communities, the general mail-order house may deliver the merchandise directly by truck.

By far the largest number of the hundreds of mail-order companies in the United States are small specialty sales firms. There are also numerous department stores which do a significant volume of business through their mail-order departments. The great bulk of the total mail-order business, however, is done by a few firms selling general merchandise lines. The largest and most advanced of mail-order companies are Sears, Roebuck and Co. and Montgomery Ward and Co., Inc.

Responding to major population shifts, the large mail-order companies established hundreds of retail stores across the country in the years after 192j. By mid-century the retail store sales volume of the largest firms exceeded that of their mail-order divisions. In addition to conventional over-the-counter selling, these retail stores characteristically include facilities for customers wishing to order goods through catalogues. In certain areas, catalogue offices have also been established where sample merchandise is displayed and where customers may order by mail after inspecting the samples. Another development in mail-order distribution in the large companies is that of the telephone ordering service, particularly popular in urban areas. Customers may select merchandise and order directly by telephone.

Mail-order operations have been known in the U.S. in one form or another since colonial days, but not until the latter part of the 19th century did this form of distribution assume a significant role in domestic trade. The great agricultural expansion in the U.S. together with the completion of the continental railroad network combined to provide a basic opportunity for a new form of distribution. The general merchandise mail-order houses developed to take advantage of the favourable market situation which was being inadequately serviced by conventional retailing outlets in rural areas. One of the impelling forces leading to the original success of the mail-order companies in rural markets was that they brought a variety of merchandise to the isolated farm buyer at comparatively low prices. Its great growth was stimulated by a postal rate structure which encouraged the wide dissemination of the early mail-order papers and later the distribution of catalogues. The establishment of the parcel-post system in 1913 added another important auxiliary to the continued expansion of mail-order operations.

Of significant importance in encouraging the growth of the early mail-order companies was the general antagonism U.S. farmers felt toward middlemen. The American Grange was especially vocal in expressing the resentment of the agricultural population toward what farmers considered the excessive size of distributors' trading margins. The early advertising copy of the mail-order companies capitalized effectively upon this unfavourable attitude of many farmers toward the merchant class, and the earliest years of Montgomery Ward and Company saw a close association between the company and the Grange. Members of the Grange were given special inducements to trade with Montgomery Ward when the company was founded in 1872.

The established mail-order houses came to be uniformly respected by both their customers and their competitors for adopting policies of full guarantees on merchandise and liberality in making adjustments. Although the companies were leaders in the movement for accurate and informative advertising of essentially reputable merchandise, this was not always the case. Indeed, the early years of the business were marked by something less than a high standard of ethics and by intensive advertising campaigns which attempted to exploit every possible opportunity to glorify the merchandise and to impel the incautious customer to buy. Modern mail-order catalogues, however, are nearly models of propriety and truthfulness in advertising.

The most successful mail-order companies have enjoyed certain sources of economy which are common to large-scale merchandising. They buy in large quantities; they frequently order merchandise manufactured to their own specifications: and in many cases they arrange for the production of their orders on a schedule which permits the supplier to sell at lower margins than he would otherwise demand. In some cases the large Arms contract for the entire output of particular manufacturers, and occasionally the mail-order company is completely integrated in terms of ownership of factory outlets, although this is not common.

Apart from the economies of large scale buying and selling, the mail-order operation offers certain opportunities for operating economies, since the mail-order plants themselves are essentially warehouses and may be located in relatively low rent areas. Further economies are achieved in the handling and shipping of merchandise. Orders to the mail-order company correspond to customers in the retail store, but the mail-order house has the advantage that the number of orders (or customers) at any given time of the day can be controlled. Under the schedule system originated by Sears. Roebuck and Co., the largest of all mail-order houses, orders are scheduled every 20 minutes, and the quantity in any 20-minute period depends upon the number of orders received during the day.

One mail-order firm in the mid-1950s was receiving more than 5,000 lbs. of first-class mail at all of its branches in an average day. This represents a total of approximately 300,000 letters. The mail is weighed before it is taken out of the sacks in which it arrives, and the company is able to determine the number of orders on the basis of the weight of the day's incoming mail. A thousand pounds of mail averages 55,000 letters, of which experience indicates a given percentage constitutes orders. Long experience has also demonstrated that the volume of orders received in the morning mail is a reliable index of what the day's order load will be. Given such information at the beginning of the day, it is possible to fix shipping times on a regular schedule and to pass orders along to the various merchandise departments at a rate which will keep them running at a steady pace.

Machines and mechanical aids of many types are employed. Man power is eliminated wherever a machine will be more efficient. Machines open the mail at the rate of 450 letters per minute. Pneumatic tubes, endless belt conveyors, chutes and electric trucks are used in the distribution of orders to the numerous merchandise departments into which the mail-order house is organized. Paralleling these mechanical facilities, personal effort is organized along highly specialized lines.

Throughout the entire system of buying, handling and shipping, substantial savings of time and money are achieved, which are reflected in the retail prices found in the mail-order catalogue, the primary selling instrument of the important mail-order firms.

The mail-order houses contributed substantially to improving the efficiency of retail distribution in the United States. Perhaps more important than any other single service was their effect in breaking the local monopolies of retail stores in once isolated areas by providing rural buyers with a feasible means for purchasing a wide variety of merchandise at relatively low prices.

While company sales volume of the largest mail-order firms is enormous, the relative importance of mail-order sales to retail trade in general is not great. Mail-order sales constituted less than 1% of the total retail sales volume in the United States in the mid-1950s.

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(J. E. J.)

MAIMANA, a town and khanate of Afghan Tui-kistan. The town is situated 100 mi. S.W. of Balkh, and only about 25 mi. from the frontier of Russian Turkistan. It is about two-thirds the size of Herat, square built and surrounded by a ruined wall and moat. The khanate was long in dispute between Bukhara and Kabul, but in 1868 Abdur Rahman laid siege to the town, and it was compelled to come to terms.

Its political status as an Afghan province was definitely fixed by the Russo-Afghan boundary commission of 1885. The inhabitants are chiefly Czbegs.

MAIMBOURG, LOUIS (1610–1686), French Jesuit and historian, an energetic defender of Gallican liberties in his *Traitd historique de l'établissement et des prerogatives de l'Église de Rome et de ses évêques* (1685; new ed., 1831). Born at Nancy on Jan. 10, 1610, he entered the Society of Jesus at the age of 16. His works include *Histoire du lutheranisme* (1680) and *Histoire du calvinisme* (1682), which was useful to the French government as propaganda for the revocation of the Edict of Nantes. His defense of French liberties in his *Traitk* was bitterly resented by Pope Innocent XI, who ordered the Jesuits to expel him. Louis XIV granted him a pension and a retreat at the abbey of St. Victor, Paris. He died on Aug. 13, 1686.

His works were published in 14 volumes (1686–87).

MAIMING, mutilation, a physical injury which involves the loss of, or incapacity to use, a bodily member. Maiming or mutilation is and has been practised by many peoples with various ethnical and religious significances, and was a customary form of punishment on the principle of an "eye for an eye." *(See* MUTILATIONS AND DEFORMATIONS.)

In law "maiming" was made a criminal offense; the old law term employed for a special case of maiming of persons was mayhem (*q.v.*), an Anglo-French variant form of the word. The punishment incurred for maiming of cattle in Great Britain was set at 13 to 14 years of penal servitude. Malicious injury to other animals was made a misdemeanour punishable on summary conviction. For a second offense the penalty was set at imprisonment with hard labour for more than 12 months under the Malicious Damage act of 1861. In both British and U.S. law maiming means the permanent injury of the animal; mounding or otherwise mistreating an animal is a separate offense.

MAIMON, SALQMQN (*c.* 1754–1800), Jewish philosopher who was acknowledged by Kant to be the most acute of his critics, was born about 1754 at Nieswiez in Polish Lithuania and was married off by his father at the age of 11. He gained a remarkable proficiency in Hebrew, studying outside the conventional limits of the Talmud, and acquired a particular reverence for Maimonides (*q.v.*), in whose honour he took the surname Maimon instead of the original patronymic Ben Joshua. In 1770 he estranged himself from his orthodox coreligionists by a commentary on Maimonides' *Guide of the Pevplexed.* Eight years later he left Poland for Konigsberg to begin a life of material insecurity and wandering over northern Europe only terminated in 1790 when he was offered the retreat on the estate of Count Adolf Kalkreuth at Nieder-Siegersdorf (Silesia), where he died on Nov. 22, 1800.

Nearly all Maimon's philosophical works were published during the years 1790–1800, including the two by which he is best remembered: the autobiography edited for him as *Salomon Maimons Lebensgeschichte* by Karl Philipp Moritz (1792); and *Versuch über die Transcendentalphilosophie* (1790), formulating his objections to Kantian philosophy. In this work Maimon seizes upon the fundamental incompatibility of a consciousness which can apprehend, yet is separated from, the thing-in-itself. That which is object of thought cannot be outside consciousness; just as in mathematics $\sqrt{-1}$ is an unreal quantity, so things-in-themselves are *ex hypothesi* outside consciousness, that is to say, unthinkable. The Kantian paradox he explains as the result of an attempt to explain the origin of the "given" in consciousness. The form of things is admittedly subjective; the mind endeavours to explain the material of the given in the same terms, an attempt which is not only impossible but involves a denial of the elementary laws of thought. Knowledge of the given is, therefore, essentially incomplete. Complete or perfect knowledge is confined to the domain of pure thought. to logic or mathematics. Thus the problem of the thing-in-itself is dismissed from the inquiry, and philosophy is limited to the sphere of pure thought. The Kantian categories are, indeed, demonstrable and true, but their application to the given is meaningless and unthinkable.

By this critical skepticism Maimon takes up a position intermediate between Kant and Hume. Hume's attitude to the empirical is entirely supported by Maimon. The causal concept, as given by experience, expresses not a necessary objective order of things, but an ordered scheme of perception; it is subjective and cannot be postulated as a concrete law apart from consciousness.

Maimon's other published norks include *Philosophisches Wörterbuch* (1791); *Uber die Progressen der Philosophie* (1793); *Versuch einer neuen Logik* (1794); and *Kritische Untersuchungen uber den menschlichen Geist* (1797).

See Hugo Bergman (ed.), *The Autobiography* of *Solomon Maimon,* with useiul commentary (1954).

MAIMONIDES (MOSES BEN MAIMON) (1135–1204), also known from his initials, with his title rabbi, as RAMBAM, Jewish philosopher, physician and master of rabbinic literature, was born in Córdova, Spain, of an illustrious Jewish family and educated by his learned father. When Córdova fell to the Almohades in 1148 and the position of the Jews became intolerable, the family emigrated first to Morocco, then for a short while to Palestine and finally to Egypt. Maimonides eventually settled in Fostat, a suburb of Cairo, where he attained the position of *nagid* or accredited leader of Egyptian Jewry. He was appointed court physician to Saladin and was invited by King Richard I to come to England but refused the invitation.

Maimonides' greatest work in the rabbinic field is his *Mishneh Torah,* a kind of *summa theologiae* of Judaism, composed in an elegant and concise Hebrew, arranged in 14 books and offering a systematic presentation of the entire content of the rabbinic tradition. It was preceded by his *Commentary on the Mishnah* and by the *Book of Commandments,* both written in Arabic. The *Mishneh Torah* secured for Maimonides a commanding position in the development of rabbinic law and represents the first of a series of authoritative codes. From his early youth, Maimonides was attracted to Aristotelian philosophy as taught by al-Farabi and by Avicenna. At the age of 16 he composed a *Treatise on the Terminology of Logic;* and his *Commentary on the Mishnah* embodies a fair amount of philosophy, especially in the *Eight Chapters* prefacing his comments on the tractate *Aboth.* The same applies to his code, which opens with an outline of his metaphysics and ethics. His celebrated *Guide of the Perplexed* contains the ripe fruit of his philosophical thinking and exercised considerable influence on both Jewish and Christian scholasticism. Written in Arabic, it seeks to interpret the biblical and rabbinic theology in terms of Neoplatonic Aristotelianism.

The first book of the *Guide* discusses the figurative meaning of anthropomorphic expressions applied to God in the Scriptures and examines the propriety of the various types of attributes or predications of God. The essence of God can be neither defined nor described. Existence is not something added to, but implied in, the essence of God. The *via negativa* is the only admissible way of speaking about God's essence; that is to sap, me can deny all positive statements about God which imply a deficiency. But we may also admit "attributes of action" such as justice. love, etc.. seeing that they do not touch upon the mystery of His hidden essence and describe only God's relation to the world in terms of cause and effect. The first book concludes with a comprehensive statement of the principles of the Arabian Mutakallimun (Kalamists) and their refutation. The second book proves the existence of God by the argument of the unmoved mover and by the distinction between the necessary and the possible and between the necessary and the contingent. Aristotle's cosmology is accepted in outline, and the separate intelligencies of Neoplatonic Aristotelianism moving the celestial spheres are identified with the angels of Scripture. Aristotle's doctrine of the eternity of the world Maimonides finds less acceptable, not because it contradicts the plain meaning of Scripture (this could, if necessary, be interpreted allegorically) but because it runs counter to the fundamental biblical notion of a God not bound by necessity and creating the world freely. Maimonides makes the point that unless we allow for the free operation of God's will the irregularities in the planetary motions cannot be explained. The second book also discusses the nature of prophecy: the prophets of the Bible are described as combining intellectual insight with the strongest imagination; their visions represent intuitive intellections concerning the spiritual world and their dreams future events. Following al-Farabi's The Model State and Avicenna's discussion of prophecy, Maimonides sees in the type of the prophet a kind of Platonic philosopher-king, the lawgiver of the ideal state. The third book treats of the nature of evil, of providence, of design in nature, of the historical background of the biblical ritual (this section is important as an early essay in comparative religion) and of moral virtues as steppingstones to the contemplative life. See also JEWISH PHILOSOPHY.

Editions of the Guide are: by S. Munk, Arabic text with French translation and valuable notes, 3 vol. (1856–66), English translation by M. Friedlander, 3 vol. (1881–85), and reissue, 1 vol. (1925), and German translation by A. Weiss, 3 vol. (1923). There is also an English translation of selected passages by C. Rabin, with introduction and commentary by J. Guttmann (1952).

Other texts include the Treatise on the Terminology **of Logic,** edited with English translation by I. Efros (1937–38); Eight Chapters, English translation by J. I. Gorfinkle (1912); and sections from the *Mishneh* Torah in English translation by M. Hyamson (1949 et seq.).

See bibliographies compiled by J. L. Gorfinkle in I. Epstein (ed), *Moses Maimonides, 1135–1204,* pp. 229–248 (1935); and by G. Vajda in *Jüdische Philosophie,* pp. 20–24 (1950). (A. AN)

MAIN, a river of Germany, 32j mi. long and the most important right-bank tributary of the Rhine. It has two sources, the Weisse blain (White Main) vhich rises in the granitic rocks of the Fichtelgebirge, and the Rote Main (Red Main), which, rising on the eastern slope of the Jurassic rocks of the Frankish Jura, flows past Bayreuth. They unite near Kulmbach after which the river, flowing northwest keeps to the Trias, and flows round the north end of the Frankish Jura to Bamberg. There it receives its chief tributary, the Regnitz (left), and enters upon its middle course. Flowing amid vine-clad hills it passes Würzburg, and thence, dividing the forest-clad ranges of the Spessart and the Odenwald, reaches Gemiinden. There it is joined by the Frankish Saale (right) and turning abruptly south, receives at Wertheim the beautiful Tauber (left). From the latter it proceeds due north to Aschaffenburg, whence passing Frankfort it joins the Rhine just above Mainz. It is navigable from the confluence of the Regnitz for barges and other small craft, and through the Ludwigs canal is connected with the Danube. See RHINE.

MAIN, power or strength; *e.g.,* the expression "with might and main" (Lat magnus, "great"). "The main." the high open sea. is for 'main sea," **cf.** "mainland," the principal part of a territory excluding islands and sometimes far-projecting peninsulas. The "Spanish main" was the mainland of the northeast coast of South America, stretching from the Orinoco to the isthmus of Panama, and the former Spanish possessions in Central America bordering on the Caribbean sea, or more loosely, the Caribbean sea itself. The principal pipe or cable for gas, water, electricity, etc., is called the main.

MAINA (or MANI) and **MAINOTES,** a district and people of the Peloponnesus. the modern Morea. Maina is the country occupied by the mountain range of Taygetus from Sparta to Cape Matapan, the ancient Taenarum. It is now divided between the modern districts Oetylos and Gythion. It contained over a hundred villages. The Mainotes claim to descend from the Spartans, and probably represent the Eleuthero Laconians delivered by Rome from the power of Sparta, as is suggested by traces of ancient Greek in their dialect and by their physical type. They did not become Christians till the 9th century.

Their country being a natural fortress, they were able to defend themselves against the Byzantine emperors, the barbarian invaders, the Latin princes of Achaea of the house of Villehardouin, and the Turks. As their country is also poor and maritime, they were early tempted to piratical adventure. Gibbon has referred to "the inhuman pillage of all that is shipwrecked on their rocky shore." Their neighbours gave their country the name of "Kakoboulia"—the land of wicked counsels. The passes of their mountains and their villages were fortified, so leading to their favourite epithet, Maina Polypyrgos—"many-towered." On the western side are the remains of feudal keeps, erected by William II. de Villehardouin (1245–1278) and other Latin princes of Achaea. From the 15th till the 17th century they recognized as head chiefs a family which claimed to belong to the Comneni of Trebizond. But the real power was in the hands of chiefs, a turbulent and martial aristocracy. Feuds were enduring and ferocious.

In the 18th century the family of Mavromicheli (Black Michael), in lower Maina, established a general headship after much strife and many murders. The Mainotes rose against the Turks at Russian instigation in 1770 and managed to gain virtual independence in 1777. During the Greek war of independence the Mainotes were led by Petros (Petro Bey) Mavromicheli. "the king of Maina," who undoubtedly cherished the hope of establishing a principality for himself. The freedom of Greece, for which he had fought in his own way, was the ruin of his ambition. He found the new order less compatible with his schemes than the Turkish dominion, and was imprisoned by the Greek president Capodistrias (see KAPODISTRIAS, IOANNES ANTONIOS), who was in revenge murdered by the Mavromichelis. The family were finally content to become courtiers and officials in the reign of King Otho I. In the 19th century Maina was but little affected by civilization, except so far as navies prevented piracy.

See W. Martin Leake, *Travels in the Morea* (1830); M. E. Yemeniz, "La Maina," in *Revue des deux mondes* (March 1, 1865); and Philipson, "Zur Ethnographie des Peloponnes," in *Petermanns Mittheilungen, vol. 36* (Gotha).

MAINAN, an independent linguistic stock of South American Indians, so called from the Mainas, one of its important tribes. This stock occupies a considerable area in north-eastern Peru, on the north side of the Marañon between the lower Pastaza and Tigre rivers, and south of it on the Samiria and lower Huallaga rivers, extending to the Mayo, and westward to the Potro. The Jeberos (Xeberos), often confounded with the Jivaran (*q v.*), are members of this group. The tribes of this stock were sedentary agriculturists, pottery and textile makers, and greatly given to taking enemy heads, shrinking and preserving them as do the Jivaros. They now retain little of their original culture.

See F. de Figueroa, "Relación de las Misiones . . . *en el Pais de los Maynas,"* vol i (1904).

MAINE, SIR HENRY JAMES SUMNER (1822–1888). English jurist and historian, a pioneer in the study of comparative law. was born on Aug. 15, 1822. He was educated at Christ's hospital and Pembroke college. Cambridge, where he excelled in classical studies. From 1847 to 1854 he was professor of civil law at Cambridge university and also began lecturing on Roman lan at the Inns of Court, the legal centre in London. These lectures formed the groundnork for his first book. Ancient **Law** (1861; new ed. 1930), which made his reputation at one stroke. Its object was "to indicate some of the earliest ideas of mankind. as they are reflected in ancient law. and to point out the relation of those ideas to modern thought." Historical in approach and objective in method, the work drew upon Roman law, systems of both western and eastern Europe, laws of India and primitive law in order to trace and define basic concepts. Although some of his statements necessarily were modified or invalidated by later research, Maine helped put the study of comparative jurisprudence on a sound historical footing. *Ancient Law* also was influential in political theory and, because of its controversial theories on primitive law, in anthropology.

From 1863 to 1869 Maine was a legal member of the council of the governor general in India. where he was largely responsible for plans for the codification of Indian law. He also served as vice-chancellor of Calcutta university. Upon his return to England he became, in 1869, the first professor of historical and comparative jurisprudence at Oxford and, in 1887, professor of international law (a subject that occupied his later years) at Cambridge. The recipient of many honours during his lifetime, he died on Feb. 3, 1888, at Cannes, Fr.

Maine's other books include *Village Communities in the East and West* (1871); *Early History of Institutions* (1875); *Dissertations on Early Law and Custom* (1883); *Popular Government* (1885). *See* also JURISPRUDENCE, COMPARATIVE: *Influence of Philological Research.*

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MAINE, an old French province, bounded north by Normandy, east by Orléanais, south by Touraine and Anjou and west by Brittany. Under the Romans it consisted of two *civitates* in the Provincia Lugdunensis Tertia—the Civitas Cenomannorum and the Civitas Diablintum, whose chief towns were Le Mans and Jublains. These two *civitates* were united during the barbarian period and formed a single bishopric, that of Le Mans, suffragan to the metropolitan see of Tours. This diocese corresponded under the Merovingians and Carolingians to the Pagus Cenomanensis and in the feudal period to the county of Maine. In the 16th century the county of Maine, with the addition of Perche, formed a military government—the province of Maine. Since 1790 this province has been represented approximately by the *départements* of Sarthe and Mayenne, the respective capitals of which are Le Mans and Laval. In 1855 the bishopric of Laval was separated from that of Le Mans. Roger (*c.* 892–*c.* 898) was perhaps the first hereditary count of Maine. In the 12th century Maine was attached to Anjou (*q.v.*) until 1204, when it was united to the royal domain. In 1246 it was given, with Anjou, by Louis IX to his brother Charles (Charles I of Naples). Again united to France in 1328, it was given in 1356 as an appanage to Louis, second son of King John II, and did not return to the French crown until 1481, after the death of Charles II, count of Maine. During the Hundred Years' War, Maine was taken in 1425 by the English, who lost it in 1448.

MAINE, popularly called the "Pine Tree" state, is the most northeasterly state of the United States and the largest state in New England; it was admitted to the union in 1820 as the 23rd state. It is bounded on the northwest by the Canadian province of Quebec; north and east by New Brunswick; south-southeast by the Atlantic ocean; and west by New Hampshire. It has an area of 33,215 sq.mi., 2,203 sq.mi. being water surface; in size it ranks 39th among the states.

The state capital is Augusta (*q.v.*). The white pine is the state's official tree, the white-pine cone and tassel the state flower and the chickadee the state bird. The flag is a blue field upon which is embroidered the state's coat of arms.

PHYSICAL GEOGRAPHY

Physical Features.--Maine lies between the extremes of approximately 43" 4' and 47° 28' N. lat. and 66° 57' and 71" 7 W. long. Considering the area as a whole, the surface of Maine is a gently rolling upland, above which rise mountain peaks, isolated and in clusters, and below which are numerous river valleys. The highest peak is Mt. Katahdin (5,268 ft.), other high mountains being Saddleback mountain (4,116 ft.), Mt. Abraham (4,039 ft.), Mt. Bigelow (4,150 ft.) and Mt. Blue (3,187 ft.). A little north of this line of mountain peaks is the water parting which divides the state into a north slope and a south slope. The north slope, though hilly in the middle and west, is so poorly drained that swamps abound in all sections. The south slope, which contains nearly all the mountains and is generally more hilly, has a mean descent toward the sea of about seven feet to the mile.

During the period of the great continental glaciation, Maine was overrun by the glacial icecap, which left more than 1,600 lakes scattered throughout the state. Few other states have so many large lakes of such beauty, and they contribute largely to a constant supply of water power, for which the rivers of southwest Maine are exceptionally well adapted. Moosehead lake (about 117 sq.mi.) is the largest lake in Maine and the largest inland body of water wholly in New England; the Kennebec river is its principal outlet. Other lakes, such as the Rangeleys, the Chesuncook and Twin lakes, on the Penobscot, and the Grand lake, at the headwaters of the St. Croix river, equal Moosehead's picturesque setting.

Another important feature of Maine's physiography is the irregular coast line with its numerous islands and bays and many good harbours. The shortest distance between extremities of the coast is only 225 mi., but because of projections and indentations the coast line measures about 2,500 mi. West of the mouth of the Kennebec river are marshes and low grassy islands, but east of the river the shore becomes much bolder and rises in precipitous cliffs. Casco, Penobscot and Passamaquoddy bays are representative of the capacious and well-protected harbours.

The principal river systems of Maine are the St. John on the north slope and the Penobscot, Kennebec, Androscoggin and Saco, with numerous falls and rapids, on the south slope.

Climate.—The climate of the state is moist and rather cold. The precipitation is about 42.5 in. annually and is distributed very evenly throughout the year, 10 to 11 in. of rain or its equivalent in snow falling each season. The snowfall varies from about 60 in. on the coast to more than 100 in. on the north slope, the average for the state being about 83 in. The summers are short, with a growing season of only about 4½ months. The mean summer temperature is about 62° F., the mean winter temperature approximately 20° F. The mean annual temperature for the entire state is 42° F.

Soil.—The soil types, though exceedingly varied, are in general poor, as a result of glaciation. The most productive area of the state is the potato-growing region in Aroostook county.

Vegetation.—Maine once was famous for its virgin stands of white-pine trees, and there still exist great numbers of white pine, fir and spruce. Among the other kinds of trees are hemlock, balsam fir, red and burr oak, white and yellow birch, sugar and mountain maple, box elder, tamarack, red spruce, white cedar, black willow, aspen poplar, beech, white or American elm (especially typical of New England), mountain ash and wild fruit trees. The flowers and blossoming shrubs are those that are common to the north temperate zone. Among the more widely distributed ones are the anemone, all kinds of asters, wild bergamot, bittersweet, black-eyed Susan, clover, daisy, blue flag, goldenrod, many varieties of lilies and the trailing arbutus. Devil's-paintbrush, pinks, rhodoras, wild roses and violets also grow in profusion.

Animal Life.—Perhaps the most numerous of the wild animals common to Maine are deer. more than 40,000 of which are killed annually by hunters. Others are black bear, beaver, red fox, otter, mink, weasel, squirrel, rabbit, porcupine, muskrat, woodchuck and wildcat. Game birds native to the state include the Canada goose, wood duck, ruffed grouse, pheasant and many others. Other birds are the American eagle and varieties of owls and loons, and, among songbirds, robins, orioles, bobolinks, kingbirds, swallows and chickadees. Trout, pickerel and salmon are plentiful in the lakes; coastal fish include tuna, cod and flounder.

Parks, Memorial Sites and Recreation.—Established in 1919 as Lafayette National park, with headquarters at Bar Harbor, Acadia National park is the only national park in New England and the oldest east of the Mississippi river. Baxter State park, in the northern Maine wilderness, has Mt. Katahdin as its chief attraction. Other state parks of interest include Aroostook State park. near Presque Isle, and Fort Knox State park, at Prospect, on the site of a fortification built after the Aroostook War. Among the memorial sites are Fort Edgecomb memorial, on Davis Island, built in 1808 to defend Wiscasset harbour; Fort Machias memorial, off which the British schooner "Margaretta" was captured early in the Revolutionary War; Fort McClary memorial, the first recorded fortification of the Massachusetts bay colony on the Maine side of the Piscataqua river; Fort George memorial, at Castine, which has earthworks and fortifications built by the British in 1779; Fort William Henry memorial. at Bristol: and Fort Popham memorial, at Phippsburg, on a site fortified during the Revolutionary War and the War of 1812 and meant to guard the entrance to the Kennebec river.

Maine's position as a favourite resort for summer vacationists dates from about 1870. when camps, summer hotels and boardinghouses began to multiply throughout the state. Maine is now one of the nation's leading vacation spots.

HISTORY

Discovery and Settlement. — Most historical scholars believe that Maine was sighted by Norsemen about A.D. 1000. but for lack of definite evidence the credit of discovering Maine passes to others. John Cabot probably saw Maine on his second voyage to the new world in 1498. Among the explorers of the 16th and early 17th centuries who reached hlaine were Giovanni da Verrazano (1524), Pierre du Guast, Sieur de Monts (1604), George Weymouth (1605) and John Smith (1614). Smith explored and mapped the coast and gave to the country the name New England.

At the time of these early explorations there were probably at least 25,000 Indians of the Algonkin group living in Maine, separated from the main body of Algonkins by their bitter enemies the Iroquois. They lived in semipermanent villages along the main rivers and subsisted on fish, game and a primitive agriculture, which featured corn and other garden vegetables. Property was owned in common. The manner of government varied from tribe to tribe.

In 1603 De Monts received from the king of France a grant of all the land between the site of Philadelphia and Newfoundland, and in 1604 he established a colony on St. Croix Island. at the mouth of the St. Croix river. Samuel de Champlain, the geographer of the expedition, explored the Maine coast, ascended the Penobscot and Kennebec rivers and discovered and named Mount Desert Island, on which Bar Harbor is now located. Bitter cold and scurvy reduced the St. Croix colony to less than one-half its original size by spring, when it was decided to relocate at Port Royal (now Annapolis Royal, Nova Scotia). In 1605 George Weymouth explored the St. George river area, captured five Indians and carried them to England, where three of them lived for a time in the family of Sir Ferdinando Gorges, who was to become the leader in founding Maine. In 1607 the Plymouth company, of which Gorges nas a member, sent out a colony, numbering 120 persons, under the direction of George Popham and Raleigh Gilbert. The colony was established at the mouth of the Kennebec river in August, but because of insufficient supplies about three-fifths of the company returned to England in December. Popham died during the winter and Gilbert assumed command. The next spring the news of the death of one of the colony's chief sponsors and a rich inheritance for Gilbert, together with the hardships of the winter, caused the colonists to abandon the settlement and return to England. In 1613 the French Jesuits Pierre Biard and Edmond Masse began the construction of a mission station on Mount Desert Island, but the station was destroyed by Sir Samuel Argall, acting under the instructions of the English at Jamestown. Va.

Proprietary Period and Massachusetts Ownership. — In 1620 the Council for New England, successor to the Plymouth company, obtained a grant of the country between 40" and 48° N., extending from sea to sea; and two years later Gorges and John Mason received the land between the Merrimack and Kennebec rivers under the name Province of Maine. In 1629 the territory was divided, with Gorges taking the portion between the Piscataqua and Kennebec rivers. In the early 1630s numerous land grants were made in the vicinity of Kittery, Wells, York, Saco, Scarboro and Falmouth (Portland), and permanent settlements were established. In 1635 the Council for New England surrendered its charter, but Gorges kept the land which had been granted to him, calling it New Somersetshire. In 1639 he procured a royal charter investing him with feudal powers. His charter, however, conflicted with other grants by the Council for New England; his authority was contested especially by George Cleeve, whose Lygonia patent issued by the council extended along the coast from the Kennebunk to the Kennebec.

Simultaneously, Massachusetts, fearing the royal authority in Blaine, reinterpreted its charter so as to make its northern boundary an east-west line 3 mi. N. of the source of the Merrimack river. This meant that blassachusetts laid claim to land as far east as Casco bay, or almost the whole of settled Maine. Massachusetts received the allegiance of Maine towns between 1652 and 1658. In 1677 Massachusetts purchased the claims of the Gorges family for £1,250 and held the province as a proprietor until 1691, when, by the new Massachusetts charter, hlaine mas extended to the St. Croix river and made an integral part of Massachusetts.

Maine was subjected to the rigours of six wars (known collectively as the Indian Wars) between 1675 and 1763. In four of these the French were active allies of the Maine Indians against the English. During the first three wars the English were virtually driven from Maine, but the tide turned permanently in their favour after the treaty of Utrecht in 1713.

During the American Revolutionary War, in 1775, the town of Falmouth (Portland) was burned as a reprisal for its defiance of British law. Benedict Arnold marched through Maine on his expedition to Quebec (1775), and the first naval engagement (the battle of the "Margaretta") of the Revolutionary War occurred off Machias. An attempt by the Americans to recapture Castine, which the British had occupied in 1779, was a dismal failure. From 1807 to 1812 the embargo and nonintercourse laws were a severe blow to Maine's shipping industry, and eastern Maine was occupied by the British with only token resistance in the War of 1812.

Statehood.—Maine was generally well governed by Massachusetts, but geographical separation, a heavy debt, unequal representation in the legislature and different economic and political policies (Maine was largely Democratic and Massachusetts Federalist) created a desire for independence even before the close of the Revolutionary War. After the War of 1812 the independence movement gained momentum, and in 1816 Massachusetts authorized separation if a popular vote gave a majority of five to four for separation. As the vote was only 11.969 yeas to 10.347 nays, the advocates of separation were unsuccessful A source of strong opposition to separation was removed in 1819 when congress rearranged the customs districts so that coasting vessels from Maine, as a separate state, would not have to enter and clear on every trip to or from Boston. Consequently, separation measures were carried by large majorities that year, and a constitution was framed by a convention that met in Portland in October. The constitution nas ratified by toun meetings in December and Maine applied for admission into the union. Because of the controversy then current in congress concerning the admission of Missouri as a slave state. Maine's admission became an important national issue. Finally by an act of March 15, 1820, Maine was admitted, its admission being a part of the Missouri Compromise (*q.v.*).

Boundary Dispute. — The northeast boundary of the state, which forms the northeast boundary of the United States, was long a matter of serious controversy between the United States and Great Britain. The treaty of 1783 ending the Revolutionary War identified the boundary in part as extending along the middle of the St. Croix river to its source, from there due north to certain highlands and along the highlands "to the north-westernmost head of Connecticut river." The dispute concerned just what the St. Croix river was and the location of its source and which highlands nere to mark the boundary. The exact location of the St. Croix and its source nas established by a commission provided for by the Jay treaty of 1794, but identifying the highlands proved to be a more difficult problem. Maine claimed that the highlands referred to overlooked the St. Lawrence river, but Great Britain contended that they were in the vicinity of Mars hill. The king of the Netherlands was chosen as arbitrator, and in 1831 he returned a decision unfavourable to Maine, causing the federal senate to withhold its assent. The disputed area thus became the scene of a disturbance known as the Aroostook War in 1838–39. Maine erected forts along the line it claimed, and the federal government prepared to resist British efforts to exercise exclusive jurisdiction. War seemed inevitable until Gen. Winfield Scott, who had been sent to take command on the Maine frontier. was able to arrange a truce whereby both sides withdrew their armed forces in favour of a civilian posse. Three years later the Webster-Ashburton treaty was effected, whereby Maine and Great Britain divided the disputed territory virtually in half.

19th-Century Politics. — From 1820 until 1854 Maine was classed as a Democratic state, although Whig governors were elected in 1837, 1840, 1852 and 1853. With its prohibitory laws of 1846 and 1851, Maine pioneered in regulating the liquor business. As a result of the prohibition and slavery questions there was a party disintegration between 1850 and 1855, followed by the supremacy of the Republican party from 1856 to 1878. In the latter year no gubernatorial candidate received a majority of the votes as required by the constitution and consequently a Democratic-Greenback fusion in the legislature declared the Democratic candidate, Alonzo Garcelon (1813–1906), governor. The electorate again failing to select a governor the following year. Governor Garcelon and his council counted out Republicans and replaced them with fusion candidates in the legislature. On Jan. 3, 1880, the supreme court declared the governor and council in error in counting in a fusion majority, but on Jan. 7 the governor swore in a legislature with 78 fusion and only two Republican members; the governor's term having expired, the president of the senate, James D. Lamson, became governor ex-officio. On Jan. 12 the Republicans, whose organized legislature was declared legal by the supreme court, seized the legislative chambers and chose as governor Daniel F. Davis. Former Governor Joshua L. Chamberlain was largely responsible for the peaceful solution of the difficulty which had had the state on the edge of civil war for a number of weeks, and ultimately Republican legislators and a Republican governor took office. In 1880 the Democrats and Greenbackers united and elected their candidate, but after 1882 Maine was strongly Republican until 1910.

Modern Times. — In 1910 the Democrats elected a governor and also in 1914, but Republicans again dominated politics otherwise until the 1930s. Louis Brann, Democrat, was elected in 1932 and re-elected in 1934, but Franklin D. Roosevelt failed to carry the state. In 1933 Maine voted for the repeal of the 18th amendment (prohibition) and in 1934 repealed its own prohibition statute. The high hopes held for the Passamaquoddy bay hydroelectric project were dashed in 1936 when congress discontinued funds for it though President Roosevelt favoured it. In 1950 a Canadian-U.S. commission indicated that detailed study must be made before the project's revival as a joint undertaking would be possible. After World War II several army and navy airfields in Maine were closed, but construction of the huge Loring air base at Limestone was undertaken. The Presque Isle, Bangor and Brunswick air bases were reactivated in 1951 and became increasingly important in the national defense system.

Maine's traditional Republicanism was shaken in 1954 when Democrat Edmund S. Muskie won the governorship; he easily won re-election in 1956, and in 1958 he became the state's first popularly elected Democratic U.S. senator. Adding to the Democratic trend was the election in 1956 of a Democratic congressman, Frank Coffin, who was re-elected in 1958 and joined by another Democratic congressman, James C. Oliver, to give the Democrats two of Maine's three seats in the house. Clinton A. Clauson, Democrat, won election that year as Maine's first four-year-term governor; on his death in 1960, however, he was succeeded by the Republican president of the state senate, John Reed. In the 1960 elections Reed defeated Coffin for the governorship and at the same time, Maine's three house seats were returned to Republican control.

GOVERNMENT

Maine was long noted as the only state to hold elections in September, but a constitutional amendment approved by the voters in 1957 moved its election day to the November date of other states, effective in 1960. The state has had only one constitution, ratified in Dec. 1819. It admits of amendment by a two-thirds vote of both houses of the legislature, followed by a majority vote of the electorate at the next election; or, as provided by an amendment adopted in 1875, the legislature may by a two-thirds vote of each house summon a constitutional convention. Among the more important amendments adopted have been those which granted the franchise to the Indians, authorized a $20,000,000 bond issue for a state industrial mortgage program, changed the election date from September to November and established the four-year term for governor.

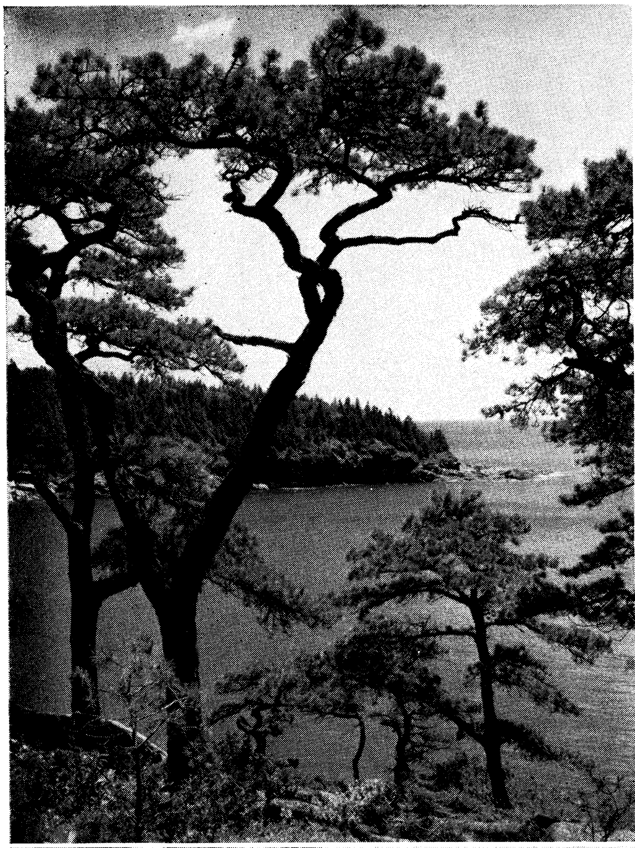
Executive. — The governor is the only executive officer of the state elected by popular vote. There is no lieutenant governor, the president of the senate succeeding to the office of governor in case of a vacancy. There is also a council of seven members elected by the legislature (not more than one from any one senatorial district), whose sole function is to advise the governor. His power of appointment is unusually extensive, but the advice and consent of the council (instead of that of the senate as in other states) are required for his appointments. He appoints judges, medical examiners and notaries public, besides all other civil and military officers for whose appointment neither the constitution nor the laws provide otherwise. His removal power extends even to the locally elected sheriffs and county attorneys. Besides the seven members of the council, the secretary of state, the treasurer, the attorney general, the commissioner of agriculture and the auditor are elected by the legislature.

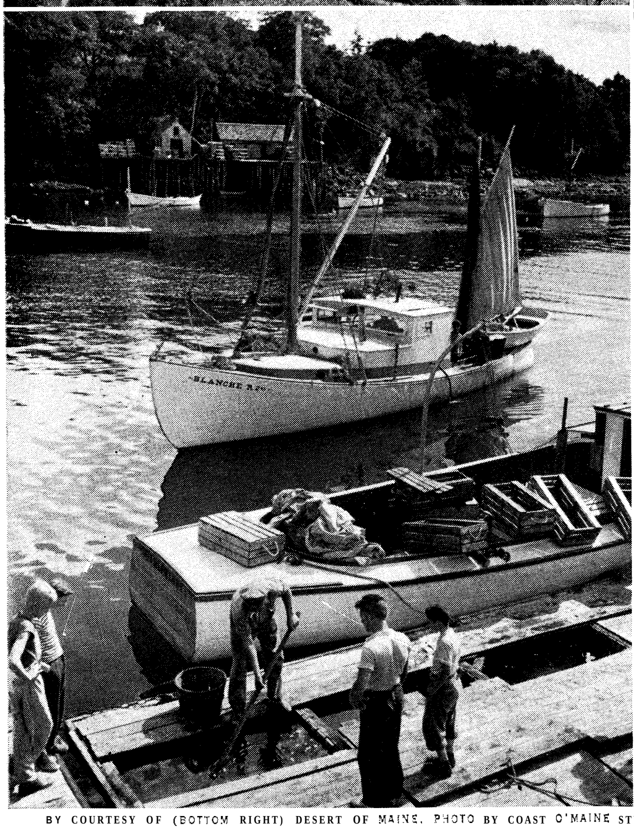
Legislative. — The legislature meets on the first Wednesday in January in odd-numbered years. It is composed of a senate of 33 members and a house of representatives of 151 members. Members of each house are elected for terms of two years, senators by counties roughly on the basis of one for each 30,000 inhabitants, and representatives approximately according to the population of towns and cities, with a maximum of seven for any one municipality. In 1908 a constitutional amendment provided for referendum and initiative by the people.

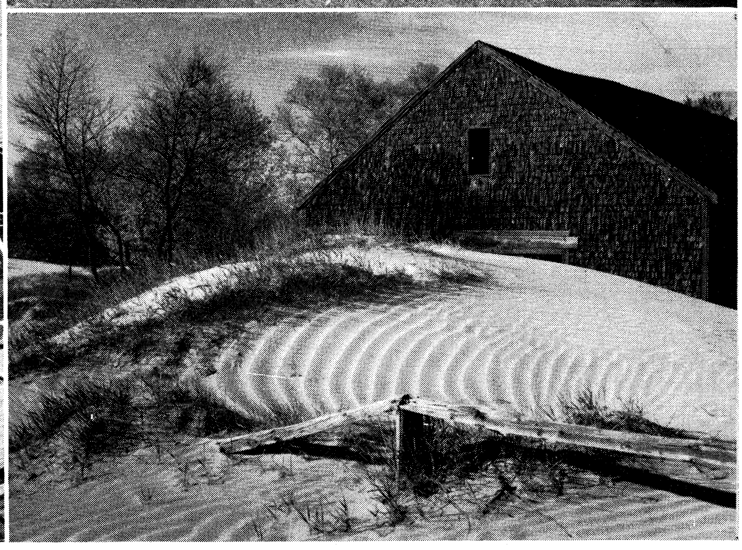
Judiciary. — At the head of the judicial branch is the supreme judicial court, which consists of a chief justice and five associate justices appointed by the governor and council for terms of seven years. The court's chief function is to hear appeals on points of law, but it renders advisory opinions when requested by the governor, council or either branch of the legislature. Below the supreme court is a seven-member superior court, whose members are also appointed for seven-year terms. Each judge goes on cir-, cuit in various counties as assigned by the chief justice of the supreme court. The superior courts are the only jury courts in Maine. They hear appeals from the local courts and hear the more important civil and criminal cases as courts of first instance.

Local Government. — The principal units of local government are the town (or toanship), the plantation, the county and the city. As in other parts of New England, the town or city is the most important of these. At the regular town meeting, ordinarily held in March, the electorate of the town assembles, decides what shall be done for the town during the ensuing year, elects officers to execute its decisions with limited discretion and votes money to meet the expenses. The principal officers are the selectmen (usually three), town clerk, assessors, collector, treasurer, school committee and road commissioner. Maine is the only state in the union that retains what is known as the organized plantation. This is a gokernmental unit organized from an unincorporated township having at least 200 inhabitants, and its principal officers are the moderator, clerk, three assessors, treasurer, collector, constable and school committee. The city-manager form of government was introduced in Maine in 1917 in the city of Auburn. The county is an intermediate organization between the state and the towns, to assist chiefly in the administralion of justice, especially in the custody of offenders. Its officers are three commissioners, a treasurer, a register of deeds, a judge of probate, a register of probate, a clerk of courts, a county attorney and a sheriff.

Finance. — Before 1912 the state constitution forbade the borrowing of money in excess of $300,000, except for the suppression of a rebellion, for war purposes or for repelling an invasion. In







BY COURTESY OF (BOTTOM RIGHT) DESERT OF MAINE. PHOTO BY COAST O'MAINE STUDIO; PHOTOGRAPHS (TOP LEFT) A. DEVANEY, (TOP RIGHT) SAMUEL CHAMBERLAIN, (CENTRE RIGHT) EWING GALLOWAY, (BOTTOM LEFT) H. ARMSTRONG ROBERTS

VIEWS OF MAINE

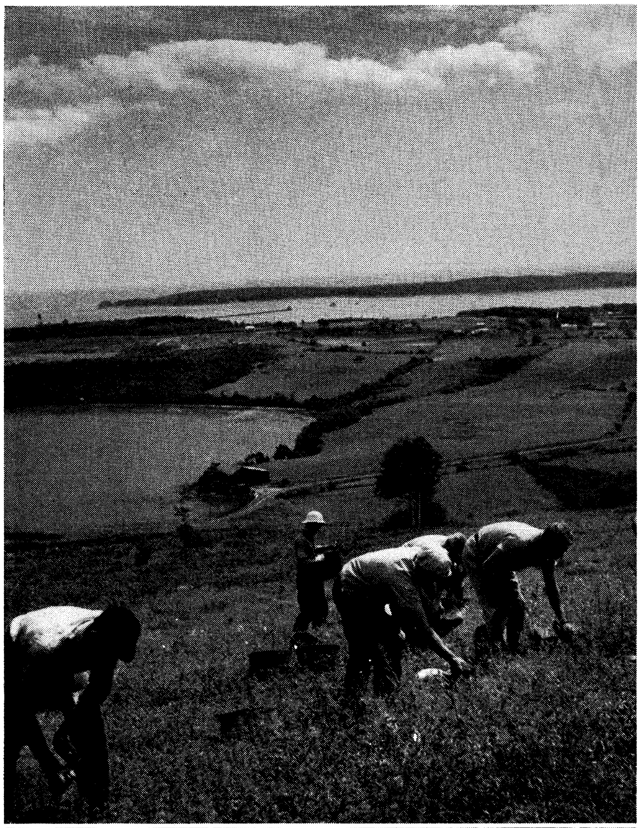
Top left: Pines along the ocean near Bar Harbor, on Mount Desert Island, site of Acadia National park

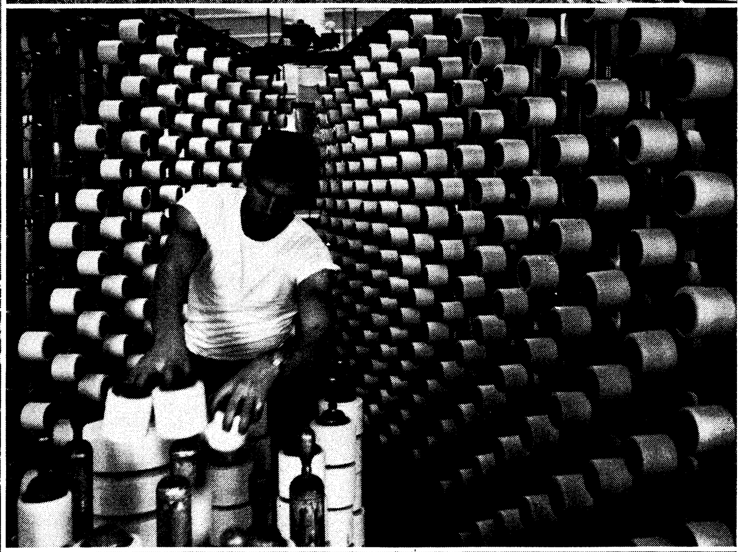
Top right: Portland Head light. 1791, oldest lighthouse on the Maine coast, rises 101 ft. above high water. From the hurricane deck can be seen most of the more than 200 Casco Bay islands and Cape Elizabeth shore

Centre right: The public square at Kennebunk, with Civil War monument and cannon from the Revolution. Settled about 1650, Kennebunk is one of the oldest towns in Maine

Bottom left: Lobster boats at New Harbor

Bottom right: Old barn on the edge of the Desert of Maine





BY COURTESY OF (BOTTOM RIGHT) THE MAINE DEPARTMENT OF DEVELCPMENT OF INDUSTRY AND COVMERCE; PHOTOGRAPHS, (TOP LEFT) RUOHOMAA FROM BLACK STAR, (TOP RIGHT) A. DEVANEY, (CENTRE RIGHT AND BOTTOM LEFT) ERICH HARTMANN FROM MAGNUM

AGRICULTURE, FISHING AND INDUSTRY

Top left: Blueberry-pickers at work on a farm overlooking Penobscot bay. The fruit has considerable commercial importance in the state

Top right: Lobster fisherman at work on equipment. Maine is noted for the quality of its lobsters

Centre right: Spool-loader in a factory at Biddeford, which has one of the largest textile machine plants in the U.S.

Bottom left: Lumberjack at work near Rangeley. Lumbering and forestry products comprise Maine's leading industry

Bottom ***right:*** Potato harvesting. Maine has the largest potato crop in the U.S.

that year an amendment to the constitution was adopted allowing the state to incur a debt not exceeding $2,000,000 for state highway purposes. Between 1912 and 1935, 12 amendments dealt with state debt and bond issues, gradually increasing the debt limit. An amendment adopted in 1950 removed all debt limitations and permitted bonds to be issued at the discretion of the legislature. by a two-thirds vote of each house, subject to popular referendum.

In order of importance, the chief sources of state funds in the second half of the 20th century were federal grants, gasoline tax, liquor, registrations and drivers' licences, general property tax, cigarette and tobacco taxes and public utility and insurance company taxes. These accounted for about three-fourths of the operating funds. Revenue was more than $100,000,000 annually, about 20% of which was from federal grants. Lacking an income tax or general sales tax. the state had a narrow tax base until 1951, when the legislature enacted a general 2% sales tax (exempting, however, food). In 1957 the rate was increased to 3%. With the additional revenue thus provided, the state was able to increase substantially its services, particularly in the fields of education and health and welfare. At that time, expenditures were about $110,000,000 annually. The bonded debt was nearly $40,000,000. The major expenditures were for highways, health and hospitals, education, and public welfare. Total expenditures nearly doubled between 1950 and 1960, but revenues maintained a similar pace. Per capita income had risen from $1,188 in 1950, nearly $300 below the national average, to $1,768 in 1959.

POPULATION

The census of 1820, the year Maine entered the union, revealed that the state had a population of 298,335. This placed it 11th among the 27 states and territories that then composed the union. The population was classified as a little more than 97% rural. The decade between the censuses of 1790 and 1800 was the period of most rapid growth—the population showed an increase of 57.2% in 1800 over that of 1790. At mid-19th century the state had a population of 583,169 (86% rural) and was 16th in population among the 37 states and territories. During the decade between 1860 and 1870 Maine's population declined by about 0.2%. In 1900 the population mas 649,466 (66% rural) and ranked the state 31st in the union. The 1950 population figure was 913,774 (35th among the states), 51.7% of which was urban. In 1960 Maine had a population of 969,265, an increase of 55,491 or 6.1% over 1950. The total urban population for 1960 was 497,114 or 51.3% of the total. The standard metropolitan statistical area of Portland had a population of 120,655 in 1960, an increase of 713 over 1950. The population per square mile in 1960 was 29.2, as compared with 49.6 for the United States as a whole.

Distribution by colour and nativity in 1950 was as follows: 91.5% native white; 8.1% foreign-born white; and 0.3% nonwhite. Of the foreign-born white population, 38.1% mere French Canadians, 35% were other Canadians. 6.1% were born in Great Britain and 2.8% in Ireland. Of the total population, 10.2% was 65 years old or over. Of the population 14 years old and over, 51.2% was in the labour force.

*Maine: Places of 5,000 or More Population (1960 census)**

Place	Population				
	1960	1950	1940	1920	1900
Total state	969,265	913,774	847,226	768,014	694,466
Auburn	24,449	23,134	19,817	16,985	12,951
Augusta	21,680	20,913	19,360	14,114	11,683
Bangor	38,912	31,558	29,822	25,978	21,850
Bath	10,717	10,644	10,235	14,731	10,477
Belfast	6,140	5,960	5,540	5,083	4,615
Biddeford	19,255	20,836	19,790	18,008	16,145
Brewer	9,009	6,862	6,510	6,064	4,835
Brunsivickt	15,797	10,996	8,658	7,261	6,806
Brunswick'	9,444	7,342	7,003	—	—
Caribou	8,305	4,500	8,218†	6,018†	4,758†
Gardiner	6,897	6,649	6,044	5,475	5,501
Houlton†	8,202	8,377	7,771	6,191	4,686
Houlton	5,976	6,029	—	—	—
Kitterv	8,051	6,692	5,374†	4,763†	2,872†
Lewiston	40,804	40,974	38,598	31,791	23,761
Millinocket	7,318	5,755	6,223†	4,528†	—
Old Town	8,626	8,261	7,688	6,956	5,763
Portland	72,566	77,634	73,643	69,272	50,145
Presque Isle	12,886	9,954	7,939	5,581	3,804
Rockland	8,769	9,234	8,899	8,109	8,150
Rumford	7,233	7,888	8,447	8,576†	3,770†
Saco	10,515	10,324	8,631	6,817	6,122
Sanford	10,936	11,094	14,886†	10,691†	6,078†
Skowhegan	6,667	6,183	7,159†	5,981†	5,180†
South Portland	22,788	21,866	15,781	9,254	6,287
Waterville	18,695	18,287	16,688	13,351	9,477
Westbrook	13,820	12,284	11,087	9,453	7,283

*Populations are reported as constituted at date of each census.
†Township.
Note: Dash indicates place did not exist during reported census, or data not available.

EDUCATION

Public Schools.—The first school in Maine was a mission established in 1696 by Father Sebastian Rasle on the Kennebec river. Other Jesuit missions were shortly afterward established at Passamaquoddy and at Indian Island. The first town school was established at York in 1701. Characteristic of the early days of education in Maine were the "moving schools," which traveled from place to place, remaining only a few weeks in one location. Greater organization was introduced in 1789 when Massachusetts, of which Maine was then a part, adopted a law requiring liberal instruction for all children and college training for all teachers. When Maine became a separate state in 1820, its educational system was patterned after that of Massachusetts. In 1828 the income from certain state lands was designated a public-school fund. Legislation passed in 1873 provided for the creation of free public high schools; education was made mandatory in 1875.

The state department of education is administered by a commissioner selected by an unpaid state board of education, consisting of ten members serving five-year overlapping terms. The department supervises the distribution of state subsidies to local areas on the basis of complex legislative formulas, designed to secure uniform minimum standards and to aid the less wealthy communities. The department exerts considerable control over school-building design, curriculums, teaching methods and teacher training, certification and placement. It is also responsible for education in the unorganized toanships where there is no local government. Still further, it groups towns and small cities into unions which are administered by locally chosen superintendents of schools. Towns and cities retain considerable local autonomy in school affairs. A sizable quantity of school-building districts mere created by special legislative acts to allow municipalities to circumvent the constitutional debt limit (usually 5% of the assessed valuation).

In 1957 the legislature passed the Sinclair bill, designed to encourage the formation of school districts and the consolidation of small high schools. At that time Maine had more than 125 high schools with fewer than 100 pupils.

Children between the ages of 7 and 15 are reauired to attend school. The free public elementary and secondary schools are supplemented by numerous parochial schools and more than 50 private schools and academies. At mid-20th century Maine was spending about $222 annually per pupil, or about $70 less than the national average.

Higher Education.— The state department of education (see above) administers four state teachers' colleges, at Gorham, Farmington, Machias and Presque Isle; a normal school at Fort Rent; and a trade school, the Vocational Technical institute, at South Portland. The state also operates a maritime academy at Castine.

Chief among the state-controlled institutions of higher learning is the University of Maine, at Orono, established in 1865 as the State College of Agriculture and the Mechanic Arts; the name was changed to University of Maine in 1897. The university is composed of schools and colleges of arts and sciences, agriculture, home economics. technology and education, forestry, nursing. and physical education and athletics. In 1957 the university absorbed the Portland junior college, after which the latter nas operated as a branch under the name of the University of Maine in Portland. In addition to the two campuses, the university maintains educational centres at Presque Isle, Auburn-Augusta and Machias. More than 4.000 students are enrolled annually, and the faculty numbers over 300.

Among the private institutions of higher learning is Bowdoin college, founded in 1794 at Brunswick (*q.v.*). Other colleges are Bates college (Lewiston, nonsectarian, 1864) and Colby college (Waterville, nonsectarian, 1813).

HEALTH AND WELFARE

The state's welfare activities were co-ordinated in 1931 by an act establishing the department of health and welfare. The department was composed of three bureaus, health, welfare and institutional service. having authority over the state's welfare program. In 1939 the legislature removed control of state institutions from health and welfare to a new department of institutional service.

The penal and reformatory institutions consist of the state prison, at Thomaston; the reformatory for men, at South Windham; the reformatory for women, at Skowhegan; the state (reform) school for boys, at South Portland; and the state (reform) school for girls, at Hallowell; the state schools are not places of punishment, but reformatories for delinquent boys from 8 to 16 years of age and girls from 6 to 16 years of age who have been committed by the courts for violations of law, or, in the case of girls, who by force of circumstances or association, are "in manifest danger of becoming outcasts oi society." The inmates in these schools get instruction in various trades and occupations so as to be able to earn a living when discharged.

Paupers formerly were cared for chiefly by touns and cities, those nholly dependent being placed in almshouses and those only partially dependent receiving aid in their homes. Federal-state funds for old-age assistance, aid to dependent children, aid to the blind and aid to the permanently and totally disabled are administered by the department of health and welfare. Unemployment compensation is administered by an employment security commission of three members.

The mental and charitable institutions maintained by the state are. the Augusta State hospital, at Augusta; Bangor State hospital, at Bangor; Central Maine sanatorium, at Fairfield; Pineland Hospital and Training School for the Feeble-minded, at West Pownal; Military and Naval Children's home, at Bath; and the Maine School for the Deaf, at Portland.

THE ECONOMY

Agriculture. — Agriculture is less important than it once was in Maine, the number of farms having declined from around 50,000 at the time of World War I to about 23,000 in the second half of the 20th century. Maine ranks first among the states in potato production, with Aroostook county as the leading producing centre. Production usually amounts to more than 60,000.000 bu. annually. To avoid a one-crop economy Aroostook county has begun raising peas, oats and beef cattle. Other important state crops are corn, barley, hay, beans, McIntosh apples and blueberries. Market gardening is important in the area around Portland. Dairying has long rivaled potatoes in importance. The most significant agricultural development after World War II was the raising of poultry, especially broilers. In ten years the number of broilers raised multiplied more than five times, to more than 50,000,000. Belfast is the centre of the industry.

Industry. — The construction of wooden ships was a principal industry in Maine until the middle of the 19th century, with some building of wooden (principally "downeasters" and schooners) and steel ships continuing, especially during World Wars I and II. Bath remains the chief centre of this activity. Cotton, woolen and paper mills, built in large numbers in the 19th century, were located on rivers to take advantage of the abundant water power. Sawmills were numerous from early colonial days. Later a variety of woodworking industries was established. After World War I there began a decline in textile manufacturing, which continued after World War II. Paper mills, shoe factories and food processing plants replaced the textile factories. The paper and textile industries were the leaders in the value of their products, but the leather products industry, especially shoes, employed the largest number of persons.

Minerals. — Maine formerly produced bricks, lime, granite and slate in sizable quantities, but output of these materials has dwindled. The state's principal mineral products in order of value are cement (New England's only cement plant is located at Thomaston), sand and gravel, stone, sheet mica and feldspar (about 25% of all the feldspar produced in the U.S.), with an average annual value in excess of $12,000,000. Maine. however, produces less than 1% of the total mineral output of the U.S.

Fisheries. — Fishing is an important coastal industry, affording employment to about 10% of the state's population. The catching and packing of young herring under the trade name of sardines represents the largest annual catch but is greatly exceeded in value by the lobster catch. Other fish of commercial importance include cod, haddock, hake, pollack, mackerel, ocean perch, alewives and flounders. Clams, sea scallops and crabs are also abundant in Maine waters. A rapidly growing activity is the collection of bloodworms and sandworms for bait. Average annual landings at Maine ports in the second half oi the 20th century totaled about 300,000,000 lb. valued at approximately $20,000,000. Lobsters alone accounted for about 55% of these revenues.

Forestry. — More than iour-fifths of the land area of Maine is forested (after Alaska the largest per capita acreage in the nation), and more than one-half of the land area is unorganized territory, nith no local government and few permanent inhabitants. A forest district tax on timberlands finances fire protection and other services performed by the Maine forest service.

Lumbering has always been Maine's chief industry. In colonial days Maine pine trees uere the chief source of masts for the British navy. In the 19th century the forests sustained the many shipyards, and Maine was long the leading producer of wooden ships in the United States. In the 20th century the same forests supplied pulpwood for the paper mills and lumber for the building trades. The annual production of pulpwood in the second half of the 20th century was more than 1,900.000 cords and that of lumber exceeded 500,000,000 bd.ft. Hardwoods, such as maple, beech and birch. were also widely used to make plywood, spools, dowels, toothpicks, skis, furniture, toys and novelties. Wood-using industries employed more than one-third of the wage earners of the state.

Transportation and Communications. — The southwestern part of the state, where the manufacturing, quarrying and much of the older agricultural district are located, always has had satisfactory means of transportation either by water or rail. The first international railroad in North America, the Atlantic and St. Lawrence (now a part of the Canadian National system), connected Portland and Montreal in 1853. During the American Civil War the chief railroad system in Maine was begun when the Maine Central was formed out of two short-line railroads connecting Lewiston and Bangor. It was not until the last decade of the 19th century that the forests, farmlands and summer resorts of Aroostook county nere reached by rail. In the second half of the 20th century, following considerable contraction, particularly in the less populous areas, the total railway mileage was slightly more than 2,000. Formerly there were five narrow gauge lines (two feet between the rails) and numerous electric lines operating in the state, but they have all become defunct. Many branch rail lines have been abandoned and passenger service on the Maine Central ceased in 1960.

Maine's coast line has many excellent harbours. The Kennebec river is navigable for coast vessels to Augusta, and the Penobscot to Bangor. For decades steamboats regularly plied between Maine ports and Boston, New York and several Canadian ports, but none have operated since just before World War II. In 1956 the Canadian National railways instituted a daily ferry service between Bar Harbor, on Mount Desert Island, and Yarmouth, Nova Scotia. This service proved attractive to the tourists who annually visit Mount Desert Island and Acadia National park.

Maine is connected with the other states by commercial airlines. Plane and auto transportation have all but eliminated rail passenger service and drastically reduced rail freight traffic. Modern highways have been built in many parts of the state, including a turnpike running from the state capital, Augusta, to the New Hampshire line Highways totaled more than 20,500 mi.

See also Index references under "Maine" in the Index volume.

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Current statistics on production, employment, industry, etc., may be obtained from the pertinent state departments; the principal figures, together with the current history, are summarized annually in the *Britannica Book of the Year,* American edition. (R. M. Y.)

MAINE DE BIRAN, MARIE FRANÇOIS PIERRE GONTHIER (1766–1824), French philosopher, was born at Bergerac, Fr., on Nov. 29, 1766. The name Maine he assumed from an estate called Le Maine which belonged to his father. Maine de Biran entered the king's lifeguards and defended Louis XVI at Versailles on Oct. 5 and 6, 1789. He then retired to his estate at Grateloup, near Bergerac, and pursued his studies in mathematics and philosophy until, after the fall of Robespierre, he entered public life as an administrator in the de'partement of the Dordogne. He became a member of the Corps Législatif in 1809 and was among those who expressed public opposition to Napoleon in 1813. After the Restoration he became treasurer to the chamber of deputies. He died in Paris on July 16. 1824.

Maine de Biran first became known in the intellectual world as one of the Idéologues. These philosophers developed the antimetaphysical and empiricist aspects of Locke's philosophy in the manner of Etienne de Condillac; and Maine de Biran's philosophical importance consists in his gradual and detailed discovery of the inadequacies of this point of view. His diary, in which he commented on his administrative and political activities as well as on his philosophical reading, throws valuable light on the thoughts and struggles of a diffident philosopher forced to play a decisive part in politics. Both as philosopher and as diarist his interest is in the inner life of man.

His first important philosophical writing and one of the few published during his lifetime was *Influence* de *l'habitude sur* la *faculté* de *penser* (1802; Eng. trans. by M. D. Boehm, Baltimore, 1929). In it, developing an idea of Destutt de Tracy's, he stresses the role of the will in our perception of the physical world and argues that the result of becoming habituated on a being that possessed only sense-experience would be that it would lose consciousness altogether. These themes of the importance of the will and of the impossibility of analyzing the self entirely in terms of sensation and feeling were developed in later works. In his *Mémoire sur* la *décomposition* de la *pensée* (1804). Maine de Biran criticizes Descartes for confusing the self considered as subject with the self considered as a substance in the natural world and is thus led to suppose that the methods appropriate to the study of nature are incapable of revealing the essence of selves or subjects. In his Essai *sur* les *fondements* de la *psychologie* (1812), Maine de Biran concluded that there is a "hyperorganic" element in the self, even though "my body and myself form a single being." In his *Nouveaux essais* d'anthropologie (1823–24) he describes the self as developing through an animal, purely sensitive phase (vie *animale*) to a human phase of will and freedom (vie humaine) and culminating in experiences which transcend humanity (vie de *l'esprit*).

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MAINE-ET-LOIRE, a de'partement of western France, formed in 1790 for the most part out of the southern portion of the former province of Anjou, and bounded north by the departments of Mayenne and Sarthe, east by Indre-et-Loire, southeast by Vienne, south by Deux-Sèvres and Vendée, west by Loire-Inférieure, and northwest by Ille-et-Vilaine. Area 2,787 sq.mi. Pop. (1954) 518,241. The department includes the course of the Authion and the lower course of the Maine, with its feeders, the Loir, Sarthe, Mayenne and Oudon, on the right bank of the Loire; as well as those of the Layon, Evre and Divatte on the left. The Val d'Anjou, followed by the Loire, forms a zone of rich meadows, market gardens and orchards from east to west. The west of the department is floored by Palaeozoic rocks and granites of the Armorican system, but east of the line of the Sarthe the rocks are chiefly cretaceous, with tertiary capping on the somewhat higher ground between the rivers. The name Val d'Anjou belongs strictly to the eastern part of the Loire valley in the department. The climate is mild. The mean annual temperature of Angers is about 54°; the rainfall is between 23 and 24 in. annually. The frequent fogs, combined with the peculiar nature of the soil in the southeast of the department, are highly favourable to meadow growths. The winter colds are never severe, and readily permit the cultivation of certain trees which cannot be reared in the adjoining departments.

The chief cereals grown are wheat: oats and barley, and potatoes and mangels also give good returns. Much hemp is grown in the valley of the Loire, and the vegetables, melons and other fruits of that region are of the finest quality. Good wine is produced at Serrant and other places near Angers, and on the right bank of the Layon and near Saumur, famous for its sparkling white wine. Cider apples, and fruit generally, are produced. Woodland, chiefly of oak and beech, covers large tracts. The fattening of cattle is an important industry round Cholet, and horses are reared. There are important slate quarries near Angers, tufa is worked in the river valleys, and freestone and other stone, iron and coal are also found. The manufactures include linen and woollen stuffs. The department is served by the railways of the State and of the Orléans company. The Mayenne, the Sarthe and the Loire, together with some of the lesser rivers, provide about 130 mi. of navigable waterway. In the southeast the canal of the Dive covers some 10 mi. in the department.

There are four arrondissements—Angers, Cholet, Saumur and Segré, with 34 cantons and 381 communes. Maine-et-Loire belongs to the académie (educational division) of Rennes. to the region of the IX army corps (Tours) and to the ecclesiastical province of Tours. Angers (*q.v.*), the capital, is the seat of a bishopric and of a court of appeal. Other important places are Cholet. Saumur and Fontevrault. For architectural interest there may also be mentioned the châteaux of Brissac (17th century), Serrant (1jth and 16th centuries). Montreuil-Bellay (14th and 15th centuries), and Ecueillé (1jth century), and the churches of Puy-Notre-Dame (13th century) and St. Florent-le-Vieil (13th, 17th and 19th centuries). the last containing the fine monument to Charles Bonchamps, the Vendean leader, by David d'Angers. Gennes has remains of a theatre and other Roman remains, as well as two churches dating in part from the 10th century. Ponts-de-CC, an interesting old town built partly on islands in the Loire, is important. because until the Revolution its bridges formed the only way across the Loire between Saumur and Nantes.

MAINE RIVER, France, is a right-bank tributary of the Loire (*q.v.*) which it enters at La Pointe below Angers. The Maine itself (7 mi. long) is formed from the confluence of the Mayenne, Sarthe and Loir rivers. The Mayenne, rising in the hills of Normandy, flows south past Laval through the hilly pastoral country of the easternmost part of the crystalline Armorican massif. The Sarthe and its tributary the Huisne, which joins it at Le Mans, rise in the hills of the Perche. Before joining the Mayenne, the Sarthe receives the Loir, flowing westward from the margins of the limestone platform of Beauce. The dry, sandy platforms of Maine. which the Sarthe and Loir traverse, are far from fertile and carry much woodland! but the broad river valleys, with their alluvial floors, are exceptions as strips of rich cultivation, including orchards and vineyards at their northern limit. Below Angers, the Maine valley enters the wide alluvial trench of the Loire, there known as the Val d'Anjou. The navigable waterway of the lower Loire is continued by the Maine, and the Mayenne is navigable by small craft as far as Brives and the Sarthe less satisfactorily to Le Mans. (AR. E. S.)

MAINPURI, a town and district in the Agra division of Uttar Pradesh, India. The town (pop. 1951, 22,932) consists of two separate parts, Mainpuri proper and Mukhamganj. Jaswant Rao Holkar plundered and burned part of the town in 1804, but was repulsed by the local militia. After the British occupation the population rapidly increased and many improvements mere carried out. The Agra branch of the Grand Trunk road runs through the town, forming a wide street lined on both sides by shops. which constitute the principal bazaar. Mainpuri has a specialty in the production of carved wooden articles inlaid with brass wire. The American Presbyterian mission manages a high school in the town.

The DISTRICT OF MAINPURI lies in the central Doab. Area, 1,680 sq.mi. The population (1951) was 993,890. It consists of an almost unbroken plain wooded throughout with mango groves, and isolated clumps of *bábul* trees occasionally relieve the bareness of its saline *usar* plains. On the southwestern boundary the Jumna flows in a deep alluvial bed, sometimes sweeping close to the high banks which overhang its valley, and elsewhere leaving room for a narrow strip of fertile soil between the river and the upland plain. The district is watered by two branches of the Ganges canal.

Mainpuri anciently formed part of the great kingdom of Kanauj, and after the fall of that famous state it was divided into a number of petty principalities, of which Rapri and Bhongaon were the chief. In 1194 Rapri was made the seat of a Moslem governor. Mainpuri fell to the Moguls on Baber's invasion in 1526, passed, toward the end of the 18th century, into the power of the Marathas, and finally became a part of the province of Oudh. When this part of the country was ceded to the British in 1801 Mainpuri town became the headquarters of the extensive district of Etawah, which was in 1856 reduced by the formation of Etah and Mainpuri into separate collectorates.

MAINTAINED PRICE: *see* PRICE MAINTENANCE.

MAINTENANCE AND CHAMPERTY. In English law maintenance is the maintaining or assisting a party, with money or otherwise, to prosecute or defend an action in which the maintainer has no legitimate interest. The law allows a master to assist his servant. near relations to support each other, the charitable to assist the poor, and persons having an interest even contingent in the subject matter or principle involved in a suit to assist a party to it. Other maintenance is a criminal offense and a civil cause of action. In theory, even if the maintained action succeeds so that a party is assisted only to secure his legal due. the unsuccessful party can sue the maintainer if he can prove that he has suffered damage (*Neville* v. London *Express Newspaper Ltd.*, 1919. *A.C.* 368), but this is seldom if ever possible since the damages and costs which he is compelled to pay flow from his own wrong and not from the maintenance. If the maintainer is to be rewarded by receiving some part of the subject matter of or some profit from the suit the bargain is the criminal offense of champerty. (S.)

United States.—Maintenance and champerty as defined by the common law are still generally criminal in the United States. The criminal aspect of maintenance and champerty has now little significance, but the concepts retain their vigour in rendering unethical the conduct of a particular attorney or illegal contracts between attorneys and clients concerning remuneration for services rendered in the prosecuting of a suit. The charging of legal fees contingent upon success is technically champerty, but the strict definition has relaxed as the social necessity of such a practice has become increasingly apparent. The common law doctrines that made illegal all champertous agreements were consequently greatly modified by judicial decision. A few states followed the so-called Massachusetts rule which made illegal an agreement by an attorney that he shall receive a specific share in the proceeds of the suit but considered an agreement legal which merely provides for a larger fee in the event of success. The majority of states follow the rule that champerty of itself does not make the agreement illegal unless it is accompanied either by maintenance in the form of an agreement that the attorney will bear the expenses of the suit, or by a provision binding the client not to compromise or release the claim without the consent of the attorney. The fact that such rules consider the form and not the substance of the agreement has led to the modern view held by a few states, namely that neither technical champerty nor maintenance invalidates the contract but its validity is to be determined by a consideration of whether the particular agreement induced the litigation and revealed an overreaching of the client by the attorney. Many states unfortunately have allowed an attorney whose agreement for fees is invalid because of champerty or maintenance to recover reasonable fees from his client, thus permitting him to charge any fees that he may desire in the first instance and in the unusual event of litigation assuring him no matter what the final outcome a reasonable compensation. The champertous character of an agreement between attorney and client can be availed of only by the parties to it, and no defendant can successfully defend the claim against him by proving that the plaintiff is prosecuting it under a champertous agreement.

The ease with which the practices of champerty, maintenance and barratry or the stirring up of vexatious litigation eluded both the criminal law and the restraining influence of doctrines rendering contracts between lawyers and clients illegal led in the large cities to the practice of ambulance chasing. Unscrupulous attorneys eager to solicit business in negligence cases employ runners who keep track of accidents with the aid of police. newspaper reporters. doctors, etc., and by appearing on the scene shortly after the accident manage to inveigle the victims into engaging them to prosecute their claims. Needless litigation over minor and often spurious injuries is thus aroused. In Minnesota by virtue of a statute, which was declared unconstitutional, attorneys sought to bring within the jurisdiction of Minnesota courts claims for injuries arising out of railroad transportation which may have occurred a thousand or more miles from the place of trial merely on the ground that the railroad maintained a freight and passenger agent in the state although it operated no trackage within the state. nor was the plaintiff a resident of the state. Similar attempts have been made in other states to facilitate the trial of accident cases remote from the place of their occurrence so as to harass the defendent into a settlement irrespective of the merits of the plaintiff's claim by the prospect of the costs that he would incur in bringing his witnesses to the place of trial. (J. M. LA.)

MAINTENON, FRANÇOISE D'AUBIGNÉ, MARQUISE DE (1635–1719), the second wife of Louis XIV, was born in a prison at Niort, on Nov. 27, 1635. Her father, Constant d'Aubigné, was the son of Agrippa d'Aubigné, the friend and general of Henry IV, and had been imprisoned as a Huguenot malcontent, but her mother had the child christened a Catholic. After the release of d'Aubigné the family went to Martinique. There the father died. Mother and child returned to France. where Françoise was surrendered to a Protestant relative who is said to have converted her to Protestantism. She was removed by an order of state to Catholic guardianship, and reconverted. She and her mother were penniless, and the girl married (1652) Scarron, the famous wit, to whom she was more nurse than wife. He died in 1660. Anne of Austria continued his pension to his widow, and even increased it to 2,000 livres a year, which enabled her to entertain and frequent literary society. After Anne's death the pension was continued by the king on the intercession of his mistress, Madame de Montespan, who put her in charge of the children whom she bore to Louis. In 1674 the king determined to have his children at court, and their governess who had now made sufficient fortune to buy the estate of Maintenon, accompanied them. In 1678 her estate at Maintenon was raised to a marquisate. Mme. de Montespan's jealousy mas aroused by these favours, and Mme. de Maintenon's position was almost unendurable until Mme. de Montespan left the court. Madame de Maintenon now became the king's mistress "en titre." The queen declared she had never been so well treated as at this time, and eventually died in Mme. de Maintenon's arms in 1683. In 1684 Mme. de Maintenon was made first lady in waiting to the dauphiness, and in the winter of 1685–1686 she was privately married to the king by Harlay, archbishop of Paris, in the presence, it is believed. of Père la Chaise, the king's confessor, the marquis de Montchevreuil, the chevalier de Forbin, the marquis de Louvois and the valet, Bontemps. No wrltten proof of the marriage is extant, but that it took place is nevertheless certain. Her life during the next 30 years can be fully studied in her letters.

Her political influence has probably been exaggerated, but it was supreme in matters of detail. The ministers of the day used to discuss and arrange all the business to be done with the king beforehand with her, and it was all done in her cabinet and in her presence, but the king in more important matters often chose not to consult her. Such mistakes as, for instance, the replacing of Catinet by Villeroi may be attributed to her, but not whole policies—notably, according to Saint-Simon, not the policy with regard to the Spanish succession. Even the revocation of the edict of Nantes and the dragonnades have been unjustly laid to her charge. Her influence was on the whole a moderating and prudent force. Her social influence was always exercised on the side of decency and morality.

Side by side with this public life, she passed a happier existence as the foundress of St. Cyr. Mme. de Maintenon was a born teacher; and she had always wished to establish a home for poor girls of good family placed in such straits as she herself had experienced.

As soon as her fortunes began to mend she started a small home for poor girls at Ruil, which she afterward moved to Noisy, and which was the nucleus of the splendid institution of St. Cyr, which the king endowed in 1686, out of the funds of the abbey of St. Denis.

She was in her element there. She herself drew up the rules of the institution and examined every minute detail. She befriended her pupils in every way, and often turned her attention from the weariness of Versailles or of Marly to her "little sisters" at St. Cyr. It was for them that Jean Racine wrote his Esther and his *Athalie.*

Because he managed the affairs of St. Cyr so well, Michel Chamillart was made controller general of the finances. The later years of her power were marked by the promotion of her old pupils, the children of the king and Mme. de Montespan, to high dignity between the blood royal and the peers of the realm, and it was doubtless under the influence of her dislike for the duke of Orleans that the king drew up his will, leaving the personal care of his successor to the duke of Maine, and hampering the duke of Orleans by a council of regency, an arrangement which mas overthrown by the parlement after the king's death. The regent Orleans visited her at St. Cyr and continued her pension of 48,000 livres.

She spent her last years at St. Cyr in seclusion but an object of great interest to visitors to France, all of whom, however, with the exception of Peter the Great, found it impossible to get an audience with her.

On April 15, 1719, she died and was buried in the choir at St. Cyr. She bequeathed her estate at Maintenon to her niece, the only daughter of her brother Charles and the wife of the maréchal de Noailles.

Her *Lettres historiques et édifiantes* (7 vols.) and her *Correspondance générale* (4 vol., 1888), were edited by Th. Lavallée. Saint-Simon's account of the court in her day i: contained in vol. xii of his *Mémoires. See* also Mademoiselle d'Aumale's *Souvenirs sur Madame de Maintenon,* ed. Comte d'Haussonville and G. Hanotaux, 3 vol. (1902–04); A. Geffroy, *Madame de Maintenon d'après sa correspondance authentique,* 2 vol. (Paris, 1887); A. de Boislisle, *Paul Scarron et Françoise d'Aubigné d'aprbs des documents nouveaux* (1894); É. Pilastre, *Vie et caractbre de Madame de Maintenon d'aprbs les oeuvres du duc de Saint-Simon et des documents anciens ou récents* (1907); A. Rosset, *Madame de Maintenon et la révocation de l'édit de Nantes* (1897); Mme. Saint-René Taillandier, *Madame de Maintenon* (1920; Eng. trans. 1922); H. C. Barnard, *Madame de Maintenon and Saint-Cyr* (1934); Maud Cruttwell, *Madame de Maintenon* (1930).

MAINZ (Fr. Mayence), a city and episcopal see of Germany, which grew up on the left bank of the Rhine, almost opposite the influx of the Main; the city has spread also to the right bank of the river. It lies at the junction of the important main lines of railway from Cologne to Mannheim and Frankfurt-on-Main, 25 mi. W. of the latter. Pop. (1950) 88,369, of whom two-thirds are Roman Catholic.

History.—Mainz was a pre-Roman settlement at which, about 13 B.C., Nero Claudius Drusus, the stepson of Augustus, erected a fortified camp; the *Castellum Mattiacorum* (the modern Kastel) on the opposite bank was afterward added to it, the two being connected with a bridge at the opening of the Christian era. The earlier name became latinized as Maguntiacum, or *Mogontiacum,* and a town gradually arose around the camp, which became the capital of Germania Superior. During the Volkerwanderung Mainz suffered severely, being destroyed on different occasions by the Alamanni, the Vandals and the Huns. Christianity seems to have been introduced into the town at a very early period; and a church already stood there in the 4th century. In the 6th century a new Mainz was founded by Bishop Sidonius. In the middle of the 8th century under St. Boniface it became an archbishopric, and to this the primacy of Germany was soon annexed. Charlemagne, who had a palace in the neighbourhood, gave privileges to Mainz, which rose rapidly in wealth and importance, becoming a free city in 1118. In 1160 the citizens revolted against Archbishop Arnold, and in 1163 the walls of the city were pulled down by order of the emperor Frederick I.

In 1244 certain rights of self-government were given to the citizens; and in 1254 Mainz was the centre and mainspring of a powerful league of Rhenish towns. In 1462 there was warfare between two rival archbishops. The citizens espoused the losing cause and were deprived of their privileges. Many of the inhabitants were driven into exile, and these carried into other lands a knowledge of the art of printing, which had been invented at Mainz by Johann Gutenberg in 1450.

During the Thirty Years' War Mainz was occupied by the Swedes and by the French. In 1792 the citizens welcomed the ideas of the French Revolution; they expelled their archbishop, and opened their gates to the French troops. Mainz was ceded to France by the treaty of Campo Formio in 1797, and again by the treaty of Lunéville in 1801. In 1814 it was restored to Germany and in 1816 it was handed over to the grand duke of Hesse. After World War I it was occupied by Allied troops. During World War II it was bombed by the British.

Architecture and Trade.—The cathedral is a Romanesque edifice with numerous Gothic additions and details. It was originally erected between 975 and 1009, but has since been repeatedly burned down and rebuilt. and in its present form dates chiefly from the 12th, 13th and 14th centuries. The whole building was restored by order of Napoleon in 1814, and another thorough renovation was made later. Other noteworthy churches are those of St. Ignatius (18th century), with a finely painted ceiling; of St. Stephen, built 1257–1328 and restored after an explosion in 1857; and of St. Peter (18th century). These churches were renovated after World War II. The old electoral palace (1627–78), a large building of red sandstone, now contains a valuable, collection of Roman and Germanic antiquities. Among the other principal buildings are the former palace of the grand duke of Hesse, built in the 1730s as a lodge of the Teutonic order, and the government buildings. A statue of Gutenberg, by Bertel Thorwaldsen, was erected at Mainz in 1837. Mainz still retains many relics of the Roman period, the most important of which is the Eigelstein; this monument is believed to have been erected by the Roman legions during the 1st century B.C. in honour of the illustrious general Drusus. It stands within the citadel, which occupies the site of the Roman castrum. A little to the southwest of the town are the remains of a large Roman aqueduct, of which more than 60 pillars are still standing.

The University of Mainz. founded in 1477, was suppressed following the French Revolution in 1798. It was revived in 1946 under the name of the Johannes Gutenberg university.

The site of Mainz would seem to mark it out naturally as a great centre of trade, but the illiberal rule of the archbishops and its military importance seriously hampered its commercial and industrial development. It is now, however: the chief emporium of the Rhenish wine traffic, and also carries on an extensive transit trade in grain, timber, flour, petroleum, paper and vegetables. The principal manufactures are leather goods, furniture, carriages, chemicals, musical instruments. cement and boots. Other industries include brewing, shipbuilding and printing. Mainz is the capital of the *Land* Rhineland-Palatinate.

The Archbishopric of **Mainz,** dating from 747, was one of the seven electorates of the Holy Roman Empire, and became a powerful state during the middle ages. retaining some of its importance until the dissolution of the empire in 1806. Its archbishop was president of the electoral college, archchancellor of the empire and primate of Germany. The lands of the electorate were on both banks of the Rhine; their area at the time of the French Revolution was about 3,200 sq.mi. The archbishopric was secularized in 1803, two years after the lands on the left bank of the Rhine had been seized by France. Some of those on the right bank were given to Prussia and to Hesse; others were formed into a grand duchy for Karl von Dalberg. The archbishopric itself was transferred to Regensburg, and Mainz became a bishopric only.

MAIR, ALEXANDER WILLIAM (1875–1928), Scottish classical scholar. was born on June 9, 1875. at Deerhill, Banff. After a distinguished career at Aberdeen and Cambridge he was appointed (1899) assistant professor and (1903) professor of Greek at Edinburgh university.

He was an unusually able and meticulous scholar of the Cambridge school, and a highly successful teacher. His chief works were his editions and translations of Hesiod, Callimachus. Lycophron and Oppian (the last-named being unpublished at his death). He also wrote a biography of PLINY and LUCIAN, as well as several other articles for the *Encyclopædia Britannica.*

He was burned to death by an accident in his study on Nov. 12, 1928.

MAIRET, JEAN **DE** (1604–1686), French dramatist, was born at Besançon, and died there on Jan. 31, 1686. His own statement that he was born in 1610 has been disproved. He went to Paris to study at the Collège des Grassins about 1625, in which year he produced his first piece *Chriséide et Arimand,* followed in 1626 by *Sylvie,* a "pastoral tragi-comedy." In 1634 appeared his masterpiece, *Sophonisbe,* which marks, in its observance of the rules, the beginning of the "regular" tragedies. Mairet was one of the bitterest assailants of Corneille in the controversy over *The Cid.* It was perhaps his jealousy of Corneille that made him give up writing for the stage. He was appointed in 1648 official representative of the Franche-Comté in Paris, but in 1653 he was exiled for a short time by Mazarin. His other plays include *Silvanire ou la Morte-vive,* published in 1631 with a preface on the observance of the unities, *Les Galanteries du duc d'Orsonne* (1632), *Virginie* (1633), *Marc-Antoine* (1635) and *Le Grand et dernier Solyman* (1637).

See G. Bizos, *Etude sur* la *vie et les oeuvres de Jean de Mairet* (1877). *Sophonisbe* was edited by K. Vollmoller (Heilbronn, 1888), and *Silvanire* by R. Otto (Bamberg, 1890).

MAIRONIS (1862–1932), Lithuanian poet, whose real name is Jonas Mačiulis, was born at Pasandvaris, in the Kaunas (Kovno) district. In 1909, Maironis was appointed rector of the Kaunas seminary and in 1922 became a professor and deacon of the theological faculty of the Kaunas University which he helped to found. His songs are sung all over Lithuania. His famous poem *Young Lithuania* describes the national rebirth; *Our Sufferings* is a poem descriptive of the Lithuanian national ripening and conquest of independence; his *Magdalen* of *Raseiniai* castigates the national vices, while his Polish poem *Znad Biruty* appeals to the Polonised Lithuanian nobility. His dramatic works include *Where is Salvation? The Death of Kestutis,* and *Vytautas with the Crusaders,* the two last being historical plays of the 14th century. Maironis also translated the *Rigveda* into Lithuanian.

MAISTRE, JOSEPH DE (1754–1821), French diplomatist and polemical writer, was born at Chambéry on April 1, 1754. His family was an ancient and noble one, and is said to have been of Languedocian extraction. The father of Joseph was president of the senate of Savoy, and held other important offices. Joseph himself, after studying at Turin, entered the civil service of Savoy, finally becoming a member of the senate. In 1786 he married Françoise de Morand. The invasion and annexation of Savoy by the French Republicans made him an exile. He betook himself to the neutral territory of Lausanne. There, in 1796, he published his *Considérations sur la France.* In this he developed his Legitimist views, based on his religious convictions. The philosophism of his day was his lifelong aversion.

Charles Emmanuel now summoned de Maistre to Turin; he followed the king to Sardinia, and in 1802 he was appointed envoy extraordinary and minister plenipotentiary at St. Petersburg During these years he only published a single treatise, on the *Principe générateur des Constitutions;* but he wrote his best and most famous works, Du *Pape* (written in 1817) and its continuation, *De L'église gallicane* and the *Soire'es de St. Pétersbourg,* the last of which was never finished. *Du Pape,* written from the standpoint of papal absolutism, is a treatise on the relations of the sovereign pontiff to the Church, to temporal sovereigns, to civilization generally, and to schismatics, especially Anglicans and the Greek Church. The *Soirées de St. Pe'tersbourg* deals with the fortunes of virtue and vice in this world. It contains two of De Maistre's most famous pieces, his panegyric on the executioner as the foundatior. of social order, and his acrimonious, and in part unfair, but also in part very damaging, attack on Locke. Besides these works he wrote an examination of the philosophy of Bacon, some letters on the Inquisition, and, earlier than any of these, a translation of Plutarch's "Essay on the Delay of Divine Justice," with somewhat copious notes. After 1815 he returned to Savoy, and was appointed to high office. He died on Feb. 26, 1821, at Turin. Most of the works mentioned were posthumous, and it was not till 1851 that a collection of *Lettres et opuscules* appeared.

Joseph de Maistre was one of the most powerful, and by far the ablest, of the leaders of the neo-Catholic and anti-revolutionary movement. He regarded the temporal monarchy as an institution of altogether inferior importance to the spiritual primacy of the pope. He was by no means a political absolutist, except in so far as he regarded obedience as the first of political virtues, and he seldom loses an opportunity of stipulating for a tempered monarchy. But the pope's power is not to be tempered at all, either by councils or by the temporal power or by national churches, least of all by private judgment. The absolute necessity of order was, doubtless, the first principle of this thinker, who will invite comparison with Hobbes. The anarchic tendencies of the Revolution in politics and religion offended him. Moreover, he was profoundly and accurately learned in history and philosophy and the superficial blunders of the *philosophes* irritated him as much as their doctrines. To Voltaire he shows no mercy.

Of the two works named as his masterpieces, *Du Pape* and the *Soirées de St. Pétersbourg,* editions are extremely numerous. So complete edition of his works appeared till 1884–87, when one was published at Lyons in 14 volumes. This had been preceded, and has been followed, by numerous biographies and discussions: C Barthélemy, *L'Ésprit de Joseph de Maistre* (1859); *R.* de Sézeval, *Joseph de Maistre* (1865); *L. I.* Moreau, *Joseph de Maistre* (1879); F. Paulhan, *Joseph de Maistre et sa philosophie* (1893); *L.* Cogordan, "Joseph de Maistre" in the *Grands écrivains français* (1894); F. Descostes, *Joseph de Maistre avant la révolution* (1896), and other works by the same uriter; J. Mandoul, *Un Homme d'ttat italien: Joseph de Maistre et la politique de la maison de Savoie* (1900); *E.* Grasset, *Joseph de Maistre* (1901); *L.* Arnould, *La Providence et le Bonheur d'après Bossuet et Joseph de Maistre* (1916); C. Besse. *Le paradox celebre de J. de Maistre sur la guerre* (1916); *M.* Jugie, *J. de Maistre et l'église Gréco-Russe* (1922); and F. Vermale, *Notes sur J. de Maistre inconnu* (Chambéry, 1921).

MAISTRE, XAVIER DE (1763–1852), younger brother of Joseph de Maistre, was born at Chambéry on Nov. 8, 1763. He served in the Piedmontese army, and wrote his delightful fantasy, *Voyage autour de ma chambre* (published 1794) when he was under arrest at Turin in consequence of a duel. On the annexation of Savoy to France, he left the service and took a commission in the Russian army. He served under Suvarov in his victorious Austro-Russian campaign and accompanied the marshal to Russia. He shared the disgrace of his general, and supported himself for some time in St. Petersburg by mmiature painting. But on his brother's arrival in St. Petersburg he was introduced to the minister of marine. He was appointed to several posts in the capital, but also saw active service, mas wounded in the Caucasus, and attained the rank of major general. He died at St. Petersburg on June 12, 1852. Besides the *Voyage* already mentioned, Xavier de Maistre's works (all of which are of very modest dimensions) are *Le Lépreux de la citd d'Aoste* (1811); *Les Prisonniers du Caucase* (182j), *La Jeune Sibe'rienne* (1825) and the *Expddition nocturne*, a sequel to the *Voyage autour de ma chambre* (1825).

His works, with the exception of some brief chemical tractates, are included in the collections of Charpentier, Garnier, etc., and in his *Oeuvres ine'dites*, 2 vol., 1877.

See Sainte-Beuve's *Portraits contemporains*, vol. iii; A. Berthier, *Xavier de Maistre* (1920); C. de Bultet, *Aperçu de la vie de Xavier de Maistre* (1919).

MAITLAND, EDWARD (1824–1897), English humanitarian writer, was born at Ipswich on Oct. 27, 1824, and was educated at Caius college, Cambridge. With Anna Kingsford (1846–88), the supporter of vegetarianism and antivivisectionism, he brought out *Keys of the Creeds* (1875), *The Perfect Way: or the Finding of Christ* (1882) and founded the Hermetic society in 1884. After her death he founded the Esoteric Christian Union in 1891, and wrote her *Life and Letters*. He died on Oct. 2, 1897.

MAITLAND, FREDERIC WILLIAM (1850–1906). English jurist and historian, son of John Gorham Maitland, was born on May 28, 1850, and educated at Eton and Trinity, Cambridge. He was called to the bar (Lincoln's Inn) in 1876, and became a thoroughly competent equity lawyer and conveyancer, but finally devoted himself to comparative jurisprudence and especially the history of English law. In 1884 he was appointed reader in English law at Cambridge, and in 1888 became Downing professor of the laws of England. Though handicapped in his later years by poor health, his intellectual grasp and wide knowledge and research gradually made him famous as a jurist and historian. He edited numerous volumes for the Selden society, including *Select Pleas for the Crown, 1200–1225, Select Pleas in Manorial Courts* and *The Court Baron;* and among his principal works were *Gloucester Pleas* (1884), *Justice and Police* (188j), *Bracton's Note-Book* (1887), *History of English Law* (with Sir F. Pollock, 1895; new ed., 1898); *Domesday Book and Beyond* (1897), *Township and Borough* (1898), *Canon Law in England* (1898), *English Law and the Renaissance* (1901), the *Lzfe of Leslie Stephen* (1906). His writings are marked by vigour and vitality of style, as well as by the highest qualities of the historian who recreates the past from the original sources; he had no sympathy with either legal or historical pedantry. He died at Grand Canary on Dec. 19, 1906.

See P. Vinogradoff's article on Maitland in the *English Historical Review* (1907); Sir F. Pollock's in the *Quarterly Review* (1907); G. T. Lapsley's in *The Green Bag* (1907); A. L. Smith, *F. W. Maitland* (1908); H. A. L. Fisher, F. W. *Maitland* (1910).

MAITLAND, SIR RICHARD (LORD LETHINGTON) (1496–1586), Scottish poet, lawyer. statesman and compiler of an important collection of Scottish verse. "Manly Maitland," as he was called in an epitaph, was the son of Sir William Maitland of Lethington, who was killed at Flodden. He studied law at St. Andrews and Paris, served James V and was keeper of the Great Seal (1562–67) under Queen Mary. Although he went blind about 1561, he remained active as a judge until 1584 and busied himself with writing and collecting Scottish poetry. He died on March 20, 1j86. Maitland's poems reflect the troubled condition of Scotland in his time. Many have social and political themes, which they treat sometimes satirically, sometimes with the meditative seriousness of an old and blind man who loves his country and who asks his more fanatical and intolerant contemporaries, "How suld our commonweill endure?" They have frequently a nice and laconic strength and a metrical expressiveness, both reminiscent of his English contemporary, Sir Thomas Wyatt. Maitland included his own poems in his valuable collection of Scottish poetry known as the *Maitland Folio Manuscript* (begun about 1570), and his daughter added others when she compiled the smaller anthology called the *Maitland Quarto Manuscript* (1586). The 183 leaves of the folio and the 138 leaves of the quarto also contain a selection of works by Robert Henryson, William Dunbar, Gavin Douglas and other poets of the period. Maitland's services to Scottish history and literature were commemorated by the foundation of the Maitland club in 1828 to continue their study.

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(E. G. M.)

MAITLAND (MAITLAND OF LETHINGTON), **WILLIAM** (*c.* 1528–1573), Scottish statesman, eldest son of Sir Richard Maitland (1496–1586) (*q.v.*), was educated at St. Andrews and in 1558 became secretary of state to the regent, Mary of Lorraine. In 1559, however, Maitland threw in his lot with the lords of the congregation. He was sent to Elizabeth I for assistance and worked consistently for a union between the two crowns. In 1561 he was appointed secretary of state, and for about six years he directed the policy of Scotland and enjoyed the confidence of Mary Queen of Scots. John Knox was consistently antagonistic to him, and their encounter in the general assembly of 1564 is famous.

Maitland was doubtless concerned in the conspiracy against David Rizzio, and after Rizzio's murder was obliged to leave the court and was himself in danger of assassination. In 1567 he was again at Mary's side. He was a consenting party to the murder of Darnley, although he had favoured his marriage with Mary, but the enmity between Bothwell and himself was one of the reasons which drove him into the arms of the queen's enemies, among whom he figured at Langside.

He was one of the Scots who met Elizabeth's representatives at York in 1568; there he showed a desire to exculpate Mary and to marry her to the duke of Norfolk. but he was arrested in Sept. 1569 because of his share in the Darnley murder. He was delivered from his captors by a ruse on the part of his friend Sir William Kirkcaldy of Grange. Maitland now became the leader of the remnant which stood by the cause of the imprisoned queen, and with Kirkcaldy held Edinburgh castle against the regent Morton. The castle surrendered in May 1573 and on June 7 or 9, 1573, Maitland died at Leith.

"Secretary Maitland" was a man of great learning with a ready wit and a caustic tongue. He placed his country above the claims of either the Roman Catholic or the Protestant religions. Among the testimonies to his abilities are those of Queen Elizabeth I, of William Cecil and of Knox.

See J. Skelton, *Maitland of Lethington* (1894); A. Lang, *History of Scotland*, vol. ii (1902).

MAITLAND, a city of New South Wales, Austr., situated in the lower valley of the Hunter river, 20 mi. N.W. of Newcastle. Maitland is subject to flooding. but its suburbs, East Maitland, Morpeth, Tenambit. Lorn, Telarah and Rutherford are on high ground to the east and west. Pop. (1954) 21,331. In the adjacent farming area, mixed farming is extensively practised, as well as dairying and beekeeping. Lucerne, maize, millet, potatoes and vegetables are grown. Maitland is the market centre for stock and the local abattoir processes meat for local. metropolitan and export markets. Industries include the manufacture of rayon and textiles, clothing, bricks. tiles, pipes and light engineering. There are bus services to all centres within 30 mi. and the city is within the Newcastle suburban train service, while daily express train services link the district with Sydney and the northern half of New South Wales.

Cessnock (pop. [1954] 14,417) lies 18 mi. S.W. of Maitland and is the market town of the south Maitland coalfields. which cover an area of about 100 sq mi.. and contain some 1,640,000,000 tons of reserves. In the mid-1950s the average annual production was 9,000,000 tons of excellent quality coal. Cessnock is also the centre of a good agricultural district.

MAITREYA, the name of the bodhisattva nho is to be the next future Buddha. In accordance with the Hindu theory of recurrent cycles of the universe, Buddhism held that its truths have been repeatedly taught by Buddhas. who arise in succession, and that the doctrine after its decay and disappearance will be again realized and taught by other Buddhas in the future. A cycle in which no Buddha appears is called empty, but in this cycle there are to be five, or according to some schools 1,000. Four have already appeared, and the fifth is to be Maitreya (Pali, *Metteyya).*

The theory of recurrent Buddhas may not be primitive, but it certainly arose before the close of the Pali Canon, as Metteyya is twice mentioned there *(Digha-nikaya,* no. 26, *Buddhavamsa,* ch. 27), and the belief became established in all schools. According to the *Lalita-vistura* Maitreya was appointed vicegerent in the Tushita heaven when Gotama left it to become Buddha. He is sometimes represented in Mahayana sutras as being present as a bodhisattva at the Buddha's discourses.

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(E. J. T.)

MAITTAIRE, MICHAEL (1668–1747), English bibliographer, was born in France but went to England with his parents. who were Huguenots, after the revocation of the Edict of Nantes in 1685. He was educated at Westminster school and at Christ Church college, Oxford, after which he taught at Westminster (1695–99) and at a school of his own. For a time he was tutor to Philip Stanhope. Lord Chesterfield's natural son. He died in London, Sept. 7, 1747.

His works include: *Annales typographici* ab *artis inventae origine ad annum 1557 cum appendice ad annum 1664* (1719–41), still consulted by bibliographers; *Graecae linguae dialecti* (1706), originally written. as was his *English Grammar* (1712), for the use of Westminster school and surviving as a textbook for generations of schoolboys in J. Seager's translation (1831) from the Leipzig edition (1807); editions of classical texts (1713–25); and *Historia typographorum aliquot Parisiensium* (1717).

MAIWAND, a village of Afghanistan, jo mi. N.W. of Kandahar. It is chiefly notable for the defeat inflicted on a British brigade under General Burrows by Ayub Khan on July 27. 1880, during the second Afghan War *(see* AFGHANISTAN). Ayub Khan, Shere Ali's younger son. who had been holding Herat during the British operations at Kabul and Kandahar, set out toward Kandahar with a small army in June 1880, and a brigade under General Burrows was detached from Kandahar to oppose him. Burrows advanced to the Helmund, opposite Girishk, but was deserted there by Shere Ali, the wali of Kandahar, and had to retreat to Kushk-i-Nakhud. In order to prevent Ayub passing to Ghazni, Burrows advanced to Maiwand on July 27 and attacked Ayub, who had already seized that place.

The Afghans, who numbered 25,000, outflanked the British. the artillery expended their ammunition, and the native portion of the brigade got out of hand and pressed back on the British battalion. The brigade was completely routed and had to thank the apathy of the Afghans for escaping total annihilation. Of the 2.476 British troops engaged, 934 were killed and 175 wounded or missing. This defeat necessitated Sir Frederick Roberts' famous march from Kabul to Kandahar.

MAIZE (CORN or INDIAN CORN), the principal food plant of America. The word maize, derived from the Arawak Indian word *má-hiz,* was formerly preferred in international usage since corn, the term by which the plant is known in the United States and Canada, was in many countries synonymous with grain and was applied to any cereal. The botanical name is *Zea mays.* The Spanish equivalent, maiz, is still used in the Spanish-speaking countries of America, but elsewhere in the world wherever English is commonly spoken the word maize is giving way to corn. In southwestern United States maize means specifically a variety of sorghum, milo maize. *See* CORN. (P. C. MF.)

MAJANO (MAIANO), **BENEDETTO DA** (1442–1497), Italian sculptor, was born at Majano, near Florence. His earliest surviving work is the shrine of S. Savino (1468–70) in Faenza cathedral. Between 1470 and 1475 he was engaged on the altar of Sta. Fina in the Collegiata at S. Gimignano, in a chapel designed by his elder brother Giuliano (1468) and decorated with frescoes by Domenico Ghirlandaio. The connection between Benedetto da Majano and Domenico Ghirlandaio is reflected in the five narrative reliefs in Benedetto's masterpiece, the pulpit in Sta. Croce in Florence (probably 1472). A bust of Pietro Mellini (Museo Nazionale, Florence) by whom the pulpit was commissioned, is dated 1474, and reveals the same accumulation of naturalistic detail as is found in the male portraits of Ghirlandaio. The ornate decorative parts of the Sta. Croce pulpit are of great distinction, and have a counterpart in the marble doorway of the Sala dei Gigli in the Palazzo Vecchio, Florence.

After this time Benedetto was employed on two major works for the church of Monte Oliveto in Naples, the tomb of Mary of Aragon (d. 1470), begun by Antonio Rossellino, and an altarpiece of the Annunciation (1489). Concurrently he was employed by Filippo Strozzi, of whom he made a portrait bust (marble in the Louvre, Paris; terra cotta in the Kaiser Friedrich museum, Berlin) and whose tomb in Sta. Maria Novella, Florence, he completed after 1491. His last major works, the altar of S. Bartolo in S. Agostino at S. Gimignano (1493–9j) and an unfinished group representing the "Coronation of Ferdinand of Aragon" (Museo Nazionale) show some decline in quality.

As a sculptor Majano occupies a place above Mino da Fiesole and below Andrea del Verrocchio, and his work depends for its effect less on invention and originality than on unfailing taste and an exceptionally high level of technical skill. He was also an architect.

Majano died on May 24, 1497.

See L. Dussler, *Benedetto da Majano* (1924). (J. W. P.-H.)

MAJESTY, that is, awe-inspiring greatness, in particular the attribute of divine or sovereign power. The ancient Romans spoke of the majesty *(maiestas)* of the republic or of the Roman people, violation of which entailed a charge "of injured majesty," *crimen laesae mniestatis; i.e.,* of *lèse-majesté* or treason *(q.v.).* Under the principate the majesty of the state was transferred to the emperor's person, whose *maiestas augustalis* was protected from disrespect by extension of the law of treason. An early example of the modern usage of the term as an honorific form of address occurs in a letter of Q. Aurelius Symmachus to Theodosius I, whom he calls "Tour Majesty," after which it becomes frequent in addresses to the western emperors (cf. the *megaleiotes* of the Byzantines).

In the middle ages the Holy Roman emperors had "majesty" from the time of Louis the Pious; but kings *(e.g.,* Henry II of England), popes, cardinals and archbishops also enjoyed it occasionally; and we even find Hugh, count of Champagne, referring to his own in a letter to the monks of Saint-Remi (1114) and the citizens of Ghent ascribing it to Philip the Good, duke of Burgundy (1453). In these instances, however, one of the parties to the communication recognized the other as his superior: no precedent was therefore established for solving the problems that obstructed diplomacy when the emperor proved unwilling to accord "majesty" to other sovereigns who claimed it. Having withheld it from Francis I of France at the signing of the treaty of Cambrai (1529), Charles V eventually allowed it to him at the peace of Crepy-en-Laonnois (1544), with the distinction however that Charles's "majesty" was there specified as "Caesarean" while Francis' was only "Royal." The kings of Spain, on the other hand, managed to retain the "majesty" acquired when Charles was both king of Spain and emperor.

Embarrassments recurred (notably in the preliminaries of the peace of Westphalia) until the solution adumbrated in 1344 was generally adopted in the 18th century, when the "majesty" of the several kings was determined by qualification with the special epithets that the papacy had given them as kings: the king of France, then, as "Most Christian king," became "His Most Christian Majesty"; the king of Spain, "His Catholic"; and the king of Portugal, "His Most Faithful." Maria Theresa, during the War of the Austrian Succession, had "Apostolic Majesty" as undisputed successor of the "Apostolic kings" of Hungary; later, their right to the empire established, she and her successors had "Imperial and Apostolic."

The sovereign of the United Kingdom is "His" or "Her Britannic Majesty" for international purposes. "His Majesty" is usually enough for any ruler within his own realm but may be amplified: "His Sacred" (16th–17th century), "His Most Gracious" and "His Most Excellent Majesty" are English forms.

MAJLÁTH, JÁNOS or JOHN, COUNT (1786–1855), Hungarian historian and poet, was born at Budapest on Oct. 5, 1786. First educated at home, he subsequently studied philosophy at Eger (Erlau) and law at Gyor (Raab), his father, Count Joseph Majláth, an Austrian minister of state, eventually obtaining for him an appointment in the public service. Majláth devoted himself to historical research and the translation into German of Magyar folk tales and of selections from the works of the best of his country's native poets. Moreover. as an original lyrical writer and as an editor and adapter of old German poems, Majláth showed considerable talent.

During the greater part of his life he resided either at Budapest or Vienna, but a few years before his death he moved to Munich, where he fell into a state of destitution and extreme despondency. Seized at last by a terrible infatuation, he and his daughter Henriette, who had long been his constant companion and amanuensis, drowned themselves in the Lake of Starnberg, a few miles southwest of Munich, Jan. 3, 18jj.

Of his historical works the most important are the *Geschichte der Magyaren*, 5 vol. (1828–31; and ed., 1852–53) and his *Geschichte des österreichischen Kaiserstuats*, *j* vol. (1834–50). Noteworthy among his metrical translations from the Hungarian are the *Magyarische Gedichte* (1825) and *Himfy's auserlesene Liebeslieder* (1829; 2nd ed., 1831). A valuable contribution to folklore appeared in the *Magyarische Sagen, Märchen und Erzählungen*, 2 vol. (1825; 2nd ed., 1837).

MAJOLICA, a name properly applied to a species of Italian ware in which the body is coated with a tin enamel, on which a painted decoration is laid and fired. It is also applied to similar wares made in imitation of the Italian mare in other countries. The word in Italian is *maiolica*. *See* POTTERY AND PORCELAIN.

MAJOR (or MAIR), **JOHN** (1470–1550), Scottish theological and historical writer, was born at Gleghornie, near North Berwick. He was educated at the school of Haddington, where John Knox was later a pupil. After a short period spent at Cambridge (at God's house, afterward Christ's college) he entered the University of Paris in 1493, studying successively at the colleges of St. Barbe, Montaigu and Navarre, and graduating as master of arts in 1496. Promoted to the doctorate in 1505, he lectured on philosophy at Montaigu college and on theology at Navarre.

He visited Scotland in 151j and returned in 1518, when he was appointed principal regent in the University of Glasgow, John Knox being one of those who attended his lectures there. In 1522 he moved to St. Andrew's university, where in 1525 George Buchanan was one of his pupils. He returned to the College of Montaigu in 152j but was once more at St. Andrcn's in 1531, nhere he nas head of St. Salvator's college from 1534 until his death in 1550.

Major's voluminous writings may be grouped under *(a)* logic and philosophy, *(b)* Scripture commentary and *(c)* history. All are in Latin. all appeared between 1503 and 1530 and all nere printed at Paris The first group includes his *Exponabilia* (1jog), his commentary on Petrus Hispanus (150j–1506), his *Inclitarum artium libri* (1506, etc.), his commentary on Joannes Dorp (1504, etc.), his *Insolubilia* (1516, etc.), his introduction to Aristotle's logic (1521. etc.), his commentary on the ethics (1530) and, chief of all, his commentary on Peter Lombard's *Sentences* (1509, etc.); the second consists of a commentary on Matthew (1518) and another on the Four Gospels (1529); the last is represented by his famous *Historia Majoris Britanniae tam Angliae quam Scotiae per J.M.* (1521).

In political philosophy he maintained the Scotist position that civil authority mas derived from the popular will, but in theology he was a scholastic conservative, though he never failed to show his approbation of Gallicanism and its plea for the reform of ecclesiastical abuses. He hoped to reconcile realism and nominalism in the interests of theological peace.

Major claimed that the historian's chief duty is to write truthfully, and he was careful to show that a theologian might fulfill this condition.

The *History*, on which his fame now rests, was reprinted by Freebairn (1740) and was translated in 1892 by Archibald Constable for the Scottish History society. The latter volume contains a full account of the author by Aeneas J. G. Mackay and a bibliography by Thomas Graves Law.

MAJOR, a military rank standing above captain. Originally, the term was used adjectivally in the title sergeant major, the "third principal officer in a regiment" (Ward, 1639), now the major. In the 16th and 17th centuries there was a similarity between the duties of the sergeant, sergeant major and sergeant major general, in that they attended to the drill and administration of a company. a regiment and an army. respectively. In conversation, sergeant major was abbreviated to major and sergeant major general to major general. whence the modern titles of major and major general derive. In the case of sergeant major the sergeant was dropped about 1660, although in some quarters it lingered for several years.

In the 17th century the duties of a major were a combination of those now performed by the major (second in command) and sergeant major, but on the introduction of adjutants he mas relieved of much of the routine work. The brigade major corresponds in a higher sphere to the adjutant of a battalion Such expressions as town major and fort major indicate the purpose of the appointment.

The rank of major has always been below that of lieutenant colonel. In a regiment commanded by a colonel, he was the third in command; in a battalion commanded by a lieutenant colonel, he was second in command. In the larger organizations of the 20th century a regiment might have three or more majors, each commanding a battalion.

Drum major was an ancient title in the British service and was adopted by the U.S. army early in its history. The drum major was responsible for training the regimental drummers and often had the additional functions of regimental postman and banker. The title sergeant major was introduced as a noncommissioned rank in the British service early in the 18th century and was elevated to warrant rank in 1881. In the U.S. army it has usually indicated the principal administrative noncommissioned officer of a unit, the chief assistant to its adjutant.

See also INSIGNIA, MILITARY; OFFICERS. For the musical meaning of the term major *see* HARMONY. (F. P. T.)

MAJORCA, the largest of the group of Spanish islands in the Mediterranean sea known as the Balearic Islands (*q.v.*). Pop. (1950) 339,948; area, 1,405 sq.mi. On the northwest the coast is precipitous, but on the other sides it is low and sloping. On the northeast the chief bays are those of Alcudia and Pollensa, while on the southwest is the still more important bay of Palma. In the northwest a chain of mountains runs parallel with the coast and attains its highest elevation in Silla de Torrellas (4,741 ft.). Majorca has typical limestone scenery. Some oi the valleys, such as those of Valldemosa and Sóller, have luxuriant vegetation. There are marble quarries, those near Santañy being celebrated; while lead, iron and cinnabar have also been obtained. Coal is found at Renisalem. Selva, Santa Maria and elsewhere.

The inhabitants are principally engaged in agriculture. Old pine woods have in many places given way to the olive! the vine and the almond tree, to fields of wheat and flax or to orchards

BY COURTESY OF SPANISH TOURIST OFFICE

ONE OF THE FAMOUS 1,000-YEAR-OLD OLIVE TREES OF MAJORCA

of figs and oranges.

Inca is the centre of the oil district. The wines are light but excellent, especially the Muscatel and Montona. Brandy is made and exported; woolen and linen cloths are woven; the silkworm is reared and its produce manufactured; and canvas, rope and cord are largely made. The four principal roads are those from Alcudia, Manacor, Sóller and Andraitx to Palma, the capital. The main railway line runs from Palma to Manacor and Alcudia. There is regular communication with Barcelona and Alicante.

The principal municipalities include — besides Palma (133,397), Felantix (11,860) and Manacor (18,702), which are described in separate articles—Andraitx (4,303), Inca (12,247), Lluchmayor (10,041), Pollensa (8,541), Santañy (5,260), Sóller (9,279) and La Puebla (10,321).

MAJORIAN (IULIUS VALERIUS MAIORIANUS), emperor of the west from 457 to 461. After the deposition of Avitus Majorian was declared emperor by the regent, Ricimer. After repelling an attack by the Vandals upon Campania (458), he prepared a large force to invade Africa. Having defeated and concluded an alliance with Theodoric the Visigoth, at the beginning of 460 he crossed the Pyrenees for the purpose of joining the powerful fleet which he had collected at Carthagena. The Vandal king Gaiseric, however, succeeded through the treachery of certain officers in destroying the Roman fleet. Majorian thereupon made peace. But his ill-success had destroyed his military reputation. A mutiny inspired by Ricimer broke out in Lombardy, and on the 2nd of August 461 Majorian was forced to resign. He died five days afterward, either of dysentery or by violence.

Majorian was the author of a number of laws, appended to the Theodosian Code. Of these the most interesting is that forbidding the use of ancient monuments as quarries for building material.

See Sidonius Apollinaris, *Panegyric of Majorian (Chronica Minora,* ed. Mommsen, vol. 1, 2, 3) ; Edward Gibbon, *Decline and Fall,* ch. xxxvi (where an outline of the "novels" of Majorian is given) ; J. B. Bury, *Later Roman Empire,* ch. iii.

MAJORITY: *see* INFANT.

MAJUBA (properly AMAJUBA, Zulu for "the hill of doves"), a mountain in the Drakenberg, of northern Natal, South Africa, rising 7,046 ft. above the sea and more than 2,000 ft. above the level of the surrounding country. It overlooks the pass over the Drakenberg known as Laing's Nek, is 8 mi. S. of the Transvaal border and 18 mi. N. of the town of Newcastle. The railway from Durban to Johannesburg skirts the base of the mountain. During the Boer War of 1880–81 Majuba was occupied on the night of Feb. 26, 1881, by about 600 British troops under Sir George Pomeroy Colley.

On the following morning the hill was stormed by the Boers under Piet Joubert and the British routed, Colley being among the slain.

MAKAH, the Indians of Cape Flattery, Washington, the only group of Nutka affiliation in the United States. Bold canoemen, they paddle far out on the ocean to harpoon whales. Their culture, of general North Pacific coast type, has closest resemblance to that of the Quileute and Nutka.

MAKARAKA ("Cannibals"), a Negroid people of central Africa, related to the powerful Azande or Niam-Niam race, occupying the Bahr-el-Ghazal west of Lado. They came originally from the country of the Kibas, north of the Welle. They are a reddish-black, with nose less flat and cheekbones less prominent than the ordinary Negroes, and they do not extract the incisors. Their long silky hair is built up in the most fantastic form by means of vegetable substances. They are well known for strength and staying power.

See W. Junker, *Travels in Africa* (1890–92).

MAKARSKA (Ital. *Macarsca*), the chief town of an administrative district in Croatia, Yugo. Pop. (1953) 2,547, chiefly Serbo-Croatian. Makarska is a steamship station and has a brisk trade in wine, grain and fruit.

Under the name of Mocrum, Makarska was a thriving Roman city, and a bishopric until 639, when the town was destroyed by the Avars. Its bishopric was revived in 1320, but merged in that of Split (Spalato) in 1830.

MAKART, HANS (1840–1884), Austrian painter, who became the most celebrated painter of the great bourgeois epoch in Vienna, was born in Salzburg on May 29, 1840. He got his decisive training in Munich under Karl von Piloty, the leading historical painter at that time. He gave himself over entirely to a superficial, idealized historicalism, even in his portraiture, taking the 16th-century Venetians, Van Dyck and Rubens, as his models in composition and colour. Makart lived in Vienna from 1869 and died there, Oct. 3, 1884. In 1879, when he was at the peak of his fame, he undertook to design the festal procession which was to celebrate the silver wedding of the emperor Francis Joseph I and the empress Elisabeth.

Makart's art, with its riotous, decorative grandiloquence, was in general the kind which is destined to fade quickly. But it is not difficult to recognize in many details and in individual works no small talent as a painter and an unusual gift for colour.

Important works are in the galleries of Vienna, Berlin, Hamburg and Stuttgart. He also executed a series of decorative lunettes for the Kunsthistorisches museum in Vienna. His great historical pictures include "Caterina Cornaro" (1873), "The Entry of Charles V Into Antwerp" (1878) and "The Plague in Florence" (1867–68); other works are "The Burg Theatre Actress Charlotte Wolter as Messalina" (1876) and "The Triumph of Ariadne" (1873).

See Emil Pirchan, *Hans Makart* (1954). (F. NY.)

MAKEMIE, FRANCIS (*c.* 1658–1707/08), American colonial Presbyterian clergyman and leader in forming the first American presbytery, was born in County Donegal, Ire., about 1658 and was educated at the University of Glasgow. In 1682 he was ordained by the Presbytery of Laggan, Ire., to go to America in response to a plea from a Colonel Stevens in Maryland. Makemie preached in Somerset county, Md., and in the Barbados for a number of years, supplementing his meagre income by trading. About 1690 he married the daughter of a wealthy merchant of Accomack, Va., and took up residence there. A year later he was in London, where he was associated with Increase Mather of Boston, with whom he had corresponded for several years, and with other Presbyterian and Congregationalist leaders.

For ten years he preached and traded between Accomack and the Barbados, and sought also to unite the various struggling Protestant churches of these areas in a common cause. However, Anglican attempts to silence him by arrest, and a severe controversy with George Keith, first a Quaker and then an Anglican zealot, awakened Makemie to the peril of the Dissenting churches in the colonies. His ties with the Boston ministers were continued, and in 1706 Makemie seems to have been the leading spirit in uniting several scattered churches and pastors in Virginia, Maryland, Pennsylvania and New Jersey into a presbytery. The following year Lord Cornbury of New York imprisoned Makemie and a colleague, John Hampton, for preaching on Long Island without licences. After several months of imprisonment, and a long and costly trial, Makemie was acquitted. Cornbury was soon recalled to London. Thereafter the provisions of the Toleration act in England were claimed by all Dissenters in the American colonies. In his trial Makemie had been aided by the Boston Congregationalist ministers, leading Dissenting ministers in London and prominent New York citizens.

Makemie's death occurred in late 1707 or early 1708. Six of his several controversial and sermonic publications are extant.

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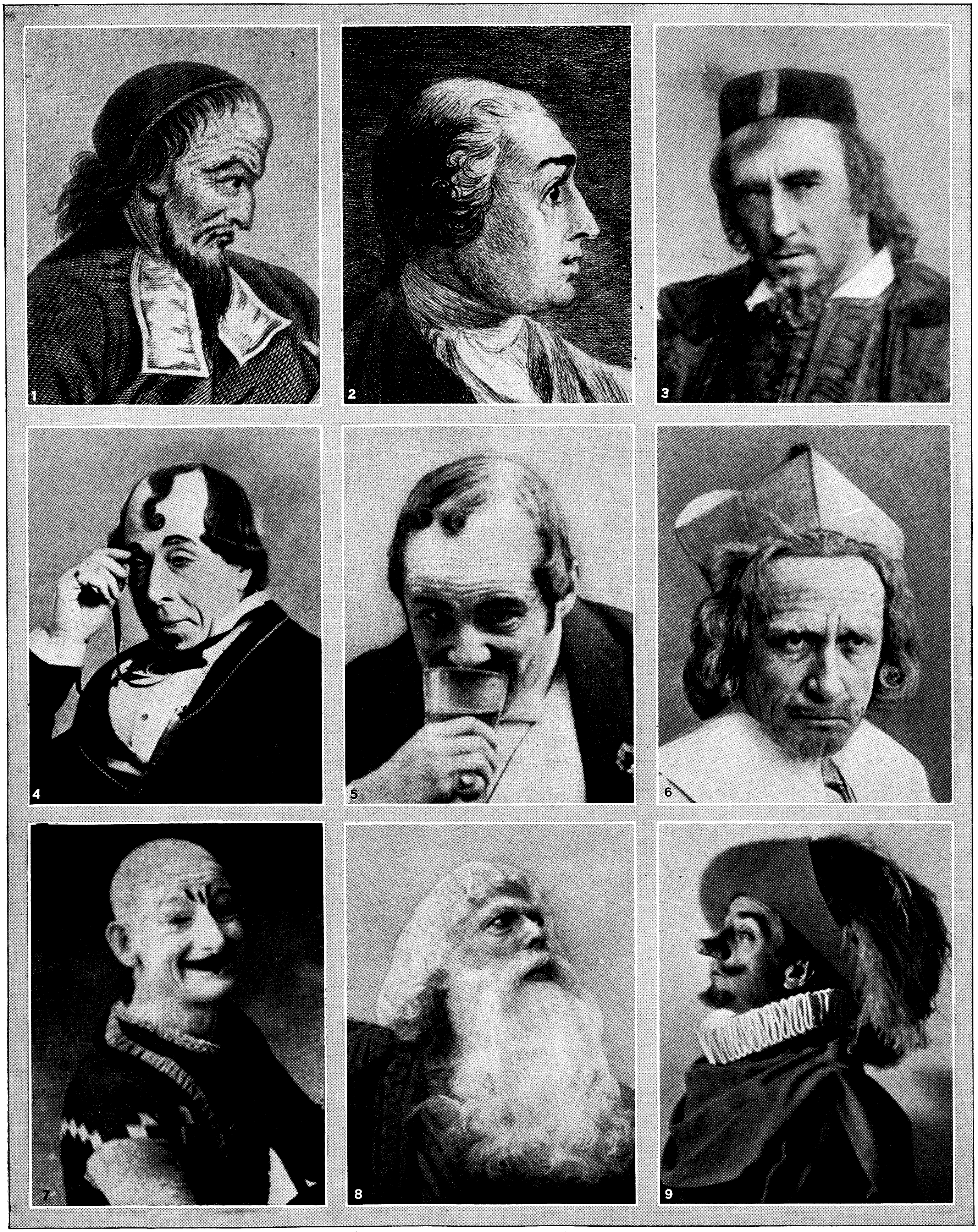

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ENGLISH AND AMERICAN ACTORS IN CHARACTER MAKE–UP

1. Charles Macklin (1697–1797), as Shylock. 2. David Garrick (1717–79), as Romeo, in 18th century costume. 3. Sir Henry Irving (1838–1905), as Shylock. 4. George Arliss (1868–1946), as Disraeli. 5. Richard Mansfield (1857–1907), as Baron Chevrial in "A Parisian Romance!' 6. Edwin Booth (1833–931, as Cardinal Richelieu. 7. George L. Fox (1825–77), celebrated American clown, in character of Humpty Dumpty. 8. Robert Mantell (1854–1928), as King Lear. 9. Walter Hampden (1879–1955). as Cyrano de Bergerac

MAKE-UP

PHOTOGRAPHS, (1) THE J. C. STRAUSS STUDIO, (3, 6, 8) THE WHITE STUDIO, (5) PIRIE MACDONALD, (7) SARONY, (9) CHAS. H. DAVIS.

OTIS SKINNER (1858–1942) IN VARIOUS RÔLES ILLUSTRATING CONTRASTS IN MAKE-UP

1. As Charles Surface in "The School for Scandal"
2. Portraying Hajj in "Kismet"
3. As Sancho Panza in Cervantes' "Don Quixote"
4. As Falstaff in "Henry IV."
5. Otis Skinner without make-up
6. As he appeared in "Mister Antonio"
7. As Denis Roulette in "Sire"
8. As Falstaff in "Merry Wives of Windsor"
9. As Philippe Bridau in "The Honor of the Family"

MAKE-UP (STAGE, MOTION PICTURE AND TELEVISION). As long as dramatic exposition has existed it has presumably been accompanied by some form of masquerade for the purpose of transforming the actor into the part he portrays. Use of make-up actually dates to earliest historical times.

Primitive Make-Up.—A suggestion of the simplicity and crudeness of the earliest devices of make-up may be found in the religious rites of primitive races in modern times. The Patagonians, whose only form of dramatic movement was the swaying of their bodies and a monotonous mumbling of incantations, made up for the occasion by smearing their faces with chalk. Among the Australian aborigines, uho rank somewhat higher in the ethnological scale, ritual ceremonies are enhanced by bodily adornments of wreaths, flowers and feathers worn over greased bodies and faces daubed with white clay.

The Aleutian Indians use painted wooden masks representing demons and sea animals for their mystic rites. while the natives of the South Sea islands dress their heads uith helmetlike structures, into which are built masks of wood, reeds, tortoise shell and human skulls, sometimes decorated with vegetable substances to represent hair. Some of these islanders, like the members of the Areoi societies, discarded the mask and impressed their spectators by painting their faces red and their bodies black. The Indians of North America, besides decorating their bodies and faces with variously hued war paints, were accustomed to behold their medicine man dressed for rituals in the skin and head of elk, bear, wolf or panther.

STAGE

Early.—The Chinese and Siamese theatre not only handed down old tradition of masks, but made use of grotesquely painted faces of blue, green, ochre, vermilion and ghastly white for demons and spirits. For the official ceremonies of the ancient Egyptians wigs were worn by kings and priests. Excavations dating back to 5000 B.C. reveal that eye and face paints also were widely used. Persian warriors wove strands of jute into their marcelled beards.

In the procession of Dionysus (out of which grew the Greek drama) the god was represented with long hair and beard: two small horns projecting from his forehead, while the reeling Bacchantes appeared with faces smeared with wine dregs or mulberry juice. Some of the followers in the train portrayed dead souls clad in shrouds with their faces covered in white lead.

Medieval.—For miracle plays of the 14th century and onward actors made up with startling realism as animals, devils, saints and angels. bluch ingenuity in facial disguise was used in a medieval play called *The Acts of the Apostles*, wherein the spectators saw the eyes of St. Matthew drawn out of his head and Simon Magus change his face several times. In an early English Passion play, Christ and the Apostles wore gilt wigs and the evil spirits appeared with bodies painted a reptilelike green, huge horns of oxen and rams ornamenting their heads.

Renaissance.—A favourite farce actor in Paris during the reign of Henry IV was known as Gros Guillaume. His face make-up consisted of a thick coating of flour which, at comic moments, he sent flying into the eyes of his fellow actors by puffing out his fat cheeks; on his chin he wore a piece of white lamb's skin, representing a beard. The popular commedia dell' arte (*q.v.*) of the Italian theatre of the 16th and 17th centuries was performed by actors masked always in the typical grotesquerie of Pierrot, Harlequin, Pantaloon, Scaramouche, Capitano, etc. The white face of the modern circus clown is a direct inheritance from the Pierrot, who in the 18th century discarded the mask and powdered his face with flour.

The English stage of Elizabeth I did away with the mask as a means of facial make-up. Instead of the set expressions of the disguised Harlequins and Pantaloons, actors mere seen as human beings with their natural faces or appropriately painted, bearded and wigged as the character called for. Cosmetics were applied simply and obviously as there was no artificial lighting to soften disguise deficiencies. The theatre of Molière encountered few make-up difficulties. The customary long ringlets of the court were worn whatever the period of the play, whether Roman or contemporary and the only beard necessary was the partly shaved mustache of the prevailing mode.

Later.—The ignoring of archaeological verity in make-up was characteristic of the English stage until after the time of David Garrick who, for nearly every character, wore the white court wig of George 111 and as Romeo appeared as a British gentleman of his day. The art of make-up was but little studied before the beginning of the 19th century. Costume was clumsy and wigs and beards for character parts were of crude material. The early method of acting Shylock was as a comedy part that roused audiences to laughter. Thomas Doggett, a celebrated Shylock, wore a ridiculous red wig and beard lor the part. The first actor to redeem the character from buffoonery was Charles Macklin, who presented him as si'nister and black-bearded. Since Macklin, actors have varied the aspect of Shylock according to their fancy. A well-remembered portrait was that of Henry Irving whose Jew was the picture of an elderly aristocrat.

The stage lighting of the period was dim and ineffectual, first by candles, later by smoking oil lamps, and in its twilight crudity passed unnoticed. As illuminating gas and calcium lights were introduced the necessity arose for greater circumspection in appearance. Make-up material, however, was still somewhat elemental and natural appearing heads and complexions a rarity.

(0. SK.; M. F.)

Modern.——With the introduction of Edison's electric light into the theatre came the need for new make-up materials and more skillful techniques of application. Crude, inartistic effects no longer could be hidden under the revealing light of electricity. A new era of realism was dawning. Stick grease paint, a revolutionary invention, soon made its first appearance, and by 1890 the demand for stage make-up had warranted its manufacture on a commercial scale.

The importance of modern stage make-up cannot be overemphasized. If it were not used, the performer quickly would discover that the lighting system of the stage actually had absorbed all the colour from his complexion. Therefore, make-up is necessary to restore this colour and define the features of the face to insure a natural appearance. It also helps the player to look and feel the part, and for most character interpretations it is absolutely essential. Standardized charts show the correct shades of straight make-up for various types of men, women and children.

MOTION PICTURES

During the early days of motion pictures, specially created make-up for the new medium was not available. Players who wore make-up at all borrowed both materials and techniques from the stage. Characters invariably were standard types: hero, heroine and villain. The hero and heroine were heavily made up with painted lips, chalk-white faces and dark eye make-up. The villain depended only upon long "moustachios" and heavily painted black eyebrows. Stick grease paint of the theatre, however! was not satisfactory. Necessarily heavy applications made it impossible for the actor to appear natural looking in close-ups and the limited range of colours failed to meet requirements of motion-picture lighting and photography.

The first make-up designed expressly for motion pictures was created by Max Factor and introduced in 1910. This mas a light, semiliquid grease paint in jars: made available in a precisely graduated range of tan-tone shades, suitable for the lighting and orthochromatic film emulsion of that period. A short time later, this new grease paint became the first make-up to be introduced in sanitary tubes. Prior to 1928, there were no established standards for motion-picture lighting or the selection of make-up colours. But with the advent of panchromatic film and incandescent lights on the sets, a complete gradation of make-up shades was created which allowed every player, from fairest blonde to darkest brunette: to appear true to type on the screen. In Feb. 1928, the Society of Motion Picture Engineers conducted a special series of tests for the purpose of standardizing the type of film, lighting and colours of make-up that proved most effective for motion pictures. Obviously, the principal consideration was given to the appearance of the players and it was quickly determined that make-up colours used for the former orthochromatic film, as well as the old method of arc lighting, would have to be changed. As a result of these experiments, Max Factor created a completely new range of make-up colours, which he presented to the motion-picture industry as Panchromatic Make-Up. For this achievement, he won a special Academy award.

The main make-up requisite used by a film player is the foundation colour, which panchromatic make-up supplies in 11 distinctive tones. ranging from a faint tan to a warm brown. With this standardized scale also including lip rouges in proportionate tones of dark red, as well as lining colours and eye shadow in panchromatic shades. the player can co-ordinate make-up colours with lighting and photographic conditions and usually be certain of uniformly correct screen results.

Motion-picture make-up is both a corrective art and a creative art. Make-up always must be applied skillfully, delicately and subtly so that facial expression will have natural freedom. The inexperienced should remember that the camera lens! particularly in close-ups, magnifies the face many times larger than life size. Consequently, every complexion flaw or crudely applied make-up artifice is clearly discernible. As a corrective art, make-up serves to cover blemishes, provide the face with a smooth, even colour tone for the most effective photography, clearly define the facial features for more visibly expressive action, make the player appear more attractive and insure a uniform appearance before the camera. As a creative art, make-up enables the player to take on the appearance of almost any type of character. It can be his means of achieving a distinctive "screen personality." It can make the young appear to age believably and the old appear to look young again. Countless special make-up devices, effects and tricks are available. Tears can be produced by blowing fumes from a menthol tube into the eyes. Weird or comedy effects may be created by blocking out teeth with black tooth enamel. Scars are realistically made with a simple brush application of collodion.

Wigs, hairpieces and mustaches also are an integral part of the motion-picture make-up art and the ancient art of wigmaking has kept pace with the general advancement and perfection of make-up. The modern hairpiece and wig is made of human hair. Each individual strand of hair is tied, one by one: with a special ventilating needle into a lacelike foundation, which is stretched over a wooden wigblock sculptured in the size and shape of the head contours. The most artistic beards and mustaches usually are achieved through the use of crepe hair. which comes in various shades and is applied with spirit gum. The bald or balding actor necessarily relies upon a hairpiece as a means of regaining a youthful appearance, but players of all ages and types depend upon hairgoods to achieve realistic characterizations. In 1937, the film production *Marie Antoinette* called for 903 ornately fashioned white wigs and 1,200 less elaborate wigs for peasant extras. Another period movie, *Forever Amber* required 4,402 wigs. In Cecil B. DeMille's *The Ten Commandments,* approximately 7,500 hairpieces, including beards and mustaches, were used.

Make-Up for Colour Films.—The introduction of colour to motion pictures brought make-up problems of the most serious nature. Existing grease paint made some players appear to have yellow jaundice. Other faces became bright red, blue or green on the screen. As colour film processes were perfected, the need for a new type of make-up became mandatory. The problem was not one of merely developing new colours. Entirely new materials had to be created. After first testing a liquid make-up, which did not prove satisfactory, experiments were started in a completely new field of make-up principles. This resulted in the introduction of a spectacularly successful solid make-up, applied with a moist sponge, known as Pan-Cake Make-Gp. Instead of covering and concealing skin surfaces, the new material could be applied in a light. transparent film of colour. It was first used in *Vogues of 1938* and later in *The Goldwyn Follies.* For the first time in history audiences saw players who appeared realistic and lifelike enough to convey the impression that they might at any time step down from the screen into the theatre. Soon Pan-Cake Make-Up started replacing grease paint to a large extent even for black-and-white films. Another highly successful material, perfected for colour motion-picture use, was a creamy foundation in semisolid stick form called Pan-Stik. Make-up charts show the correct colours to use for each type of colour film.

Basic techniques of make-up application are virtually the same for black-and-white and colour photography, except that the latter demands even greater skill and perfection in application methods for the most realistic results.

TELEVISION

As early as 1932, special make-up had been created for television. This was the result of exhaustive, practical tests conducted in collaboration with the pioneer Don Lee experimental television station, W6XAO, in Los Angeles. In all, four major phases of technical development have occurred in the evolution of this make-up. The first creation was a light-coloured monotone make-up. Next came the "painted Indian" effect, employing multiple make-up colours. which televised most naturally during the intermediate period of television. This was followed by the development of the modern TV-N series of colours in Pan-Cake and Pan-Stik foundations for black-and-white television. The fourth step was the creation of special materials and shades for colour television.

Although 11 shades (TV-IN to TV-11N) of make-up were available for black-and-white television in the latter 1950s, the average foundation make-up needs for the medium could be fulfilled with six colours—TV-4N to TV-9N. Colours in the lower numbers are light pastel pinks and beiges. In the higher numbers, they are tan, brown and dark brown. TV-IN, for instance, would provide an extremely white face while TV-11N would give the darkest possible complexion effect. Without make-up. the performer cannot expect to have an attractive complexion on television. Light complexions become ghostly white. Dark complexions look dirty. Men who may be closely shaved still appear to be in need of a shave. Everyday make-up shades used by women televise too light or too dark and ordinary lipstick colours usually wash out. Screen make-up shades are equally unsatisfactory.

For colour television, various new materials and countless variations of colours had to be tested. The very success of the medium is largely dependent upon the naturalness, accuracy and believability of the human skin tones it reproduces. It might be relatively unimportant if a green dress appeared blue on a colour-receiving set, but a performer with a green face would be ludicrous. The problem is doubly complicated because faces must look lifelike on colour television and at the same time appear natural in the simultaneous black-and-white telecasts. Like make-up for black-and-white television. the make-up used for colour television is specifically designated as the CTV series and ranges from CTV-1W to CTV-12W in Pan-Cake Make-Up and Pan-Stik.

See also COSMETICS.

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(M. F.)

MAKING-UP PRICE. A term used in the London and other British stock exchanges to denote the price at which speculative bargains are carried over from one account to the next. The carry-over of a "bull" position in Eries, for example, implies a sale for cash and a simultaneous repurchase for the new account, both bargains being done at the making-up price, fixed at noon on carry-over day, in accordance with the market price then current *(see* STOCK EXCHANGE). The term is also used in New York, where the making-up prices are fixed at the end of a day's business. in accord with the U.S. system of daily settlements.

MAKÓ, the capital of Csongrád county, Hungary, a typical market town of the Hungarian plain situated near the right bank of the Maros. Cereal cultivation and stock raising are important activities on its fertile communal lands and there are several flour mills in the town, but its chief specialization is the growth of vegetables, particularly onions for which it is famous. Pop. (1957 est.) 34.000 mun.

MAKONNEN, RAS TAFAWI (1891–), **a** king of

Abyssinia, "King of the Kings of Ethiopia, Lion of Judah, the Elect of God," born July 17, 1891, was great-grandson of Haile Melekot, King of Shoa, and son of a distinguished soldier and diplomat. He was educated by the French mission at Harrar. In 1912 he married Waizero Manin, granddaughter of Ras Michael, his eldest son being born July 27, 1916. When on Sept. 27. 1916, the dissolute Lej Yasu was dethroned and his aunt, Zauditu. proclaimed empress, Tafari, her cousin, was appointed regent, heir to the throne, and Ras (prince) of Rases. Ras Michael, Yasu's father, was defeated on Oct. 27. Yasu rallied his father's army, but it surrendered at Magdala in Dec. 1917. Yasu was imprisoned in 1921.

In order to gain authority independently of the empress Zauditu, Ras had himself proclaimed king, Nov. 7, 1928. After Zauditu's death he formally mounted the throne on Nov. 2, 1930, as Emperor Haile Selassie I. He continued his work of modernization, secured the admission of Abyssinia to the League of Nations in 1923, and toured European capitals in 1924.

Difficulties with England over control of the Nile waters were soon overshadowed by disputes with Italy. In spite of the arbitration agreement of 1928 and the action of the League of Nations, hostilities broke out late in 1935 with Italy, ending in the flight of the emperor from Addis Ababa, May 1, 1936; occupation of the capital by the Italians, May 5; and the proclaiming of King Victor Emmanuel as emperor of Abyssinia.

In May 1941 Haile Selassie returned to Addis Ababa. Great Britain recognized his nation as a sovereign state on Jan. 31, 1942, and provided financial aid to reconstruct the country.

(J. Sw.; X.)

MAKRAN (MEKRAN), the coastal region of southeastern Persia and southwestern Pakistan, extending along the Gulf of Oman for about 600 mi. from Ras (cape) el-Kuh to Las Bela (southern Baluchistan). The long lateral valley of the Kej (Kech) river and the name Makran are associated in early geographies: thus the Kei-Macoran of Marco Polo is the Makran of todav. The name is applied in particular to a former province of Persia and to one of the Baluchistan states.

Makran's long sandy coastline is broken by the magnificent cliffs of Malan, the headlands of Ormara and Gwadur, the precipitous coast of Jebel Zarain (near Pasni), the bays of Charbar (Chahbar) and Gwatar, and the inlet near Ras Maidani. Northward is a band of parallel ridges with narrow valleys between. The normal relief of southwestern Baluchistan is somewhat emphasized in Makran. The volcanic action that preceded the upheaval of recent strata and the folding of the edges of the interior highlands is evidenced by occasional boiling mud volcanoes. The coast is indented by several harbours: Ormara. Khor Kalmat, Pasni, Gwadur and Charbar are all rather difficult of approach because of the sand bar apparently extending all along the coast — probably the remains of a submerged ridge. They are all subject to lively surf under certain wind conditions. Gwadur, which with about 300 sq.mi. of hinterland belongs to the sultanate of Muscat and Oman, is the most important of them. Except in the Kej (upper Dasht) valley, and that of the Bolida, an affluent of the Kej, there is not much cultivation in Makran. These two picturesque valleys have thick date palm groves, croplands and orchards; yet the surrounding hilly waste is mainly a barren repetition of sun-cracked crags and ridges with parched valleys between. The Rakhshan and Mashkel rivers, sweeping down respectively from the Kalat highlands in Pakistan and the Koh-i-Bampusht uplands of Persia, unite to break through the hills northward and form the lake and swamps of the Hamun-i-Mashkel, and define the northern limits of Makran. In their valleys are narrow strips of very advanced cultivation, especially of dates.

The population has a prominent Arab element, for the Arabs held Makran even before they conquered Sind. There are Negroes on the coast, descended from imported slaves. The Meds of the Indus valley still provide most of the fishing population; they represent the Ichthyophagi ("fisheaters") of Arrian. The old Tajik element of Persia is not so evident in Makran as farther north; and the Karak pirates, whose depredations led to British intervention in the area, seem to have disappeared altogether.

Following the establishment of British control over Kalat earlier in the 19th century (see BALUCHISTAN) the boundary between the Persian and British (now Pakistani) parts of Makran was demarcated by a commission in 1895–96. In 1898 a British force was sent to Makran by sea, because of a rebellion against the khan of Kalat and an attack by Makrani chiefs on a British survey party. A brief campaign ended with the capture of the Kej citadel. Another expedition was needed in 1901 to storm Nodiz.

Makran is served by a fair weather motorable road in the interior uplands and, on the Persian side nearer the coast, by a pack road. The former, coming ultimately from Quetta and Kalat, passes through Turbat, crosses the frontier near Pishin and passes west of Geh before turning north to Bampur; branches run southward to Charbar and from Turbat to Pasni and Gwadur. The pack road runs from the Perso-Pakistan frontier via Charbar to Jask. The Karachi-Bushire telegraph line passes through Gwadur and the other Makran ports.

MAKRAN STATE up to 1948 was feudatory to Kalat, forming the southwesternmost of the five divisions of the khanate. On March 17, 1948, it became independent of Kalat as a result of its chief's separate declaration of accession to the new dominion of Pakistan. In 1952, with Kalat and two other Baluchistan states, it formed the Baluchistan States union (see BALUCHISTAN). With the establishment of the single West Pakistan province in 1955, Makran became in effect one of the four districts of the new Kalat division of that province. Area of Makran 23,196 sq.mi.; pop. (1951) 138,691. The capital is Turbat.

PERSIAN MAKRAN was formerly a separate province, but under the law of territorial division of administration of 1937 was made part of the *ostan* of Kerman and Makran. As a province its capital was Jask, a port once under British control about 130 mi. S.E. of Bandar Abbas.

MAKSOORA, in Mohammedan architecture, the sanctuary or praying chamber in a mosque, sometimes enclosed with a lattice screen; the word is occasionally used for a similar enclosure round a tomb.

MALABAR, a district of Madras state, Republic of India. Geographically the name is sometimes extended to the entire western coast of the peninsula. Properly it should apply to the strip below the Ghats, which is inhabited by people speaking the Malayalam language. a branch of the Dravidian stock, who form a peculiar race, with castes, customs and traditions of their own. It would thus be coextensive with the old kingdom of Chera, including the modern state of Travancore-Cochin and part of Kanara.

The district of Malabar extends for 145 mi, along the coast, running inland to the Ghats with a breadth varying from 25 to 70 mi. The administrative headquarters are at Calicut. Area, 5,844 sq.mi. Malabar is much diversified in its configuration. From the eastward the great range of the Western Ghats, only interrupted by the Palghat gap, looks down on a country broken by spurs, ravines, forests and jungle. To the westward gentler slopes and downs, and gradually widening valleys closely cultivated, succeed the forest uplands, till, nearer the seaboard, the low laterite tablelands shelve into rice plains and backwaters fringed with coconut palms. The coast runs in a southeasterly direction, and forms a few headlands and small bays. In the south there is considerable extent of tableland. The mountains of the Western Ghats, from 3,000 to 8,000 ft. high, run almost parallel to the coast, and along the coast is an almost continuous chain of lagoons or backwaters which have been formed by the action of the waves and shore currents in obstructing the waters of the rivers. Connected by artificial canals, they form a cheap means of transit for a large local trade. Fishing and fish curing is an important industry, coir is manufactured, and there are sawmills, soap and tile works. The forests are extensive and of great value. The population in 1951 was 4,758,342, of whom nearly a third are Moslems.

The staple crop is rice, the next most important products being coconuts, fruits and pepper. Coffee is grown chiefly in the upland tract known as the Wynaad (*q.v.*). The Southern railway crosses the district and runs along the coast from Calicut to Mangalore. The principal seaports are Calicut, Tellicherry and

Cannanore. The principal exports are coffee, coconut products and pepper.

MALABARI, BEHRAMJI (1853–1912), Indian journalist and social reformer, was born in 1853 at Baroda, the son of a poor Parsi in the employment of the state. He was educated in a mission school, but he never obtained an academical degree. Coming to Bombay. he fell under the influence of John Wilson, principal of the Scottish college. He published a volume of poems in Gujarati (1875), and *The Indian Muse in English Garb* (1877), which attracted attention in England. In 1880 he acquired the *Indian Spectator*, which he edited for 20 years until it was merged in the *Voice of India*. In 1901 he became editor of *East and West*. He was an ardent and indefatigable advocate of social reform in India. especially as regards child marriage and the remarriage of widows. It was largely by his efforts. in the press and in tours through the country, that the Age of Consent act was passed in 1891. He died at Bandora, near Botnbay, on July 12, 1912.

He also wrote *Gujarat and the Gujarati's* (1883) and *The Indian Eye on English Life* (1893).

See R. P. Karkaria, *India, Forty Years of Progress and Reform* (London, 1896).

MALABON, a municipality (with 21 *barrios* or districts) of the province of Rizal, Luzon, Philippine Islands, 1 mi. inland from Manila bay and 3 mi. N. of Manila, with which it is connected by a streetcar line. Pop. (1948) 46,455. Malabon is noted for its fish ponds and fisheries and for the manufacture of perfume from the flowers of ilang-ilang trees *(Cananga odorata)*.

Other leading industries are sugar refining, cigar making and the weaving of jusi cloth. Tagalog is the vernacular. Of the inhabitants aged 6 to 19 inclusive, 39.6% were reported in 1939 as attending school, while 75.2% of the population 10 years old and over was reported as literate. Malabon was formerly known as Tambóbong.

MALACCA, a town on the west coast of the Malay peninsula, which with the adjoining territory forms one of the settlements of the Federation of Malaya. and gives its name to the straits that divide Sumatra from the Malaya peninsula. Malacca is administered by a resident commissioner. The population of the town of Malacca in 1939 was about 44,000. In 1952 the population of the territory was estimated at 272,820, of whom Malays numbered 138,814, Chinese 106,779, and Indians and Pakistanis 23,160.

The trade of this once flourishing port has declined, most of the vessels being coasting craft. This is due to the shallowness of the harbour, and to the fact that Penang and Singapore, at either entrance to the straits, draw all the trade and shipping. The area of the territory is 637 sq.mi. The settlement is wholly agricultural. Much of the land has been in the hands of natives, but there is ordinarily a large acreage under rubber *(hevea)*. The settlement is well opened up by roads; and a railway, which is part of the Malayan railway system, was constructed from the town of Malacca to Tampin in the Negri Sembilan. There is a good resthouse at Malacca and a comfortable seaside bungalow at Tanjong Kling, 7 mi. from the town. Malacca is 118 mi. by sea from Singapore and 50 mi. by rail from Seremban, the capital of the Negri Sembilan. In World War II it was occupied by Japan.

History. — Malacca, visited by few ships, was the least important of the three British settlements on the Straits which gave their name to the colony. It has, however, a remarkable history *(see* MALAYA: *History)*. The precise date of its foundation cannot be ascertained, but there is reason to believe that this event took place in the 14th century. The Roman youth Ludovigo Barthema is thought to have been the first European to visit it, some time before 1503; and in 1508 Diogo Lopez de Siqueira sailed from Portugal for the purpose of exploiting Malacca. He was hospitably received, but disagreements with the natives ensued and word was brought to Siqueira that a treacherous attack was about to be made upon his ships. Siqueira sent a native man and woman ashore "with an arrow passed through their skulls" to the sultan, "who was thus informed," says João de Barros, ('through his subjects that unless he kept a good watch the treason which he had perpetrated would be punished with fire and sword." The sultan retaliated by arresting Ruy de Araujo, the factor, and 20 other men who were ashore collecting cargo. Siqueira immediately burned one of his vessels and sailed for Portugal. In 1511 Alphonso d'Albuquerque captured the town. Malacca became a Portuguese possession for 130 years, and was the base of their commercial explorations in southeastern Asia while they enjoyed, and later while they sought to hold, their monopoly in the East. It was from Malacca, immediately after its conquest. that d'Albuquerque sent Antonio d'Abreu on his voyage of discovery to the Moluccas, or Spice Islands, which later were the objective of Ferdinand Magellan's voyage of circumnavigation. Under the Portuguese government St. Francis Xavier started a mission in Malacca, the first Christian mission in Malayan lands.

The Dutch held Malacca from 1641 till 1795, when it was taken from them by Great Britain, and the Dutch system of monopoly in the straits was abolished. The colony was restored to the Dutch in 1818, but six years later it came finally into the hands of Great Britain, being exchanged by a treaty with Holland for the East India company's settlement of Bengkulen and a few other unimportant places on the west of Sumatra. By this treaty the Dutch were precluded from interference in the affairs of the Malay peninsula, and Great Britain from similar action in regard to the States of Sumatra, with the exception of Achin, the right to protect that state being maintained by Great Britain until in 1872 it was finally abandoned by a treaty concluded with Holland. It was not until 1833 that the whole territory was brought under British control.

During World War II it was under Japanese control and became a member of the Federation of Malaya in 1951.

BIBLIOGRAPHY.—*The Commentaries of d'Albuquerque* (Hakluyt Society); *The Voyages and Adventures of Fernand Mendez Pinto* (1653); Captain A. Hamilton, *An Account of the East Indies* (Edinburgh, 1727); Valentyn's *History of Malacca*, translated *by* Dudley Hervey; *Journal of the Straits* (now *Malayan*) *Branch of the Royal Asiatic Society;* "Our Tropical Possessions in Malayan India," *ibid ;* Hugh Clifford, *Further India* (1904); Sir F. Swettenham, *British Malaya* (1906); *Malaya*, ed. *R.* O. Winstedt (1923). (H. CL.)

MALACHI, the name assigned to the last book of the Old Testament in English (the last of the "prophets" in the Hebrew Bible), which according to the title (Mal. i, 1) contains the "word of Yahweh to Israel by the hand of Malachi." In form the word means "my messenger." It could be explained as a contraction of Malachiah, "messenger of Yahweh"; but the Septuagint is probably right in not regarding it as a proper name ("by the hand of His messenger"). Not only do we know nothing from internal or external evidence of the existence of a prophet of this name, but the occurrence of the word in the title is naturally explained as derived from iii, 1: "Behold, I send my messenger" (cf. ii, 7). The prophecy must, therefore, be regarded as anonymous; the title was added by the compiler who wrote similar editorial titles to the anonymous prophecies beginning Zech. ix, 1; xii, 1. (Note the use of "burden.")

The contents of the prophecy fall into a series of clearly marked sections, as in the paragraph division of the Revised Version. These apply, in various ways, the truth emphasized at the outset: Yahweh's love for Israel in contrast with his treatment of Edom (i, 2–5). Israel's response should be a proper regard for the ritual of His worship; yet any offering, however imperfect, is thought good enough for Yahweh's altar (i, 6–14). Let the priests, who are responsible, take warning, and return to their ancient ideals (ii, 1–9). Again, the common Fatherhood of God should inspire a right relation among fellow Israelites, not such conduct as the divorce of Israelite wives in order to marry non-Israelite women (ii, 10–16). The prevalence of wrongdoing has provoked scepticism as to righteous judgment; but the messenger of Yahweh is at hand to purge away indifferentism from worship and immorality from conduct (ii, 17–iii, 6). The payment of tithes now withheld mill be followed by the return of prosperity (iii, 7–12). Religion may seem useless, but Yahueh remembers His own, and will soon in open judgment distinguish them from the irreligious (iii, 13–iv, 3 The book closes with an appeal to observe the law of Moses, and with a promise that Elijah shall come before the threatened judgment--probably a later addition.

The topics noticed clearly relate the prophecy to the period of Ezra and Nehemiah, when the Temple had been rebuilt (i. 10; iii. 1, 10), the province of Judah was under a Persian governor (i. 8), and there had been time enough for the loss of earlier enthusiasm. The majority of modern scholars are agreed that the prophet prepares for the work of those reformers (Ezra, 458 *c.;* Nehemiah, 444, 432 B.C.). The priests have fallen into contempt (ii. 9) and have neglected what is still one of their chief trusts, the oral law (ii. 6 *seq.)*. The priestly code of written law, in its present form, was not promulgated until 444 B.C. (Neh. viii.-x.) and it is not presupposed by "Malachi" who writes under the influence of the earlier Code of Deuteronomy only, and must therefore belong to a date prior to 444. The independent character of the attack on current abuses (marriage with foreign women, ii. 11; non-payment of sacred dues, iii. 8) suggests priority to the work of Ezra. The prophecy affords an interesting and valuable glimpse of the post-exilic community, with its various currents of thought and life. The completion of the second Temple (j16 B.C.) has been followed by disillusionment as to the anticipated prosperity, by indifference to worship, scepticism as to providence, and moral laxity. In view of these conditions, the prophet's message is to reassert the true relation of Israel to Yahweh, and to call for a corresponding holiness, especially in regard to questions of ritual and of marriage.

The book is a significant landmark in the religious history of Israel. Its emphasis on the observance of ritual finds fullest development in the Priestly Code, subsequently promulgated; its protest against foreign marriages is made effective through the reforms of Ezra and Nehemiah; the influence of its closing words on later expectation is familiar to every reader of the new Testament (Matt. xvii. 3, 4, 10–13; xxvii. 47, 49; John i. 21, 25).

BIBLIOGRAPHY.—The chief ccmmentaries in German are those by Nowack (1897, 1904), Wellhausen (1898), Marti (1904), Sellin (1922); there is one in French by A. van Hoonacker (1908). Those recommended in English are by G. A. Smith (1898, 1927), S. R. Driver *(Century Bible,* 1906). *J.* M. P. Smith (*International Critical Commentary,* 1912, *W. E.* Barnes *(Cambridge Bible,* 1917).

(H. W. R.)

MALACHITE, a bright green mineral, consisting of a basic copper carbonate. It is one of the commonest ores of copper and perhaps the most conspicuous, being a useful guide in prospecting. It is found in the upper oxidized portions of copper deposits, and is formed by the action of water, air and carbon dioxide on primary copper sulfides, especially where calcium carbonate is present. The soluble copper salts set free by oxidation of the sulfides react with limestone or other carbonates and precipitate the insoluble malachite. The mineral is found in nearly all copper-mining districts; specially fine specimens have come from various mines in Russia, where it has often been used as a polished ornamental stone. Other well-known localities for good specimens have been the Copper Queen mine, Bisbee. Arizona, the old Burra Burra mines. Kooringa, South Australia and southwest Africa.

The composition of malachite is $CuCO_3Cu(OH)_2$. It belongs to the monoclinic system, but rarely forms good crystals, occurring mostly as nodular, botryoidal (grapelike) or reniform (kidney-shaped) masses, with pronounced radial and concentric structure, successive layers often varying much in colour. It may also be quite compact or earthy and often forms thin films or mere stains on rocks. It is very commonly associated with the deep blue azurite (*q.v.*). The density is about 4 and the hardness 3.5–4.0. It is soluble in acids with effervescence. (R. H. RA.)

MALACHOWSKI, STANISLAW (1736–1809), Polish statesman, the younger son of Stanislaw Malachowski, palatine of Posen. He was first elected a deputy to the Diet of 1764, and the Four Years' Diet unanimously elected him its speaker (1788). Malachowski worked tirelessly for reform and to save the republic. He was one of the framers of the constitution of May 3, 1791, exceeding in liberality all his colleagues and advocating the extension of the franchise to the towns and the emancipation of the serfs. In 1807 Malachowski was placed at the head of the executive committee appointed at Warsaw after its evacuation by the Prussians, and when the grand duchy of Warsaw was created Malachowski became president of the senate. In the negotiations with the Austrian government concerning the Galician salt-mines Malachowski assisted the treasury by hypothecating all his estates as an additional guarantee. In 1809 he died at Warsaw.

MALACHY, ST. (c. 1094–1148), otherwise known as Maol-Maodhog (or Maelmaedhog) Ua Morgair, archbishop of Armagh and papal legate in Ireland, was born at Armagh. His father, an Irish clergyman, the *Fearleighlinn,* or lector, at the university, was said to have been of noble family. He was vicar of Archbishop Celsus or Ceallach of Armagh, and carried out many reforms ending to increase conformity with the usage of the Church of Rome. He spent four years with Malchus, bishop of Lismore (in Munster), a strong advocate of Romanism. On his return from Lismore, Malachy undertook the government of the decayed monastery of Bangor (in Co. Down), but very soon afterwards he was elected bishop of Connor (now a small village near Ballymena). After the sack of that place by the king of Ulster he withdrew into Munster; here he was kindly received by Cormac MacCarthy, with whose assistance he built the monastery of Ibrach (in Kerry). Meanwhile he had been designated by Celsus to succeed him in the archbishopric but eventually returned, at his own desire, to the smaller and poorer portion of it, the bishopric of Down. In 1139, Malachy set out from Ireland with the purpose of soliciting from the pope the pallium for the archbishop of Armagh. On his way to Rome he visited Clairvaux, and thus began his friendship with St. Bernard. Malachy was received by Innocent II with great honour, and made papal legate in Ireland, though the pope refused to grant the pallium until it had been unanimously applied for "by a general council of the bishops, clergy and nobles." Nine years later (1148), at a synod of bishops and clergy held at Inis-Patrick (St. Patrick's island, near Skerries, Co. Dublin), Malachy was commissioned to return to Rome and make fresh application for the pallium; he did not, however, get beyond Clairvaux, where he died in the arms of St. Bernard, on Nov. 2, 1148. The object of his life was realized four years afterwards, in 1152, during the legateship of his successor. Malachy was canonized by Clement III in 1190. Malachy reformed and reorganized the Irish Church and brought it into subjection to Rome; like Boniface, he was a zealous reformer and a promoter of monasticism. He opened the first Cistercian monastery in Ireland, five more being soon afterwards established. Several works are attributed to him, but are all probably spurious.

St. Bernard's *Life* of Malachy, and two sermons on his death will be found in J. P. Migne, *Patrologia Latina,* clxxxii, clxxxiii; *see* also the ecclesiastical histories of Ireland by J. Lanigan (1829) and W. D. Killen (1875); *A.* Bellesheim, *Geschichte der katholischen Kirche in Irland,* Bd. *I.* (Mainz, 1890); G. T. Stokes, *Ireland and the Celtic Church* (6th ed., 1907); J. O'Hanlon, *Life of Saint Malachy* (Dublin, 1859); articles in *Dict. Nat. Biog.* and Herzog-Hauck's *Realencyklopädie* fur *protestantische Theologie.*

MALACOSTRACA, the largest subclass of the Crustacea (*q.v.*), including the lobsters, crawfish, crabs, shrimps, prawns, beach fleas, sow bugs and various other crustaceans. They may be briefly defined as Crustacea having the body composed of nineteen somites, all, typically, bearing appendages, the trunk-limbs differentiated into two series, a thoracic of eight and an abdominal of six pairs; and the genital openings of the female on the sixth, those of the male on the eighth thoracic somite. A study of the comparative morphology of the Malacostraca permits us to draw up a scheme for the probable course of evolution of the group which is, at least, not contradicted by our scanty knowledge of its fossil representatives. According to this scheme, the earliest Malacostraca exhibited what has been called the "caridoid facies"; that is to say, they were shrimplike in general form, with a carapace enveloping, but not coalesced with, the thoracic somites, with stalked eyes, biramous antennules, and a scale-like expodite on the antenna, with the thoracic limbs forming walking-legs with swimming exopodites and branchial epipodites and with a tendency for one or more of the anterior pairs to be assimilated to the mouth-parts as maxillipeds; with the abdominal appendages forming biramous swimmerets, except the last pair which are large, lamellar, and form with the telson a "tail-fan."

The earliest fossils that can be definitely referred to the Malacostraca occur in the Carboniferous rocks and present, with little modification, the caridoid facies described above. Some of them (Pygocephalus) have a brood-pouch formed by overlapping plates (oostegrtes) from the bases of the thoracic legs and appear, therefore, to be referable, to the Mysidacea. From the caridoid Mysidacea a series can be traced in which the carapace is progressively reduced, the thoracic exopodites are lost and the eyes become sessile. Although palaeontology gives no help, the steps of this series are indicated by the specialized offshoots which have given the Cumacea, Thermosbaenacea, Tanaidacea and Isopoda. The Amphipoda belong to the same series but their precise place in it is less clear. The other orders of Malacostraca have no brood-pouch and appear to have diverged very early from the primitive stock. Already in Carboniferous times the Syncarida had lost the carapace and had much the same general structure as the recent Anaspides and its allies. Another series in which the carapace coalesced with the thoracic somites gave rise to the great group of the Decapoda, from which the Euphausiacea are perhaps an offshoot. The Decapoda, beginning with caridoid forms, have, in several independent lines, assumed the crablike or "carcinoid facies" by reduction of the abdominal region (Brachyura or true crabs, and crablike Anomura). The Stomatopoda had assumed nearly their typical structure in Jurassic times but their earlier history is unknown.

In the scheme of phylogeny thus outlined no mention has been made of the Phyllocarida, which, in most systems of classification, are ranked as the most primitive Malacostraca, forming a link with the Branchiopoda. They differ from the other Malacostraca in having an additional somite in the abdomen, the telson terminating in a "caudal fork," and a bivalve carapace provided with an adductor muscle. The thoracic limbs are more or less flattened and leaflike and have a general resemblance to the trunk-limbs of the Branchiopoda though a close comparison is difficult. The existing genera, Nebalia and its allies, are believed to show affinity with the fossil Ceratiocaridae, the earliest of which appear in Cambrian rocks and are thus vastly more ancient than any other Malacostraca. Recent work, however, tends to diminish the significance of the differences between Phyllocarida and other Malacostraca, and, in particular, the recognition of a vestigial seventh abdominal somite in certain primitive Mysidacea suggests that the Phyllocarida may, after all, be mose closely related to the Peracaridan series than has been supposed.

The orders composing the Malacostraca may be grouped in the following five divisions, briefly characterized below:

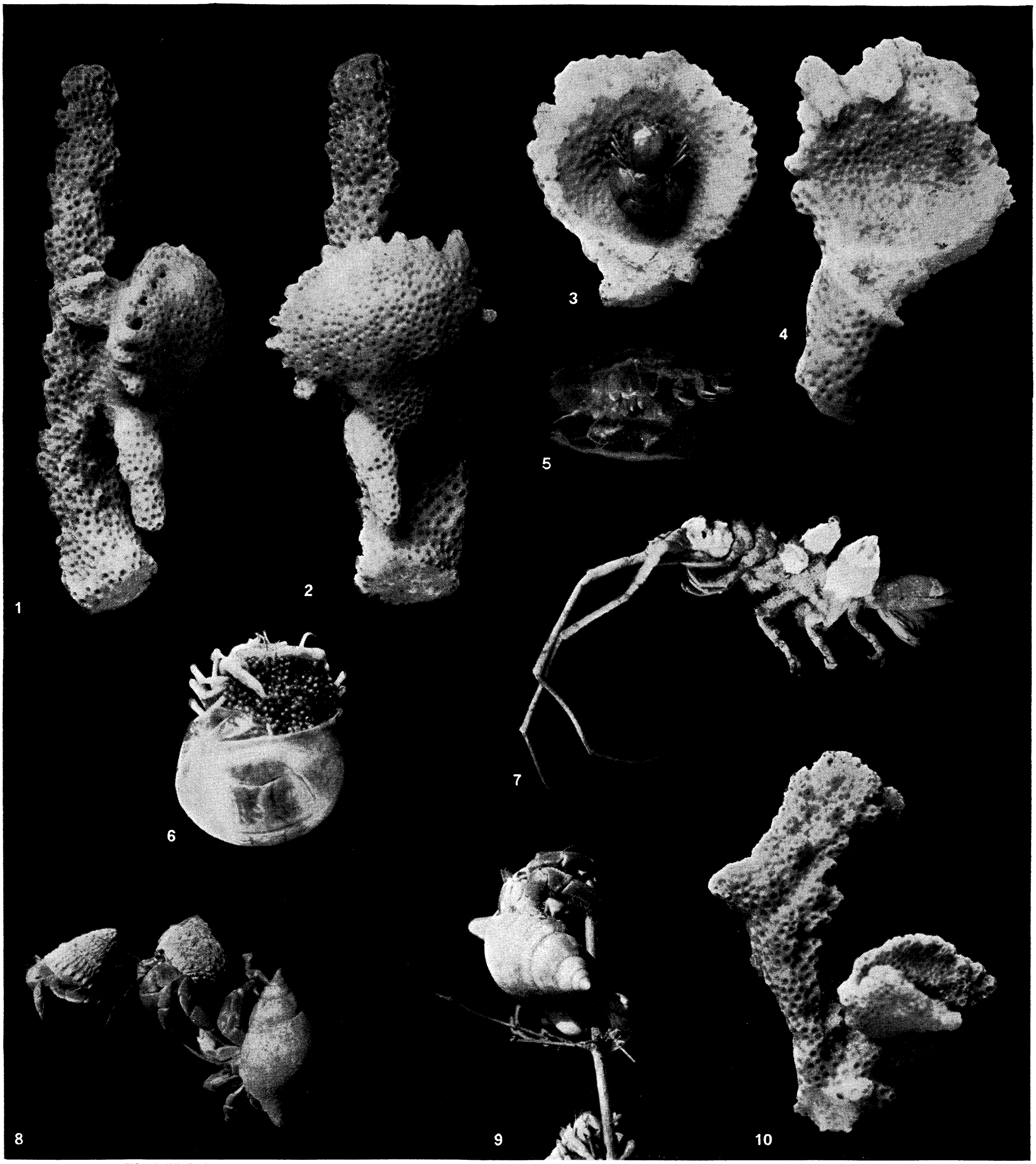
1. Peracarida. A carapace, if present, not fused with more than four thoracic somites; eyes, when present, stalked (Mysidacea, stalks movable; Tanaidacea, stalks fixed) or sessile (Cumacea, Isopoda, Amphipoda). The Mysidacea comprise generally small shrimplike swimming forms, nearly all marine. They are called "opossum" shrimps because of the brood pouch formed of oostegites or plates attached to the coxae of the thoracic legs, in which the young undergo their entire metamorphosis after hatching out as nauplii. Their size range is considerable, running from the tiny *Anchialus* pusillus, $\frac{1}{8}$ in. long, to *Gnathophausia ingens,* which exceeds *6* in. in length. Probably all serve as the food of other animals. Several species occur in fresh-water. One of these is *Mysis relicta,* a widely distributed lacustrine form in the northern hemisphere. Thermosbaenacea includes only the minute, blind, creeping Thermosbaena, found in a hot spring in Tunis. Cumacea are marine mud-burrowers but the males are, to some extent, free swimming. Tanaidacea are also part of the micro-fauna of the sea bottom, less natatory than the Cumacea. Isopoda are a very varied and successful group, creeping, mud-burrowing and sometimes actively swimming in the sea and a few in fresh water. The destructive wood-boring crustaceans are principally isopods. The most widely distributed of them in both Atlantic and Pacific oceans, Limnoria *lignorum,* the "Gribble," is often accompanied by a boring amphipod, Chelura terebrans. Next to the molluscan shipworms, the tiny Gribble ($\frac{1}{8}$ to $\frac{1}{6}$ in. long) is the worst known destroyer of submerged timbers. Infested piling may carry 300–400 individuals to the square inch of surface in favoured localities. An untreated test piece of Oregon fir 5 ft. long by 3 in. square, set in Port Jackson, Australia, was 60% destroyed in six months by a combined attack by Limnoria and Chelura. By the time nine months had elapsed, it was so utterly riddled with the assistance of shipworms, which had by this time invaded the timber, that insufficient material remained to support further ravages by the borers present. Several species of Sphaeroma, though larger ($\frac{3}{8}$ in. long, more or less), also attack wood, but not so generally as *Limnoria,* and less in American than in Australian waters. Sphaeroma quoyana is reported to have honeycombed claystone or "papa rock" used in harbour works in New Zealand to such an extent that blocks of concrete overlaying it sank several feet. Parasitism appears in many different families and leads to extremes of specialization and degeneration. One suborder, Oniscoidea, consists of the terrestrial, air-breathing mood lice. Creeping and swimming forms of Amphipoda, another varied and successful group, abound in fresh water and in the sea. A few sandhoppers or "beach fleas" may become wholly terrestrial. The vast majority of amphipods belong to one suborder (Gammaridea), which includes both free-living and parasitic forms; members of a smaller suborder (Hyperiidea) are planktonic, occur at times in vast swarms, and are consumed in great quantities by seals, cetaceans and other marine animals; a third suborder (Caprellidea) contains the exclusively parasitic family Cyamidae or whale lice.

2. *Phyllocarida.* Sometimes referred to as Leptostraca, this order is characterized in part by a large carapace which is not fused with any of the thoracic somites, stalked eyes and abdomen of seven segments (six in all other Malacostraca). The single order, Nebaliacea, includes only three or four living genera, all marine mud-burrowers, in part scavengers. They are widely distributed in all seas, usually occurring at moderate depths. Some, such as the large Nebaliopsis typica, which attains a length of more than $1\frac{1}{2}$ in., live at depths exceeding 1,000 fathoms. The doubtful affinities of the Phyllocarida are mentioned above.

3. Syncarida. This group possesses stalked eyes but no carapace. A small fresh-water group of limited distribution, to which belong the mountain shrimp (Anaspides) of Tasmania and a few allies in the Australian region, and also the Bathynellidae of central Europe, minute, blind, degenerate, subterranean forms. They appear to be survivors of a group widely distributed in Carboniferous and Permian times.

4. Eucarida. This group is recognized by its stalked eyes and carapace fused dorsally with all thoracic somites. The Euphausiacea are a small group of planktonic, phosphorescent shrimps except for a few living in the deep sea at 1,000 fathoms or more. The pelagic species are of importance as food of whalebone whales. The Decapoda, on the other hand, form the most extensive and diversified of all the orders of Crustacea. It includes the largest representatives of the class and, indeed, of living Arthropoda, and, since many of them are used for food, they are more generally familiar and more thoroughly studied than any other Crustacea. They are classified into two suborders: —Natantia, comprising the shrimps and prawns; and Reptantia, subdivided into four sections, spiny lobsters and their relatives, (Palinura), true lobsters and crayfish (Astacura), hermit and lithodid crabs and their allies (Anomura) and the true crabs (Brachyura). The headquarters of the group is in the sea but many of its members have invaded fresh waters (river prawns and river crabs in the tropics and crayfishes in temperate regions) and although a few are so far terrestrial as to deserve the name of land crabs, and may even climb lofty trees like the Coconut Crab, they pass their young stages in salt or fresh water.

5. Hoplocarida. These differ from all other Malacostraca in having the first antennae and the stalked eyes attached to movably articulated segments of the head. The carapace is small and shallow, fused with two or three thoracic somites, leaving four well-developed somites free. The members of the single order Stomatopoda are sometimes known as "mantis shrimps" from the resemblance of their large prehensile claws to those of the mantis insect. They are exclusively marine, burrowing in sand or lurking



VARIOUS CRUSTACEA MALACOSTRACA

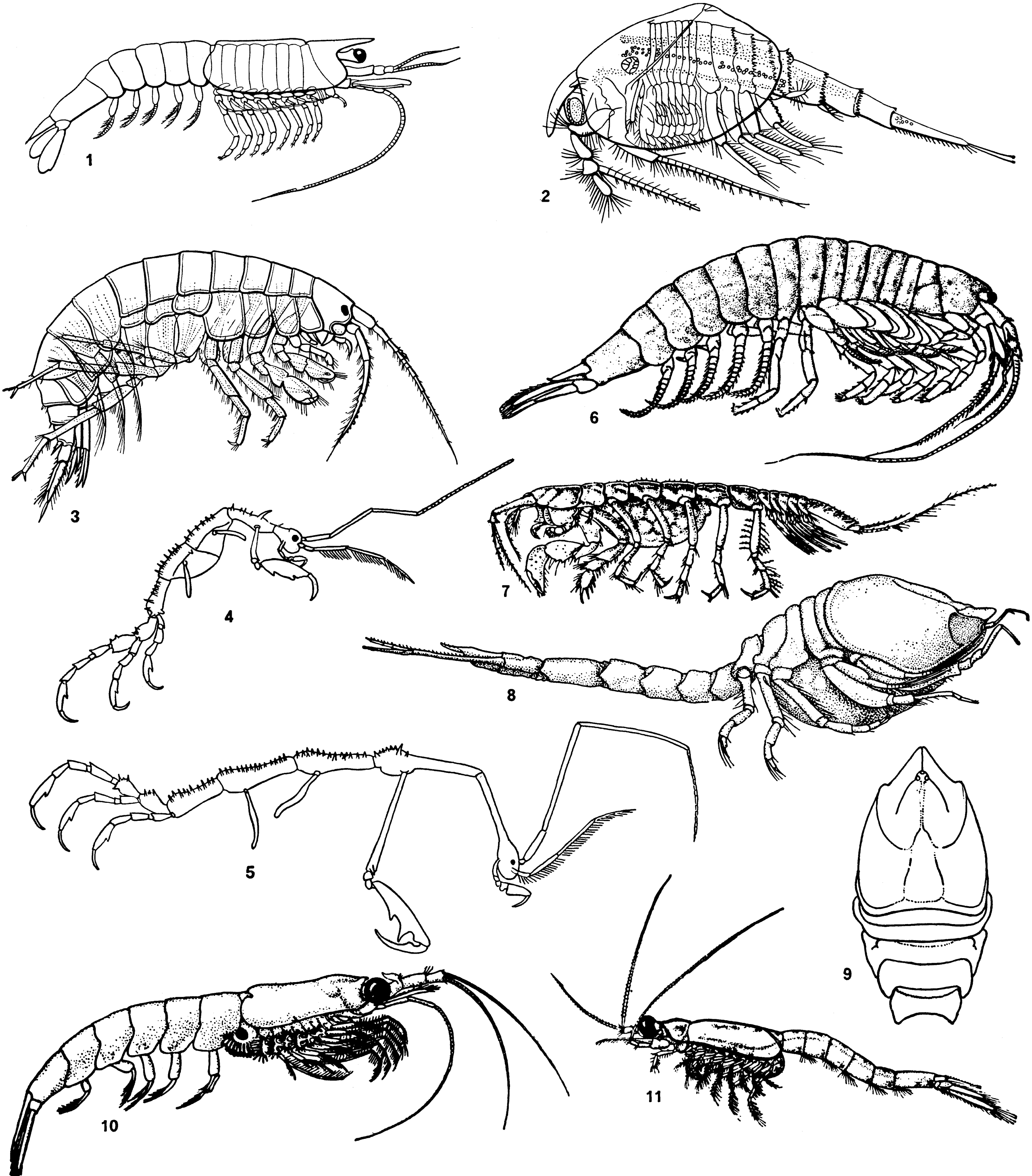
1, 2, 3, 4, 6, 10. Coral gall crab, ***Hapalocarcinus marsupialis*** (Eucarida, Order Decapoda, Section Brachyura) and "house" formed by coral, *Pocillopora* species. This crab occurs in the Indo-Pacific and in South America, on the west coast of Colombia and in the Secas Islands, Panama; specimens photographed are from Port Utria, Colombia. 1. Shows the breathing holes kept open by respiratory streams of water. 3. Opened gall with female. Figs. 1-4 about x 2. 5. Young, partially formed gall. 6. Female x 4 showing egg mass and abdominal "pouch" from which the crab derives its specific name

5. ***Phronima*** (Peracarida, Order Amphipoda, Suborder Hyperiidea) by reflected light, compare with Plate fig. 2, Crustacea. Natural size

7. ***Arcturus baffini*** (Peracarida, Order Isopoda), a North American Arctic species. The female usually carries her young around ***on*** her long antenrae. The figured specimen is an old "granny" which has not moulted for a long time, as it carries several barnacles, ***Balanus*** species (Cirripedia, Order Thoracioa), attached to its back. Natural size

8, 9. Land hermits, ***Coenobita clypeatus*** (Eucarida, Order Decapoda, Reptantia, Section Anomura), common in Florida and the Caribbean region; under favourable circumstances grow to be three or four times the size of the specimens shown here. About x ½

MALACOSTRACA



COURTESY OF (8, 9) U.S. NATIONAL MUSEUM, (1) FROM LANKESTER, "TREATISE ON ZOOLOGY" (A. & C. BLACK), (2) FROM C. CLAUS, "LEHRBUCH" (JULIUS SPRINGER), (S) FROM SIRS, "CRUSTACEA OF NORWAY" (BERGEN MUSEUM), (4-5) FROH MAYER, "CAPRELLIDEN," (6-7, 10-11) FROM CALMAN, IN "A TREATISE ON ZOOLOGY" (A. & C. BLACK)

VARIOUS CRUSTACEA MALACOSTRACA

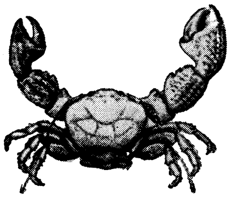
1. Diagram of a generalized malacostracan, showing the "caridoid facies"
2. ***Nebalia*** bipes (Phyllocarida, Order Nebaliacea). Appendages show through the transparent shell or carapace. ***Nebalia*** is widely distributed in both the Atlantic and Pacific oceans. About x 12
3. Freshwater amphipod, Garnrnarus ***pulex*** (Peracarida, Order Amphipoda, Suborder Gammaridea), by some called freshwater "shrimp." A widely distributed Palaearctic species ranging from England to Japan and found in some parts of North Africa; does not occur in North America

4, 5. "Skeleton shrimp," ***Caprella eximia*** (Peracarida, Order **Amphipoda,** Suborder Caprellidea); female (fig. 4) and male (fig. 5) from the Pacific shores of Asia. Enlarged x 3

6. Anaspides tasmaniae (Syncarida, Order **Anaspidacea),** found only in rocky pools at high elevations in the mountains of Tasmania. A specimen of maximum size will about equal the dimensions of the figure here given
7. Apseudes ***spinosus*** (Peracarida, Order **Tanaidacea),** female with eggs In "brood pouch" or marsupium. Primarily a Norwegian species, it has been taken off the Irish coast in 725 fathoms

8, 9. ***Diastylus planifrons*** (Peracarida, Order **Cumacea).** 8. Female with eggs in "brood pouch" from the Straits of **Magellan.** About x 7. 9. Same, dorsal view of **cephalothorax**

10. ***Meganyctiphanes norvegica*** (Eucarida, Order **Euphausiacea),** male, common in the cooler parts of the north Atlantic; in immense swarms or schools, called "krill" by Norwegian fishermen and whalers, serves as food of whales. About x 2
11. Opossum shrimp, ***Mysis relicta*** (Peracarida, Order **Mysidacea),** female with brood pouch. A circumpolar species found In the larger freshwater lakes of North America, Europe, and Asia. About x 3%



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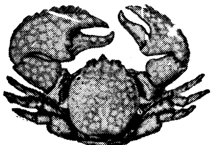

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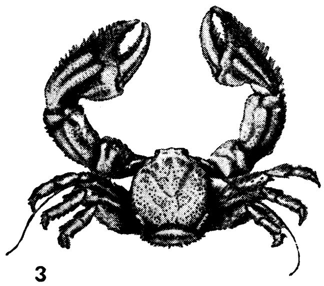

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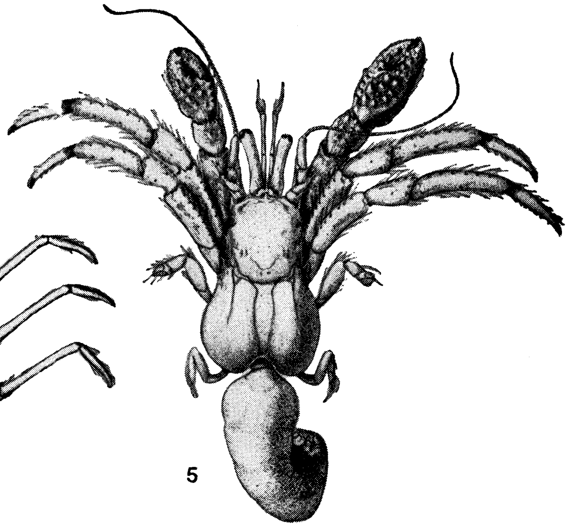

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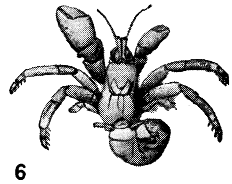

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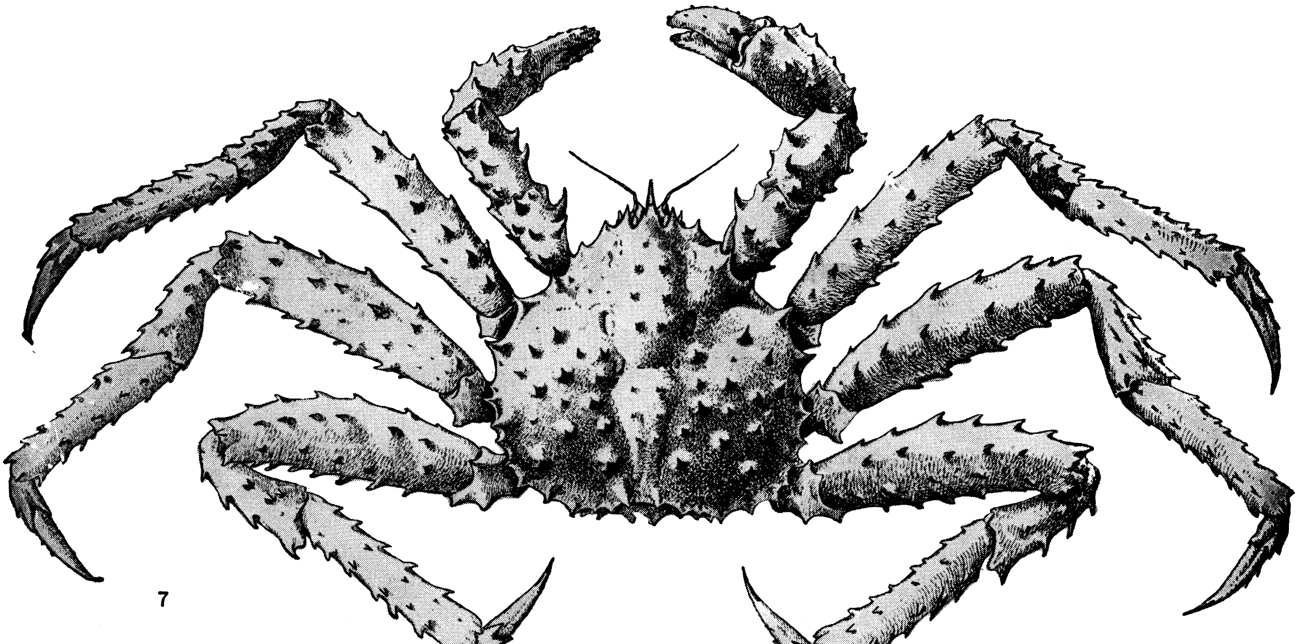

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COURTESY OF (1-6) U.S. FISH AND WILDLIFE SERVICE, (7) FROM MARKAROV, "FAUNE DE L'URSS" (ACAD. SCI. DE L'URSS)

VARIOUS CRUSTACEA MALACOSTRACA (EUCARIDA, ORDER DECAPODA, REPTANTIA, SECTION ANOMURA)

1, 2, 3. Porcellanid "crabs." 1. Pachycheles rugirnanus, ranging from North Carolina through the West Indies. About x 2. 2. *Porcellana sayana,* ranging from North Carolina through the Caribbean area to Panamá; generally found commensal with hermit crabs in gastropod mollusk shells. About natural size. 3. Megalobrachiurn *poeyi,* ranging from the Bahamas through the West Indies to Colombia. About x 2

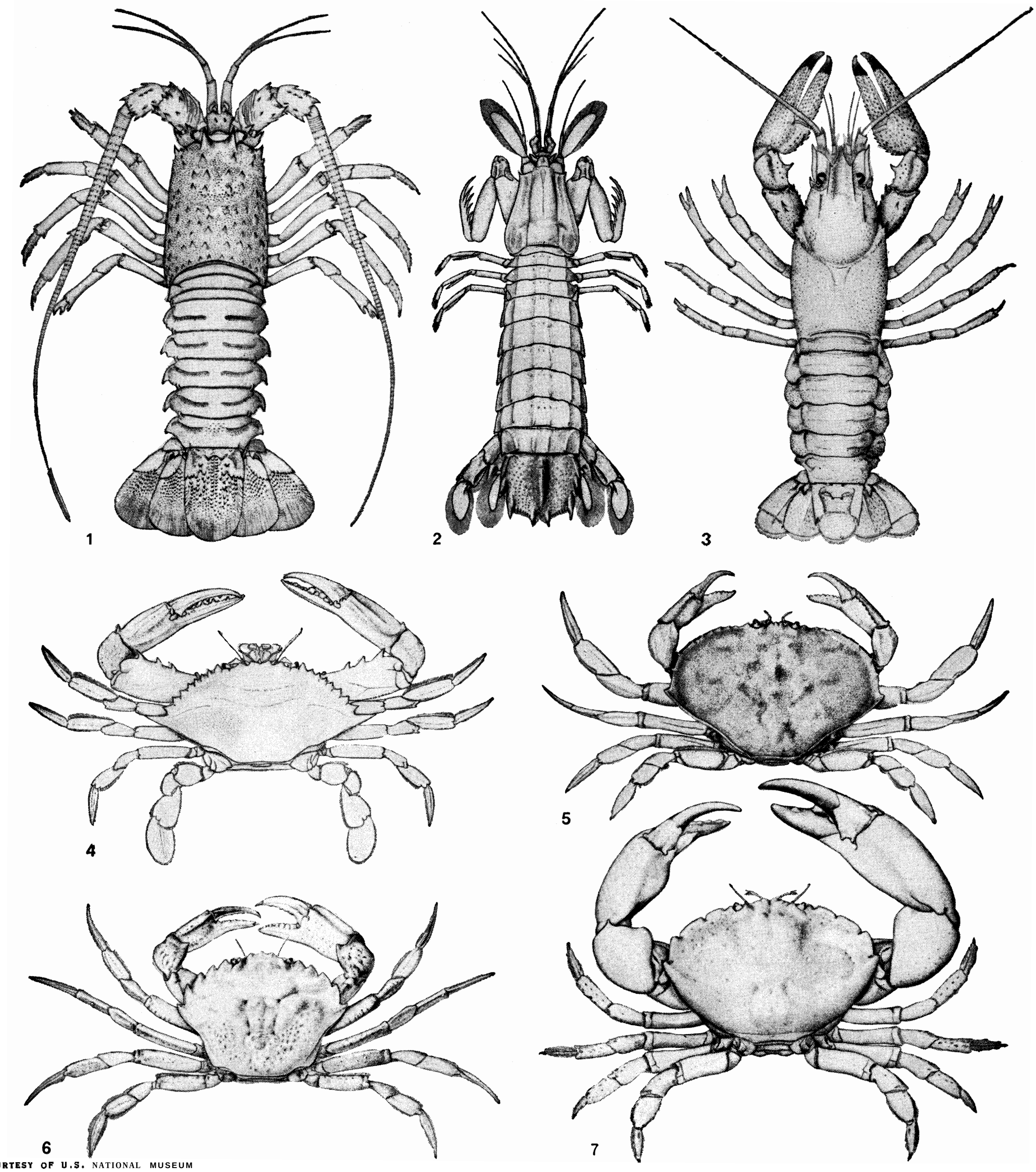
4. "Munida" or squat lobster, Munida *evermanni,* known only from deep water (220-225 fathoms) off Puerto Rico. About x 1½

5, 6. Hermit crabs without their usually carried gastropod shells. 5. *Clibanarius* tricolor, found in Bermuda and ranging from Florida through the West Indies to Barbados, a common species. About x 6. 6. Calcinus tibicen, more widely distributed than the preceding species, ranging from Florida to Brazil. About natural size

7. Paralithodes *camtschatica,* Alaskan king crab. Related species are called rock crabs in Europe. Occurring in the north Pacific ocean and the Bering sea, from the shores of Japan and Kamtschatka northward to Bering strait and south to southeastern Alaska. Males are larger than the females, attaining an over-all spread of 4 or 5 ft., with shell or carapace measuring nearly 12 in. in length; weight up to 22 lb.

It is to be noticed in the Anomura that the fifth pair of legs, counting the pincer legs or chelipeds, are much reduced in size and are often hidden under the shell or carapace, as in the king crab, fig. 7. In the hermit crabs the fourth pair of legs, as well, are reduced in size

MALACOSTRACA



COURTESY OF U.S. NATIONAL MUSEUM

CRUSTACEA MALACOSTRACA

1. Spiny or rock lobster of the Pacific coast of North America, Panulirus interruptus (Eucarida, Order Decapoda, Reptantia, Section Palinura). The Florida counterpart, *Panulirus* argus, as well as the South African spiny lobster, attains a body length of 18 in. A California spiny lobster weighing 17 lb. has been recorded. About one-Rfth natural size
2. Mantis shrimp, *Squilla* empusa (Hoplocarida, Order **Stomatopoda)** **from** Woods Hole, Mass. Not auite one-half natural size
3. River crayfish, *Cambarus* affinis (Eucarida, Order Decapoda, Reptantia. Section Astacura), from Havre de Grace, Md. About one-half natural size
4. Blue crab of the east coast of the United States. ***Callinectes sapidus*** (Eucarida, Order Decapoda, Reptantia, Section Brachyura), about three-tenths natural sire; fully grown males may attain a shell width of as much as 8¾ in.
5. Edible crab of Pacific coast of North America, also known as the Dungeness crab, Cancer ***magister*** (Eucarida, Order Decapoda, Reptantia, Section Brachyura); attains a shell or carapace width of approximately 8 in.
6. Green crab, or "Joe Rocker," common shore crab of Europe, ***Carçinides maenas*** (Eucarida, Order Decapoda, Reptantia, Section Brachyura), occurring on north Atlantic coast of the United States, Pernambuco, Brazil, Bay of Panama, coasts of Europe and North Africa, Suez Canal, Red Sea, Ceylon, Australia and Hawaiian Islands. About one-third natural size.
7. Stone crab, Menippe ***mercenarıa*** (Eucarida, Order Decapoda. Reptantia, **Section** Brachyura); southern Atlantic and Gulf coasts of United States and Mexico. Attains a width of shell or carapace of 5 in. Like the blue crab, the stone crab is much relished **for food** in the eastern and southern **U.S.**

in crevices in the shallow waters of all the warmer seas. A few go into brackish water. Many species are rare, known only from a few specimens, yet others are found in greater abundance, such as *Squilla investigatoris,* of which 500 were taken in a single haul from 110 fathoms in the Indian ocean. Despite their vicious claws, they have numerous enemies among the fish and octopuses. They are much used fresh or fried for food in the Mediterranean region, in the Philippines, Malaya and elsewhere. In Japan they are cheaper than other edible crustacea. One of the largest stomatopods on record is a Philippine specimen of *Lysiosquilla maculata,* whose body measured slightly more than 1j in. in length.

See CRAB; CRAYFISH; HERMIT CRAB; LOBSTER; SHRIMP; WOOD LOUSE. (W. T. C.; W. L. ST.)

MÁLAGA, a maritime province of Spain, one of the eight modern subdivisions of Andalusia; bounded on the west by Cidiz, north by Seville and Córdoba. east by Granada, and south by the Mediterranean sea. Pop. (1960 est.) 826.327; area. 2.809 square miles. The northern half of Málaga belongs to the Andalusian plain watered by the Guadalquivir. the southern is mountainous, and rises steeply from the coast. Of the numerous sierras is that of Alhama. separating the province from Granada, rising above 6.800 ft.; its westward continuation in the Sierra de Abdalajis and the Axarquia between Xntequera and Málaga; and not far from the Cadiz boundary the Sierras de Ronda, de Mijas, de Tolox and Rermeja. converging and culminating in a summit of nearly 6,500 ft. The principal river is the Guadalhorce. which rises in the Sierra de Alhama. After a westerly course past Antequera it bends through the defile of Peñarrubia and the *Vega* or Vale of Málaga, falling into the sea near that city. The only other considerable stream is the Guadiaro or Guadalevín, which has the greater part of its course within the province and flows past Ronda. There is an extensive salt lagoon near the northern boundary. The mountains are rich in lead and iron. There are warm sulphurous springs and baths at Carratraca. Large quantities of grapes and raisins, oranges and lemons, figs and almonds, are exported. The oil and wines of Málaga are also esteemed. After 1870 the manufacture of beet and cane sugar developed into an important industry. The fisheries are important. The province is traversed by the Córdoba-Málaga railway. The nationalists occupied the province during the civil war of 1936–39.

Málaga, the capital (mun. pop. [1960] 318.102), Antequera ([1950] 43.576), Vélez-Málaga (31,948), Ronda (30,653) and Coin (20.183) are described in separate articles.

MÁLAGA, the capital of Málaga province, an episcopal see and a port of southern Spain, is situated on the Mediterranean, about 75 mi. N.E. of Gibraltar. It lies on the left bank of the Guadalmedina ("river of the city") at the eastern end of the fertile Málaga plain near the slopes of Mt. Gibralfaro. a western spur of the Axarquia (or Málaga hills). The surrounding amphitheatre of mountains protects Málaga in winter from cold north winds; in summer the weather is mild. Pop. (1960) mun., 318,102.

Málaga, as a city founded by the Phoenicians. is mentioned by Strabo. Pliny the Elder and Ptolemy. After passing from Carthaginian rule. it became an ally of Rome and, later, a municipality. In the 6th century the Visigoth Leovigild took Málaga, and it remained in the hands of the Visigoths for two centuries. being also made an episcopal see. until it fell in 711 to the Arabs. They retained the city. despite Castillian attempts to take it. until finally it fell to Ferdinand and Isabella in 1487 after a long siege.

Málaga was the scene of several disturbances among which were the rebellions of the Moors in 1501, an English naval attack in 1570 and French occupation from 1810 to 1812. On Feb. 8, 1937, the city was captured by the nationalist general Queipo de Llano. In 1878 the local vineyards were stricken by *Phylloxera* and, in 1884, an earthquake and floods did much damage.

The cathedral. built primarily between 1528 and 1782, stands on the site of a mosque; in it are carvings by Pedro de Mena. Málaga's famous churches include those of Santo Cristo, the Iglesia del Sagrario and la Victoria. The provincial museum of fine arts contains paintings by Zurbarán. Guido Reni and other masters including. among the moderns. paintings by Pablo Picasso, who was born in Málaga. There are still remains of the Moorish fortress of Alcazába, while that of Gibralfaro has been made into a museum and garden.

The old port of Málaga can hold 30 large vessels and offers a draft of 30–45 ft. Near it is the Cluh Mediterráneo. a centre for nautical sports, especially during n·inter regattas. The city's exports include a wide variety of local products: the chief imports are petroleum, grains. chemical products. iron and steel. Local manufactures and products include cement. bricks. mosaics, paint, chemical fertilizers, pharmaceutical products. soap. cotton and cotton goods, leather, and food products such as flour, vinegar, sugar, and the well-known Málaga wines, fruits, almonds, fish and shellfish. (A. C. A.)

MALAGASY REPUBLIC: *see* MADAGASCAR.

MALAKAND, an agency of the Peshawar division, West Pakistan, controlled by a political agent residing in the town of the same name. 41 mi. N.E. of Peshawar. The total area of Malakand is 13.419 sq.mi.; the population in 1961 was 1,517,000. The agency includes Chitral, Swat (*qq.v.*) and Dir states, Kalam, the Malakand Protected area and the areas called Swat Ranizai and Sam Ranizai. Malakand is inhibited by *azad* (free) tribes having their own chiefs or *sardars.*

At Malakand is a 20,000-kw. hydroelectric power station, opened in 1938. The Dargai hydroelectric station nearby produces another 20.000 kw. There is a training centre at Batkhelo for woolen textiles and rugmaking. The Malakand pass connects the Mardan and Peshawar districts with the Swat valley. It is traversed by an ancient Buddhist road. (K. S. AD.)

MALALAS (or MALELAS) (Syriac for "orator"). **JOHN** (*c.* 491–578), Byzantine chronicler. was born at Antioch. He wrote a chronicle beginning with the creation and ending with the death of Justinian (565).

It possesses little historical value: it is. however, important as the first specimen of a chronicle written not for the learned but for the instruction of the monks and the common people, in the language of the vulgar. with an admixture of Latin and oriental words. It is preserved in an abridged form in a single manuscript at Oxford.

Fur a full discussion see Krumhachcr, *Geschichte der byzantinischen Literatur,* pp. 332–334 (1897); and the first edition, by E. Chilmead (Oxford. 1691).

MALAN, DANIEL FRANÇOIS (1874–1959), South African advocate of *apartheid* (racial segregation), was born at Riebeck West. Cape Pro ince. on May 22. 1874. He was educated at Victoria college. Stellenhosch, and at the University of Utrecht. Neth.. where he obtained the degree of doctor of theology. He returned to South Africa as a minister of the Reformed Church and in 191j became editor of ***Die*** *Burger,* shortly afterward being elected chairman of the newly formed Nationalist party in the Cape. He was elected to the house of assembly in 1917 and was minister of the interior. health and education during 1924–33.

At the outbreak of World War II Malan supported Gen. James Hertzog's policy of neutrality, and on the general's death in 1942 succeeded him as leader of the opposition to the government of J. C. Smuts. In the 1948 election the Nationalist party obtained a majority and Malan became prime minister. Under his leadership the government carried out an aggressive program of racial segregation with the announced goal of the complete separation of mces. Malan's Nationalist party carried the general elections in 1953, but on Nov. 30, 1954. he retired from politics at the age of 80. He died in Stellenbosch, U. of S. Af., on Feb. 7, 1959.

MALANGE: *see* ANGOLA.

MALAR, a lake of Sweden, extending 75 mi. W. from Stockholm, which lies at its junction with the Saltsjö, an arm of the Baltic sea. The height of the lake normally reaches only one foot above sea level, and its outflow is sometimes reversed. The area is 440 sq.mi., the deepest sounding is 210 ft. It contnlns numerous islands and its outline is very irregular, the mean breadth being about 15 mi., but an arm extends northward for 30 mi. nearly to the city of Uppsala.

The lake is connected by navigable channels with Lake Hjelmar to the southwest and the Baltic to the south, by the Södertelge canal and by two channels at Stockholm. The more important towns, besides Stockholm, are Vesterås on the north, Sodertelge and Eskilstuna near the south shore.

The lake offers a field for recreation fully appreciated by the inhabitants of Stockholm, and many of the businessmen of the capital city have residences on the shores of the lake. On the island of Drottningholm (Queen's Island, named in honour of Catherine, wife of John III) is a palace with a fine park and formal gardens. a summer residence of the royal family, built by Nicodemus Tessin and his son Nicodemus in the second half of the 17th century on the site of the one built by John III at the close of the 16th century. Near Mariefred on the south shore is the picturesque castle of Gripsholm, dating from 1537, built by Gustavus Vasa, containing a large collection of portraits. Strengnas, also on the south shore, became an episcopal see in 1291, when the fine cathedral, later much altered, was consecrated. In the episcopal palace there. a building of the 1jth century later used as a school, Gustavus Vasa was elected to the throne of Sweden in 1523. On the northward arm of the lake is the palace of Rosersberg, later used as a school of gunnery. in a well-wooded park.

On a branch of the same arm is Sigtuna, a village whose ruined churches are a memorial of its former rank among the principal towns of Sweden after its foundation in the 11th century. Remains prove that on Bjorko. an island in the eastern part of the lake, there was a large settlement of earlier importance than Sigtuna. There a cross commemorates the preaching of Christianity by St. Ansgar in 829.

On the northern arm of Lake Mälar, about 10 mi. S. of Uppsala, is the chateau of Skokloster, occupying the site of a monastery, and presented by Gustavus Adolphus to Marshal Herman Wrangel, whose son Charles Gustavus Wrangel stored it with a remarkable collection of trophies from Germany. taken during the Thirty Tears' War, and including a library, an armoury and a great collection of curios.

MALARIA. Malaria is an infection principally of man, apes, monkeys, birds and reptiles. It is caused by several species of Protozoa (one-cell animal organisms). which are classified as blood Sporozoa (suborder Haemosporidiidae) and belong to the single genus *Plasmodium* (*see* PROTOZOA: *Taxonomy*). As far as is known, all are transmitted by mosquitoes.

A given species has a limited ability to infect both vertebrate and mosquito hosts. Thus, *Plasmodium brasilianum* can be transmitted to several species of new world monkeys and marmosets. but has never been successfully transmitted to man or old world monkeys. Only one species, *P. knowlesi,* occurring in monkeys, has been successfully transmitted to man. The culicine genera *Culex* and *Aedes* are the most important transmitters of bird malaria. whereas the genus *Anopheles* is the sole known transmitter of the human species. In a zoological sense, the mosquito in which the parasite undergoes its sexual processes is the definitive host, and man or other vertebrates are the intermediate hosts.

The stages of the malarial parasites which invade mature red cells containing hemoglobin in the vertebrate host have the interesting biochemical habit of splitting hemoglobin into its pigment, heme. and the protein carrier. globin. The parasite utilizes the globin and discards the heme. When the heme accumulates in the red cells and in various organs, it is known as malarial pigment. The same method of producing pigment occurs in infections caused by close relatives of the malarial parasites that belong to the genera *Haemoproteus,* infecting birds, and *Hepatocystis,* infecting monkeys, bats and squirrels. These infections are frequently, but inappropriately, referred to as malaria.

The present article will deal chiefly with the malarial parasites of man. No parasite producing malaria in man has been successfully transmitted to any lower animal except to the chimpanzee and, for very transient infections. to howler monkeys. For this reason, many advances in the knowledge of the human disease have been based on work on several species occurring in birds and monkeys. The discovery of P. *berghei* which infects the Congo tree rat and can be maintained in mice and rats is a promising mid-20th century addition to the available research material.

Clinically, malaria is characterized by periodic paroxysms, popularly known as chills and fever, and a tendency to assume a chronic form with frequent relapses. During World War II marked advances were made in the treatment of the disease as well as the discovery of efficient insecticides which gave promise of removing the disease as one of the leading scourges of the inhabitable world, particularly in the tropic and subtropic areas.

History. — Historically, malaria is one of the most ancient infections known to man, having been noted in some of the earliest records. 5th century B.C., a-hen Hippocrates differentiated the fever into different types: namely! quotidian (daily), tertian (alternate days) or quartan (fever three days apart) types. He further observed that those who drank the stagnant marsh water had large stiff spleens, a characteristic of the disease, and fatal dropsy was common among them. It is not known when malaria first made its appearance in the Americas, but it is highly probable that it was a post-Columbian importation; some rather severe epidemics were first noted in 1493. The origin of the word malaria is not known, although reputedly it refers to *mal* aria, meaning "evil air." There has always been recognition of the association between swampy, marshy areas and the disease, although the exact roles of the mosquito and the parasite were not known until the beginning of the 20th century.

An effective treatment was known long before the cause of the disease was understood. There are many legends which indicate that the countess of Chinchón, suffering from chills and fever, was treated in 1630 with an infusion of the bark of a certain tree in Peru. The reason why the infusion was used is not exactly clear, although certain Jesuits were thought to have learned about it from the natives. Discovery of the countess' diary failed to reveal that she ever had malaria. The fact remains. however, that the tree with the therapeutically active bark mas named for her as the cinchona tree; and from 1700 its most active principle, quinine, was used universally for the treatment of malaria.

The first person known to have described the malarial parasite and to have recognized it as the cause of the disease was Alphonse Laveran in 1880 in Algeria. In 1886 the Italian investigator Camillo Golgi, known best for his studies on the structure of the nervous system, pointed out that the paroxysms are coincident with the segmentation of the blood parasites. Detailed knowledge of the tissue stages came later and represents the work of many investigators. Special mention should be made of the U.S. parasitologists C. G. Huff and F. Coulston. who in 1944 described the complete development of early tissue stages in the avian P. *gallinaceum,* and the English parasitologists H. E. Shortt and P. C. C. Garnham. who with their associates first described in 1948 tissue stages in human malaria.

The discovery of the mosquito transmission of the disease had an involved history which turned into an exciting race toward the turn of the 19th century. The U.S. investigators Theobald Smith and F. L. Kilborne. between 1889 and 1893, had shown that the tick is the carrier of the piroplasm producing Texas fever of cattle and thus laid the basis for the demonstration of the role not only of ticks but also of other arthropods, such as mites, crustacea and especially insects in the transmission of human and animal diseases. Sir Patrick Nanson, British pioneer in tropical medicine, stated in 1894 that he suspected the mosquito to be the vector (carrier) of malaria. In 1898 in India the British physician Sir Ronald Ross proved that bird malaria is transmitted by *Culex* mosquitoes and described the entire development of the parasite in the mosquito. Just the year before, he had seen pigmented cysts in anopheline mosquitoes fed on patients with falciparum malaria. In Nov. 1898 the Italian investigators A. Bignami, G. B. Grassi and G. Bastianelli first infected man by mosquitoes, described the full development in man and noted that malaria is probably transmitted only by anopheline mosquitoes, an observation that continues to hold true. The disease can be transmitted unnaturally by common use of the hypodermic needle, as among drug addicts, or occasionally by blood transfusion from infected donors.

For therapy. a major event was the mass cultivation of strains of cinchona trees giving high yields of quinine alkaloids. This was achieved by the Dutch in the East Indies. In 1891 P. Guttmann and Paul Ehrlich found that methylene blue had a slight therapeutic effect. The shortage of quinine in Germany during World War I led to the research of W. Schulemann and his associates which culminated in the discovery of Plasmochin or pamaquine in 1924. It was made by modifying methylene blue. In 1930 W. Kikuth, in collaboration with W. Mauss and F. Mietzsch, produced Atabrine, which became known as quinacrine or mepacrine. Both compounds are potent antimalarials. The discovery of improved synthetic compounds during World War II by U.S. and British investigators presaged eventual replacement of both quinine and quinacrine.

The vast malaria-control projects conducted in Panamá by William C. Gorgas, who practically eliminated the disease that, with yellow fever, had previously prevented the construction of the canal; the restoration of the Pontine marshes as a place of healthful habitation for the Italians; and the species eradication of *Anopheles gambiae* from Brazil by the Brazilian government, initiated and directed by the Rockefeller foundation! were outstanding events in malaria history. The acute problem in Brazil resulted from the transmission by aircraft or surface craft of an effective vector from Africa that spread over many thousands of acres and was responsible for an epidemic which cost thousands of lives before being eradicated. Although pyrethrum and kerosene sprays had been used to kill the larvae and adults of mosquitoes, their effectiveness was surpassed by DDT (dichloro-diphenyl-trichloroethane), first synthesized in 1874 by O. Zeidler in Strasbourg. In 1939 a small quantity was produced in Switzerland and was found to be lethal for potato bugs. In 1942 it was found to be surprisingly effective against lice, and samples were transported to the United States. The U.S. department of agriculture proved it to be an effective killer not only of lice but also of mosquitoes, flies and fleas.

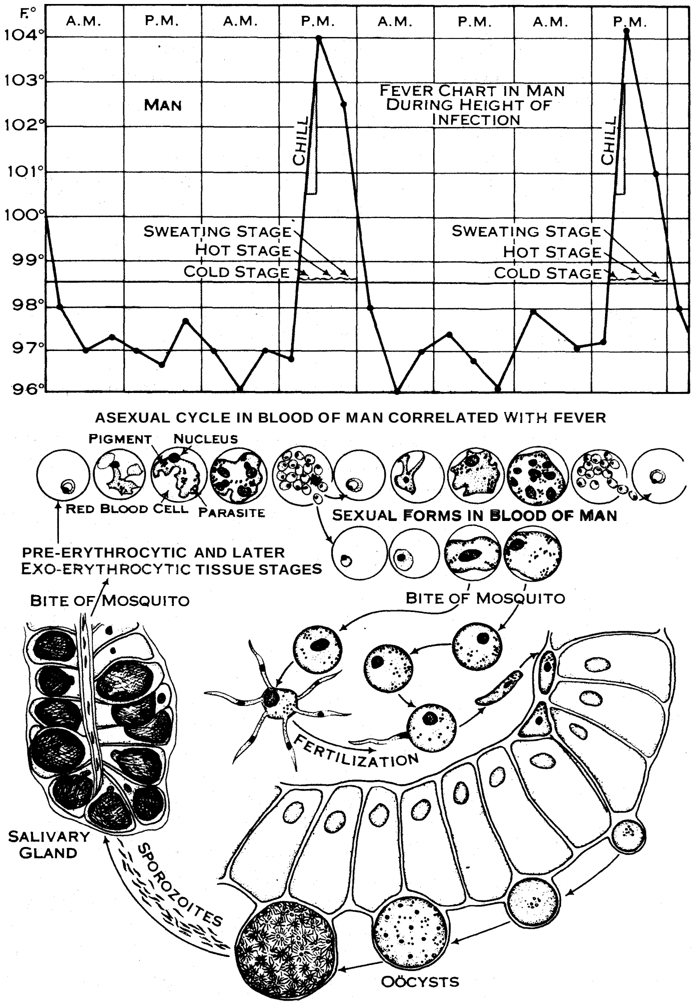
Distribution and Prevalence of Malaria.—Malaria is a world-wide disease, and there are probably more cases of it than of any other infection. It is most common in the tropics, where climatic conditions are favourable for the mosquito and for transmission of the disease throughout the year. As one approaches the poles, it becomes less prevalent, although it has been recorded as far north as Archangel. U.S.S.R. In the continental United States malaria was once a severe menace in the south, the Mississippi river basin and lower California. By mid-20th century it was at its lowest ebb in history; fewer than 500 cases were recorded in 1955. Hyperendemic areas are found in Central and South America, north and central Africa, southern Europe, all countries bordering and the islands of the Mediterranean and the middle and far east. There are some favourable areas still malaria-free because of the absence of mosquito vectors, including such Pacific areas as the Fiji Islands, Hawaii and Guam.

In India it was estimated at mid-century that malaria was still killing 1,000,000 persons annually; in many parts of the world probably the entire population is infected more or less constantly. P. F. Russell estimated that there "are not less than 3,000,000 malarial deaths and at least 300,000,000 cases of malarial fever each year throughout the world." (P. F. Russell, *Bull. New York Acad. Med.*, 19:599–630 [1943]).

Vivax malaria is the most widespread variety, aided by its ability to withstand therapy and remain chronic. Falciparum malaria, the most malignant, requires higher temperatures for optimal development; hence it is confined more closely to the tropical areas. In west Africa, for example, it exists almost to the exclusion of the other varieties. Malaria caused by *Plasmodium malariae* is very prevalent in the Mediterranean area. Instances of this infection persisting without active relapse for 40 years or more have been recorded. Many factors determine the distribution and incidence of malaria, in addition to those of cardinal necessity: the anopheline mosquito, a reservoir of infection and a susceptible human population. These include climate, rainfall, occupation, housing conditions, agriculture, wars, migrations of peoples, economic conditions, etc.

The Parasite.—Four species of the parasite are known to produce disease in man, *P. vivax*, *P. falciparum*, *P. malariae* and *P. ovale*. They cause, respectively, vivax (tertian), falciparum (subtertian or malignant tertian), malariae (quartan) and ovale tertian malaria. Each species has an asexual cycle in the tissues and blood of man and a sexual cycle which starts in the red blood cells of man and is completed in the mosquito.

The accompanying figure illustrates the life cycle of P. *vivax*. The infective stage (sporozoite). which is introduced into man by the bite of the mosquito, initiates a series of generations of pre-erythrocytic stages which occur in tissue cells before parasites invade the red cells. These in turn develop into erythrocytic stages so named because they infect red blood cells. (Except in P. *falciparum*, the pre-erythrocytic stages also give rise to exo-erythrocytic stages which not only can maintain themselves in



MODIFIED FROM W. H. TALIAFERRO, "MICROORGANISMS AND THEIR ROLES IN NATURE,,, "THE WORLD AND MAN," AND FROM C G HUFF. "A MANUAL OF MEDICAL PARASITOLOGY," BY COURTESY OF W. H. TALIAFERRO. C. G. HUFF AND THE UNIVERSITY OF CHICAGO PRESS

LIFE CYCLE OF PLASMODIUM VIVAX IN MAN AND THE FEMALE ANOPHELINE MOSQUITO

The fever curve in man as correlated with the asexual cycle of the parasite in the blood and as correlated with the beginning of the sexual cycle in the blood. The asexual cycle starts with a small parasite (ring stage) possessing a single nucleus. The parasite grows as the original nucleus undergoes successive divisions and finally becomes a segmenter which produces a brood of small parasites (rnerozoites) which can infect new red cells. The completion of the sexual cycle takes place in the mosquito and the sexually fertilized ookinete eventually develops into sporozoites

tissue cells, but also can develop into erythrocytic stages. Since the persistent tissue stages are resistant to most drugs, they probably keep the infection going and relapsing. As far as is known, they do not produce clinical symptoms.)

During the erythrocytic asexual cycle, a young ring stage in P. *vivax* requires two days to grow and develop into a segmenter containing 16 to 24 daughter parasites (merozoites). (Other species produce different numbers of merozoites.) The infected red cells then rupture and each daughter parasite that survives—many die—invades a new red cell. A remarkable aspect of the asexual cycle is that the parasites grow and divide synchronously and therefore at the time of segmentation the parasitized erythrocytes disintegrate in batches and liberate malarial pigment and other residues of parasite and red cell. This process, provided enough parasites are present, produces the typical. regularly recurring malarial paroxysm, which lasts four to ten hours and consists successively of a cold stage (chill), a hot stage and a sweating stage. The cold symptoms of the chill are subjective as they occur after the body temperature is elevated. Between paroxysms, the temperature may be normal or subnormal. The figure shows the relation of the asexual blood cycle and the paroxysms of chills and fever.

A regular tertian fever because of the two-day cycle is produced by P. vivax and P. *ovale.* A quartan fever is produced by P. *malariae.* (Parenthetically. the terms tertian for a two-day interval and quartan for a three-day interval arise from the classical method of including the first and last day of each interval.) The two-day cycle of P. *falciparum* is irregular, and fever may be more or less continuous with chills and sweating at irregular intervals. In this species, only the young rings and sexually mature stages of gametocytes are usually seen in blood smears; the other stages develop in the deeper blood vessels of the body. Infections with one or more species can occur simultaneously. Furthermore, a double brood of tertian parasites can segment on alternate days, giving a daily or quotidian fever. Double or triple broods of the quartan parasite, P. *malariae,* may occur with chills and fever for two days followed by a free day or with fever every day.

After the blood stages have developed asexually about ten days, ring stages similar if not identical to the asexual ones initiate the sexual cycle. The young sexual parasites do not segment but grow into male forms (microgametocytes) or female forms (macrogametocytes), which eventually perish if not taken up by a susceptible anopheline mosquito. In a susceptible mosquito, they undergo maturation and fertilization similar to that of the germ cells of higher animals. The process of forming microgametes (equivalent to spermatozoa in higher forms) is termed exflagellation because the filamentous microgametes behave very much like flagellums as they lash about in freeing themselves from the original gametocyte. After becoming free, a single microgamete fertilizes a macrogamete (equivalent to an ovum). The resulting ookinete (so-called because it actively moves) becomes an oocyst on the outside stomach wall. Within a week or ten days. these oocysts produce scores of sporozoites which are the infective form and which migrate to many parts of the mosquito, including the salivary gland. From this site they are injected by the bite of the mosquito into the vertebrate host and infect new individuals. (See also REPRODUCTION : Dual Hosts.)

Malarial parasites have been difficult to cultivate in the laboratory. Some progress, however, has been made by F. L. Hawking in England and by Eric Ball and Q. M. Geiman in the United States. The parasites remain viable at extremely low temperatures, $-65°$ C., and this characteristic has been utilized to preserve various strains for research.

The Mosquito **Vector.**—Anopheline mosquitoes are the only known vectors of human malaria, and approximately 35 different species perform this function satisfactorily in different parts of the world. These mosquitoes undergo an aquatic larval stage, pupate and hatch into flying adults in about ten days, depending on the temperature of the water. The females require blood meals to produce fertile eggs; the males live on plant juices. According to the species, some prefer animal to human blood, hence are not good malaria vectors. Different species may live preferentially in streams, ponds, hoofprints, tree holes, in shade or sunlight. Usually their flight range is one mile or less from the source of human blood and infection. These mosquitoes are distributed throughout the world, more prevalently in the tropics, but some are present at latitude 50° N. In Ceylon they have been reported at an altitude of 8,000 ft.

The Disease in Man.—The disease in man is recognized by periodic chills and fever, anemia and, later, cachexia (general poor health) and an enlarged spleen. The different patterns of chills and fever have been described above. In falciparum malaria the symptoms are much more severe than in the other varieties. This type may be accompanied by various symptoms depending largely upon the localization of the asexual parasites. Intestinal localization may produce diarrhea and vomiting, and cerebral localization may cause delirium or coma. Only prompt treatment can prevent death in these severe infections.

Diagnosis.—Once clinically suspected, the diagnosis is made by identification of the parasite in stained blood smears. A dehemoglobinized drop of blood can also be stained. The parasites take a characteristic stain, and all stages are easily identified if present and properly stained. There are no satisfactory serological diagnostic tests such as precipitin or agglutination. The complement fixation was shown by L. T. Coggeshall and M. D. Eaton to be reliable when positive, but in many instances known cases failed to furnish more than a weak reaction. The white blood cell (leucocyte) count is usually low and mild anemia is a constant finding. Usually an enlarged spleen can be palpated.

Immunity.—A malaria infection confers a low-grade but specific immunity upon its host after the acute attack has subsided. This acquired immunity in man is of short duration, as a person may have repeated attacks produced by the same organism within a relatively short space of time. In experimental animals the residual immunity following complete eradication of the infection persists only a few weeks. It is held by many that a host is immune to malaria only in the presence of infection. There is no cross immunity in human malaria, as it is frequently observed that a person may have a simultaneous infection with two or more types of malaria. It is highly probable that a person is resistant only to the malaria in his particular locality; for example, it has been shown that a person immune to a strain of vivax malaria in Florida behaves as a normal when exposed to infection from a vivax parasite from Cuba. Immunity is fundamentally antiparasitic, *i.e.*, directed against the parasite. and is not antitoxic. Immunological suppression of the blood infection is chiefly brought about by macrophages (sometimes called scavenger cells) of the spleen and liver and, to a lesser extent, the bone marrow (see discussion of malarial immunity in PARASITISM AND PARASITOLOGY). These organs are the most important of the so-called filter organs of the blood and their macrophages, which are part of the reticulo-endothelial system, are so oriented as to remove material from the blood. The macrophages phagocytose (eat) many parasites and parasitized red cells throughout the infection and especially after the development of acquired immunity due, undoubtedly, to specific antibodies. Moreover. the macrophages themselves markedly increase in number chiefly by development from lymphocytes and monocytes (see PATHOLOGY: *Phagocytosis;* BLOOD: White Blood Cells). Immunity against pre-erythrocytic and exo-erythrocytic stages also occurs in some avian malarias and may occur in n an. It has not been thoroughly studied.

Drug Treatment and Prophylaxis.—Antimalarial drugs may be used either curatively to treat malaria or prophylactically to prevent the disease. Suppressive treatment or clinical cure primarily involves the administration during acute attacks of drugs which will quickly suppress the population of blood asexual parasites so that symptoms disappear. In general, such treatment does not eliminate the exo-erythrocytic stages in the tissues. Continuous suppressive treatment may be used in both uninfected and chronically infected persons to prevent the asexual blood stages from reaching a level at which symptoms appear. The drawback to this type of control (frequently called clinical or suppressive prophylaxis) is that an infection may be acquired during treatment and may flare up after treatment is stopped unless an adequate immunity has been built up. It was the only type of drug prevention available when quinine was the sole antimalarial. Causal prophylaxis occurs only with drugs that prevent the infection by killing or inhibiting the development of sporozoites and pre-erythrocytic tissue stages. Radical cure is brought about by drugs that can eradicate all stages of the parasite, both in the blood and in the tissues. After such a cure, no relapse is possible, but a new infection can take place. It would seem at first glance that only those drugs should be used that give true causal prophylaxis and radical cure. The suppressive drugs, however, often act on the blood parasites much faster than do the curative drugs. Therefore, both kinds of drugs are often prescribed, particularly with vivax malaria, to relieve symptoms quickly and to eradicate the infection eventually. Under certain conditions such as active military operations. suppression (clinical prophylaxis) may be superior to causal prophylaxis. Thus, suppression with drugs allows the development of a low-grade infection during which immunity develops and is maintained under conditions where it is very difficult to maintain an effective dosage level of a causal prophylactic drug.

Treatment of malaria depends upon the species of parasite involved. Entreated vivax and quartan infections eventually subside, but untreated ialciparum malaria may be fatal. In fact, falciparum malaria is responsible for practically all uncomplicated deaths from malaria. It is. however, easier to cure than the so-called benign malarias. During World War II it was radically cured by long-continued treatment with quinacrine. This difference is now generally believed to be due to differences in the persisting tissue stages. Pre-erythrocytic stages of P. *falciparum* are not long lived and give rise only to initial blood stages. whereas those of P. *vivax*, P. *malariae* and *P. ovale* produce, in addition to blood stages, persistent drug-resisting tissue exo-erythrocytic stages that are responsible for long-term relapses. The tissue exo-erythrocytic stages can be eradicated only by a few of the never drugs.

In this connection, it is interesting that a vivax infection. when transmitted by a transfusion of blood from an infected person, can be cured by any effective suppressive drug including quinine because no tissue stages occur.

Older Drugs.—The importance of quinine cannot be overemphasized. Without it many of the most fertile areas of the world would never have been habitable. Its chief shortcoming has been its inability to eradicate such infections as vivax malaria. It may also give rise to partial deafness. Quinine is still the preferred drug throughout the world in spite of the introduction of improved drugs. Quinacrine is highly effective and remains in use. Its disadvantages are that it also does not cure vivax infections, it discolours the skin and, at times, leads to gastric disorders. skin rashes and serious mental disorders. In 1928 the English investigators J. A. Sinton and W Bird discovered in India that the 8-aminoquinoline pamaquine (Plasmochin) would cure vivax malaria as indicated by a greatly reduced relapse rate. The drug was too toxic for wide acceptance, but led directly to the development of other 8-aminoquinolines, The best of these, primaquine. was first found effective in man by Alf S. Alving and his associates.

Later Drugs.—Because of the shortage of quinine and the great demand for quinacrine. an intensive research program was initiated during World War II by the National Research council of the United States. As a result, promising drugs were developed by United States and British investigators. of which four were found to possess superior therapeutic properties.

Chloroquine. 7-chloro-4-(4-diethylamino-1-methylbutylamino)-quinoline, commonly known under the trade name of Aralen, was first synthesized in 1934 by German scientists. It is superior to quinine or quinacrine because it is less toxic, relieves symptoms more quickly by eliminating more rapidly the asexual blood stages and prolongs subsequent latent periods The ultimate total relapse rate, however, is the same for all three drugs.

Amodiaquin, frequently known by the trade name Camoquin. is like chloroquine in being a 4-aminoquinoline. It was discovered in 1946 by J. H. Burckhalter and his co-workers. It is similar to chloroquine in its nontoxicity and effectiveness as a suppressive drug, but it has not been as extensively tested as has chloroquine.

Primaquine. 8-(4-amino-1-methylbuty1amino)-6-methoxyquinoline, is an 8-aminoquinoline that was developed in the United States during World War II. It is much less toxic than the earlier drug, pamaquine, to nhich it is related. Its outstanding characteristic is that it can cure vivax malaria. It is not, however, very active in eliminating the blood parasites. Hence, during an acute attack or during an appreciable parasitemia, it is combined nith an effective suppressive drug such as quinine, chloroquine or amodiaquin. Quinacrine is not used for this purpose as it seems to potentiate, or increase, the toxicity of primaquine. Primaquine in addition has largely replaced pentaquine and isopentaquine, two other 8-aminoquinolines, which were developed a few years earlier by U.S. workers.

The most recent drug, pyrimethamine. 2,4-diamino-5-*p*-chlorophenyl-6-ethylpyrimidine, which goes under the trade name of Daraprin. was first synthesized in the United States and tested there and in England. It is relatively nontoxic and has a marked prophylactic value. Not only is it a suppressive prophylactic to both vivax and falciparum malaria when given at weekly intervals. but it acts as a true causal prophylactic when begun soon enough by arresting the early pre-erythrocytic stages. It is also effective against P. *malariae.*

Pyrimethamine only slowly suppresses acute attacks. It is, therefore, often supplemented by such drugs as chloroquine, amodiaquin. quinacrine or quinine Pyrimethamine has largely replaced the related but less effective drug proguanil (=paludrine), that was earlier developed by English workers.

It is interesting that some of the antimalarial drugs have been found to be effective in other infections. Thus. chloroquine and amodiaquin are used to treat the dysentery amoeba *Endamoeba histolytica* when it has invaded the liver; quinacrine has been found to be active against infections nith some of the intestinal tapeworms and the intestinal protozoan *Giardia lamblia;* and pentaquine, and especially primaquine, are the best suppressive drugs yet found for infections with *Trypanosoma cruzi.*

Acquired drug resistance is an important factor in antibiotic therapy *(see* ANTIBIOTICS; PARASITISM AND PARASITOLOGY: *Chemotherapy).* It does not occur to any appreciable extent with the older drugs and was first noted in the case of proguanil. The resistance of *P. vivax* to proguanil has been raised a thousand times by contact with the drug. Blood stages of both P. *vivax* and *P. falciparum* also become resistant to pyrimethamine.

Control.—The methods of control of malaria are varied according to the habits of the particular mosquito involved. Elimination of all breeding places of *Anopheles* by drainage or filling is essential wherever practical. Human beings should be protected from the bites of mosquitoes. Dwellings should be screened and bed nets used. since most *Anopheles* feed at night. The use of DDT is a major item; it can be used as a spray for dwellings to destroy the adult mosquito. Likewise, when applied as a dust to the surface of water, in breeding places. it will eliminate the larvae.

The problem of mosquito control by DDT is complicated by the development of strains of *Anopheles* which are resistant to DDT or other specific insecticides. One of the most successful insecticides for DDT-resistant mosquitos has been dieldrin (a synthetic chlorinated hydrocarbon also known as compound 49; and Octalox). Some use is also being made of lindane, the gamma isomer of benzol hexachloride.

In some areas it is possible to reduce the reservoir of infection. thus interfering with transmission, by the use of drugs. particularly the later ones. There are other natural methods, such as the introduction of the surface-feeding minnow *Gambusia,* a natural enemy of the mosquito; increasing the salinity of nater near the seaside by tide gates; raising and lowering nater levels; and eliminating protruding vegetation and debris from the breeding places. making it unfavourable to the mosquito. These are but a few of the many applicable methods. (See MOSQUITO: *Control Measures.*)

Blackwater Fever.—Blackwater fever is the most serious and the least understood complication of malaria. It is characterized by a rapidly developing and severe anemia, passage of dark-red to black urine, signs of severe toxicity and a high mortality. It is usually a complication of malaria of the falciparum variety, although occasionally it may appear after an attack of vivax or quartan malaria. The incidence of blackwater fever seems to be in proportion to the amount of malaria in a certain area. Non-immune immigrants in heavily endemic areas are frequent sufferers from this complication. In nest Africa, where blackwater fever is prevalent, it was found to occur once in every 900 attacks of malaria. It seldom appeared in a person until he had had at least four attacks of malaria and had been in the area for six months. The disease, which was relatively uncommon in World War II, is certainly not caused by repeated attacks of vivax malaria because it was not observed by L. T. Coggeshall in more than 5.000 relapsing cases with an average of 14 relapses per patient. This would indicate that repeated reinfection by infected mosquitoes is probably the most important factor. Other predisposing factors are quinine, alcohol, etc.

Symptomatology.—The onset is usually accompanied by single or multiple rigors and extreme prostration. There is no characteristic pattern of fever, although it is usually high, 103° to 105° F. The pulse is rapid, and the patient usually exhibits a considerable degree of pallor. With the hemolytic crisis there is a profound drop in the number of red cells, so that the count may be as low as 2,000,000. Jaundice makes an appearance early in the course of the disease. Vomiting and anemia are frequently observed.

Prognosis and Treatment. — A 50% mortality is approximately the rate to be expected. If the patients are anuric (lacking in the secretion of urine) the rate is muchhigher. Repeated hemolytic crises tend to affect the prognosis adversely. One attack of blackwater fever predisposes to others; the patient should therefore be removed from the endemic malarious area upon recovery. Treatment is entirely supportive.

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(L. T. Co.; W. H. T.)

MALATYA (MALATIEH or ASPUZU), the chief town of a province in Turkey, on the Samsun-Sivas-Diarbekr road, altitude 2,900 ft., situated about 10 mi. S.W. of the junction of the Tokhma Su (medieval Kubakib) with the Euphrates, near the south end of a fertile plain, and at the northern foot of the Taurus. Pop. (1955) 64,880.

Malatya was rebuilt after the earthquake of 1893, and is noted for its fruit orchards. Eskishehr or Old Malatya (Melitene), 5 mi. N E and 3 mi. from the medieval bridge (Kirkgeuz) over the Tokhma Su, has large gardens and many ruined mosques. baths, etc. The earliest site was possibly Arslan Tepe about 2 mi. S. of Eskishehr where two "Hittite" stelae, representing hunting scenes, were found.

Under Titus, Melitene was the seat of the 12th legion; Trajan raised it to a city. Lying in a very fertile country at the focus of important routes, it grew in size and importance, and was the capital of Armenia Minor or Secunda. Justinian, who completed the walls commenced by Anastasius, made it the capital of Armenia Tertia; it was then a great place (Procop., De aed., iii, 4). The town was burned by Chosroes after his defeat there in 577. Taken by the Saracens. retaken and destroyed by Constantine Copronymus, it was recovered to Islam, and rebuilt under Mansur (A.D. 756).

The town changed hands more than once, being reckoned among the frontier towns of Syria (Istakhry, pp. 55, 62). At length the Greeks recovered it in 934, and Nicephorus II. finding the district much wasted, encouraged the Jacobites to settle in it. A convent of the Virgin and the church which bears his name were erected by Bishop Ignatius. Malatya became a great seat of the Jacobites, and was the birthplace of their famous maphrian Bar-hebraeus (or Abu'l-faraj).

At the time of the first crusade the city, being hard pressed by the Turks, was relieved by Baldwin. The city returned to the Turks in 1102 and subsequently became part of the realm of Kilij Arslan, sultan of Iconium.

MALAYA (called by Malays Tanah Malayu; *i.e.*, Malay Land), projects into the China sea and forms the most southerly portion of the continent of Asia. Geographically it begins at the Isthmus of Kra, 10° N., at which point it is only between 40 and 50 mi. wide, and the distance from sea to sea is further diminished by a large irregular salt-water inlet. From the Isthmus of Kra the peninsula extends south with a general inclination toward the east. A line drawn diagonally down the centre from the Isthmus of Kra to Cape Rumenia (east of Singapore) gives the length at about 750 mi. The breadth at the widest point, from Tanjong Penunjok in Trengganu to Tanjong Hantu in the Dindings, is about zoo mi. The peninsula runs into Thailand (Siam) in the north (nhere it is also met by a long. southward-projecting tongue from Burma) and is bounded by the China sea on the east. by the island and strait of Singapore on the south and by the Strait of Malacca on the west.

Politically the northern portion of the peninsula is a continuation of Thailand, and anthropologically must also be so regarded, rather than as a section of Malaya. South of the Thai Malay states, Malaya comprises two political units, both within the British Commonwealth: the Federation of Malaya (which has come to be known as Malaya) and the colony of Singapore. These were formerly divided into the Federated Malay States, the Unfederated Malay States and the Straits Settlements respectively. Malaya and Singapore are dealt with separately below, but it must be realized that they are closely linked both in government and economic interest. (For the city of Singapore see also SINGAPORE.)

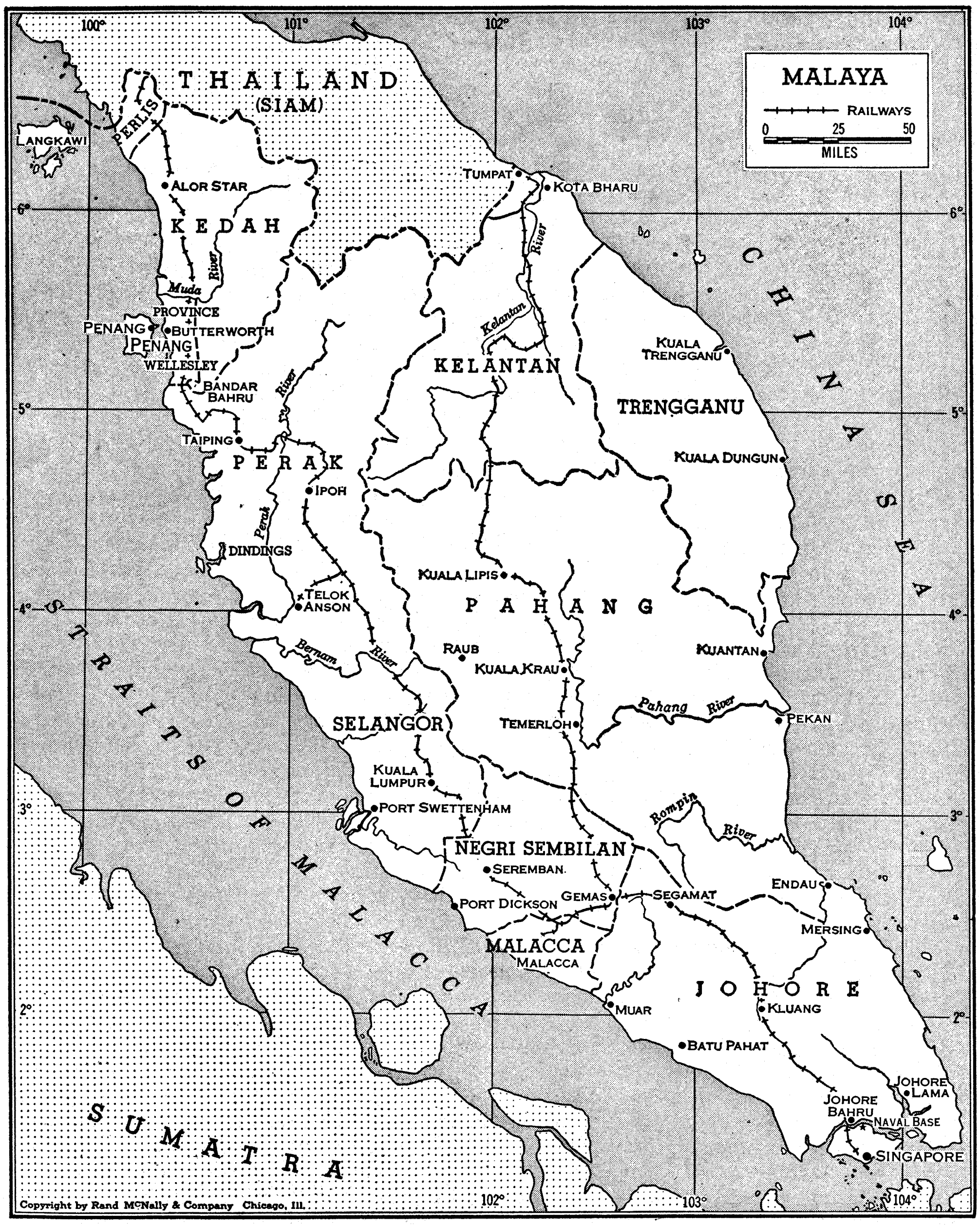
THE FEDERATION OF MALAYA

PHYSIOGRAPHY

Geographical Features. — Malaya is divided into two unequal parts by a range of mountains having a length of 300 mi. and a breadth, in places. of 30 to 40 mi. The highest peak in this range, Gunong Korbu in Perak, is 7,162 ft. and much of the country in the centre of the range is above 4,000 ft. The greater part of Malaya lies to the east of the range and contains two large isolated mountains, Gunong Benom and Gunong Tahan, the latter being the highest mountain in the country (7,186 ft.); both these are in the state of Pahang. Another area of mountainous country lies east and north of these along the border of Kelantan and Trengganu. In the relatively narrow plain to the west of the main range there is a small spur, the Larut hills, in Perak, and an isolated peak, Mt Ophir, is situated near Malacca. In the plains and foothills on both sides of the country precipitous hills or bluffs of limestone are conspicuous features in the scenery. Almost all of them contain caves, some of impressive proportions, and they are more numerous in the north; the most southern of them is the Batu Caves hill near Kuala Lumpur.

The largest river is the Pahang with a length of more than 271 mi. It has many tributaries and the main stream bears different names for different parts of its course; in its headwaters it is the Telom and in its course through the foothills it is named the Jelai. The next river in importance on the east side is the Kelantan which meets the sea very near the Thailand boundary. South of this a number of fair-sized rivers debouch on the coasts of Trengganu and Pahang, and the Endau in its lower course forms the Pahang-Johore boundary. On the west the Perak river rivals the Pahang in size, having a length of 252 mi. It rises in the broadest part of the main range, near the Thailand border, and flows southward between the central mountains and the Larut hills. No other west-coast rivers approach the Perak in size. The Bernam enters the sea a little south of the Perak, and the Muar far to the south in Johore. Much of the land between the mountains and the sea in the west is an alluvial plain, and provides the richest source of tin ore in the country. Rice is grown on this flat alluvial type of country on both sides of the range, mainly in the northern states.

The seacoast on the west side of the peninsula, facing the Malacca strait, includes some sandy stretches and a great deal of mangrove swamp, which is formed wherever rivers and streams meet the sea. The east coast facing the South China sea is very different. There heavy seas pound the shore yearly and mangrove is restricted to within the mouths of some of the rivers. Sloping golden sands. interrputed by rocky headlands and backed by casuarina trees, form the far more attractive east-coast scene. but sandy bars across the mouths of the rivers make them useless as ports and close most of them to navigation altogether during the monsoon period.



Islands are numerous offboth coasts. Offthe west *coast, in the north, are the* Langkawis, *partly of steep limestone and affording beautiful scenery. Penang lies* between *them and the Sembilan Islands offthe Perak coast. In the South China sea islands are scattered* off *the coasts of Johore, Trengganu and Kelantan; many of these are surrounded by beautiful coral reefs. Singapore and many other islands lie offthe tip of the peninsula.*

Geology. — *The conformation of the peninsula is to a great extent the result of a phase of folding and intrusion of igneous rocks dating from post-Triassic: but probably still Mesozoic, times. The strike of the folding and direction of the main intrusions are north-northwest to south-southeast, folio\+-ing the axis of the peninsula. The main range, which lies to the west of the centre of the country. is formed by the largest of these igneous intrusions. East of this another isolated igneous massif. the Benom range, rises to nearly 7,000 ft., and intrusive igneous rocks are also extensively exposed in Trengganu and Kelantan and to the south in Johore. The Mesozoic intrusive rocks are predominantly biotite granites, but hornblende granites, syenites and diorites occur in some parts, while there is considerable variety among the hypabyssal derivatives of all these rocks. It is from this great intrusive series that the mineral* wealth *of the country is derived, the tin, gold, tungsten and other metals that are mined, mainly by exploitation of natural concentrations in alluvial, eluvial and residual deposits.*

The sedimentary rocks older than the granite range from the Lower Carboniferous to the Trias in age. They can be divided into two *main series, an older, largely calcareous, series of Carboniferous and Permian age, consisting of interstratified limestone and shale. and a younger Triassic series of conglomerate. sandstone and shale. Volcanic rocks, chiefly andesitic tuffs, occur in both series and have been named collectively the* Pahang *volcanic series.* Many *of these rocks have been altered by heat and pressure, consequent upon the* folding *and igneous intrusions, and are* now *represented by massive crystalline limestone. schist, phyllite, quartzite and other* metamorphic rocks. *Although the main mountain ranges and peaks are of granite, the highest mountain in the country. Gunong Tahan, is topped bv Triassic auartzite.* Recognizable *fossils are scarce in these* Palaeozoic *and* Mesozoic *rocks. The oldest knonn are from the Kuantan district of* Pahang *and indicate a Loner Carboniferous* (Visean) *age.*

Triassic fossils occur rather more generally and have been found in some quantity on Singapore Island.

No Mesozoic *sedimentary rocks later than Triassic are* known, *and the only deposits so far proved to be of Tertiary age are* coal-*bearing beds. The only operating mine is situated at Batu Arang* in *Selangor The alluvial deposits of the coastal plains are mainly of recent date. Some are raised above sea level and may nell date from the Pleistocene, but* fossil *evidence of their age is almost completely lacking.*

Climate. — *Situated just north of the equator and at no point more than* 100 *mi. from the sea,* Malaya *has a* climate *distinguished principally* by *high humidity and uniform temperature. The prevailing ninds are controlled mainly by the southnest and northeast monsoons, modified by land and sea breezes The effect of the* southwest *monsoon is relatively slight. but the northeast, bloning from about October to February, brings high seas and much rain to the east coast.*

Malaya *is outside the range of typhoons and the local storms* known *as sumatras. though strong and sudden, are never violently destructive.*

Rainfall coincides in intensity with the northeast monsoon on the east side of the country southward to Singapore. In the northwest two *rainfall peaks are discernible, each coinciding in time* with *the transition betneen the monsoons. There is.* however. *no dry season* anywhere *at any time in the year. Average annual rainfall over the* whole *peninsula is probably about* 100 *in. Day temperatures at sea level are generally* between 80° *and go° F. and seldom much exceed the latter figure.* Night *temperatures, especially inland. often fall* below 70° F. *In the hill stations, at about* 4,000 *ft.. temperatures are, of course, lower and may fall at night well below* 60° F.

Vegetation.— The natural vegetation of Malaya consists of the high, continuous evergreen forest called rain forest. It comprises an enormous variety of trees, the tallest mostly belonging to the family Dipterocarpaceae, which furnishes most of the commercial timber of the country.

A notable feature of the rain forest is the universal presence of epiphytic plants. which are mainly of three classes! orchids, aroids and ferns. Of orchids about 800 species are known. Lianes are also present in variety and their ropelike stems are a feature of the jungle. One group of them, the rattans, have exceedingly long, tough. flexible stems, and climb by means of small recurved thorns on the prolonged leaf tips. Rattan forms the basis of an important furniture-making industry and is used for a variety of other purposes.

The biggest known flower, *Rafflesia* arnoldi, which measures 18 in. across. and other species of *Rafflesia* are found parasitic upon the woody stems of the lianes (Vitis).

Large bamboos are also a feature of the lowland and foothill forest and are much used by the aborigines and country people for making containers, rafts for river use and in house building. Palms are abundant and varied. More than 70% of the country is still covered by forest of this type. The mangrove of the coastal belt forms forest of a very distinct type, of great value as a source of firewood. and on the sandy shores coconut palms and casuarina trees are the most conspicuous vegetation.

Fauna.— The zoological affinities of Malaya are rather with the Greater Sunda Islands. Borneo, Sumatra and Java, than with the Asiatic continent. a circumstance derived from the fact that during the Ice Age the whole Sunda shelf was continuous land.

Elephants are still fairly numerous and the large black wild cattle called gaur or seladang are found in the larger forested areas. Two species of rhinoceros are listed in the fauna, the larger of which. Rhinoceros *sondaicus*, may be extinct, but the two-horned *Didermoceros sumatrensis* still exists in small numbers in the remoter hilly areas. The strange parti-coloured Asiatic tapir is not rare. and sambar, barking deer, two species of mouse deer (*Tragulus*) and two of wild pig are among the other ungulates. Carnivores include tiger, leopard (mostly the black variety), clouded leopard and a variety of smaller cats and civets (Viverridae). The large black siamang and two smaller forms of gibbon represent the anthropoid apes, and there are five species of monkeys. There is a single true lemur, the slow loris, and the very interesting and primitive primates called tree shrews (*Tupaia*) are common. Of the smaller mammals. bats. rats and squirrels are present in great variety, the former including the large flying fox (*Pteropus*) with a wing span of four to five feet. In the flying squirrels a membrane of skin between fore and hind limbs serves as a parachute and enables the animal to glide from one tree to a lower point on another. Similarly equipped is the so-called flying lemur (Cynocephalus, sometimes classified as *Galeopterus*), which is not really a lemur, its affinities among the mammals being obscure.

Birds are numerous and varied. Bulbuls, tiny sunbirds, brilliant kingfishers and the black and white magpie robin are familiar garden birds, and a host of others. many seldom seen, live in the forest. Notable among these are the large grotesque hornbills, the magnificent argus pheasant and the brightly coloured trogons and pittas.

Reptiles include the estuarine crocodile of the coastal mangrove and the Malayan gharial (Tomistoma) of the inland swamps. Snakes are numerous but only a small number are venomous and known deaths from snakebite are rare. The largest existing snake, the reticulated python, and the largest venomous snake, the hamadryad or king cobra, are both found. Among the most remarkable reptiles are the flying lizards (Druco and Ptychozoon) which glide from tree to tree as the flying squirrels do. The most familiar ones are the little house geckos which astonish newcomers by their ability to run upside down on the ceiling.

A very large variety of fish is found in the surrounding seas and in the ditches. lakes, swamps and rivers. Important fisheries exist all round the coast. Insects and other invertebrates are diverse beyond computation and many groups are imperfectly known. An example of this diversity is the presence of nearly 900 species of butterflies in the country.

Anthropology.— The indigenous population comprises a majority of Malays and a minority of jungle-dwelling aboriginal people, The distinction between the two is not always sharp and is determined rather by religious belief and custom than by race. The Malays are all Mohammedans. Physically the Malays are a brown-skinned Austro-Asiatic people of very similar type to the Indonesians. Although they are homogeneous it is difficult to speak with certainty of their origin. Some. particularly those of the southwestern states, certainly come from Minangkabau in Sumatra. Many of the Malays are probably descendants of the early settling of various Indonesian seafaring people on the coasts of the peninsula. They occupy themselves chiefly with agriculture and fishing, and speak a language, Malay, which, with minor variations, is uniform throughout the country and which provides a lingua franca over all the Indonesian region.

The greater number of the aborigines live in the jungles of the main range. They can be divided racially into three types: Negritos, small Negroid people; Senoi, slimly built, wavy-haired, relatively fair-skinned people; aboriginal Malays, more stoutly built. dark skinned, with straight or slightly wavy hair. Most of them live by hunting and by a system of shifting agriculture, involving the felling and burning of new areas of jungle each year. They hunt animals of all kinds by trapping and with the blowgun. This is most usually made of a slender bamboo enclosed and supported in a stouter one, about eight feet long. A slender wooden dart with a soft pith butt is shot from the blowgun by a sharp expulsion of the breath; the dart itself inflicts only a trivial wound and to make it effective it is invariably poisoned at the tip; vegetable poisons of two types are used, the brown latex of the Ipoh tree, *Antiaris* toxicaria, and a preparation made from creepers of the genus *Strychnos*. A less common type of blowgun is made like a lead pencil without the lead; two hemicylindrical pieces of wood are carefully grooved and fitted together to form a tube. The traditional weapon of the Negritos (*q.v.*) was the bow, but they have now mostly adopted the blowgun.

Several distinct languages are spoken by the aborigines, and they include words of the Mon-Khmer family, pointing to the origin of these people in the Indochinese region. The word Sakai is often used to comprise all the Malayan aborigines. As it is without exact meaning and is regarded by the people themselves as derogatory, its use should be discontinued.

Archaeology.— Archaeological study in Malaya has shown a long and interesting sequence of Stone Age cultures, but signs of the early Metal Age are scanty. The earliest stone industry is the Tampanian, represented by large, very crude pebble tools comparable with those of the Soan of India, the Pajitanian of Java and others. On typological grounds it can be regarded as probably dating from the Pleistocene, and it has been found only at one site, Kota Tampan in the valley of the Perak river. A mesolithic culture, closely allied to the Hoabinhian of Tongking, is represented by abundant pebble tools in middens in caves and rock shelters. They are usually worked only by flaking on one or both sides of a river pebble, but some are edge-ground. Accompanying them are bones of animals, all of existing species, numerous snail shells and human remains suggesting that the bearers of the culture were of Melanesian type. The Neolithic is represented in Malaya by very diverse and well-made tools of hornstone. almost all having a quadrangular cross section. Adzes are more numerous than any other type. These implements were fashioned by skilful flaking and finished by grinding and polishing, and most of them appear to be the tools of workers in wood rather than weapons of the chase or of war. They are accompanied by great quantities of unglazed pottery, usually ornamented with an impressed pattern of twisted cord (cord marking) and of diverse and often highly artistic forms. The contrast between the cave-dwelling hunters of the Hoabinhian and the apparently peaceful, industrious and artistic neolithic people is striking. Some other industries, represented by round axes and bone tools, have been found, but their relations with the main succession of cultures are obscure.

Early Metal-Age finds include two bronze drums of Dong Son type and a few bronze celts. These are certainly importations as no copper accessible to primitive mining methods exists in Malaya. Peculiar iron implements of a type not known outside Malaya have been found, some of them associated with slab graves (pits lined with slabs of desquamated granite), small glass beads and ill-preserved pottery. The affinities of this assemblage of objects are still in doubt. (M. W. F. T.)

HISTORY

Early Civilizations. — The earliest civilizations of southeast Asia derived their culture from India and more especially from Kalinga (in Orissa) and Palavas (near Madras). Palava inscriptions found in Kedah, Perak and elsewhere suggest a measure of direct Indian influence in Malaya and may date from as early as A.D. 400. More Indian influence, however, was felt indirectly through Sumatra and Java. The Sumatran empire of Sri Vijaya, with its capital at what is now Palembang, seems to have conquered most of Malaya in or before the 7th century. This Sumatran, Buddhist rule may have introduced, among other things, the name Melayu, which the Chinese regarded as another or a later name for Sri Vijaya itself. To the rulers and merchants of Sri Vijaya the Malay peninsula presented itself mainly, no doubt, as a barrier between India and China, forcing trade into a long southward detour which was of benefit to themselves. But this obstacle might be circumvented by crossing it overland at its narrowest point, the Isthmus of Kra, or else farther north at Mergui. This latter crossing would tend naturally to fall under the control of the people inhabiting the Menam Chao Phya river valley, the nearest plain capable of supporting a population of any size. In the earliest 13th century, there was a state called Ligor in northern Malaya but the Mongol invasion of southern China drove out the Thais, who entered what is now Thailand in 1280 and destroyed the Khmer rulers of Kambuja before setting up a new kingdom of their own. For a period, their expansion farther southward was checked by Ligor but they were eventually able to seize Tenasserim, the point at which the trade route crossed the peninsula. Southward from there. the territory which is now Malaya offered to the invader no particular obstacle and Thai rule probably extended over much of the peninsula in the 14th century.

Meanwhile, however, a new empire had arisen in Java, also under the influence of Indian culture. This was the Hindu-Javanese empire of Majapahit, which arose in the second half of the 13th century to challenge and eclipse the influence of Sri Vijaya. Majapahit supremacy continued for a century or more and extended not only over Java and Sumatra but also over southern Malaya. Although the claims of the Javanese and Thais must surely have overlapped, there is no record of conflict and they seem to have divided their spheres of influence in rather the same way as the Thais were later to divide Malaya with the British. From their capital of Aijudhya, the Thai rulers continued to dominate the overland route.

But it was not every merchant who chose to pass that way. The trader who preferred the sea passage between India and China would necessarily pass, as now, the southern tip of the Malay peninsula. More than that, he would tend to time his arrival there at about the change of the monsoon so as to make the best use of the wind system. Once in that vicinity he was near the Spice Islands and also in a position to profit from any trade the peninsula itself might offer. These circumstances all tended to favour the establishment of a port in roughly the area now occupied by the city of Singapore. Where exactly this port was situated remains doubtful and the contention that it occupied the same site as the modern city has become difficult to sustain in view of the almost total lack of archaeological evidence. The straits of Johore and of Singapore had their importance, nevertheless, and were the scene of 14th-century conflict between the local inhabitants and the Javanese. That there were fortified settlements up the Johore river is certain. Elsewhere, farther north, there may have been mining for gold and tin. But all the early history of Malaya is obscure and depends upon the doubtful identification of the place names mentioned by Arab and Chinese travellers.

Whatever the advantages of Malaya in mineral wealth and geographical position, its population remained insignificant and was quite small even in the 20th century. The country was a prey to neighbouring powers and we hear of no native civilization before the rise of Malacca in the middle of the 14th century. According to Malay legend, Malacca was first settled by a Malay chief whose original home (at or near Singapore and perhaps called Tumasuk) had been sacked and destroyed by the Javanese. Malacca is without some of the geographical advantages which such an earlier settlement would have provided but it offered, at that period, a sheltered roadstead, a navigable river, a good defensive position and a supply of fresh water, this last asset being none too common among the mangrove swamps of western Malaya. It also offered an overland line of communication by river, with only a short portage, to Pahang on the east coast. As that coast is unapproachable for sailing craft during the northeast monsoon, the trade of Pahang may have found its way to Malacca for at least half the year. In that trade was included the export of gold as well as tin.

Malacca, the first Malay kingdom, was a dependency of Thailand. to which it paid tribute in gold. But Chinese sources show that efforts were made to establish an alliance on tributary terms with China. These overtures in 1403–11 give us almost the first firm dates in Malayan history. Although effective Chinese help was unlikely, the Malays were emboldened to throw off allegiance to Thailand and even gain control of Pahang and other adjacent territories. The great days of the Malacca kingdom were from about 1450 to 1490 and have certainly lost nothing in the telling. Of prime importance, however, is the fact that the Malacca dynasty had been converted to Islam, probably in the 14th century, and was now influential in spreading Moslem doctrines throughout the peninsula. If the Malays were now Moslem, however, they readily countenanced the resort to Malacca of Hindu, Chinese and other traders. By the end of the 15th century Malacca was a place of sufficient importance to have given its name to the straits and perhaps to the peninsula itself.

Portuguese and Dutch Control. — So completely had Malacca assumed the commercial role of modern Singapore that the Portuguese, arriving in the east by the Cape route in 1498, marked it down for early conquest. It was captured by Alphonso d'Albuquerque in 1511 and absorbed into a Portuguese system designed to control the eastern trade; a system organized from Goa but stretching eventually from Ormuz to Macao. To deflect the trade from the old route (via the Red sea or Persian gulf) to the new oceanic route, possession of Malacca was essential. That city was stormed accordingly in 1511 and fortified against recapture.

The Portuguese exploited to the full the commercial possibilities of Malacca but never succeeded in destroying its native monarchy. Sultan Mahmud of Malacca established a new Malay capital as centre of a kingdom which now comprised Johore and the Riouw archipelago. He thus returned, in effect, to the vicinity of the original Malay city. Of his two sons, one became sultan of Perak. The other built a new capital at Johore Lama, on the Johore river. in about 1530. In the triangular war which continued with the Portuguese and with Achin in Sumatra, Malacca was repeatedly but unsuccessfully attacked. Johore Lama, on the other hand, was captured by the Portuguese in 1584. Recent excavation on this site has revealed a fortified settlement with pottery fragments dating from the 15th to the 17th century. All evidence suggests that, while the town was probably of some importance before 1530, it hardly survived its capture by the Portuguese and soon dwindled to its present status as a village.

Malacca fell to the Dutch and Malays in 1641, long after the Portuguese had lost naval control of the straits. By this date the Dutch had opened a new oceanic route from the Cape to the Straits of Sunda, a route which by-passed the Malacca straits and avoided Malaya altogether. Malacca was a place of reduced importance, therefore, under Dutch rule, with a declining population and trade. Deserted temporarily as a result of Achinese attacks, the Johore kingdom flourished again for a time, only to be sacked once more by the Sumatrans in 1673. Soon after, the royal line in that branch became extinct. The Dutch ruled as much of Malaya as suited them, making a state monopoly of the export of tin and building forts to guard the places of shipment.

British Rule. — The Dutch were unable to prevent the British

East India company from establishing a settlement at Pulo Penang in 1786 and the French wars which broke out in 1793 gave the British the opportunity to capture Malacca in 1795. Province Wellesley was acquired by purchase in 1800. This was followed by the foundation of another settlement at Singapore in 1819 and, in the treaty of London of 1824, the Dutch agreed to cede to the British all rights in Malaya, receiving in return the cession of all British rights in Sumatra. The East India company's establishments at Singapore, Penang, Malacca and Province Wellealey formed collectively the Straits Settlements and were a part of British India until 1867. Penang, originally designed as a naval base, and Malacca enjoyed only a mild prosperity but Singapore grew rapidly and became the base for the British expansion in Sarawak, Labuan and North Borneo. It was no part of British policy during this period to assert more control over the peninsula than would serve to exclude the influence of other European powers.

As a result of local agitation in the years following the Indian mutiny, the Straits Settlements were transferred in 1867 from the control of the government of India to the direct rule of the colonial office. This was a period during which other western powers were making their influence felt in southeast Asia, the French in Indochina, the Spanish in the Sulu archipelago and the Dutch in Sumatra. These last were nearest to Malaya; they were on the borders of Achin by 186j and clearly intending a further advance. International rivalry was intensified when the Suez canal was opened in 1869, bringing the main eastern trade back to its former route through the Straits of Malacca. This altered situation allowed the Singapore and Penang houses of agency to demand an extension of British influence in the Malay peninsula. It needed only a Conservative government to start the movement and such a cabinet took office in Feb. 1874.

Perak, Selangor, Negri Sembilan and Pahang were brought successively under British control (with a resident in each as the native ruler's adviser), with but one occasion for a display of force (during the Perak War of 187j). Two native states, Johore and Kedah, were already so influenced respectively by Singapore and Penang that any more systematic "advice" was for long deemed needless, In 1895 the four protected states were formed into a federation with a resident general at Kuala Lumpur. Up to this period the western states depended for their revenue upon tin mines. worked almost exclusively by Chinese. and communications were first developed between these mines and the coast. Later, the state railway systems were linked with each other, thus tending to unify the federation. The early planting was done by European planters along the line of the railways, coffee giving place to rubber from about 1900. An important result of this development was the recruitment of labour for the estates from southern India. The arrival of Tamil labourers, brought by government-subsidized shipping and protected by special legislation, added a new element to an already mixed population. Indians had not hitherto been present, except in Province Wellesley, in large numbers. The coming of the motorcar led to a rubber boom in 1906 and a bigger boom during and after World War I. Before this, however, in 1909, a treaty signed with Thailand transferred to British protection the states of Kelantan, Trengganu, Kedah and Perlis,' thus fixing the frontier on its present line. These territories were not absorbed into the federation but were governed more loosely as nonfederated states. Relations with Johore were not regulated by treaty until 1914 and even the Federated Malay States were never annexed as British territory.

In the years following World War I and the termination of the Japanese alliance. work began on a scheme for creating a full-scale naval base at Singapore (see below; also SINGAPORE). It was realized that the development of long-range aircraft made a defense of the naval base impossible without a defense of Malaya as a whole. Airfields were constructed in northern Malaya and the beginning of World War II brought to Malaya the troops needed to defend the airfields. When the Japanese attacked the United States and Great Britain in Dec. 1941 there were the equivalent of three and a half divisions of infantry in Malaya but few warships and few modern aircraft. With the temporary loss of sea power, Malaya was open to an invasion by seasoned Japanese infantry. This led to the conquest of Malaya and so to the fall of Singapore in Feb. 1942.

Malaya was occupied by the Japanese during the years 1942–45 and recovered only after the war ended. British prestige had suffered severely during the campaign and afterward, when the entire remaining British population was interned. It was hoped, nevertheless, to recover not merely the former degree of influence but a new and direct control following virtual annexation of the Malay territories in 1946. The constitution of the Malayan union, as thus established, was strongly opposed by the Malays and eventually withdrawn. Following new negotiations another constitution was drawn up and came into force on Feb. 1, 1948. This established the Federation of Malaya with Penang and Malacca included but Singapore was left as a crown colony. Co-ordination between the separate governments of the federation, Singapore and British Borneo was entrusted to a commissioner general whose functions were to be mainly diplomatic and advisory.

Toward Self-Government. — The end of the war with Japan did not bring immediate peace to Malaya, for the only effective local opposition to the Japanese had come from (mainly Chinese) Communists and these were armed and in the field when the Japanese surrendered. These now continued their guerrilla operations. A series of atrocities and attacks on property culminated in the ambush of Oct. 6, 1951, in which Sir Henry Gurney (high commissioner of the federation) was killed. This period of unrest coincided with a postwar boom in rubber and tin, initially caused by the cessation of exports during the previous period of enemy occupation and then intensified by the efforts of the United States to acquire stocks of these materials. Malaya thus served as a dollar-earner for the sterling area in 1949–52, the boom period ending only in 1953. Under the next high commissioner. Lieut. Gen. Sir Gerald Templer, the security forces were more effectively deployed and by mid-1954 Templer was able to relinquish the high commission to his deputy, Sir Donald MacGillivray, and the direction of military operations to a senior army officer. Measures to end the state of emergency included political as well as military action: in 19jj the federal executive council was transformed into a ministerial body and, on July 27, the first elections were held to the federal legislative council, 52 of whose 98 seats were elective. Fifty-one seats were secured by a triple alliance of the principal moderately nationalist community parties, Malay, Chinese and Indian. Tengku Abdul Rahman, leader of the United Malays' National organization (U.M.N.O.) and of the alliance, took on the chief ministry and the portfolio of home affairs. In Jan.–Feb. 1956 he attended a conference in London at which it was agreed that a new constitution providing full independence and self-government for the federation within the commonwealth should be introduced. The Malayan government assumed responsibility for finance. internal defense and security, including the prosecution of the war against the Communists. In December, however, it was made clear that even after independence had been achieved, British forces would be available until terrorism was completely crushed. Food control, which had proved a successful weapon, was tightened. and in 1956 the biggest single success of the emergency, the killing of the deputy secretary general of the Malayan Communist party, took place. On Aug. 5, 1957, MacGillivray signed an agreement providing for the admission of Malaya into the British commonwealth as an independent state on Aug. 31, 1957, and ceding the British settlements of Penang and Malacca to the new federation. Sir Xbdul Rahman was elected monarch at a conference of Malayan rulers on Aug. 3. (C. N. P.; X.)

POPULATION

The Federation of Malaya (area: 50,600 sq.mi.) had a population (1957) of 6,276,915, composed as follows: nine Malay states, Johore (925,919), Pahang (312,978), Negri Sembilan (365,045), Selangor (1,012,047), Kedah (701,486), Perlis (90,834), Kelantan (505,171), Trengganu (278,147), Perak (1,220,633); and two British settlements, Penang (274,325) and Malacca (291,233).

Table I shows the population increase after 1931 (the first census year).

TABLE I.—*Population, 1931–55*

	1931 (census)	1947 (census)	1955 (est.)
Malaysians	1,863,872	2,427,834	3,003,181
Chinese	1,284,888	1,884,534	2,326,498
Indians and Pakistanis	570,987	530,638	729,013
Others	68,011	65,080	93,407
Total	3,787,758	4,908,086	6,152,099

The Chinese predominate in the southwestern states, in Penang and in the commercial and industrial areas whereas there is a bigger percentage of Malays in the north and east and in Malacca.

Religion, Education and Health.—Malaya is basically a Moslem country. the Malays and many of the Indians folloning the Moslem religion. The other major religions practised are the Christian, Buddhist and Hindu.

The problems of education in Malaya are complicated by the fact that it is a multiracial community. The official languages are Malay and English. but many of the Chinese dialects, particularly Cantonese and Hokkien, and south Indian languages, chiefly Tamil. Telugu and Malayalam, are also spoken. Daily newspapers are published in most of the vernacular languages.

Secondary education is only available in schools in which English is the chief language of instruction, which are open to all races. and in some Chinese schools. In 1952 an education ordinance gave legal sanction to the provision of free and compulsory primary education and provided for a new multiracial school, called the National school, with either Malay or English as the medium of instruction, with Chinese and Tamil as subsidiary languages. Later, it was decided to introduce English-medium classes into the vernacular schools, and to discourage the setting up of purely vernacular schools. The policy of encouraging education was hampered by lack of teachers and by lack of funds. It was estimated that by 1954 405% of the population mere literate.

Table II shows the number of pupils enrolled in schools of all types in 1938, 1947, 1954 and 1955. In 1955 there were 4,751 schools of all types. Enrolment in the multiracial English-medium schools did not reflect the proportions of the races in the population: there were 26% Malays, 49.4% Chinese, 22.25% Indians and 2 4% others. From 1949 onward, a noticeable development was the rising number of Malays enrolling in multiracial schools.

The University of Malaya, established in 1949 and centred in Singapore, serves the federation and Singapore and has faculties of arts, science and medicine. There are also two technical colleges.

TABLE II.—*Education, 1938–55*

	1938	1947	1954	1955
English	18,444	52,900	158,485	178,644
Malay	57,144	149,414	349,583	368,017
Chinese	...	193,340	251,124	277,454
Indian	22,915	35,378	44,561	46,247

Principal diseases treated in government hospitals in the federation are malaria, pulmonary tuberculosis, dysentery. diarrhoea and enteritis, pneumonia, bronchitis, beriberi, venereal diseases and enteric fever. A remarkable development during the first half of the 20th century was the success of the campaign against malaria. By the mid-1950s it had ceased to be an indigenous disease; cases admitted to government hospitals continued to fall (from 22,281 in 1947 to 8,577 in 1955) and efforts were directed toward preventing its recurrence, and to fighting tuberculosis, the next most serious scourge of the Malay peninsula.

A ten-year health program was adopted in 1948. By 1955 there were 68 government hospitals, 161 private hospitals, 184 static dispensaries and 77 mobile dispensaries. There were also a maternity hospital and 553 maternity and child welfare clinics, and institutions for the treatment of tuberculosis, venereal disease, leprosy and mental diseases. There is an important Institute for Medical Research at Kuala Lumpur.

CONSTITUTION AND GOVERNMENT

The constitution of the Federation of Malaya dates from 1948 when the Federation of Malaya agreement between the British sovereign and the rulers of the Malay states came into force. The agreement established the federation under the protection of the United Kingdom, the government of the United Kingdom bearing responsibility for defense and foreign relations. In Feb. 1956, it was agreed that a new constitution should be introduced, if possible by Aug. 1957, granting the federation full self-government within the commonwealth. Meanwhile the Malayan government would take over full responsibility for finance, internal defense and security. In Nov. 1956, the high commissioner announced that independence day would be Aug. 1, 1957, and also made immediate amendments to the constitution to allow for Malayanization of the civil service.

The central or federal government is established at Kuala Lumpur. It is composed of the high commissioner, the federal executive council and the federal legislative council. Executive authority is exercised by the high commissioner through the executive council; ministerial responsibility for the work of the various government departments is borne by the members of the executive council, whose members, including the chief minister, are drawn from the political party with the majority in the legislative council, with, in addition, a few official members, who are senior government officers. The legislative council, which is presided over by the speaker, is composed of 98 members of whom 52 are elected. The council has powers to make laws on matters which are clearly defined in the federation agreement. Laws passed by the legislative council require the assent of the high commissioner and of the rulers. The high commissioner retains certain reserve powers to legislate if he considers it in the public interest.

There is established under the federal agreement the conference of rulers comprising the nine rulers of the states and their Malay advisers. This conference, which has no executive authority, meets at least three times a year and provides a channel for consultation between the high commissioner and the rulers and enables the high commissioner to ascertain the views of the rulers on matters of importance.

Under the various state agreements between the rulers and the British sovereign the executive authority in each state is exercised by the ruler aided by the state executive council composed of both official and unofficial members. The authority of the state executive council extends to all matters not within the executive authority of the federal agreement and is generally concerned with the internal administration of the states. In each state there is also a council of state, the composition of which varies but which in each case has a proportion of elected members which, with the nominated unofficial members constitutes a majority; it may pass laws on any subject other than those in respect of which the federal legislative council has the powers to legislate. The assent of the ruler is required before a law passed by the council of state comes into force. The rulers retain certain reserve powers similar to those retained by the high commissioner. The principal officer of the state is the *mentri besar* who is also the president of the council of state and in that capacity is the representative of the state on the federal legislative council.

The settlements of Penang and Malacca were incorporated in the Federation of Malaya under the Federation of Malaya order in council, 1948. The resident commissioner is the chief executive authority and presides over the settlement council which corresponds to the council of state in the states.

The chief executive officer of the state is the *mentri besar,* and of the settlement the resident commissioner. The states and settlements are divided into administrative districts under district officers. Many of the districts are subdivided into subdistricts and *mukims* or parishes, the administration of which is in the charge of an assistant district officer and *penghulus* or *pegawais.*

The executive responsibility for local government rests with the respective state and settlement governments. There are three municipalities, Penang, Malacca and Kuala Lumpur, with elected majorities. There are 22 elected town councils and 242 local councils which are fully elected bodies responsible for the administration of villages and kampongs roughly corresponding to the English parish council. The number of these is steadily increasing.

Legal System.—Generally the legal system of England, as modified and codified for India, is in force in the federation.

The control of executive actions of the courts is maintained by proceedings in the nature of the English writs of habeas corpus, mandamus and the like. The judicial system of the federation comprises a supreme court, divided into the court of appeal and the high court, which has unlimited civil and criminal jurisdiction. There are, in addition, sessions courts and magistrates' courts with limited civil and criminal jurisdiction, from which appeal lies to the high court and thence, conditionally, to the court of appeal. A final appeal from all courts lies to the sovereign in council (the judicial committee of the privy council). The attorney general is the principal legal adviser to the government, and he is also, in his capacity as public prosecutor, responsible for the direction and conduct of all criminal prosecutions.

The Torrens system of land registration of title ***(see*** TORRENS, SIR ROBERT RICHARD) is in force except in the settlements of Penang and Malacca. Most alienated land is held in perpetuity on payment of an annual rent to the government. Land may be alienated to anyone except in Malay reservations where it may not be alienated to non-Malays.

All persons born in the settlements of Penang and Malacca are British subjects, citizens of the United Kingdom and colonies and automatically citizens of the Federation of Malaya. Subjects, whether by birth or naturalization, of the rulers of the Malay states are also citizens of the federation. Citizenship may also be acquired by registration. All citizens of the Federation of Malaya, if not otherwise British subjects, are British-protected persons.

Defense. — The external defense of the federation is the responsibility of the United Kingdom government. In 1956. however, when responsibility for internal defense was transferred to a Malayan minister for internal defense and security, a Federal Armed Services council uas set up, to administer the growing armed forces of the federation.

ECONOMIC CONDITIONS

Agriculture, Forestry, Fisheries. — Malaya produces about 32% of the world's natural rubber. and rubber is its most important commercial crop. About 64% of the total planted area is devoted to it, and its importance to the country's economy is indicated by the fact that in 1954 the net value of rubber exported was M.$859,500,000, 55% of the total value of all exports.

TABLE *111.—Agricultural Crops*

(000 acres)

	1940	1950	1952	1955
Rubber.	3,412	3,358	3,613	3,728*
Rice	786	876	834	891
Coconut	601	485	485	500
Oil palm	78	96	100	109*
Fruits	185	176	164	187*
Food crops	110	87	74	97
Spices	67	56	53	56*
Other	76	51	66	60*

*1954.

Rubber is grown both on estates, mostly owned by Europeans, and small holdings, owned by Asians. In 1955, of the total planted area under rubber (about 3,500,000 ac.), the estates area was about 2,030,000 ac., and estates produced 352,000 tons of the total production of 637,000 tons.

The growth of the synthetic rubber industry led the Malayan government to take steps to increase efficiency in the rubber industry. Efforts were made to encourage replanting, particularly on small holdings. Estates growing rubber have. in the main, carried out a steady policy of replanting old rubber trees with trees of proved high-yielding capacity. A tax was imposed on the export of locally produced rubber to provide funds for replanting on small holdings. In 1954, a mission of inquiry into the rubber industry (the Mudie mission) reported on the urgency of expanding the area planted to high-yielding rubber. and as a result, legislation was passed to regulate the export duty and to introduce an 11-year replanting program.

Malayan soils are poor judged by the standards of temperate regions. Their productivity depends upon optimum conditions of rainfall and temperature for plant growth, and on intensive weathering continually making available small quantities of plant food. The particular characteristics of the soils and climate and the topography of the country have led to the development of intrinsically simple systems of agriculture well adapted to Malayan conditions, which do not exploit soil resources. Soils that are exposed to the weather deteriorate rapidly and except for Chinese market gardening, which is famed for its soil-building quality, systems of dry-land arable farming have not been developed. The swamps and the flat coastal plains are best utilized for wet paddy, and the higher undulating areas for permanent tree crops.

The percentage of production to consumption of rice is about 50%. Paddy cultivation is almost solely confined to the Malays. After rubber and rice, coconut is the most important crop. Other food crops are tapioca, sweet potatoes, yams, maize, peanuts, cucumbers, etc., and pineapple. Encouragement of pineapple growing on plantations was a feature of post-World War II agricultural policy. Tea is grown in the highlands and lowlands of Malaya, mostly on estates. Tables III and IV show acreages planted and production of the most important crops.

The total volume of timber (excluding poles, firewood and charcoal) produced in the Federation of Malaya in 1955 was 74,279,000 cu.ft. round measure which almost equalled the 1952 record of 74,479,000 cu.ft. Malaya is self-sufficient in timber.

TABLE *lV.—Agricultural Production*

(tons unless otherwise stated)

	1940	1950	1952	1955
Rubber. , . . .	544,000	693,000	583,000	639,000
Rice	536,000*	703,000	700,000	652,000
Palm oil , . . .	57,000	53,000	45,000	56,000
Palm kernel. . . .	10,000	13,000	11,000	15,000
Copra	...	149,000	155,000	144,000
Coconut oil . . . ,	...	73,000	81,000	95,000
Tea (lb.) . . .	...	...	3,785,000	5,306,000
Pineapple (canned tons) .	...	...	13,851	23,717†

*1938. †1954.

The majority of the 49,500 fishermen in Malaya are Malays, but the financing and marketing of fish is preponderantly in the hands of the other races. Total production in 1955 was 109,422 tons, of which approximately 25,000 tons came from fresh-water fisheries. Fish is the most important protein element in the local diet.

The Rural and Industrial Development authority was inaugurated in 1951 and incorporated in 1953. Its object is to provide the rural and urban population with means of improving their economic and social standards by means of assistance from the authority and by promoting self-help among the people concerned. The authority's work is proving a great benefit, especially in the rural areas.

Mining. — The Federation of Malaya is responsible for about one-third of the world's production of tin. More than 90% of the ore (cassiterite) is won from alluvial deposits in the states of Perak and Selangor. The commonest methods of mining are by dredges and by gravel pump. Other minerals of economic importance are iron ore, gold, bauxite, ilmenite, columbite. wolfram and scheelite. Table V gives figures of mining production.

TABLE V.—*Mining Production, 1940–55*

(in tons unless otherwise stated)

	1940	1950	1952	1955
Tin-in-concentrates	80,651	57,737	56,838	61,245
Iron ore . .	1,962,463	498,903	1,055,506	1,466,184
Coal . .	781,509	415,777	314,922	206,118
Gold (troy oz.) .	35,689	18,436	19,806	22,838

Finance **and** Trade. — The following is the table of public finance (federal, state and settlement together), 1949–53.

The public debt at the end of 1953 amounted to M.$364,648,245 (approximately M.$63 per head of population). The states and settlements have their oun budgets for local administration.

The main items of revenue are derived from export duties on rubber and tin. import duties on tobacco, beer, spirits. gasoline and textiles and from income tax. The flow of imports depends upon the export earnings, which are largely derived from rubber and tin. There is an old-established entrepôt trade at Penang which is conducted in small vessels trading with northern Sumatra, south and western Thailand and Burma. In 1955 the value of imports was M.$1,543,000 and exports M.$2,360,000. Table VII gives principal exports by commodities. 1947–55.

Table VI.—*Revenue and Expenditure, 1949–53*

*1954.

The standard currency is the Malayan dollar linked to sterling and valued at 2*s*.4*d*. The standard measures are the imperial yard, imperial gallon and imperial pound, though there are local equivalents.

Communications. — The public road system covered 6,354 mi. in 1955, of which 4,403 mi. were macadamized. The main trunk road runs north and south from the Thailand border in Perlis to Johore Bahru. passing through all the state capitals of the nest coast states. An east-west trunk road connects the east coast at Kuantan with the main north-south road 40 mi. N. of Kuala Lumpur. A partially metalled road connects the east coast from Pekan in Pahang north to Kota Bharu in Kelantan.

The Malayan railway, which is government-owned extends for over 1,000 mi. The main line runs from Singapore to Prai on the mainland opposite to Penang and thence up to the Thai border where it connects with the Thai railway system. A line branches off the main line at Gemas in Negri Sembilan and connects with Kota Bharu in Kelantan from where it also connects with the Thai railway system.

The principal ports are Penang and Port Swettenham. Services to and from the United Kingdom are provided by the main shipping companies on the far eastern service. Local companies provide coastal services and services to ports in southeast Asia.

There are civil customs aerodromes at Kuala Lumpur, Ipoh, Taiping, Penang, Alor Star, Kota Bharu, Kuantan and Malacca; 48 smaller airfields can be used for commercial, military and private purposes.

There is a telephone system throughout the country. Most urban areas have an electricity supply. A government-owned broadcasting system broadcasts in most of the languages spoken in the country. (J. H. Lh.)

SINGAPORE

Singapore, the British colony and city which adjoins Malaya, is separated from it only by the narrow Straits of Johore and these are crossed by a causeway, which carries the railway, the main road and the city's water-supply pipe line. The islsnd lies in 1° 1;' N. latitude and 103° 51′ E. longitude and measures 27 mi. from east to west, 14 mi. from north to south. The area of Singapore, including adjacent islands, is 28; sq.mi.

Besides the city of Singapore (*see* Singapore), the island contains the naval base on its northern coast, east of the causeway, a royal air force airfield at Changi and several other and smaller R.A.F. stations. Coastal batteries and other defensive installations are sited mainly on the southern or seaward coast and upon immediately adjacent islands. A large civil airport at Kallang has been superseded by one still larger at Paya Lebar. Industrial development outside the docks area is largely confined to the main road which crosses the island toward the causeway, other parts of the island being either suburban or rural and only lightly populated. West of the town and inland from Pasir Panjang lies a large area devoted to military barracks. supply depots and hospitals.

Physiography

In its geography, geology, fauna and flora Singapore Island is merely a small sample of Malaya (*see* above). The highest hill, Bukit Timah, rises to only 581 ft. and the rivers are small and end. where they are not canalized. in mangrove swamps. Of the Malayan geological formations only the Triassic shales and sandstones and the hlesozoic igneous rocks are exposed, and these are overlain in places by alluvium. some of nhich is raised above sea level. There are no metalliferous deposits on the island. but granite is quarried on a large scale and Triassic shales are used for brickmaking. When A. R. Wallace visited Singapore in the 1850s he remarked that on an average a man was killed by tigers every day. Now the largest mammals are monkeys. civets and mouse deer. Birds are numerous and most species are protected by law. An area of about 12 sq.mi. in the centre of the island, surrounding the three reservoirs, is preserved as a catchment area and felling of trees and hunting and shooting are forbidden in it. There a fairly representative sample of the smaller animal life of southern Malaya, reptiles, insects and the like. is to be found. Most of the jungle in this area is secondary — that is, it has grown up after felling — but a most interesting and valuable relic of the primary forest is preserved on Bukit Timah hill, which is coextensive with the catchment area. (M. W. F. T.)

History

There is believed to have been a port in the vicinity of Singapore in the 12th–13th centuries but there is little evidence to show either its position or extent. Malay sources allude to a town destroyed by the Javanese in the 14th century. and it was a study of these sources which encouraged the modern founder of Singapore to choose a site nhich he identified with that formerly occupied. Whatever the truth of this matter, it is certain that Singapore Island was scarcely inhabited at the beginning of the 19th century. It belonged then to the sultan of Johore whose remaining territories comprised also the Riouw archipelago. Pahang and what is now Johore proper, all supposed to be under Dutch protection. The Dutch control over the East Indies was weakened during the French wars of 1793–1815 n-hen. the Netherlands being under the control of France. one Dutch colony after another came to be occupied by British troops. Eventually, in 1811, Java itself was taken and Stamford Raffles placed there as governor. The Dutch East Indies were returned to the Netherlands nhen peace was made but Raffles, now lieutenant governor of Benkulen in Sumatra. was anxious to prevent the Dutch regaining or extending their influence in the Malay archipelago. He persuaded the governor general of India to allow him to found a new British settlement near the southern entrance to the Straits of Malacca. This was done in 1819, the island of Singapore being the place chosen although not the site originally preferred. Dutch protests ended in a general agreement in 1824 (the treaty of London) by nhich Benkulen was yielded in exchange for Malacca and a line agreed upon dividing the British and Dutch spheres of influence. Raffles had established Singapore as a free port and the town grew rapidly for several years, attracting much of its trade from the Dutch ports and some from Penang. The East India company lost its monopoly of the China trade. however, in 1833, and with it such interest as it had previously shown in Singapore. The port suffered again from the establishment of Hong Kong in 1831 and thenceforward enjoyed only a moderate prosperity until about 1870 The opening of the Suez canal. and with it the replacement of sailing vessels by steamships, brought about a transformation in the port's activities. This was represented in the first place by the development of the Tanjong Pagar docks, and, in the second place, by the accumulation in Singapore of coal for naval purposes which had, in turn, to be protected by batteries. With the development of the resources of the Malay states. Singapore added to its existing entrepôt trade a partial monopoly of Malayan exports and imports. The Straits Trading company set up its vast tin-smelting works on the island of Pulau Brani, to which came most of the tin ore from the mainland. Docks and warehouses multiplied and the port rapidly became a world-famous centre of commerce. Its prosperity was marked by the construction of government buildings, town hall, supreme court. hospitals and schools. It was the seat of government for the Straits Settlements as a whole and the governor was also, before World War II, high commissioner for the Federation of Malaya.

In 1921 began the construction of the naval base, situated between Singapore Island and the mainland. Modern coastal defenses were developed from about 1932 and these. with the necessary airfields. led to Singapore's being termed a fortress. It scarcely deserved that title on its landward side where, obviously, the defense of the naval base could not be conducted from the island itself. When the Japanese oifensive of 1942 drove the commonwealth forces back into Singapore Island hopes centred on the possibilities of a protracted siege defense and the arrival of a relieving army by sea. But in effect there was nothing left to defend. With enemy artillery in South Johore and enemy land-based aircraft within easy striking distance, the naval base, the commercial harbour and the Singapore airfields were all practically useless. However. the British government was reluctant to surrender a base on nhich so much had been spent. The result was not only an order to defend the island to the end but the arrival at the last moment of another infantry division, too late to do much more than swell the total of prisoners.

The Japanese offensive began on Feb. 8, 1942, the Straits of Johore proving no greater obstacle to the invaders than several rivers they had already crossed. A landing mas made in the northwest part of the island and the defenders were driven back toward Singapore town. their withdrawal allowing the island's reservoirs to fall into enemv hands. Lieut. Gen. A. E. Percival was authorized to surrender; this he did unconditionally on Feb. 15. With forces consisting partly of troops which were exhausted by a fighting withdrawal from northern Malaya and partly of troops which were unacclimatized, there was little more he could have done. There can be no doubt that a defense of Singapore, street by street and house by house (destroying the town and most of its population in the process) would have done more to uphold British prestige in the east. But humanitarian motives prevailed and Singapore passed more easily into Japanese hands, remaining a Japanese base until the end of the war. It was then recovered more or less intact save for the naval base installations, wrecked before the surrender or damaged by Allied bombing afterward.

In 1946, with the transfer to the federation of the settlements of Penang and Malacca, Singapore Island became a crown colony. Singapore received its royal charter as a city in 1951. The naval base played a part in refitting warships taking part in the Korean war hut there was unrest among the workers. In 1955 the colony's executive council became a council of ministers, and on April 2 the first general elections were held to a newly constituted legislative assembly, 2j of whose seats were elective. A "labour front," left-wing and "anticolonial" (but anticommunist), emerged as the main group in the assembly, with 10 of the elective seats. Its leader, David Marshall. a moderate socialist. assumed the chief ministry and the commerce portfolio. A conflict with the governor about the latter's discretionary powers ended in a compromise, by which the legal status of the governor's discretionary powers was unaltered. but he was instructed to exercise them only according to the advice of the chief minister. In April–May 1956 Marshall took part in a London conference at which he urged Singapore's desire for self-government. Negotiations broke down over the problem of responsibility far internal security if Singapore became a self-governing member of the commonwealth, and Marshall resigned in June, being succeeded by Lim Yew Hock, the president of the Labour front. On April 11, 1957, an agreement was signed in London outlining terms for a constitution granting Singapore internal self-government. A date for relaxation of controls was to be decided by Jan. 1, 1958. (C. N. P.)

Population

At the census of the colony of Singapore taken in Sept. 1947 the population numbered 940.824. Pop. (1957 census) 1,466,800.

BY COURTESY OF BRITISH INFORMATION SERVICES

WASHING CASSITERITE. TIN ORE. AT AN OPEN-PIT MINE ON THE WEST COAST OF MALAYA. THE ORE IS SMELTED AT PENANG AND SINGAPORE

Singapore's position as a focal point for the trade of southeast Asia made the growth of a mixed population inevitable. In 19jj it was estimated that there were 927,981 Chinese (76% of the total), 148,520 Malaysians, 94,295 Indians and Pakistanis, 18,305 Europeans, 11,684 Eurasians and 11,803 others. The influx of Chinese and Indians followed the establishment of British rule in 1819. The population at the first census in 1824 numbered 10,683 persons of all nationalities. By 1860 it had risen to 81,734 but with a significant majority (more than 50,000) of Chinese. In 1919 the population within the municipal limits was estimated at 305,000 persons. In 1931 it was 559,945, of which 74.9% was Chinese. During the slump of 1928 to 1933 immigration was reduced and a system of quotas for the entry of aliens introduced. The quota did not prove effective in obtaining the right type of immigrant, and from 1934 to 1938 the net increase in population was 648,000 persons, mostly males. During the Japanese occupation of Malaya. transportation of large numbers of workers out of Singapore took place compulsorily. After the war the influx began again and by 1946 it became desirable to introduce selective immigration. In August entry was prohibited except to those who could contribute to the commerce and industry of the colony, and those who could provide specialized services not available locally.

Social Services.—In 195j it was estimated that 862,222 persons lived in the city and about 340,000 in the rural area of Singapore. This large concentration of population in the city area, barely 3 mi. in radius, as well as the shortage of good agricultural land, has made the provision of social services very important and has restricted development of food production. For the years 1955–59, the government intended spending Mal. $150,000,000 as capital expenditure on social development. The medical plan was to cost about Mal. $52,000,000 from 1951 to 1960. By 1955 buildings costing Mal. $5,000,000 had been built. To staff these, 100 doctors and 1.000 nurses were recruited and trained.

The governments of the Federation of Malaya and Singapore agreed on the future development of the University of Malaya and guaranteed a part of the funds. The medical: arts and science faculties were to be sited in Singapore while those for agriculture and engineering would be established in the federation. Because of the difficult conditions prevailing in China and the lack of higher Chinese education in the federation and the colony, the Chinese community in Malaya founded in 1954 a second university in Singapore, the Nan Yang university. The well-known Chinese writer Lin Yutang was elected its first chancellor. By April 1955, however, relations had deteriorated between the governing body and the faculty, who resigned as a body. The project was put in abeyance. Legislation was passed in 1954 for the establishment of a polytechnic college.

Constitution and Government

The Japanese surrendered Singapore to the British in 1945. On April 1, 1946, the British military administration of Malaya came to an end and at the same time the Malayan union and the colony of Singapore came into being. The United Kingdom secretary of state for the colonies announced in May 1947 that a legislative council with an unofficial majority would be set up. It was to comprise the governor: 9 official and 13 unofficial members, of whom 6 mould be popularly elected. An elections ordinance was brought into force in July 1947 providing universal adult suffrage for all British subjects resident in the colony. In March 1948. 63% of the registered voters went to the polls. Fifteen candidates were nominated. five representing the Progressive party (the only party then formed) and ten standing as independents. Three of each group were returned.

In 1951 the number of popularly elected members was increased from six to nine. In the same year the legislative council elected an unofficial member to be its vice-president and take the chair in the governor's absence. Two unofficial members were also elected to the executive council, thus linking the two councils together. After 1951 the legislative council consisted of the governor as president, 4 ex-officio members, 5 nominated officials, 4 unofficial members and 12 elected members. Of those elected. nine were chosen by popular ballot and three by the principal chambers of commerce. The four other unofficial members were nominated by the governor to represent important interests not otherwise represented.

In 1953, the governor appointed a constitutional commission under Sir George Rendel, a senior British diplomat. In Feb. 1954 the commission recommended a system of automatic registration of voters and the establishment of a mainly elected legislative assembly with a speaker. The assembly was to comprise 25 popularly elected members. 3 ex-officio members and 4 members nominated by the governor. The majority party in the assembly was to form a council of nine ministers. with the governor as president. Six of the nine were to be from the elected members of assembly with the leader of the majority party as chief minister. The remaining three were the ex-officio members. Elections for the assembly were held in April 1955 and out of the 25 elective seats the Labour front obtained 10, more than any other group, and was thus able to form a ministry.

The municipal affairs of the city are in the hands of a council under a civil servant as president. The council was established by royal charter in 1951, being then incorporated from a municipal commission into a city council. Of the 27 members of this council, 18 are elected by popular franchise and 9 nominated by the governor. Outside the city boundaries the island is administered by a rural board which includes representatives of village committees.

Economic Conditions

Finance and **Commerce.**—The basis of Singapore's prosperity is its entrepôt trade. The colony is a free port and the only customs duties are those levied on spirits, tobacco and petroleum. The biggest revenue earner, however, is income tax, which was introduced in 1948

The monetary unit is the Malayan dollar, the value of which was fixed in 1906 at *2s.4d.* sterling. Currency is circulated under a currency agreement of Jan. 1, 1952, between the governments of the Federation of Malaya, Singapore. Sarau-ak, North Borneo and Brunei. The currency commissioners have the sole right to issue notes and coin in these five territories and, as a backing for the currency, they manage a fund consisting of sterling securities.

During 1950–5j revenue was buoyant as a result of favourable trading conditions. After World War II Singapore enjoyed a trade boom. In 1948 the value of total trade was £285,000,000 as against £118,000,000 in 1946 and £81,000,000 in 1938. The peak of the boom was 1951 when trade totalled £901,000,000. The prices of rubber and tin are the main factors which govern trade. The boom of 1950–51 was mainly caused by increased world prices for these two commodities resulting from the outbreak of the Korean war. A high proportion of Singapore's postwar trade mas conducted with the United States and the British commonwealth. They were the main suppliers of the colony's imports of manufactured goods. Trade also expanded with Indonesia, Thailand, Borneo, Sarawak and Indochina, though, after 1952, the introduction of import restrictions by the governments of a number of these territories hampered the growth of the colony's trade.

Communications. — Singapore has a natural deep-water harbour. free of mud and shoals, with excellent dock and wharf facilities. Dock accommodation includes five graving docks. Deep-water wharves totalled 13,500 ft. in 1955, and there was at that date storage for about 1,800,000 sq.ft. of cargo. Air services on all the international routes are provided by the major airline companies. Kallang airport, in the city area: opened in 1937, was replaced in 19jj by a larger and more up-to-date one at Paya Lebar to the northeast. It was large enough for any aircraft likely to be used on international routes. Good road and rail services connect the colony with the Federation of Malaya. About 16 mi. of dock railways enable bulk carriage of the valuable entrepôt commodities, *e.g.* rubber, palm oil; latex. etc., between Singapore and the mainland. (G. E. Bs.)

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MALAYALAM, one of the four literary languages of the

Dravidian family, is spoken on the west coast of southern India. It developed out of Tamil between the jth and the 10th centuries. In general it differs from Tamil in the absence of personal terminations in the verb. The colloquial and even more the literary language uses many words borrowed from Sanskrit. There were estimated to be 14,000,000 speakers at mid-20th century.

See *Linguistic Survey* of *India*, vol. iv (1906) ; R. Caldwell, *Comparative Grammar* of *the Dravidian Languages* (1913). (M. B. E.)

MALAY ARCHIPELAGO, also known as Malaysia and the East Indies. the largest group of islands in the world, consisting of the more than 3,000 islands of Indonesia and the 7,000 islands and unnamed rocks of the Philippine group. New Guinea is usually arbitrarily included in the Malay archipelago while the Andaman and Nicobar Islands in the northnest and the Bismarck archipelago in the east are not. The principal islands and groups of Indonesia include Sumatra. Java. Borneo (Kalimantan), Celebes (Sulawesi), the Lesser Sunda Islands and the Moluccas, including Halmahera. The Philippines include the large islands of Luzon in the north and Mindanao in the south. with the Visayan group between. For political divisions, see the Table in Population, below.

The archipelago extends along both sides of the equator for a longitudinal distance of more than 3.800 mi. and is 2,200 mi. in its greatest north-south dimension. The festoons of islands with their enclosed seas are situated between the Pacific and Indian oceans. Stretching from the mainland of Asia to Australia. the archipelago is separated from mainland Asia in the west by the 30-mi. Strait of Malacca, from Formosa in the north by the 100-mi. Bashi channel and from Australia by the 100-mi. Torres strait.

This island bridge is an area of physical and cultural transition between Asia and Australia. Due to its transitional nature and physical fragmentation, the region is one of great variety in physical landscape, climate, vegetation, animal life. land use and stage of economic development. The different peoples, their distinct cultures, myriad languages and many religions add to this diversity. The region has been subject to Indian, Chinese. Australian, Melanesian and European influences, all contributing to its cultural multiformity.

PHYSICAL GEOGRAPHY

Geology and Physical Features. — Structurally the Malay archipelago divides into three parts: the Sunda platform, the Sahul shelf and the area of recent tectonic activity which lies between the two. The Sunda platform is a stable continental extension of mainland southeast Asia. Most of the platform is covered by shallow seas averaging less than 2j fathoms. Borneo and parts of Java, Sumatra and associated islands are sections of the platform above sea level. These are areas of worn-down mountains of old metamorphic rock and are of complex geologic origin. The Sahul shelf, of which New Guinea and related islands are a part, is an extension of the Australian continent similar in structure to the Sunda platform and also covered by shallow seas. Between these stable continental platforms is a zone of recent tectonic activity: faulted and folded steep young mountain systems arranged in long mountain ranges or chains of islands. The main arc runs from Burma through the line of the Andaman and Nicobar Islands, forms the main ranges of Java, Sumatra and the Lesser Sunda Islands and then curves back through the Moluccas to Celebes. A circumpacific arc runs southward through the Philippines, through Halmahera and eastward along New Guinea. Other arcs run from the Philippines to Celebes and from the Philippines to Borneo. Around Celebes is a confused area of fragmented arcs and downfaulted basins.

Tectonic activity is characterized by frequent earthquakes, more than 1,500 a year occurring on the island of Banda in the Moluccas. Along the fracture lines associated with Tertiary folding are found a string of volcanic peaks, dating from the Late Tertiary and Quaternary. There are more than 300 cones, of which jo are still active. Volcanic cones are scattered through the Philippines, northern Celebes and the Moluccas, and form the impressive chain of peaks which dot the Lesser Sunda Islands and march majestically down the length of Java and Sumatra. Eruptions are often of the explosive type but the benefits from volcanoes far outweigh the harm. The ejecta and ash weather into extremely fertile soil; the forest-covered permeable ash cones collect and store rainfall which is later made available for agriculture by surface streams.

Associated with the arcs are deep offshore trenches or basins. More than 20 are located in the area between the continental shelves and are occupied by deep seas. many over 2,500 fathoms deep. Coral growth reaches its greatest development in the Great Sunda reef which marks the edge of the Sunda platform off the east coast of Borneo. Coral reefs and atolls are found throughout eastern Indonesia and the southern Philippines.

The mountainous nature of the islands plus the generally high annual rainfall results in many short, steep-gradient rivers with erosive power. On the islands which lie on the continental shelves. the rivers deposit eroded, material in the shallow surrounding seas and rapidly build extensive flood plains and deltas. Across these lowlands develop long rivers, such as the Musi in Sumatra, the Kapuas and Barito in Borneo and the Sepik and Fly in New Guinea. The islands which rise steeply from the deep seas between the continental shelves have little opportunity to build coastal plains and deltas in the surrounding deeps; level lowlands are limited and the rivers are usually short and steep.

Climate. — The Malay archipelago lies entirely within the tropics and, with the exception of the northern islands of the Philippines, within 10° of the equator, which bisects the major islands of Indonesia. Because of this equatorial location, temperatures are high, averaging 80° F. The annual variation in temperatures is only a few degrees at the equator, but increases away from the equator to about 20° F. in northern Luzon. Annual variation in temperature is modified by the maritime influence of the surrounding seas. Temperatures are also modified by elevation, and many hill stations such as Baguio (*q.v.*) in Luzon and Prapat in Sumatra have been established in the highlands to take advantage of the lower average temperatures.

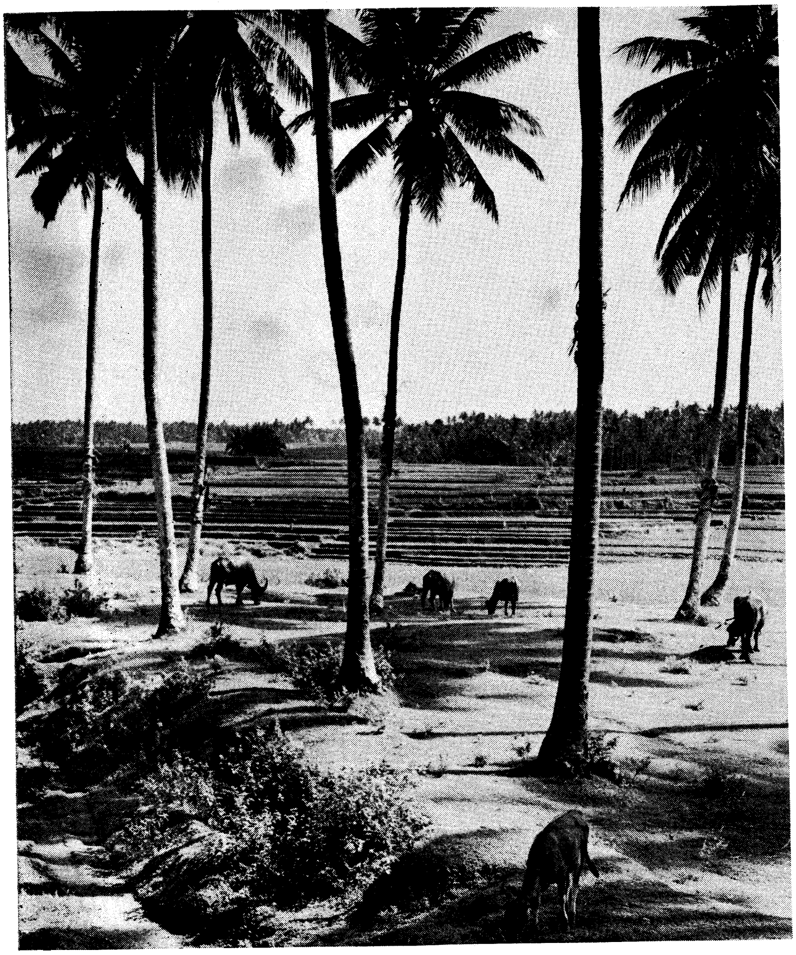
The variable element in the climate is rainfall, which ranges from more than 320 in. annually on exposed mountain slopes in Sumatra and Java to less than 20 in. in rain-shadow areas of western Celebes and the Lesser Sunda Islands. Most of the archipelago averages more than 80 in. of rainfall well distributed through the year. but the total decreases and the length of the dry season increases from central Java eastward through the Lesser Sundas and from Mindanao northward in the Philippines. Timor, in the Lesser Sunda Islands, has a dry season of more than six months per year. There is also great local variation in rainfall depending on elevation, relief and wind direction.

Another climatic element is the typhoon. More than 20 of these storms arise each year in the Southwest Pacific from July through November and then swing westward and northward, bringing violent winds and heavy rains to the Philippines north of Mindanao.

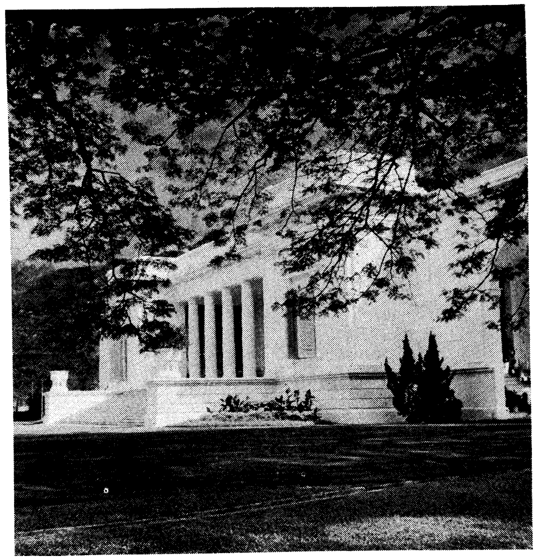
The region is usually under the effect of the doldrums or intertropical front. a zone of convergence of the northeast trade winds from north of the equator and the southeast trades from the southern hemisphere. Rising moist air in this zone of convergence results in heavy rainfall. This frontal zone of convergence moves north and south with the seasons. The proximity of the two continents of Asia and Australia further influences the wind pattern and consequently the rainfall pattern of the archipelago. During the northern hemisphere winter the northeast trades are reinforced by cold air masses from a high-pressure area over the middle of Asia. Thus reinforced. the northeast trades sweep over the islands toward the low-pressure centre in Australia and this is known as the northeast (or northwest) monsoon. In the northern hemisphere summer this pattern is reversed and the southeast (or southwest) monsoon results. Most islands receive rainfall from both monsoons.

Vegetation.——The natural vegetation of the islands reflects their transitional climatic nature and differences in total rainfall and its annual distribution. Throughout most of the area heavy rainfall and high temperatures result in continuous, rapid plant growth of great variety. Evergreen tropical rain forest with a great variety of large dipterocarps covers areas with ample rainfall. In drier areas there is a semideciduous monsoon forest, including such trees as teak and eucalyptus. This forest has seasonal rather

MALAY ARCHIPELAGO



Balinese farm. In the foreground cattle graze under coconut trees; in the background are terraced rice paddies



Istana Merdeka (Freedom palace), residence of the president of Indonesia, Jakarta, Java

Hanging sheets of rubber to dry in a processing plant at Medan, Sumatra

Balinese dancer

Street scene, Medan, Sumatra, largest city of the island

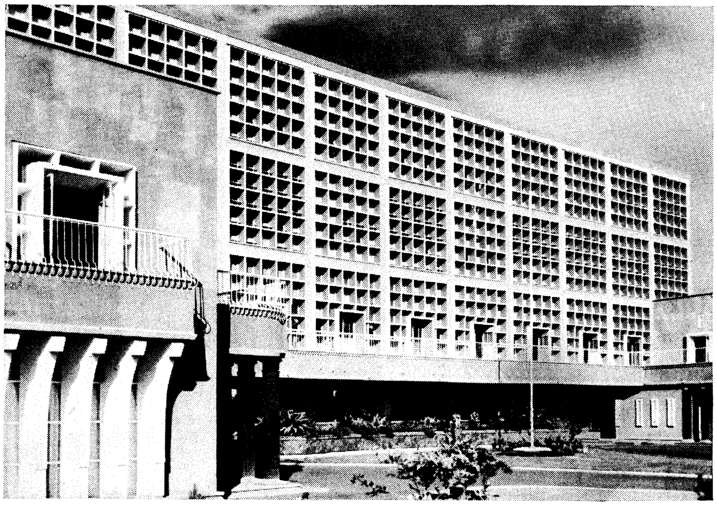
SCENES OF BALI, SUMATRA AND JAVA

PHOTOGRAPHS, (TOP LEFT, RICHARD HARRINGTON FROM THREE LIONS, (TOP RIGHT) WAAGENAAR—PIX FROM PUBLIX, (CENTRE RIGHT, BOTTOM LEFT, BOTTOM RIGHT) AVA HAMILTON

MALAY ARCHIPELAGO

Balinese boy tending herd of geese

Hindu temple of carved stone at Boni, Bali



Modern building of the People's Agricultural centre, Jakarta

Farm women returning from the fields. In the background is Merapi ("Fire mountain"), an active volcano of central Java

Gabensis, a typical village of the Morobe district, eastern New Guinea

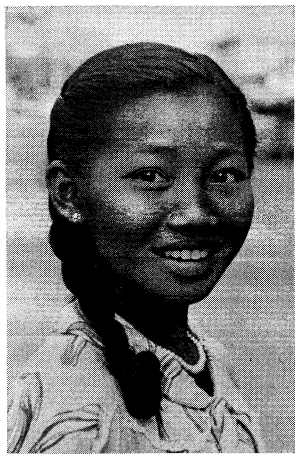
VIEWS OF INDONESIA AND NEW GUINEA

BY COURTESY OF (CENTRE LEFT) INDONESIAN EMBASSY LONDON (BOTTOM RIGHT) AUSTRALIAN NEWS & INFORMATION BUREAU: PHOTOGRAPHS, (TOP LEFT) EBRI FROM THREE LIONS (TOP RIGHT) RICHARD HARRINGTON FROM THREE LIONS (BOTTOM LEFT) W SUSCHITZKY

Typical thatched house, raised on bamboo stilts, near Macassar, Celebes

Jungle vegetation along the banks of the Rejang river, Sarawak, British Borneo

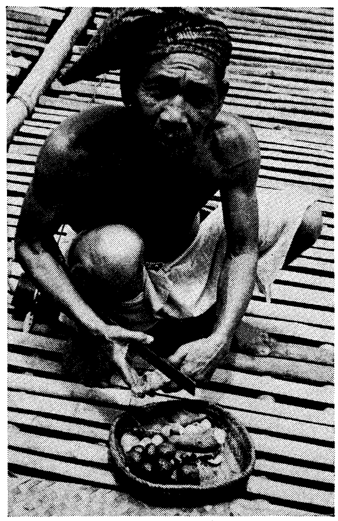
Rubber worker gathering latex at a plantation near Pematangsiantar, central Sumatra



Typical Sumatran girl

Farmer sowing rice seeds, Java

Hillside rice terraces, Bali, an important rice-growing island of Indonesia

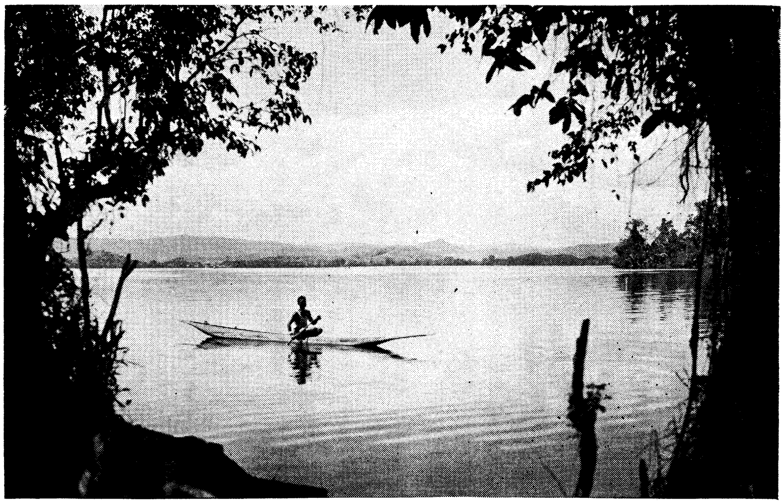


Land Dayak of British Borneo

PEOPLE, PLACES AND ECONOMIC ACTIVITIES OF THE ARCHIPELAGO

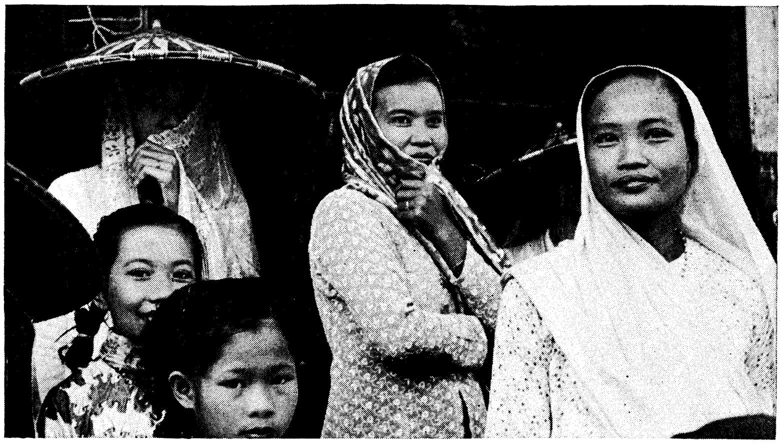
BY COURTESY OF (CENTRE RIGHT) UNITED NATIONS PHOTOGRAPHS (TOP LEFT) K. PFLZER FROM BLACK STAR, (TOP RIGHT, CENTRE LEFT CENTRE, BOTTOM RIGHT) AVA HAMILTON, (BOTTOM LEFT) SPAA—PIX FROM PUBLIX

MALAY ARCHIPELAGO



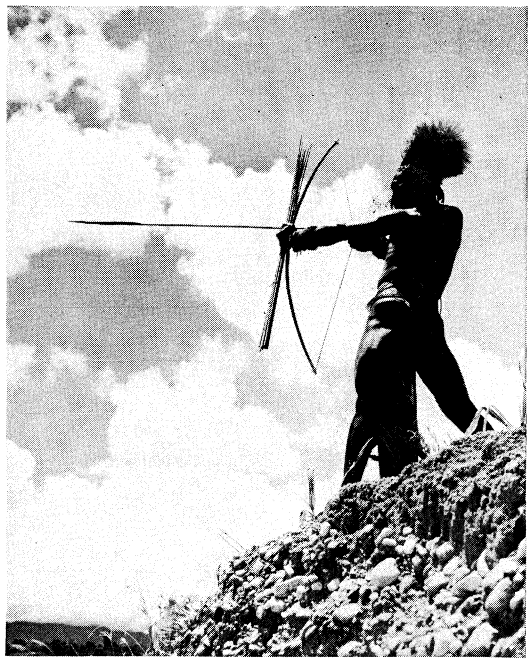
View from the shore of Lake Sentani, northern New Guinea

Costumed actor in a temple drama, Bali



Women and children of Kuching, capital of Sarawak, Borneo

Women washing their clothes in the canal which runs along the main street of Jakarta



Minj tribesman of the southern highlands district of Papua territory. New Guinea

INDONESIA AND BRITISH POSSESSIONS OF THE REGION

BY COURTESY OF (BOTTOM RIGHT) AUSTRALIAN NEWS & INFORMATION BUREAU; PHOTOGRAPHS, (TOP LEFT, CENTRE RIGHT BOTTOM LEFT) AVA HAMILTON (TOP RIGHT) J. B. GUSS FROM BLACK STAR

than continuous growth. Other forest types include coastal forests (mangrove. nipa palms, pandanus), swamp forests and mountain forests. There are more than 150 species of palms, including the coconut, lontar, sugar, sago and areca palms, and bamboo is found in all parts. Large areas of the natural forest have been repeatedly cleared and dominated by cogon grass (*Imperata cylindricn)*.

The flora of the Malay archipelago is probably the most varied in the world. More than 30,000 species of trees, shrubs and grasses belonging to more than 2,500 families have been recorded. This wealth of different species is the result of the heavy rainfall, long growing period, relief! variety of environments and the position of the Malay archipelago as a bridge between Asia and Australia. Mingling of the flora and the fauna of these two continents takes place in the islands. Some species have undergone a complex evolution as a result of geologic changes; island groups have been joined together, then separated. then rejoined. increasing the almost unimaginable diversity and complexity of plant and animal life.

Animal **Life.**—While the fauna of the archipelago is very rich, there are few large animals. Elephants, tigers, rhinoceros, wild cattle, tapir and orangutan are all part of the Asian fauna. They are unevenly distributed on the islands of the Sunda platform and indicate differing periods of connection between these islands. Of the Australian fauna, kangaroos are found in New Guinea and other marsupials have moved beyond the Sahul shelf as far as Timor and Celebes. Some of the islands in between have endemic species, such as the anoa or dwarf buffalo and the giant monitor lizard or "dragon" of Komodo Island near Flores in the Lesser Sundas. Insects and birds have wider distribution, and the archipelago has probably the richest insect and bird life of the world. Particularly notable are the large longicorn beetles, the giant butterflies. the exotic birds of paradise, argus pheasants and myriad-coloured cockatoos.

The transitional flora and fauna of the area early attracted the attention of naturalists and after extensive work in 1854–62 A. R. Wallace attempted to fix a line between the Asian fauna and that of Australia. Later work established that Asian species extend to the edge of the Sahul shelf and that the area between represents a zone of mixing, transition and local evolution.

For a more detailed discussion of the geography of the archipelago, *see* the articles dealing with separate islands or island groups such as JAVA; MOLUCCAS; SUMATRA; etc.

NATURAL RESOURCES

Agriculture. — The raw material wealth of the Indies is legendary and brings to mind rare spices and precious metals. Of the great variety of resources the most important is agricultural production, which provides employment for almost 90% of the population. Productive agricultural areas are based on favourable water and soil conditions. Most islands have ample water in all seasons. but the Lesser Sunda Islands from Sumbawa eastward are chronically short of water and large areas support only extensive grazing. Eastern Indonesia and the northern Philippines suffer severe seasonal drought.

Most upland soils are of weathered lateritic types of low fertility. Tree crops can be grown on some lateritic soils and shifting cultivators also make temporary use of these areas. The intensively cultivated irrigated rice areas are on the fertile alluvial soils of river valleys, deltas and coastal swamps. Basic volcanic rocks: ash and mudflows develop into fertile soils and support intensive cultivation in parts of Sumatra, Java and Bali.

The agricultural economy is varied. Shifting hill cultivators raise subsistence dry crops of rice and corn in upland areas. The majority of the rural popuiation are sedentary cultivators, usually growing irrigated rice; but sometimes corn, yams or cassava as their principal food crop. Many commercial crops such as rubber and tobacco. although introduced on plantations, are now grown by these sedentary small holders. The small holder produces most of the region's sugar, copra. pepper, nutmeg. spices, kapok, sago. tobacco and abacá. The plantations, introduced in the colonial period and located principally in Sumatra and Java, provide valuable exports of rubber, palm oil, sisal, cinchona and tea, as well as some cofiee. tobacco and copra.

Other Resources. — Forests provide valuable resources in timber and in rosins, rattans and other gathered forest products. Timber exports are particularly important in the less-developed economies of Sarawak. North Borneo, Mindanao, Sumatra and Indonesian Borneo. Fishing and livestock production are important for domestic consumption only.

Petroleum is the principal mineral deposit of the archipelago. exploited in Sumatra Indonesian Borneo. Brunei and western New Guinea (Irian) Production in the 1960s was only 3% of the world total but was important in the petroleum-poor areas of Asia. Tin mines on Singkep. Bangka and Billiton provide about 20% of the norld's production. Deposits of bauxite are available in the Riouw archipelago and iron ore is mined in the central Philippines. Nickel is found in Celebes, and gold. chrome manganese and copper in the Philippines Coal resources throughout the archipelago are limited and of only fair quality; hydroelectric power potential is great although little developed.

Manufacturing is not greatly developed. Most important are handicraft industries and industries engaged in primary processing of agricultural and mineral products for export. Light manufacturing is expanding with spinning mills, paper. glass, soap and cigarette factories as well as some heavy industry. For a more detailed consideration of the economy, *see* the articles on each major island or island group. (L. A. P. G.)

ANTHROPOLOGY

Prehistory.—The prehistory of the area goes back to Pleistocene deposits in Java. where several exceedingly primitive manlike beings. collectively known as *Pithecanthropus erectus*, have been found. In strata of the third interglacial appear Neanderthal-like humans, there known as *Homo soloensis;* while in still later horizons the fossil remains of Wadjak man seem to be related to the modern Australoids. On the mainland, skeletal remains give evidence of a Negroid physical type which in Late Paleolithic (Mesolithic) times was moving eastward into the Pacific toward New Guinea. No groups of large Negroes now exist in southeast Asia but remnant bands of Pygmy blacks, known as Negritos or Semang. are found in the Andaman Islands. the Malay peninsula and the Philippines. The Neolithic or New Stone Age introduces a new. non-Negroid physical type, possibly of a Veddalike people which once occupied the coasts from southern India and Ceylon eastward into Malaysia. The Senoi (Sakai) of the Malay peninsula and minor groups in Sumatra, Celebes and some eastern islands of the archipelago appear to be related to this once widespread population. (*See* VEDDA; SENOI.)

Pygmies and **Senoi.**—The Pygmies are nomadic hunters and food gatherers who roam the jungles in small unorganized bands. They build only frail shelters and have scanty bark-cloth garments and few permanent possessions. The Senoi combine a limited agriculture n-ith hunting. in which they employ the blowgun and poisoned darts. Their typical dwelling is a one-room structure raised high above the ground on piles. but some communal houses appear. Each settlement is under a headman — usually an elder—who exercises a limited authority. Considering the simplicity of their material culture, the Senoi have a rather intricate set of religious beliefs, including superior beings. wandering spirits and life after death. An unorganized group of individuals. called *halak*, deals with the spirit world by means of ceremonies and magic rites. The Senoi are of slight build. with rather long heads and angular faces. Skin oolour is light reddish-brown; hair is dark and wavy and when worn uncut falls to the shoulders.

Proto-Malays. — The dominant population of Malaysia appears to have entered the area from the mainland, probably by following the river courses which spread south and southeast from the Tibetan borders. The character of the country did not permit mass migration but there was a steady drift of a people much like the Malay, although of stockier build, longer heads, heavier features and with wavy hair. Because of their earlier appearance and their evident relationship to the Malays they are known as Proto-Malays. As they advanced they drove out or absorbed most of the aboriginal peoples. They were followed by an infiltration of a related but more definitely southern Mongoloid physical type. Amalgamation of the two produced the present-day Malayan. Isolated groups of the Proto-Malays are found on the mainland, while powerful tribes such as the Igorot-Ifugao of the northern Philippines, the Tenggerese of Java, the Toradja of the Celebes and in less pure strain the Batak of Sumatra still remain.

Malays. — The Malayan peoples spread over the mainland nearly to the borders of China, down the peninsula and out into the Pacific until they had occupied Formosa, the Philippines, Borneo and Indonesia. In later centuries, as they became competent seafarers. they went east to the coasts of New Guinea, while to the west they reached and colonized Madagascar off the coast of Africa. On the continent, except for the peninsula, they were eventually dispossessed or absorbed by incoming peoples such as the Mon-Khmer, Thai, Burmese and Assamese. Even there small islands of Malay-speaking groups still exist. Both Malay and Proto-Malay speak dialects of Malayo-Polynesian. (See MALAY LANGUAGE.)

The typical Malay is of slight build; men are about 5 ft. 4 in., women slightly shorter. They have brachycephalic heads, broad faces and noses of medium size. The Mongolian (epicanthic) fold of the eye is common; the chin is prominent. Skin colour ranges from olive to a reddish-brown; eyes and hair are dark and the latter ranges from straight to wavy. In both the Proto-Malay and the Malay there is evidence of Caucasian mixture, probably due to crossing in the interior homeland.

The early Malayan kampong (village) was a small, largely self-sufficient unit. Bamboo and thatch houses of one or two rooms were raised high above the ground on piles. Close to the settlements mere plots of rice, sweet potatoes, taro and in some places spices. Always coconut and betel nut palms were nearby. Industries consisted of weaving, mat- and basketmaking, handmade pottery and ironworking. Such a village was governed by a headman and a council of elders, but there was no higher, organized rule. Religion was highly developed around a belief in spirits, some good, some bad, some ancestral, some self-existing through time. Contact with the spirit world was through mediums who, in trances, conducted elaborate ceremonies for the general welfare. A rich folklore gave the background for the religious beliefs as well as for the near-universal practices of magic and head-hunting. Today the bilateral family, with inheritance and descent in both lines, is typical but a highly specialized variant type exists among the Menangkabau of Sumatra and in some other areas. There is found a clan and phratry system with inheritance and descent through the female line. In such areas the long house or community dwelling is prevalent. (*See* also MALAYS.)

Other Elements. — Early in the Christian era Indian traders and petty princes entered the area in search of spices. Soon they set themselves up as rulers. Out of such beginnings empires arose (see History, below). Indian influence became dominant at the higher levels; elaborate courts were established together with Buddhistic and Brahmanistic rites. The Indian epics, given a local setting, became the literature of the people. During this period there was some intermarriage between the newcomers and the upper-class natives. Into this situation came Arabian traders and teachers who in a short time succeeded in introducing the religion of Mohammed. Only in Bali did the Indian religion persist, but the cultural influence of India ,is still strong in Malaysia. In the Philippines, Christianity, introduced by the Spanish, resisted the spread of Islam.

The 15th century witnessed the appearance of the colonizing powers of Europe. Their influence has been great, especially as related to the economic life. In the Philippines, Spain wrought great changes and succeeded in establishing the only Christian population in Asia. European exploitation of such natural resources as tin and rubber called for manpower, a need answered in part by the introduction of Chinese and south Indian labourers. Chinese contacts had begun in Malaysia by the jth century but extensive immigration did not start until after the advent of the European powers. With settled conditions and opportunities for gain there was a great influx of Chinese! in some areas as traders and shopkeepers, in others as settlers or as coolie labourers. In the Malay peninsula and Singapore they were so successful that many remained and came to constitute about half the population. Another important element, especially in the peninsula, is the south Indian (Tamil), who came primarily as a labourer on the estates. Indians make up about 10% of the population. On the peninsula a pluralistic society emerged, composed of Malays, who are Mohammedans; Chinese, mostly Buddhists; and south Indians, with Hinduism dominant. Because of the differences in religion, language and economic activities, there has been little intercommunication and few community interests are shared. (F.-C. CE.)

HISTORY

The Hindu **and** Moslem Periods. — Indians — merchants and political refugees — arrived in Indonesia prior to the Christian era. The immigration continued for seven centuries but the number was never large. They intermarried with the Indonesian aristocracy and their descendants formed the governing class. The immigrants deeply affected government and religion and exerted their greatest influence in Java and Sumatra. From there the new culture spread to Bali and the Moluccas, with some traces in Borneo and Celebes.

While the majority of the immigrants were Hindus, some were Buddhists. The two religions coexisted without persecution and provided the models for architecture and sculpture. Chinese traders arrived about the same time as the Indians but had little influence on Indonesia.

The two most powerful kingdoms between the 5th and 9th centuries were Srivijaya (Criwidjaya) and Sailendra (Cailendra). The former, with its capital at Palembang in Sumatra. included part of Sumatra and the Malay peninsula and was a commercial and naval power. The Sailendra dynasty ruled in central Java during the 8th and 9th centuries; under it Indian art reached its highest development in, for example, the Buddhist temple at Borobudur. Later. eastern Java became the most powerful kingdom and in the late 13th century King Kertanagara conquered part of Sumatra, Borneo, Bali and several of the Moluccas. After an interlude of civil war and the intervention of a Chinese fleet and army sent by Kublai Khan. Vijaya (Widjaya) became king in 1294. He founded the empire of Majapahit, whose strength rested upon sea power and control of the spice trade. The empire finally collapsed in the late 1jth or early 16th century. (*See* JAVA and SUMATRA for a more detailed history.)

The decay of Majapahit was hastened by the spread of the Moslem religion, introduced by traders. In 1292 Rlarco Polo visited the islands and found that the northern tip of Sumatra had been converted to Islam. From there it spread gradually through the islands until Hinduism survived only in Bali. The process of conversion was still in progress when the Portuguese arrived, and their efforts to substitute Christianity for Islam had little effect.

The Portuguese and Spanish. — In 1511 a Portuguese expedition under Antonio d'Abreu was dispatched to find a route to the Moluccas and Banda Islands; then famous for their cloves and nutmegs. The explorers reached Amboina and Ternate, after gaining some knowledge of Java, Madura, Sumbawa and other islands. In 1514 a second Portuguese fleet arrived at Ternate, n-hich became the centre of Portuguese enterprise in the archipelago. In 1529 a treaty was concluded between Spain and Portugal by which the boundary between the Spanish and Portuguese spheres was fixed at 17° E. of the Moluccas; the Philippines were included within the Spanish sphere.

Portuguese traders frequented the coast of Java and established a trading port in Sumatra, but annexed no territory in either. Farther east they founded numerous forts and factories, notably in Amboina, Banda, Celebes and Halmahera. Ternate remained the seat of the governor of the Moluccas, the highest official in the archipelago. Portuguese power in the east was weakened by administrative corruption and by incessant war with native states, notably Bintang and Xtjeh (Achin); bitter hostility was aroused by the attempts of the Portuguese to establish a commercial monopoly and to convert their subjects and 'allies.

The Dutch and English, 1595–1674. — The Dutch came to the east to avenge the injuries inflicted on their country by the Spaniards and to break the commercial monopoly of the peninsular states. They already possessed a large interest in the spice trade, for the Portuguese, having no direct access to the principal European markets, sent cargo to the Netherlands for distribution by way of the Scheldt and Rhine. The Dutch now sought to monopolize not only the distribution but the production of spices. The first Dutch fleet, under the command of Cornelius Houtman, reached Sumatra in 1596. In 1602 the Dutch East India company (*q.v.*) was incorporated, and for nearly two centuries played the chief part in the history of Indonesia. The Dutch were the stronger power at sea. They attacked the Portuguese in Ceylon (1602), and defeated a powerful fleet off Banda. In 1608 they forced the Portuguese to assent to an armistice for 12 years, and in 1609 Pieter Both was chosen as first governor general of Netherlands India. In 1611 the headquarters of the Dutch was changed from Bantam to Jakarta (*q.v.*), which in 1619 was renamed Batavia and became the Dutch capital. (The name Jakarta was restored in 1949.)

Meanwhile the English East India company extended its operations to the archipelago. After 1611 the commercial rivalry between the Dutch and British became acute, and commissioners met to arrange for co-operation between the Dutch and British companies and the maintenance of a joint fleet. But neither company could restrain its agents from aggressive action and many fresh causes of dispute arose. The treaty of defense lapsed in 1637. The Dutch company opened up trade with Japan and China and prosecuted the war against Portugal with great vigour.

A new war between Great Britain and the Setherlands broke out and was terminated by the treaty of Westminster in 1674. Thenceforward the British company devoted its energies chiefly to the development of its Indian possessions, while the Dutch were left supreme in the archipelago.

The system of practical slavery enforced on the native races provoked an insurrection throughout Java, in which the Chinese settlers participated; but the Dutch maintained naval and military forces strong enough to crush all resistance, and by 1749 they were practically supreme in Java.

British Occupation, 1811–16.—The Netherlands Indies were at this time part of the Napoleonic empire, with which Great Britain was at war. A British naval squadron captured Amboina, Banda and Ternate in 1810. and in 1811 a strong fleet captured Java. Thomas Stamford Raffles (*q.v.*) was appointed lieutenant governor and introduced many important changes in the departments of revenue, commerce and judicature. In 1816 the Setherlands Indies were returned to the Dutch, in accordance with the treaty of Vienna.

Restoration of Dutch Power, 1816–1940.—The history of the archipelago was changed by Raffles' occupation of Singapore in 1819 to prevent the Dutch from acquiring a monopoly of trade throughout Malaya and with China. Questions between Great Britain and the Netherlands were settled by treaty in 1824. The Dutch were given freedom of action in Sumatra, while the Malay peninsula was recognized as within the British sphere of influence.

The extension of Dutch political power—notably in Java, Sumatra, Celebes, the Moluccas, Borneo, the Lesser Sunda Islands and New Guinea—involved several wars with various native states. A large expedition mas sent to Lombok in 1894 and almost the whole of that island was incorporated in the Dutch dominions. A 30 years' war with Atjeh (*see* SUMATRA) began in 1873.

While the Dutch were consolidating their authority, other countries were acquiring interests in the archipelago. Immigration from China and Japan steadily increased. In 1841 Sir James Brooke (*q.v.*) established British sovereignty in northwest Borneo. In 1885 New Guinea was divided between Great Britain, Germany and the Netherlands. The Spanish-American War of 1898 resulted in the cession of the Philippines to the United States. Australian and Japanese trade in the archipelago was stimulated by the establishment of the Australian commonwealth (1901) and by the Russo-Japanese War (1904–05).

The effect of World War I was to deprive Germany of the northern part of New Guinea, which was administered under mandate by the commonwealth of Australia. The division of Timor between Portugal and the Netherlands was reminiscent of the struggles of past centuries; the Dutch-Portuguese treaty in 1904 settled all outstanding questions (see TIMOR). Apart from the Philippines, the Malay archipelago was before World War II almost wholly in the hands of the British and the Dutch.

After World War 11.—In World War II almost the entire Malay archipelago was brought under Japanese control. After Japan capitulated, the Indonesian republic was proclaimed on Aug. 17, 1945, and, following more than four years of Dutch-Indonesian hostilities, the transfer of sovereignty from the Netherlands to the United States of Indonesia took place on Dec. 27, 1949. On Aug. 17, 1950, the unitary Republic of Indonesia was proclaimed (see INDONESIA). The commonwealth of the Philippines obtained full independence on July 4. 1946, and became a republic (*see* PHILIPPINES, REPUBLIC OF THE).

See also the articles on the other political units in the archipelago. (K. G. J.; C.H.; E.S.; G. W.O.)

POPULATION

The population of the Malay archipelago is over 116,000,000, almost 5% of the total world population (see Table).

The distribution of population shows great variation in density. The most densely settled parts of Java have a rural population of more than 4,000 per square mile while the adjacent island of Borneo averages less than 5 persons per square mile and has large areas without population. This reflects the productivity of land and many historical and cultural factors.

About 80% of the Indonesian and Philippine population is rural. After World War II and independence there was a pronounced movement to the cities, resulting in the rapid growth of such urban areas as Jakarta and Manila (*qq.v.*). Almost 40% of the population is under 20 years of age, accelerating the already rapid rate of annual increase of 2% in Indonesia and the Philippines. Population pressure is severe in parts of Java and Madura in Indonesia. In the Philippines northwest Luzon as well as several islands in the Visayan group suffer population pressure.

Migration, both voluntary and government sponsored, has resulted in the settlement of Javanese in southern Sumatra, around Medan in northeastern Sumatra and along the southern coasts of Borneo. Filipinos from Luzon and the Visayan Islands have settled on sparsely populated Mindanao. Some have migrated outside the Malay archipelago: Indonesians to Malaya and Filipinos to Hawaii and the United States. But migration alone is an ineffective and temporary solution to population pressure. There are areas of the Malay archipelago where additional settlement is possible but continued rapid population increase will pose many problems. *See* also references under "Malay Archipelago" in the Index volume. (L. A. P. G.)

Area and Population

Political Unit	Area (sq.mi.)	Population
Indonesia	575,893	84,432,141*
Philippines	115,707	27,455,799†
British Borneo	79,864	1,282,596
Brunei	2,226	83,877†
North Borneo	29,388	454,3281
Sarawak	48,250	744,391†
Portuguese Timor	7,332	472,000*
Christmas Island	62	2,619:
Cocos (Keeling) Islands	5	651†
New Guinea	344,218	2,102,619
Netherlands New Guinea	160,618	701,1615
Trust Territory of North Guinea	93,000	1,206,749‖
Papua	90,600	494,70911
Total	1,123,081	116,048,425

*1956 estimate. †1960 census. ‡1957 census. $1958 estimate. ‖1954 census

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Chinese in Southeast Asia (1956). For the period 1511–95 the chief Portuguese authorities are the chronicles of Barros, Correa, Castanheda and Couto *(see* PORTUGAL), with the letters of Francis Xavier *(q.v.)* and the *Tratado* of A. Galvão (1563, 1731), of which a translation entitled *Discoveries of the World* was made for Richard Hakluyt and reprinted by the Hakluyt Society (1862). *See* also M. F. de Navarette, *Coiccion de los viages,* vol. 4 and 5 (1837). For later history *see* John Crawford, *Descriptive Dictionary of the Indian Islands* (1820) ; A. Wright (ed.), *Twentieth Century Impressions of Netherlands India* (1910), which gives references to the principal English and Dutch authorities. Further bibliography will be found in J. A. Van der Chijs, *Proeve eener nederlandschitzdische Bibliografie, 1659–1870* (1875) *See* also A. Cahaton, *Java, Sumatra and the Other Islands of the Dutch East Indies* (1912) ; A. Wright and T. H. Reid, *The Malay Peninsula* (1912); H. Daniel, *Islands of the East Indies* (1944) ; Sir R. O. Winstedt, *Britain and Malaya 1786–1941* (1944) ; D. G. E. Hall *A History of South-east Asia* (1955); Brian Harrison *South-east Asia* (1954).
(L. A. P. G.; F.-C. CE.)

MALAY LANGUAGE is one of the Malayo-Polynesian (Austronesian) languages *(q.v.).* It is most closely related to Menangkabau in west Sumatra and perhaps connected with it by the varied dialects of south and west central Sumatra sometimes called Middle Malay. It is next most closely related with other Malayo-Polynesian languages of Sumatra: Java and Borneo and the Cham languages of Vietnam. It is the native language of about 9,000,000 people distributed over the Malay peninsula, the east coast of Sumatra, the entire coast of Borneo and the smaller islands that lie between these areas, the Riouw archipelago, Bangka, Billiton, the Great Natuna Islands, etc. The local varieties differ noticeably from each other, but not as much as from the native Malay of Jakarta and that of Amboina.

The dialect of highest prestige is that of the Riouw Islands and the southern Malay peninsula. It is regarded as the basis of the standard Malay of the Federation of Malaya and also of the Bahasa Indonesia ("Indonesian language") or Indonesian, which is the official language of the Republic of Indonesia. A Malay pidgin often called Bazaar Malay *(mdlayu pasar* "market Malay") developed as a lingua franca in the East Indian archipelago probably before the arrival of the Portuguese. This pidgin varies somewhat locally. The variety used by the large Chinese colonies of Malaya and Indonesia is called Baba Malay. The formation of Bazaar Malay is no doubt due to the dominant position held successively by Palembang. Tumasik (old Singapore'). Malacca and Singapore as the centre of trade between the East Indies and other countries. The Java form of Bazaar Malay was used by the Dutch as the colonial language. The movement for Indonesian independence adopted Malay in 1927. As the variety of Malay spoken by most of the members of this movement, the same Java form had a noticeable influence on present standard Indonesian. The Japanese sponsored an Indonesian more like standard Malay and this has continued as the Indonesian standard. The European words in standard peninsular Malay are mainly from English whereas those of Indonesian are from Dutch. Another difference is the increase in Indonesian vocabulary fostered by the Indonesian government.

The earliest records in Malay are Sumatran inscriptions of the late 7th century in a Pallava (south Indian) alphabet. Such an alphabet is used in the so-called *renchong* script of southern Sumatra (Bengkulu, Palembang). With the coming of Islam in the 14th century, Malay became the local language of religious commentaries in converted Sumatra and in the Malay-speaking areas. An Arabic alphabet was developed for these commentaries and this orthography is still used in Malaya and parts of Sumatra for Malay. This alphabet is called Jawi *(huruf jawi* "Jawi letters"), perhaps because Java (Malay *Jawa)* dominated Sumatra and large parts of the peninsula at the time of the conversion.

An orthography with Latin letters was constructed by English scholars and has been used in some publications. The standard Indonesian orthography uses Latin letters, but since its basis was constructed by the Dutch, it differs from its Malay counterpart. After the modifications introduced by the Indonesian government the difference between the two Latin orthographies involved chiefly four letters: Malay *ch, j, ny, y* = Indonesian *tj, dj, nj, j,* respectively.

The Malay of the southern peninsula distinguishes the syllabics *i, e, è, ĕ, a, u, o, ò* and the nonsyllabics *k, g, ng, ch, j, ny, t, d, n, p, b, m, y, w, r, l, s, h, q.* Syllabics appear nasalized *(tãõn* "town") or unnasalized *(taon* "year") ; *è* appears in loan words *(bèk* "bag"). Likewise *k* is final only in loan words; romanized final *k* (= Jawi *qāf)* or apostrophe (= Jawi *hamzah)* correspond to a glottal stop (q) in pronunciation: *r* is a velar spirant. In pronunciation *ĕ* appears for final orthographic *a,* and *e* and *o* for orthographic *i* and *u* commonly appear before final consonants (in disagreement with the standard orthography) : *apĕ* "what," *baeq* "good," *bagos* "fine,!' orthographic *apa, baik, bagus.* Stress as well as pitch is part of the phrase structure and is conditioned by the shape of the words rather than the particular words.

Malay has a number of parts of speech. The chief ones are particles and full words of which only the latter appear with attributes. The particles are exclamatory *(e.g., wah* "gosh"), prepositional *(e.g., di* "at," *kd* "to"), conjunctional *(e.g., jang* "that," *kalau* "if," *kavdna* "because") and attributive *(e.g., chuma* "only"). The full words are nouns *(e.g., rumah* "house," *saja "I")* and verbals, the latter being further classified as adjectives *(e.g., bĕsar* "big"), numerals *(e.g., satu* "one") and verbs *(e.g., bĕli* "buy," *pdrgi* "go"). As predicator a noun has the negative *bukan (itu bukan rumah* "that is not a house") whereas a verbal has *tidak (saya tidak pdrgi* "I did not go"). An adjective follows the noun it modifies *(rumah bĕsar* "a big house"). A numeral precedes the noun it modifies *(satu rumah* "one house'!). Usually there is a choice between a simple numeral as above and a compound numeral *(sĕbuah rumah* "a house") ; in such cases the simple numeral calls particular attention to the number *(dua rumah* "two houses." *duabuah rumah* "some two houses").

A noun is followed by a noun which modifies it; such a modifier is either descriptive *(orang mĕlayu* "[person Malay] a Malay") or partitive-possessive *(rumah kawan saja* "[house friend my] my friend's house"). A passive verb is followed immediately by the agent *(itu dibdli orang* "[that bought person] that was bought by somebody"): although more commonly in Malay and less frequently in Indonesian a phrase with the preposition *oleh* is found *(itu dibdli oleh kawan saya* "that was bought by my friend"). Subject and predicate are in most cases invertible with a difference in emphasis; besides *dia kawan saya* "he is my friend," there is also the more emphatic *kawan saya dia.* Many common constructions of Malay resemble those of English *(e.g.,* prepositional: *di rumah saya* "at my house"; verb goal: *bdli rumah* "buy a house").

Words are simple. complex or compound. Simple words contain a single meaningful element: *nama* "name." Complex words contain at least two meaningful elements which differ as affix and root: *e.g., namakan* "to name." Compound words contain at least two meaningful elements neither of which is an affix: *rumah-makan* "(house-eat) restaurant." Longer sequences resemble one or the other type of word.

There is a fair variety of affixes among which doubling *(e.g., nama-nama* "names") is to be counted. Nouns and adjectives are inflected for number (but noncompulsorily) : *rumah* "house." *rumah-rumah* "houses"; *panas* "hot," *panas-panas* "hot" (pl.). Transitive verbs have a passive *(di-bĕli* "be bought") and active *(mĕm-bĕli* "buy") and a simplex which appears in commands *(bdli* "Buy!") and in other constructions. Various affixes appear in derivation, such as doubling *(e.g.,* with nouns "an analogue of": *jari* "finger," *jari-jari* "spoke," with verbs "diffusely, persistently": *bĕrlari* "run," *bĕrlari-lari* "run around, keep running").

Various affixes appear in derivation and very often these have ill-defined or varied meanings. There are two common suffixes: *-kan* (forms transitive verbs) and *-an (makanan* "food," *makan* "to eat"). The suffix *-i* is very rare in colloquial Malay *(lalui* "pass, traverse," *lalu* "go past") but is common in literary Malay and in very wide use in Indonesian. The number of prefixes is much larger *(e.g., bdr-, tĕr-, pĕng-, mĕng-, kd-).* Combinations of affixal elements are found that resemble the addition of a prefix and a suffix or prefix and doubling or the like without, however; showing the meaning of these as separate elements; *e.g., kĕmauan* "desire," *mau* "want," *kdkuningkuningan* "tinted yellow," *kuning* "yellow," *sĕchĕpatchĕpatnja* "as fast as possible," *chĕpat* "fast."

The combinations of elements in analyzable words are usually transparent. The chief exceptions are the active prefix (*mĕng-*) and others which behave like it. For these the shape of the combination depends on the initial of the following element as it would otherwise appear. If the initial of the base is *p, t,* k, or *s,* then a corresponding nasal appears at the seam (potong "cut," *mĕmotong; tipu* "deceive:" *mĕnipu; kirim* "send," *mĕngirim; sapu* "sweep," *mĕnyapu*), otherwise the initial appears with the nasal it determines (*e.g.,* angkat "lift," *mĕngangkat;* bawa "bring," *mĕmbawa;* chari "seek," mdnchari).

All Malay literature postdates the arrival of Islam. Its original form is believed to have been poetry, probably the *pantun.* The other poetic genre is the sja ir. In it are written long poems, religious, historical and dramatic. The latter are no longer popular. The extensive prose literature consists largely of lengthy novels (*hikajat*), most of which are reworkings of Javanese drama literature, the *wayang.* Some also have a Persian or Arabic background. "Moslem legends," stories from the Koran, are also widely read. The historical novel is represented by *Hang* Tuah, the story of a hero who travels through many lands encountering known figures from Javanese history. The best known of the works classifiable as "historical writing" is the *Sĕdjarah* Malayu (1612). A series of funny stories utilizes the mouse deer (kantjil, *pĕlanduk*) as the chief character. The flow and variety of Malay literature greatly increased as a result of independence, particularly in Indonesia, where many revolutionaries had literary aspirations.

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MALAYO-POLYNESIAN LANGUAGES (also known as the AUSTRONESIAN LANGUAGES) are a family of related languages with about 110,000,000 speakers in Madagascar, southern Vietnam, the Malay peninsula, Indonesia, the Philippine Islands, Formosa, New Guinea, the Melanesian, Micronesian and Polynesian islands and New Zealand. In pre-Columbian times this was the most widespread language family, extending from the Malagasy of Madagascar to the Rapanui of the Easter Islanders. The number of Malayo-Polynesian languages is more than 300 and perhaps exceeds 500 (depending upon the way in which languages are distinguished from dialects). They constitute 10%–15% of all languages in the world. The vast majority of speakers are in the Philippines and Indonesia, the island of Java containing somewhat less than half. There are four large countries in which a Malayo-Polynesian language is the official language or one of the official languages: Malay in the Federation of Malaya, Indonesian in the Republic of Indonesia, Tagalog in the Republic of the Philippines and Malagasy in the Malagasy Republic.

The Malayo-Polynesian languages are widely, but falsely, thought to be phonetically and grammatically simple. Malay and the Polynesian Ianguages do have relatively simple phonemic systems, but their grammatical structures are not particularly simple. On the other hand a language like that of Yap shows complicated phonemic and grammatical structures.

The itfalayo-Polynesian languages were once a single language. The original undifferentiated language became diversified locally, and the hundreds of Malayo-Polynesian languages are the result. The features of the original language, called Proto-Malayo-Polynesian, can only be inferred by comparing the modern forms.

Although the classification of the members of the family has not been completed, some close relationships seem to be observable. Most of the Philippine languages appear to be closely related to each other. With these are often grouped the Chamorro language of Guam and the language of the Palau Islands. The languages of western Indonesia (*e.g.,* Malay, Achinese, Minangkabau, Batak, Sundanese, Javanese, Balinese and some of the languages of Borneo) seem closely related to each other, to the Cham languages of southern Vietnam and to Malagasy. The languages of the Carolines with the exception of Palau, Chamorro (see above) and Yapese are closely related to each other and more distantly to Ponapean. Gilbertese and Marshallese. These are likewise closely related to the Polynesian language (*q.v.*). Since the languages of Micronesia and Polynesia are closely related to some of the languages of Melanesia (*e.g.,* the Banks Islands and northern New Hebrides), and since those of the Philippines are probably related to those of western Indonesia, some scholars postulate two subgroups of Malayo-Polynesian: Eastern and Western. The languages of eastern Indonesia and of New Guinea resemble those of Melanesia, but are not clearly of either subgroup.

Not all of the languages in the vast island area demarcated above are Malayo-Polynesian. Most of the languages of New Guinea are non-Malayo-Polynesian. The Malayo-Polynesian area is limited to a large region near the isthmus connecting the northwest peninsula nith the main body of New Guinea and the northern (both of the northwest peninsula and the main body) and eastern coasts. Non-Malayo-Polynesian languages are spoken in the northern two-thirds of Halmahera, in Alor and Timor in Indonesia and in the Solomon Islands in Melanesia.

The most likely next of kin of the Malayo-Polynesian languages is the Thai family. The generally accepted hypothesis regarding the Malayo-Polynesian migration states that it came from the continent of Asia via the Malay peninsula and the neighbouring chain of islands to the Pacific. Madagascar was probably settled from Borneo in the first part of the 1st millennium A.D., not long after the Indians came to the Malay archipelago. The latter found the forerunners of the contemporary languages there, and these were no doubt already different from the forerunners of the Malayo-Polynesian languages elsewhere (except Madagascar). Thus the migration must have been well under way by then, perhaps for more than 2.000 years. The connection with the Thai family, however, is not beyond a reasonable doubt.

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MALAYS, a people of southeast Asia.

It is thought that the neolithic ancestors of the Malays (Proto-Austronesians, Proto-Malays, Mongoloid Indonesians or Malaysians) descended from Yunnan province, southern China, between 2500 B.C. and 1500 B.C. down the valley of the Mekong river to the Malay peninsula and so to Indonesia and on to Madagascar and Easter Island. They had already cultivated the banana, sugar cane, millet and rice, domesticated the pig and buffalo and could count up to a thousand. They were boatbuilders and fishermen as well as hunters and agriculturists. They built houses of bamboo or wood on piles, made pottery in great variety and erected megaliths to dead chiefs. These early peoples were head-hunters. Then, about the beginning of the Christian era, came Indian immigrants who spread their cultural influence along with Buddhism, Saivism and Vishnuism, until, between the 13th and 15th centuries, Islam ousted all religions except in Bali, which remained Hindu, and the Philippines. where the Spaniards introduced the Roman Catholic faith. The modern or Deutero-Malays are the primitive Malay with foreign strains derived from intermarriage with Chinese from Chou times down to the Malay conversion to Islam, and with Indians, Siamese and Arabs. The Malay groups bore many local names until, probably in the 13th century, they got their generic name from Jambi, also called Melayu, in Sumatra.

Religion and Folklore.—Relics of animism survive in the Malays' fear of malignant spirits of the soil and jungle, in dread of banshees hostile to pregnant women and in respect for sacred places, rocks and trees, holy persons and sacred animals though, except in remote hamlets, these superstitions now count for no more than a European's dislike of walking under a ladder. The thousand years of Hindu influence left behind ceremonials for weddings and the installation of rulers, many Sanskrit terms especially at courts, even the word raja denoting an Indian rank, and a host of gods and demons for the invocations of the obsolescent shaman.

In 1292 Marco Polo found Islam established on the north coast of Sumatra by missionaries from the Coromandel coast; early in the 15th century the rulers of Malacca embraced it, and from there it was carried to Java, Borneo and other islands until -outside the Philippines and Bali—almost all peoples of Malaysia became orthodox Moslems of the school of Shafi'i.

After conversion to Islam, the Arabic script with some Persian additions and three new letters took the place of earlier alphabets based on Sanskrit. Malay translations of the Ramayana and Mahabharata gave way to the early romances of Islamic heroes, Alexander the Great, Amir Hamzah, Mohammed Hanafiah and to Moslem stories, such as the Tales of a Parrot, as well as many Moslem treatises on religion from the Persian and Arabic. Malay is now written either in Arabic or Romanized script.

Social and Political Structure.—Except in the state of Negri Sembilan in southwestern Malaya, where a matrilineal system derived from the Menangkabau (*q.v.*) prevails, the Malay reckons descent and relationships bilaterally. through both male and female lines. Separation and divorce are relatively easy and common. Husband and wife both have property rights in case of divorce or the death of a spouse. Women traditionally are active and influential in economic affairs, often carrying on trade and handling money matters. In the state of Kelantan in northeastern Malaya, one-quarter of the women earn a regular income and one-half are employed from time to time. In the Malay village or kampong, often located along coasts or streams, the rather widely dispersed houses are separated by fruit trees and vegetable gardens. The village economy revolves about rice or rubber cultivation and fishing. While men do the heavy work, women sell garden produce or cooked food and plant and harvest rice. Women also may weave or make floor mats and baskets, wash for alluvial tin or gold. tap rubber or teach in schools.

The Malay is still a handy man rather than a specialist in any trade, but he was not slow to plant rubber after the plant was introduced early in the 20th century and has adjusted himself to an industrial age.

Hinduism gave the Malay, instead of tribal chiefs, territorial rulers, who in theory took the advice of high court officials and governed through district chiefs. These rulers, as incarnations of Hindu gods, tended to wield absolute power down to the British period. Its source forgotten, a political structure of 4 great, 8 major and 16 minor chiefs, whose numbers were determined by astrological notions centring round the Hindu Olympus. Mahameru, survived to modern times.

The main class division is between raja and commoner, though within both there are degrees based on 'birth, means, profession and personal characteristics. The gap between the two main classes is bridged by a ruler's being able to marry a woman of any class though raja women lose social standing unless they marry a raja or a Sayid (*i.e.*, descendant of the prophet Mohammed). Before the British period, there were also slaves who might have. been Malay debt-bondsmen, criminals, or pagan aborigines or Africans bought by pilgrims to Mecca. As a Moslem, a Malay may marry a Christian or a Jew but not a polytheist or a pagan, unless conversion to Islam has occurred.

All classes and national groups meet on the football field. The Malays enjoy all forms of sport within their means—football, swimming, boat racing, physical drill. The capital invested under British protection in tin and rubber provided revenue for an educational system extolled before World War I as unrivalled in Asia outside Japan, and for a medical service that abolished cholera, yaws. beriberi and smallpox and confined malaria to remote rural areas. Better health and changed social and political conditions have stopped the notorious amok or homicidal mania; suicide among Malays is almost unknown and serious crime very rare. Far from conservative, the Malay has welcomed innovation in custom, law, medicine, politics and dress, whether introduced by Hindu, Moslem or the European.

Costume and Weapons.—Except for a bark loincloth and a blowpipe for killing game, the early Malay had neither clothes nor weapons. The men's coat, bearing a Persian name, and the skirt (sarong) worn by both sexes came from India. Malay trousers may have been copied from the Chinese but have an Arabic name, as also has the velvet cap now worn by all males; the rice planter's sun hat was brought from Yunnan and the elaborately tied headkerchief (now seen only on ceremonial occasions) probably was of Hindu origin. The usual jacket for Malay women in the peninsula is a coat of cotton or silk, knee-length and pinned with three brooches, which was introduced by the Portuguese in the 16th century. Women wear this jacket, or a more modern short jacket, with the sarong down to their ankles. For formal dress a man nears trousers covered from waist to knee by the sarong. The most prized sarongs, heavily interwoven with gold thread, come from Batu Bara and Palembang in Sumatra, though silk sarongs of mottled patterns and interwoven with gold thread are made in Trengganu and sarongs of modern type in Kelantan. Most sarongs are imported, the silk ones from Sumatra, the cotton ones from Pulicat, India, for men and from Java for women.

The two-edged Malay dagger or kris came from Java, though its prototype belongs to the Bronze-Age culture of Dongson in Annam. It is never represented on early Indo-Javanese sculpture. By the end of the 13th century it had changed from a one-piece weapon to a dagger nith a separate hilt of gold, ivory or wood, carved to represent Vishnu's bird the Garuda, or a Hindu demon Raksasa or rarely Hanuman the monkey god. The blade became wavy to represent serpents or Nagas. Bronze knives of 1000 B C. from Anyang in China and bronze knives from Ordos in Mongolia together with the kidney-shaped guard of the Scythian sword are identical with the shape and guard of the small Malay dagger known as the "pepper crusher," The needs of piracy led to the Bugis (Celebes) sundang, or short swords with blades straight or wavy and cockatoo hilts There is a great variety of wood knives. A finger knife for cutting rice stalk by stalk has a stone prototype unearthed in Tonkin

See MALAYA; MALAY LANGUAGE

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(R. O. WT.)

MALBONE, EDWARD GREENE (1777–1807), U.S. artist generally regarded as the greatest of American miniaturists, was born at Newport, R.I., in Aug. 1777. Largely sell-taught, he began his professional career in Providence, R.I., at seventeen and quickly developed a remarkably fine technique. A man of agreeable manners, diligent and blessed with what Washington Allston called "the happy talent . . . of elevating the character without impairing the likeness," Malbone was during his short career the most sought-after miniaturist of his day in Providence, Newport, Boston. New York city. Philadelphia and Savannah. His career was cut short by tuberculosis, of which he died at Savannah, Ga.. on May 7, 1807.

Many of his miniatures have survived and are highly prized for their delicacy of drawing, richness of colour and convincing characterization. He had no formal pupils, but freely advised other artists, notably Charles Fraser, William Dunlap and John Wesley Jarvis.

See Ruel P. Tolman, *Life of Edward Greene Malbone* (1957).

(D. H. W.)

MALCOLM, the name of four Scottish kings.

MALCOLM I. king 943–954, received Strathclyde from Edmund, king of the English, in terms of a treaty of alliance in 945.

MALCOLM II, grandson of Malcolm I, was king from 1005 to 1034 and frequently invaded northern England. By the battle of Carham (*c.* 1016 or 1018?) he finally secured Lothian for Scotland.

MALCOLM III (Canmore), great-grandson of Malcolm II, became king after the defeat of Macbeth at Lumphanan and ruled from 1058 to 1093. He had spent several years of his youth in exile at the court of Edward the Confessor and after the Norman Conquest gave asylum in Scotland to Edgar the Aetheling and his sisters: one of whom, Margaret (*q.v.*), he married in 1070. He did homage to William the Conqueror at Abernethy in 1072, giving his eldest son as a hostage and receiving lands in England. His frequent raids into England caused the building of castles at Newcastle-upon-Tyne and Carlisle.

A visit to William Rufus at Gloucester in 1092 only worsened their relations, so that Malcolm the next year led his last invasion, reaching Alnwick where he was killed with his son Edward. In his reign English influence increased and the southern parts of his kingdom grew in importance, the first mention being found of Dunfermline and Edinburgh as royal residences. On his death a Celtic reaction carried his brother, Donald Bane, to the throne. By his first wife. Ingibiorg, he had a son, afterward Duncan II; by his second, St. Margaret, six sons (of whom Edgar, Alexander and David in turn succeeded to the throne) and two daughters, Matilda (married Henry I of England) and Mary (married Count Eustace of Boulogne).

MALCOLM IV (the Maiden), born 1142, eldest son of Henry, earl of Huntingdon, succeeded his grandfather, David I, in 11j3. His treaty with Henry II of England in 1157 fixed the boundary of the kingdoms at the Tweed and Solway. He was knighted by Henry during the Toulouse campaign of 1159. He died at Jedburgh on Dec. 9, 116j.

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MALCOLM, JAMES PELLER (1767–1815), engraver and antiquary, was born in Philadelphia, Pa., in Aug. 1767, the son of a merchant. He first studied at a Quaker school in Philadelphia and later in Pottstown. Pa., his family having moved there to avoid the dangers of the Revolutionary War.

After the war he returned to Philadelphia to study art. He later attended schools of the Roval academv. London. He abandoned his original intention of becoming a painter, concentrating instead on engraving. He compiled and illustrated a number of books on various historical and topographical subjects and contributed illustrations to magazines in England, where he spent the last half of his life.

His works include *Londinium Redivivum, or an Antient History and Modern Description of London,* a parochial history published in four volumes, the work being completed in 1807; *Excursions in the Counties of Kent, Gloucester, Hereford, Monmouth, and Somersetshire . . . Illustrated by Descriptive Sketches* (London, 1807); *Anecdotes of the Manners and Customs of London, From the Roman Invasoin to the Year 1700, Illustrated by Eighteen Engravings* (London, 1811); and *An Historical Sketclz of the Art of Caricaturing, With Graphic Illustrations* (London, 1813).

Malcolm died in London on April 5, 181j.

His autobiography was published in the *Gentleman's Magazine,* May 181j.

MALCOLM, SIR JOHN (1769–1833), Anglo-Indian soldier, diplomatist, administrator and author, was born in Dumfriesshire, Scot., on May 2, 1769, the son of a farmer. He received a cadetship in the Indian army at the age of 12, and in April 1783 he landed at Madras, shortly afterward joining his regiment at Vellore.

He held various important appointments in India from 1792. In that year, having for some time studied Persian, he was appointed to the staff of Lord Cornwallis as Persian interpreter. Two years later, however, he was compelled by ill health to leave for England.

On his return to India in 1796 he became military secretary to Sir Alured Clarke, commander in chief at Madras, and afterward to his successor Lord Harris. In 1798 he was appointed by Lord Wellesley assistant to the resident at Hyderabad. In that capacity he distinguished himself by the manner in which he gave effect to the difficult measure of disbanding the French corps in the pay of the nizam.

In 1799 began his lifelong friendship with Col. Arthur Wellesley. In the course of the same year he acted as first secretary to the commission appointed to settle the Mysore government, and before its close he was appointed by Lord Wellesley to proceed as envoy to the court of Persia for the purpose of counteracting the policy of the French by inducing that country to form a British alliance. Arriving at Teheran late in 1800. he was successful in negotiating favourable treaties, both political and commercial, and returned to Bombay by way of Baghdad in May 1801.

He then for some time held the interim post of private secretary to Lord Wellesley, and in 1803 was appointed to the Mysore residency. At the close of the Mahratta War in 1804, and again in 1805, he negotiated important treaties with Sindhia and Holkar, and in 1806, besides seeing the arrangements arising out of these alliances carried out, he directed the difficult work of reducing the immense body of irregular native troops.

In 1808 Malcolm was again sent on a mission to Persia. After his return to England he wrote his *History of Persia* (2 vol., 1815). On his return to India in 1817 he was appointed by Lord Moira his political agent in the Deccan; as brigadier general under Sir T. Hislop he took'a distinguished part in the victory of Mehidpur (Dec. 21, 1817), as also in the subsequent work of settling the country.

In 1821 he returned once more to England, where he remained until 1827, when he was appointed governor of Bombay. His influence in this office was directed to the promotion of various economical reforms and useful administrative measures. Leaving India for the last time in 1830, shortly after his arrival in England he entered parliament as member for Launceston and opposed the Reform bill. He died on May 30, 1833.

Besides the work mentioned above, Sir John Malcolm published *Sketch of the Political History of India since . . . 1784* (in 1811 and 1826); *Sketch of the Sikhs* (1812); *Observations on the Disturbances in the Madras Army in 1809* (1812); *Persia, a Poem*, anonymous (1814); *A Memoir of Central India* (2 vol., 1823); and *Sketches of Persia*, anonymous (1827). A posthumous work, *Life of Robert, Lord Clive,* appeared in 1836. See *Life and Correspondence of Sir John Malcolm,* by J. W. Kaye (2 vol., 1856).

MALDA, a district, formerly oi British India, in the Rajshahi division of Bengal. In the partition of India in 1947, two-fifths of the area and about one-third of the population became part of East Pakistan. The remaining three-fifths of area (1,429 sq.mi.) and two-thirds of population (1951, 937,580) went to the state of West Bengal in India. The former British district was divided into two almost equal parts by the Mahananda river, flowing from north to south. The tract between the Mahananda and the main stream of the Ganges is an alluvial plain of sandy soil and great fertility. The eastern half of the former British district is a slightly elevated region. called the Barind. The soil here is a hard red clay; and the whole is sparsely populated. Agricultural prosperity centres on the Mahananda, where mango orchards extend continuously along both banks; the mangoes of Malda have a wide reputation and demand. The principal industry is the production of silk. The weaving of piece goods has declined, but the rearing of silkworms and the export of ram silk and silk thread are carried on upon a large scale.

Malda supplied three capitals to the early Mohammedan kings of Bengal. The sites of Gaur and Pandua exhibit the most interesting remains to be found in the lower valley of the Ganges; the site of Tanda, the capital from about 1564 to 1595, was washed away by floods in 1826 and no trace of it remains. (*See* GAUR.)

Malda was connected with the East India company for many years. As early as 1676 there was a factory there, and in 1770 the city of English Bazar was fixed upon for a commercial residency.

MALDEN, a city in Middlesex county, Mass., U.S., on the Malden river, a branch of the Mystic river, 5 mi. N. of Boston.

It is almost surrounded by Melrose, Revere, Everett and Medford (*qq.v.*), with the Middlesex Fells (a state reservation) forming its northwest boundary.

When first settled. mainly by Puritans, on the north side of the Mystic river, Malden was part of Charlestown (*q.v.*) and was known as the Mystic Side. It was incorporared as the town of Mauldon (for Malden, Eng., the home of some of the early settlers) in 1649 and was chartered as a city in 1881. Its bicameral council was abolished in 1958 in favour of a single chamber council. Of historic interest is Bell Rock Memorial park, named ior the bell which in colonial times summoned the people to worship or sounded alarms in times of danger, with a Civil War Soldiers and Sailors monument at its summit.

Malden is a residential community with some industrial development and is also an important suburban Boston shopping centre. Manufactures include rubber footwear, electronic and radio parts, aircraft engine parts, metal cans, paints, drugs, knitted clothing and foods. Pop. (1960) 57,676. (L. G. H.)

MALDEN AND COOMBE, a municipal borough in the Kingston upon Thames parliamentary division of Surrey. Eng., is about 10 mi. S.W. of London: it lies immediately south of Richmond park. Pop. (1951) 45.566. Area 4.9 sq.mi. Walter de Merton, lord chancellor of England, founded a college there in 1264 for the maintenance of 20 scholars at Oxford, where Merton college was founded about two years later. From 1894 to 1936. when they were incorporated as a borough, Malden and Coombe were governed by an urban district council. The district is mainly residential. but there are a few small factories.

MALDIVE ISLANDS, an archipelago of coral islets in the Indian ocean. forming a chain between 7° 6' N. and 0° 42' S. It lies 400 mi. S.W. of Ceylon. and some 300 of the numerous islands in the 17 Maldivian atolls are inhabited. In the extreme south are the isolated atolls of Addu and Fua-Mulaku, separated from Suvadiva by the Equatorial channel. which is itself separated from the main chain of atolls by One-and-a-half-degree channel. Thence the chain continues northward to the Eight-degree channel. beyond which lies Minicoy, 71 mi. from the nearest point of the Maldives and 110 mi. from that of the Laccadives to the north. The main part, north of One-and-a-half-degree channel. consists of a series of banks either surrounded or studded all over with reefs.

Aiter the Portuguese. from about 1518 onward, had attempted many times to establish themselves on the islands by iorce. and after the Maldivians had endured frequent raids by the Mopla pirates of the Malabar coast. they began to send tokens of homage and claims of protection (the first recorded being in 1645) to the rulers of Ceylon. Formerly a dependency of Ceylon. the Maldive Islands are now a sultanate, and a protected state of the United Kingdom. In 1956 the population of the Maldives was 81,950. The people have been classed in four ethnological divisions. (1) Those of the atolls north of the Kardiva channel. There the people are more vigorous than their less warlike southern neighbours. They annually visited the coasts of India or Ceylon. and often married Indian wives, thus acquiring distinct racial characters of an approximately Dravidian type. (2) Those of the central division, under the direct rule of the sultan, and more exposed to Arab influences. They formerly traded with Arabia and Malaysia. and many Arabs settled among them, so that they betray a strong strain of Semitic blood in their features. (3 and 4) The natives of the southern clusters, who have had little communication with the Central Mali. people, and probably preserve more of the primitive type, approximating in appearance to the Sinhalese villagers of Ceylon.

The language is a dialect of Sinhalese: but indicating a separation of ancient date, and many of the Maldivians read Arabic with considerable fluency. They are an intelligent and industrious people. More than half of the men earn their livelihood as fishermen. Coir making is the industry second in importance. The finest quality of coir is found in the Tiladummati atoll. A large number of the people arc also engaged in the manufacture of lace. The chief exports of the islands, besides coir, are coconuts, copra, millet and fruit.

Minicoy atoll, belonging to India, with the numerous wrecks on its reefs. and its lighthouse, is a familiar sight to seafarers in these waters. The atoll is growing outward on every side, and at one place it rises 19 ft. above sea level. The population. which numbers 3.804 (1931), is divided into five castes, of which the three highest are pure Maldivians, the lower two the same as in the Laccadives, All are centred in a village opposite Mou Rambu Point. on the west or lagoon side; but most of the men are employed with the Lascar crews on large vessels plying in the eastern seas.

See F. W. Hockley, *A Short Account of the People, History and Customs of the Maldive Archipelago* (1935).

MALDON, a market town, municipal borough and port, in the Maldon parliamentary division of Essex, Eng., on the south side of the Blackwater, 10 mi. E. of Chelmsford by road. Pop. (1951) 9,726. Area 7.5 sq.mi. Finds of prehistoric objects indicate early settlement, and an earthwork, of which traces exist, may be Saxon or Danish. The Anglo-Saxon Chronicle relates that Edward the Elder established a "burh" there about 921. Maldon was more remarkable for its fortress than for its commercial importance. In 991 it was the site of a battle fought by Byrhtnoth, earldorman of Essex, against Danish marauders who were victorious. The incident is commemorated in an Old English poem, *The Battle of Maldon.* It remained a royal town up to the reign of Henry I and thus is entered as being on *terra regis* in Domesday Book. Henry II granted the burgesses their first charter in 1171. Maldon was incorporated by Philip and Mary in 1554. The church of All Saints dates from 1056, the Moot hall, formerly D'Arcy's tower, was built in the reign of Henry VI, and the Plume library, founded by Thomas Plume, archdeacon of Rochester, before 1704. Maldon has many summer visitors and there are foundries, timber and flour mills, an oyster fishery and some shipping.

Beeleigh abbey, 1 mi. W., a Premonstratensian house founded about 1180, is a residence in which the beautiful Early English chapter house. the warming house and dormitory are incorporated.

MALEBRANCHE, NICOLAS (1638–1715), French philosopher of the Cartesian school, the youngest child of Nicolas Malebranche, secretary to Louis XIII, and Catherine de Lauzon. sister of a viceroy of Canada. was born at Paris on Aug. 6, 1638. Deformed and constitutionally feeble, he studied theology at the Sorbonne, and in 1660 he joined the congregation of the Oratory. In 1664 he read Descartes's *Traité de l'homme (De homine)*. After ten years' study of the works of Descartes he produced the famous *De la recherche de la vérité où l'on traite de la nature de l'esprit de l'homme et de l'usage qu'il en doit faire pour éviter l'erreur dans la science* (1674; Eng. trans., 1694–95), followed at intervals by other works, both speculative and controversial. Like most of the great metaphysicians of the 17th century, Malebranche interested himself also in questions of mathematics and natural philosophy, and in 1699 was admitted an honorary member of the Academy of Sciences. During his later years his society was much courted, and he received many visits from foreigners of distinction. He died on Oct. 13, 1715; his end was said to have been hastened by a metaphysical argument in an interview with Bishop Berkeley. For Malebranchc's place in the history of philosophy, *see* CARTESIANS. His other works include *Conversations métaphysiques et chrétiennes* (1677; Eng. trans., 1695); *Traite' de la nature et de la grâce* (Amsterdam, 1680; Eng. trans., 1695); *Méditations chrétiennes et métaphysiques* (1683); *Traité de morale* (Rotterdam, 1684; Eng. trans. by Sir J. Shipton 1699); several polemical works against Arnauld from 1684 to 1688; *Entretiens sur la métaphysique et sur la religion* (1688); *Traite' de l'amour de Dieu* (1697); *Entretiens d'un philosophe chrétien et d'un philosophe chinois sur l'existence et la nature de Dieu* (1708); *Réflexions sur la prémotion physique* (1715).

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MALENKOV, GEORGI MAXIMILIANOVICH (1902–), Soviet statesman, was born at Orenburg (Chkalov), Russia, on Jan. 8, 1902. He joined the Communist party in April 1920. After the civil war, he studied at Moscow Higher Technical college and was secretary of the Communist students' organization. In 1925 he was appointed personal secretary to Joseph Stalin. In 1930 he was organizing secretary of the Moscow section of the party. In March 1934, before the purges of 1936–38, Stalin appointed him member of the Orgburo and head of the personnel department. The 18th congress of March 1939 elected him member of the central committee of the All-Union Communist party which, in turn, appointed him one of the five secretaries. On Feb. 21, 1941, he became a substitute member of the Politburo and on June 30. 1941, a member of the State Defense committee. For organizing aircraft production during World War II he was awarded in 1943 the title of Hero of Socialist Labour and the Order of Lenin. On March 19, 1946, he was appointed one of ten full members of the Politburo and one of the deputy chairmen of the council of ministers. Besides Stalin, only Malenkov was simultaneously a member of the government and of the three key party bodies: Politburo, Orgburo and secretariat. On Sept. 22–23, 1947, he and Andrei A. Zhdanov were Soviet delegates at the conference at Wilcza Gora, Poland, at which the Cominform was created. At the 19th congress of the Communist Party of the Soviet Union (as it was now called). Malenkov read the main report (Oct. 5, 1952) and was elected member of a commission of 11 to revise the party program (Oct. 13) as well as of the new central committee of 125 (Oct. 14). On Oct. 16 the last-named elected him to the new key party bodies a 25-member presidium and a 10-member secretariat. On March 6. 1953, the day after Stalin's death. a reorganization of the Soviet party and state was announced: the party presidium was reduced to ten. with Malenkov heading the list; the secretariat. to five. with Malenkov as first secretary (eight days later he resigned from that post). He became chairman of the council of ministers and the number of deputy chairmen was reduced to five. with Lavrenti P. Beria in the first place. The changes mere approved by the supreme soviet of the C.S.S.R. on March 15. Beria, who had proposed Malenkov's appointment as chairman of the council of ministers, was later denounced by Malenkov for "criminal actions" and executed in 1953. On Feb. 8, 1955, Malenkov resigned, assuming responsibility for failure of the agriculture program and calling for further development of heavy industry. N S. Khrushchev, who had been appointed first secretary of the Communist party, nominated Malenkov's successor, Marshal Nikolai Bulganin, who, under various titles, had been in charge of the armed forces for more than ten years.

MALESHERBES, CHRETIEN GUILLAUME DE LAMOIGNON DE (1721–1794), French law reformer and statesman, was born at Paris on Dec. 6. After completing his historical and legal studies, he became *conseiller* of the parlement of Paris at the age of 24 and premier president of the *cour des aides* in 1750. In the same year, his father, Guillaume de Lamoignon, who had just become chancellor, placed him at the head of the French press-censorship as *directeur de la libvaivie.* Malesherbes held this appointment till 1768 and in him the philosophers found an understanding critic and unofficial protector. His enlightened views and his friendly relations with the foremost French writers of the time, including Voltaire, Rousseau and Diderot, made it possible for the *Encyclopédie* to continue to appear, and even for works which had been printed abroad to evade the censorship to circulate inside France.

Malesherbes was a prominent member of the opposition to the abolition of the parlements in 1771, and was exiled to his estates at St. Lucie. After the restoration of the parlements under Louis XVI, Malesherbes resumed his presidency of the *cour des aides,* but resigned on becoming secretary of state for the *maison du roi* on July 21, 1775. In this ministerial position. which carried with it responsibility for the police. ecclesiastical affairs a considerable part of the provincial government of France and the capital, Malesherbes gave disinterested, but hardly energetic, support to the reforming activities of Turgot. He devoted himself to the cause of prison reform and did much to control the abuses of the system of *lettres de cachet* (*q.v.*). On Turgot's fall from power. Malesherbes resigned office on May 12, 1776, and, for the rest of his life took no prominent part in politics, though he held office again in 1787–88. In retirement he travelled in Switzerland, Germany and Holland. cultivated his literary and botanical interests, and campaigned for the recognition of the civil status of Protestants in France. His intellectual distinction brought him membership of the Academy of Sciences (1750), the Academy of Inscriptions (1759) and of the Académie Française (1775).

Malesherbes re-emerged from his retirement in Dec. 1792 in order to offer his services to Louis XVI. on trial before the Convention. He assisted Tronchet and de Sèze in the conduct of the defense and broke the news of the verdict to the king. He was arrested in Dec. 1793, condemned to death by the Revolutionary Tribunal for counter-revolutionary activities and guillotined, with his daughter. son-in-law and grandchildren, on April 22. 1794.

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(A. Gn.)

MALHERBE, FRANÇOIS DE (1555–1628), French poet, critic and translator, was born at Caen, the eldest son of another François de Malherbe, *conseiller du roi* in the magistracy of Caen. He himself was educated at Caen, at Paris, at Heidelberg and at Basle. At the age of 21 he entered the household of Henri d'Angoulême, grand prior of France, the natural son of Henry II. He served this prince as secretary in Provence, and married there in 1581 Madelaine de Coriolis. After his patron's death he lived partly in Provence and partly in Normandy for many years, but very little is known of his life during this period. He was presented by his countryman. the Cardinal Du Perron, to Henry IV. and was at last summoned to court and endowed after one fashion or another. It is said that the pension promised him was not paid till the next reign. His father died in 1606, and he came into his inheritance. From this time forward he lived at court, corresponding affectionately with his wife, but seeing her only twice in some 20 years. His old age was saddened by a great misfortune. His son, Marc Antoine, a young man of promise. fell in a duel in 1626. His father used his utmost influence to have the guilty parties brought to justice, but he died before the suit was decided (it is said in consequence of disease caught at the camp of La Rochelle, whither he had gone to petition the king). Malherbe's first poem *Les Larmes de Saint Pierre* appeared in 1587. His poetical work is scanty in amount. The beautiful *Consolation à Duperier* (*c.* 1599), in which occurs the famous line—

"Et rose, elle a vécu ce que vivent les roses—"

the odes to Marie de' Medici and to Louis XIII, and a few other pieces comprise all that is really worth remembering of him. His prose work is much more abundant, not less remarkable for care as to style and expression, and of greater positive value. It consists of some translations of Livy and Seneca, and of a very large number of interesting and admirably written letters, many of which are addressed to Peiresc, the man of science of whom Gassendi has left a delightful Latin *Life.* It contains also the *Commentaire sur Desportes,* in which Malherbe's minute and carping style of verbal criticism is displayed on the great scale.

The personal character of Malherbe was far from amiable, but he exercised, or at least indicated the exercise of, a great and enduring effect upon French literature, though by no means a wholly beneficial one. The lines of Boileau beginning *Enfin Malherbe vint* are rendered only partially applicable by the extraordinary ignorance of older French poetry which distinguished that peremptory critic. But the good as well as bad side of Malherbe's theory and practice is excellently described by his contemporary and superior Regnier, who was animated against him, not merely by reason of his own devotion to Ronsard but because of Malherbe's discourtesy toward Regnier's uncle P. Desportes, whom the Norman poet had at first distinctly copied. These are the lines:—

Cependant leur savoir ne s'étend nullement
Qu'à régratter un mot douteux au jugement,
Prendre garde qu'un *qui* ne heurte une diphthongue,
Epier si des vers la rime est brève ou longue,
Ou bien si la voyelle à l'autre s'unissant
Ne rend point à l'oreille un vers trop languissant.

. . . .

C'est proser de la rime et rimer de la prose.

This is perfectly true, and from the time of Malherbe dates that great and deplorable falling off of French poetry in its more poetic qualities, which was not made good till 1830. Nevertheless the critical and restraining tendency of Rialherbe was not ill in place after the luxuriant importation and innovation of the *Pléiade;* and if he had confined himself to preaching greater technical perfection, and especially greater simplicity and purity in vocabulary and versification. instead of superciliously striking his pen through the great works of his predecessors. he would have deserved wholly well. As it was, his reforms helped to elaborate the kind of verse necessary for the classical tragedy, and that is the most that can be said for him.

Malherbe's works were published two years after his death. He left behind him an unenviable reputation for acerbity in his relations with his contemporaries. but his influence as a critic was great and far reaching. He represents the reaction against the innovations of the Pléiade and the beginning of the strict French classical school.

The chief authorities for the biography of Malherbe are the Vie *de Malherbe* by his friend and pupil Racan, and the long *Historiette* which Tallemant des Réaux has devoted to him. The standard edition is that of Ludovic Lalanne, 5 vol. (1862–69).

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MALIBRAN, MARIE FÉLICITÉ (1808–1836), operatic singer. daughter of Manuel Garcia (q v), was born in Paris on March 24, 1808. Her father was then a member of the company of the Théâtre des Italiens. and she accompanied him to Italy and London. She possessed a soprano voice of unusual beauty and phenomenal compass, which was carefully cultivated by her father.

Mme. Malibran was only seventeen when she was suddenly asked to take Pasta's place in *The Barber of Seville* at Covent Garden. She was engaged for the remaining six weeks of the season. and then appeared in New York in *Othello, The Barber of Seville, Don Juan, Romeo and Juliet, Tancred.* Her gifts as an actress were on a par with her magnificent voice: and her gaiety made her irresistible in light opera. although her greatest triumphs were obtained in tragic parts. She married a French banker of New York, named Malibran, who was much older than herself. The marriage was an unhappy one, and Mme. Malibran returned alone to Europe in 1828, when she began the series of representations at the Théâtre des Italiens, which excited an enthusiasm in Paris only exceeded by the reception she received in the principal towns of Italy. She was formally divorced from Malibran in 1835, and married the Belgian violinist, Charles de Beriot. She died on Sept. 23, 1836.

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MALINES (Flemish, MECHELEN), an ancient and important city, and the seat since 1559 of the only Belgian archbishopric. Pop. (19jj est.) 63,293. It is on the Dyle in the province of Antwerp, about half-way between Antwerp and Brussels. The archbishop is the primate of the country. The archbishop's palace is in a picturesque situation, and dates from the creation of the see. The fine cathedral dedicated to St. Rombaut was begun in the 12th and finished early in the 14th century, and modified in the 15th after a fire. The massive tower of over 300 ft., which is described as unfinished because the original intention was to carry it to joo ft., is its most striking external feature. The cathedral contains a fine altar-piece by Van Dyck. The old palace of Margaret of Austria, regent for Charles V, has been preserved and is now a court of justice. In the church of Our Lady (16th century) is Rubens' masterpiece "the Miraculous Draught of Fishes," and in that of St. John is a fine triptych by the same master. Malines, although no longer famous for its lace, carries on a large trade in linen, needles, furniture and oil; it is a great junction for the lines Ghent-Liége and Antwerp-Brussels and has large state railway-works.

The lordship of Malines was conferred as a separate fief by Pippin the Short on his kinsman Count Adon in 754. In the 9th century Charles the Bald bestowed the fief on the bishop of Liége, and it passed to Philip the Bold, of Burgundy, in 1384. During the religious troubles of the 16th century Malines suffered greatly, and in 1572 it was sacked by Alva's troops during three days. In the wars of the 17th and 18th centuries it was besieged many times and captured by the French, Dutch and English on several occasions. The French finally removed the fortifications in 1804, since which year it has been an open town.

Malines was bombarded three times during World War I and seriously damaged. The law courts, restored shortly before the war, the school of music, and the picturesque houses round the Yzeren Leeh were ruined, and the south side of the cathedral of St. Rombaut and the chimes badly damaged. The Cloth Hall, also restored before the war, was, afterwards, used as the Town hall. Conferences were held there, 1921–25, between Cardinal Mercier, Archbishop of Malines, and some dignitaries of the Church of England, to further a reunion of the churches.

In World War II, the British first met the Germans near Malines. Its fall led to the capture of Antwerp and Brussels.

MALINKE, the name of a tribe, formerly commonly called Negroid, of west Sudan. Malinké is a general term covering many individual divisions of speech and tribe. The languages spoken are divided into (1) Malinké proper (Eastern Malinké), used throughout the length of the Upper Niger above Bamako and between Niger and Bafing; (2) Xasonké, usually called Northern Malinké in the Kayes region; (3) Western Malinké on the Gambia and (4) Southern Malinké on the edge of the dense forests. These languages belong to the Nigero-Senegalese group of tongues, as does the lingua franca of the region Kãgbe or "white language."

MALINOWSKI, BRONISLAW KASPER (1884–1942), Polish-born British anthropologist, one of the leading figures in the development of modern social anthropology, was born on April 7, 1884, in Cracow. Attracted to anthropology by Frazer's *The Golden Bough,* he studied at the University of Cracow (Ph.D., 1908), Leipzig university and the London School of Economics, where he successively became lecturer. reader and first professor (1927–42) of social anthropology. His analyses of Melanesian society, based upon four years of field work in the Trobriand Islands and northwest Melanesia (1914–18), set a standard of depth and comprehensiveness that revolutionized field research and gained him a world-wide reputation. His functional approach to the study of societies, which he saw as integrated systems of institutions subserving basic and derived needs, drew into the discussion of anthropological theory specialists in a wide range of human studies from law to psychology, and did much to obtain a secure position for anthropology in British university curriculums. He also was a pioneer in applied anthropology, and many of the British advances in colonial administration stemmed from the inspiration he gave scholars and administrators from Africa and Asia. His talent attracted to his seminars almost all the leading British specialists of the first half of the 20th century.

From 1939 until his death at New Haven, Conn., on May 16. 1942, Malinowski was visiting professor of anthropology at Yale university.

His studies include *The Family Among the Australian Aborigines* (1913); *Argonauts of the Western Pacific* (1922); *Sex and Repression in Savage Society* (1927); *Coral Gardens and Their Magic,* 2 vol. (1935); *The Foundations of Faith and Morals* (1936); and, posthumously, *A Scientific Theory of Culture* (1944); *The Dynamics of Culture Change* (1945); *Magic, Science and Religion* (1948).

See M. Gluckman, *Analysis of the Sociological Theories of B. Malinowski* (1949); and P. Murdock, "Bronislaw Malinowski," *Amer. Anthrop.,* vol. xlv (1942), with bibliography. (H. N. C. S.)

MALIPIERO, G. FRANCESCO (1882–). Italian composer. was born in Venice on March 18. 1882. He studied under Marco Enrico Bossi in Venice, and in 1902 followed him to Bologna. Later he went to Paris, but his strong individuality prevented him from attaching himself to any school. In 1921 he was appointed professor of composition at the Royal Conservatory of Parma.

Malipiero, one of the most advanced of Italian composers, aimed at the perfect fusion of music and drama, and his experiments in this direction aroused great interest and much criticism. In *Pantea,* a symphonic drama for a dancer with invisible chorus and orchestra, the dancer's movements represent, it is claimed, the "moods of the soul." *Sette Canzoni,* perhaps his best achievement, was included with the two dramas *La morte delle maschere* and *Orfeo* in a trilogy under the title *L'Orfeide.* It is divided into episodes, each with a *canzone* as its central feature and mimic action for the setting. But this *canzone* is not a song created for stage requirements but one which has a natural place in scenes of real life. Other dramatic works are: *Ellen e Fuldano, San Francesco d'Assisi, Sogno d'un tramonto d'autunno, Canossa* and *La mascherata delle principesse.* Symphonies written by him include *Impressione dal vero* (2 sets, 1911, 1914), *Ditirambo tragico* (1917), *Armenie* (1917), *Per una favola cavalleresca* (1921) and *Oriente immaginario.*

MAL-LARA, JUAN DE (?1524–1571), Spanish humanist remembered for his *Filosofia Vulgar* (1568), a commentary on Spanish proverbs, was born at Seville, studied at Salamanca (1538) and at Barcelona under the Valencian rhetorician Francisco de Escobar, returning to Salamanca in 1548. He founded a famous grammar school at Seville, where he died in 1571. His *Filosofia Vulgar* is based on the *Adagia* of Erasmus, whose ideas influenced Mal-Lara, and whose text he follows, avoiding, however, all contentious problems. It shows keen observation, apt reporting of anecdote and picturesque detail, wide learning and enlightened criticism of manners and customs and is valuable both as an authoritative work on proverbs and as an encyclopaedia of folklore. He also wrote many plays, now lost, of which three, including the *Comedia Locusta,* are praised by name by contemporary writers.

See F. Sánchez Escribano, *J. de Mal-Lara: su vida y sus obras* (1941).
(I. M. G.-LL.)

MALLARME, STÉPHANE (1842–1898), French poet and theorist, was born at Paris, on March 18, 1842. His life was simple and without event. His small income as professor of English in a French college was sufficient for his needs, and, with his wife and daughter, he divided the year between a fourth-floor flat in Paris and a cottage on the banks of the Seine. His Tuesday evening receptions, which did so much to form the thought of the more interesting of the younger French men of letters, were almost as important a part of his career as the few carefully elaborated books which he produced at long intervals. *L'Après-midi d'un faune* (1876) and other fragments of his verse and prose had been known to a few people long before the publication of the *Poésies complètes* of 1887, in a facsimile of his clear and elegant handwriting, and of the *Pages* of 1891 and the *Vers et prose* of 1893. His remarkable translation of poems of Poe appeared in 1888, "The Raven" having been published as early as 1875, with illustrations by Manet. *Divagations,* his own final edition of his prose, was published in 1897, and a more or less complete edition of the *Poésies,* posthumously, in 1899. He died at Valvins, Fontainebleau, on Sept. 9, 1898. All his life Mallarmé was in search of a new aesthetic, and his discoveries by the way were often admirable. But he was too critical ever to create freely, and too limited ever to create abundantly. His great achievement remains unfinished, and all that he left towards it is not of equal value. There are a few poems and a few pieces of imaginative prose which have the haunting quality of Gustave Moreau's pictures, with the same jewelled magnificence, mysterious and yet definite. His later work became more and more obscure, as he seemed to himself to have abolished limit after limit which holds back speech from the expression of the absolute. Finally, he abandoned punctuation in verse, and invented a new punctuation, along with a new construction, for prose. Patience in the study of so difficult an author has its reward. No one in our time has vindicated with more pride the self-sufficiency of the artist in his struggle with the material world. To those who knew him only by his writings his conversation was startling in its clearness; it was always, like all his work, at the service of a few dignified and misunderstood ideas. (A. SY.)

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MALLEABLE CAST IRON: *see* CAST-IRON.

MALLECO, an inland province of southern Chile, lying between the provinces of Bio-Bio and Cautin. Area 5,512 sq.mi.; pop. (1952) 159,419. It is in the rainy, forested region of southern Chile, inhabited to a considerable extent by Araucanian Indians. Gold placer mining has attracted some attention, but the output is small. Principal industries are cattle and wheat raising and timber cutting. The state central railway crosses the province, and the capital (Angol) is served by a branch line.

MALLET or MALLOCH, **DAVID** (?1705–1765), Scottish poet and dramatist, the son of a farmer, was born in Perthshire, probably in 1705. He went to school in Edinburgh, and in 1720, to Edinburgh university, where he made the friendship of James Thomson, author of *The Seasons.* Short poems by Mallet appeared in the *Edinburgh Miscellany,* and in Allan Ramsay's *Tea Table Miscellany,* in which his ballad "William and Margaret" was published in 1724. In this year he changed his name from Malloch to Mallet. He travelled for several years as private tutor to the duke of Montrose's sons: and in 1742 through Pope's influence was appointed secretary to the prince of Wales. For his services as a pamphleteer for the Tory party. Lord Bute gave him a lucrative sinecure in 1760. He died on April 21, 1765. In 1740, in collaboration with Thomson. Mallet produced the masque *Alfred* (containing the patriotic song "Rule, Britannia"); in 1751 after Thomson's death, he published a new version, claiming that it was almost entirely his own work.

A collection of his *Works* appeared in 1759 (3 vol.). His *Ballads and Songs* were edited by F. Dinsdale, with notes and a biographical memoir, in 1857.

MALLET DU PAN, JACQUES (1749–1800), French journalist, was born near Geneva. Voltaire obtained him a professorship at Cassel, which he soon resigned. He joined Simon Linguet (*q.v.*) in London, in the production of his *Annales politiques* (1778–80), and during Linguet's imprisonment in the Bastille (1781–83) continued them himself. Linguet resented this, and Mallet du Pan changed the title of his publication to *Mémoires historiques* (1783), which he incorporated with the *Mercure de France* in Paris from 1783. He sided with the Royalists at the Revolution. and was sent by Louis XVI on a mission to the German princes (1791–92). His antirevolutionary pamphlets, and an attack on Bonaparte and the Directory resulted in his exile in Berne (1797). In 1798 he went to London and founded the *Mercure britannique.* He died at Richmond, Surrey, on May 10, 1800. Mallet du Pan was a pioneer of modern political journalism.

Mallet du Pan's *Mémoires et correspondance* was edited by A. Sayous (1851). *See* also B. Mallet, *Mallet du Pan and the French Revolution* (1902).

MALLING, EAST and **WEST,** two villages in the Malling rural district of Kent, Eng.. respectively 4 mi. and 6 mi. W. N.W. of Maidstone. Pop. (1951) East Malling 3.258; West Malling 3,357. East Malling is known for its horticultural research station specializing in experiments in fruitgrowing. The mansion of Bradbourne is now the headquarters of the station. There are also large paper mills in the village. At West Malling are remains of Malling abbey, a Benedictine nunnery founded in 1090 by Gundulf, bishop of Rochester. The remains, partly incorporated in a modern building, include the Norman west front of the church, the Early English cloisters. the chapter house and gatehouse (the chapel of which is restored to use). Gundulf also built himself a residence. of which St. Leonard's tower survives. The village has a long cricketing tradition.

MALLOPHAGA, an order of insects comprising the biting or chewing lice; minute, wingless forms parasitic on birds and mammals. They are sometimes treated as a suborder along with Anoplura, the sucking lice, to form the order Phthiraptera. About 2,800 species are recorded. with many more. especially among the bird lice. still undescribed. Their life cycle is spent on the feathers or hair of the host, though one genus lives in the throat pouches of pelicans and cormorants.

The eggs. attached to the feathers or hairs, or occasionally laid inside quill feathers, give rise to young which pass through three nymphal stages which resemble the adult. A single bird or mammal species may be parasitized by one or more (sometimes as many as 15) species of biting lice. They often show host-specificity, being unable to survive on any but their own or a related host. Their present distribution suggests that they became parasitic at an early stage in the evolution of their hosts and evolved with them so that: with some exceptions due to subsequent transference having taken place, related hosts are parasitized by related biting lice; a particular genus may be restricted to one group of birds, and a particular species may be found on only one species of bird or on a group of related species.

Biting lice on birds feed on feathers or feathers and blood, the blood sometimes being taken from the shafts of the developing feathers; some live on blood alone and their normal chewing mandibles may then be adapted to piercing the skin. Probably all species of birds have biting lice. Preening keeps down the numbers, and birds with damaged bills are often particularly heavily infested because they cannot preen themselves properly. Normally. lice do no damage, but if they are too numerous the irritation may cause the bird to damage itself by scratching and may even interfere with egg production and fattening in poultry.

Biting lice parasitic on mammals feed on skin secretions and skin debris; it is uncertain whether they eat hair. They are less widespread than those of birds, comprising fewer genera and species. and occur on marsupials, primates, rodents, land carnivores. hyraxes and ungulates. The elephant louse, *Haematomyzus,* if of questionable affinity, is usually considered to belong to the Mallophaga. *See* LOUSE.

See M. Rothschild and T. Clay, Fleas, Flukes *and* Cuckoos, 3rd ed. (1957). (T. CL.)

MALLOW, a town and watering place of County Cork. Ire., on the Blackwater. 144½ mi. S.W. from Dublin, and 21 N. from Cork by the Great Southern railway. Pop. (1961) 5,520. The town possesses a tepid mineral spring and a spa house. There are manufactures of mineral water and condensed milk, corn mills and tanneries.

Mallow received a charter of incorporation from James I. Its name was originally Magh Allo, that is, Plain of the Allo (the old name used by Spenser for this part of the river), and the ford was defended by a castle, built by the Desmonds, the ruins of which remain. A bridge connects the town with Ballydaheen. Mallow is a centre for salmon fishing on the Blackwater.

MALLOW is any plant of the family Malvaceae, especially of the genera *Hibiscus* (*q.v.*) and *Malva,* the latter embracing about 30 species of annual and perennial herbs. widely distributed throughout the northern hemisphere. The mallows possess the kidney-shaped one-celled anthers which characterize the Malvaceae (*q.v.*). The petals also are united by their base to the tube formed by the coalesced filaments of the stamens. The special characters which separate the genus *Malva* from others most nearly allied to it are the involucre, consisting of a row of three separate bracts attached to the lower part of the true calyx. and the numerous single-seeded carpels disposed in a circle around a central axis, from which they become detached when ripe. The flowers are mostly white or pinkish. never yellow, the leaves radiate-veined and more or less lobed or cut. Three species are found in Britain. The musk mallow (*Malva moschata)* is a perennial herb with five-partite, deeply cut leaves and large rose-coloured flowers clustered together at the ends of the branched stems and is found growing along hedges and borders of fields. blossoming in July and August. It owes its name to a slight musky odour diffused by the plant in warm dry weather when it is kept in a confined situation. The round-leaved dwarf mallow (*Malva neglecta*) is a creeping perennial growing in waste sandy places, with roundish serrate leaves and small pinkish-white flowers produced in the axils of the leaves from June to September. It is common throughout Europe and the north of Africa, extending to western and northern Asia. The common mallow (*Malva sylvestris*), the *mauve* of the French, is an erect biennial or perennial plant with long-stalked roundish-angular serrate leaves, and conspicuously axillary reddish-purple flowers. blossoming from May to September. Like most plants of the order it abounds in mucilage, and hence forms a favourite domestic remedy for colds and sore throats. The aniline dye called mauve derives its name from its resemblance to the colour of this plant. Besides the foregoing, three other species have become naturalized in various parts of North America.

FROM GROOM, "ELEMENTARY BOTANY" (G. BELL AND SONS)

VERTICAL SECTION OF COMMON MALLOW (MALVA SYLVESTRIS) FLOWER

The marsh mallow *(Althaen officinalis*), the *guimauve* of the French. belongs to the same genus as the hollyhock (*q.v.*). (For rose mallow, *see* HIBISCUS.) The mallow of Scriptures, Job xxx, 4, has sometimes been identified with Jew's mallow *(Corchorus olitorius*), a member of the allied family Tiliaceae. but more plausibly with *Atriplex halimus,* the sea orache of Europe. Once widely used in medicine, mallows are no longer considered of value.

MALMÉDY, a small town acquired by Belgium from Germany through the treaties after 1918, lying in a wild and deep basin, on the Warche, 20 mi. S. of Aachen by rail via Eupen. Pop. (1955 est.) 5,941. (See EUPEN-ET-MALMÉDY.)

MALMESBURY, JAMES HARRIS, 1ST EARL OF (1746–1820), English diplomatist, was born at Salisbury on April 21, 1746, the son of James Harris, the author of *Hermes.* Educated at Winchester, Oxford and Leyden, he became secretary in 1768 to the British embassy at Madrid, then minister ad *interim,* and in 1772 minister plenipotentiary to the court of Prussia. In 1777 he was transferred to the court of Russia, where he made his reputation, for he managed to get on with Catherine in spite of her predilections for France, and steered adroitly through the accumulated difficulties of the first armed neutrality. He was made a knight of the Bath in 1778, but in 1782 returned home because of ill health, and was appointed by his friend Fox to be minister at The Hague. He furthered Pitt's policy of maintaining England's influence on the continent by the arms of her allies, and held the threads of the diplomacy which ended in the king of Prussia's overthrowing the republican party in Holland, which was inclined to France, and re-establishing the prince of Orange. He was created Baron Malmesbury of Malmesbury (Sept. 1788), and permitted by the king of Prussia to bear the Prussian eagle on his arms and by the prince of Orange to use his motto *"Je maintiendrai."* He returned to England, and seceded from the Whig party with the duke of Portland in 1793; in that year he was sent by Pitt, but in vain, to try to keep Prussia true to the first coalition against France. In 1794 he was sent to Brunswick to solicit the hand of the unfortunate Princess Caroline for the prince of Wales. In 1796 and 1797 he was at Paris and Lille vainly negotiating with the French Directory. In 1800 he was created earl of Malmesbury and Viscount Fitzharris of Heron Court in the county of Hants. He was now consulted by successive foreign ministers, trusted by men of the most different ideas in political crises and was above all the confidant, and for a short time after Pitt's death almost the political director, of Canning. Lord Palmerston, who was his ward, derived many of his ideas on foreign policy from him. Malmesbury died on Nov. 21, 1820, and was succeeded as 2nd earl by his son James Edward (1778–1841), undersecretary for foreign affairs under Canning.

Malmesbury published only an account of the Dutch revolution and an edition of his father's works, but his important *Diaries* (1844) and *Letters* (1870) were edited by his grandson.

MALMESBURY, JAMES HOWARD HARRIS, 3RD EARL OF (1807–1889), English statesman, was born on March 25, 1807, in London, and educated at Eton and at Oriel college, Oxford. Member for Wilton in 1841, when he succeeded to the title, Malmesbury first became prominent after the Conservative split over the corn laws in 1846 as a staunch old-fashioned Tory and active supporter of Lord Stanley, later Lord Derby, under whom he served as foreign secretary in 1852 and 1858–59. Despite his lack of experience, Malmesbury, who was naturally pacific and dubious of Palmerstonian methods, proved adequate to a difficult task. Francophile through inclination and his acquaintance with Napoleon III, he concentrated upon improving Anglo-French relations. He was the first to recognize the establishment of the second Empire; over the Italian question he attempted, with little success. 'to combine neutrality, tempered by a preference for the Habsburg position, with benevolence toward France. Though never holding executive officeagain. Malmesbury remained a respected and influential figure in Conservative circles. From 1866 to 1868 and from 1874 to 1876, he was lord privy seal; he died on May 17, 1889, at Heron Court, Hampshire.

Malmesbury's political career owed much to his friendship with Derby, and to the paucity of talent in his party after the secession of the Peelites. Cosmopolitan in his tastes and connections, his casual if extensive knowledge of European problems and personalities was his main qualification for the foreign office, although his performance there surprised the critics. In 1884 he published his entertaining Memoirs *of* an Ex-Minister, a valuable source for a crucial period in the history of the Conservative party.

(A. F. T.)

MALMESBURY, a market town and municipal borough in the Chippenham parliamentary division of Wiltshire, Eng., 22 mi. N.E. of Bath by road. Pop. (1961) 2,606. It stands on a ridge between the Salisbury Avon and its tributary. the Inglebourne. Maildulph, a Scottish or Irish monk, built a hermitage near the site of the modern Malmesbury in about 635. This formed the nucleus of the later abbey, of which Aldhelm, his pupil, became the first abbot. Aethelstan, who was buried there, rebuilt and endowed the monastery, and there William of Malmesbury (*q.v.*) was brought up from childhood. A Benedictine abbey church was built on this site in the 12th century and part of it, restored in 1928 by Sir Harold Brakspear, is now the parish church. The nave is transitional Norman and Decorated and the south porch is Norman. At the time of the Dissolution, the abbey and its lands were bought by a rich clothier. The abbey church was fitted with looms for weaving, and later presented to the townspeople to replace their decaying parish church. All that remains of the latter is the tower which contains the town clock and the abbey bells. In the market square stands a fine market cross of the 16th century, borne upon an octagonal battlemented basement. The 13th-century hospital of St. John of Jerusalem survives as fragments in a corporation almshouse.

The town grew up around the abbey and at the time of the Domesday Survey it was one of the only two boroughs in Wiltshire. The building of a castle by Henry I (pulled down in the 13th century) gave further impetus to the growth of the town. Following many earlier charters. the first charter of incorporation was granted in 1635. The borough returned two members to parliament from 129j to 1832 and one member from then until 1885. Thomas Hobbes, the philosopher, was born there in 1588. From the middle ages to the 1750s the town possessed a considerable cloth manufacture, and silk industries flourished during the 19th century. Today it has an agricultural trade and firms making electronic and radar and strip-lighting equipment.

MALMÖ, a seaport of Sweden, chief town of the county (*län*) of Malmohus, on a small bay of the sound, 384 mi. S.S.W. of Stockholm by rail. Pop. (1800) 38,054; (1960) 228,878.

Malmö (Malmhauge, Malmey, Malmoye, Malmoughe), sometimes called Ancona Scanorum or Ellenbogen, first appears in history about the middle of the 13th century. During the Hanseatic period it was the most important commercial town on the sound, but in the 16th and 17th centuries greatly lost ground because of the decay of its herring fisheries and the rise of its rival, Copenhagen, Den. It began to revive in the late 18th century.

It is connected with Copenhagen, 17¼ mi. N.W., by steam ferry, the sound being kept open in winter by an icebreaker. It is also the first important station in Sweden on the Berlin-Stockholm route, which crosses the sea between Sassnitz in Rügen and Trelleborg 20 mi. S.E. of Malmö. The town formerly had strong fortifications, of which only the citadel (Malmöhus) remains; in it the earl of Bothwell was imprisoned by Frederick II of Denmark for some time after his departure from Scotland in 1567. The town hall (1546, largely restored in 1864) contains a handsome chamber, the Knutssal, formerly used by the council of the guild of Canute. The church of St. Peter (*Peterkyrka*) dates in part from 1319. Malmö is second to Stockholm as an industrial centre. There are breweries and large works for the manufacture of machinery, among which are the Kockum mechanical works, with yards for the construction of vessels of war, and others; of cotton and woollen goods, rubber factories, sugar factories, gloves, chocolate, sweetmeats and tobacco. Malmö is a free port. It has a large export trade in grain, timber, cattle, flour, butter, cheese, matches, wood pulp, etc. The imports are coal, manufactures, cotton, chemicals, iron, herring, manures, grain, etc. The harbourage includes an outer harbour of 22-ft. depth, and two inner basins admitting vessels of 21-ft. draught, with dry dock and patent slip. Malmö returns four members to the second chamber of the *riksdag* (parliament).

MALMSEY is a strong, sweet wine that is made mainly in Madeira. Originally it was a Byzantine wine exported from Monemvasia, a village on a small island in the bay of Epidaurus, Peloponnesus, the name of which was corrupted in medieval Latin into *Malmasia,* whence the English form of the word. In the 16th century any strong, sweet dessert wine from Greece, the Greek archipelago, Italy or elsewhere in the Mediterranean was called malmsey—the best came from Iraklion (Candia), Crete, which for a long time had a monopoly. (C. C. H. F.)

MALNUTRITION. Maintenance of proper nutrition (*q.v.*) depends primarily on the provision of appropriate quantities of all the nutrients. Wrong proportions among these quantities results in a condition of malnutrition; an insufficient total amount of nutrients results in undernutrition, of which condition the extreme degree is starvation. Malnutrition also may be caused by impaired physiology as, for example, in certain diseases, even though the dietary intake may be adequate. Such malnutrition, usually called conditioned malnutrition, is a problem of clinical medicine and will not be discussed in this article.

Various meanings have been applied to the word malnutrition. While its literal meaning is "faulty or imperfect nutrition," the word is frequently used only to describe deficiencies. Malnutrition may also result. however, from excessive food intake. This is particularly evident in the case of excessive consumption of calories, but there is also reason to suppose that excessive consumption of carbohydrates and fats, quite apart from calories, may produce various forms of malnutrition. Obesity, the result of this type of unsatisfactory nutrition, is associated with much ill-health and in severe cases with a greatly increased mortality rate. In this review the word malnutrition will be used in its literal meaning and will be applied to conditions caused by deficiencies and excesses in the supplies of nutrients.

Detecting Malnutrition.— Various types of evidence indicate malnutrition. Presumptive or suggestive evidence includes vital statistics (growth rates. maternal mortality, infant mortality, etc.) and statistics of national available food supplies. Statistics, however, have many serious limitations as diagnostic evidence. Vital statistics, for example, reflect the collective effects of disease, environment and many factors of which nutrition is only one.

Indirect evidence must be supplemented by more specific information from nutrition surveys. The basic method is clinical appraisal combined with dietary surveys. Simple laboratory tests may usefully supplement the basic method. Clinical assessment includes a general inspection and a detailed inspection. The former includes the appearance of health, intelligence and vitality or their opposites conveyed to the mind of the examiner. The detailed examination includes inspection of the eyes. skin, mucous membranes, bones and subcutaneous deposits of fat. These body areas are those most likely to manifest evidences of undernutrition, deficiency disease and obesity.

DISORDERS OF MALNUTRITION

Nutrition surveys have revealed alarming evidence of malnutrition. the problems varying in different parts of the world. In underdeveloped areas the deficiencies, such as undernutrition, protein malnutrition, anemia, nutritional disorders of the eye and beriberi, are predominant. In regions in which food supplies are abundant and economic levels high, overnutrition is the main problem.

Deficiency States

A nutritional deficiency may be caused by anything that diminishes the availability of a nutrient or nutrients to the tissues. Thus. although adequate amounts may be eaten, there may be a failure of the body tissues to absorb nutrients, or over-rapid excretion may occur. Deficiency states are frequently multiple, hence the clinical picture is often complex.

General Undernutrition or Chronic Partial Starvation. —In places where. or in times when. food is scarce. cases of starvation occur due to insufficiency but not entire lack of food. Diets are predominantly rich in carbohydrates and deficient in most of the other nutrients. Further, coarse and unfamiliar food may be eaten, causing indigestion and diarrhea. The clinical symptoms presented by the afflicted vary with the nature of the food available. The commonest disturbances are low basal metabolic rate, slow pulse, lowered blood pressure, suppression of menses in women. dry, coarse. cold skin, bloodshot eyes, insomnia and fractures from osteoporotic changes in the bones. Nutritional edema. burning sensations in the feet and hands and sore mouth with increased salivation are common symptoms in chronic starvation. Classification of the possible degrees of undernutrition is given in the table.

Degrees of Undernutrition

State of undernutrition	Weight loss (% underweight)	Effect on functions and characteristics
Slight	10	No serious functional deterioration
Moderate	10–20	Substantial change, but condition often compatible with light or moderate work
Severe	20–30	Profound changes—may be able to do light work but condition is potentially serious
Extreme	more than 30	Patient grossly abnormal—rarely capable of any useful work
Very extreme	50	Severe and often fatal

The simplest way of treating starvation is to get the patient to take easily digested, highly nutritious food. The first to be given should be skimmed milk and well-strained vegetable and meat soups; glucose should be added to the milk. As soon as the patient is able to digest these, the diet can be gradually expanded to include whole milk, lean meat. fish, vegetables and fruits.

Protein Malnutrition.— Protein deficiency is widespread in many parts of the world, particularly in the tropics. Kwashiorkor, a form of protein malnutrition commonly occurring in infants and young children who have been fed on a diet low in protein and composed mainly of foods rich in carbohydrates, has been recognized in many parts of the world, particularly in Xfrica, India, Indonesia. southeast. Asia and Central and Latin America. The main characteristics are retarded growth and development, apathy and anorexia. edema: pellagroid skin lesions, alterations in skin and hair pigmentation. fatty liver and diarrhea. There may be signs of associated vitamin deficiency.

Protein malnutrition is found in a continuous range from the classical forms in which calories are adequate, even abundant, to those in which there have been a severe calorie deficit and considerable wasting. The latter type is often called marasmic kwashiorkor.

Treatment of patients suffering from protein malnutrition is essentially dietetic. The protein-rich diet may consist of a mixture of powdered skim milk and suitable forms of carbohydrate such as ripe bananas. As soon as the digestive function will permit, return should be made to a well-balanced normal diet suitable for the child's age, since milk alone will not satisfy calorie and other requirements. In areas where kwashiorkor is prevalent a long time would be required before adequate supplies of animal protein could be provided; hence, attention is focused upon improving the quality of protein of vegetable origin, as from soybeans, peanuts and legumes.

Nutrition and Anemia.— Anemia constitutes a public health problem of great magnitude, particularly in the underdeveloped and tropical areas of the world. Malnutrition underlies most of the anemias in these areas, affecting particularly expectant and nursing mothers, infants and young children. Deficiency anemias are classified as (1) deficiency in nutrients (iron and protein) necessary for the formation of hemoglobin (nutritional deficiency anemia); and (2) deficiency in such substances as folic acid and vitamin B_{12}, necessary for red cell formation. (See Anemia.)

Nutritional Deficiency Anemia.—The symptoms may be vague or concrete. The patient may complain only of unusual fatigue or a feeling that he is "run down." Nausea and vomiting, laboured breathing. headache and dizziness may develop after the anemia has continued for some time. The number of red cells may be low or near'normal. but they are pale and small; the hemoglobin concentration is low. Anemia is corrected by supplements of iron, given as ferrous sulfate.

Pernicious Anemia.—This disease, due to a deficiency of vitamin B_{12}, usually occurs after the age of 40. Numbness and tingling of the hands, yellowing of the skin and a burning sensation in the mouth are the first signs. Diarrhea. loss of appetite. loss of weight and weakness also are common complaints. Later the patient begins to suffer from shortness of breath. Eventually, if given no treatment, the patient becomes exhausted and finally comatose. There is a marked decrease in the red blood cell count, and a number of immature blood cells appear in the blood. Other characteristic symptoms include a decrease in the hydrochloric acid of the stomach and disturbances of the central nervous system. An unexplained phenomenon is the periods of remission during which the patient becomes almost symptom-free. The diet for pernicious anemia is a normal diet that contributes to the patient's general nutrition. supplemented by vitamin B_{12}.

Vitamin A Deficiency.—Clinical signs and symptoms include night blindness. xerophthalmia (producing dry, dull eyeballs), softening of the cornea and dermatosis characterized by eruptive lesions of the hair follicles with keratinization. Each of these manifestations may occur alone or in combination with other signs and symptoms. Treatment is with daily supplements of vitamin A, which causes prompt regression of night blindness and xerophthalmia.

Riboflavin Deficiency.— This deficiency is prevalent throughout practically all the underdeveloped world, especially among infants and children in areas where other deficiency diseases are endemic. Manifestation of this deficiency involves the eyes. lips and skin. There is vascularization of the cornea, circumcorneal infection and. later, development of opacities. Angular lesions on the lips at the corners of the mouth (cheilosis) appear. The lesion of the skin is of the seborrheic type with flaking and greasiness over a reddened base. Milk and organ meats, the rich natural sources of riboflavin. should be prescribed but other water-soluble vitamins should be given as well.

Beriberi.— This is a chronic disease endemic among people who subsist almost entirely on polished rice. Though it may be due to multiple deficiencies, the most important is that of vitamin B_1 (thiamin). Three types of beriberi have been described: (1) dry, characterized by multiple peripheral neuritis with muscular atrophy; (2) wet, where edema is present; and (3) cardiac or acute. with cardiovascular changes. Manifestations of thiamin deficiency are loss of appetite, nausea, gastrointestinal disturbances, degenerative changes in heart muscle and multiple neuritis. Treatment consists in supplying thiamin daily by mouth or injection. (See Beriberi.)

Pellagra. — This chronic disease due to deficiency of niacin is found principally among maize-eating populations, who are particularly predisposed because the principal protein of maize, zein, lacks tryptophan, an amino acid the body can convert into niacin. The symptoms characteristically involve the skin, the gastrointestinal tract and the nervous system, forming the classical clinical triad of dermatitis, diarrhea and dementia. The skin lesions tend to appear bilaterally symmetrically on the areas of the body exposed to sunlight. Treatment consists in giving niacin daily in divided doses with supplements of yeast, liver by injection and thiamin and riboflavin to combat the deficiency of the other B vitamins. *(See* PELLAGRA AND RELATED DISORDERS.)

Other Deficiency Diseases. — The occurrence of other deficiency diseases is now relatively uncommon. These include scurvy, due to a lack of vitamin C (ascorbic acid); rickets (*q.v.*), a manifestation of vitamin D deficiency; goitre, due to iodine deficiency: and hypovitaminosis K, which accounts for the occurrence of hemorrhagic disease of the newborn.

See also VITAMINS.

OVERNUTRITION

In most of the highly developed countries of the west, overweight in adults probably represents the commonest form of malnutrition. The prevalence of overweight and obesity is accompanied by increased mortality from a number of degenerative diseases, one of which is arteriosclerosis, a leading cause of death in many technically developed and well-fed countries *(see* ARTERIES, DISEASES OF).

The exact point at which obesity begins is difficult to define, but as a general rule a person is considered obese when the body weight increases by 20% above the average weight of healthy persons aged 25 and of the same height. This average weight at age 25 is termed desirable weight.

The immediate cause of obesity is the consumption of food providing calories in excess of energy requirements. However, there are multiple remote causes related to factors that cause an inappropriately positive calorie balance and eventually an inappropriately high body lipid content. The possible roles of genetic factors, hypothalamic lesions, hormonal disturbances and increased peripheral glucose utilization, which have afforded a means of study of obesity in experimental animals. do not seem to apply broadly in explaining the pathogenesis of obesity in man; obesity is generally regarded as a psychosomatic disorder of multiple cause featuring a disturbance in the mechanism that matches food intake to energy expenditure.

The most useful treatment for obesity is diet therapy — a reducing diet that should supply an intake of calories substantially less than an obese person's customary food intake (1,000 to 1.200 cal. per day) but that should contain at the same time adequate quantities of protein and the various nutrients. Exercise increases the energy requirement and stimulates basal metabolism and is, therefore, a special factor in the management of obesity. The psychological aspect is also particularly important; the pleasure of eating usually influences greatly the desire for food and may be seized upon to replace other satisfactions of living. An effort must be made to discover the cause of a person's emotional disturbance before demanding his co-operation in a reducing diet. Some substitute for the satisfaction obtained from food must be found.

CAUSES AND PREVENTION

There are a number of distinct causes of malnutrition, most of which are interrelated. The fundamental causes include agriculture, economics and social and cultural factors.

Only about one-third of the population of the world has an adequate available food supply. The areas in which deficiency diseases predominate are technically underdeveloped and agricultural yields are low. In certain countries the amount of arable land available per head of population is small. Where the population is dense, pressure on land available for cultivation is high. In many cases the growth of the population is outstripping the supply of food that can be produced at existing levels of agricultural development. In areas where such conditions obtain, the population must depend on consumption of direct products of the soil. Land must be devoted largely to such major staples as rice, maize, cassava, millets and wheat that give a high calorie yield per unit of area. Green and leafy vegetables, for example, are important "protective" foods, yet the calorie yield per acre is so low in comparison to that of the major staples that many parts of the morld cannot afford to grow them.

Throughout the underdeveloped parts of the world, therefore, the diets of the people contain a predominance of cereals or tubers or both. Other foods, and particularly foods of animal origin, are included in the diet in relatively small amounts. Diets that contain so high a proportion of cereal are inevitably deficient in terms of modern standards of nutrient requirements, thus leading to malnutrition. Typically, adults seem to survive quite well on even these predominantly cereal diets; it is among the more vulnerable groups — infants, preschool children, pregnant and nursing women — that malnutrition first appears. Improvement in agricultural practices, in varieties of crops, in storage practices, in transportation and marketing arrangements are fundamental to prevention of malnutrition in these areas of the world.

Moreover, people in these areas usually depend for their existence almost entirely on agriculture in the broad sense of this term; industry on a large scale has not been developed. Economic levels, therefore, are low and people cannot afford to buy foods to supplement the staple cereal. Families that purchase their food must spend a high proportion of the family income — often 70% or more — in obtaining their present meagre and ill-balanced diet. Until their economic condition is improved, such families cannot afford to buy supplementary foods in sufficient quantity even when they are available. Another way in which poverty influences diet is in forcing small producers to sell more expensive protective foods of which they are themselves in need in order to be able to buy the staple foods and other essentials.

With poverty go illiteracy and ignorance, and in such circumstances the improvement of food habits through education is difficult. Social systems have important effects on food habits and nutritional problems. For example, it is common to find a system of priority within families that gives the father the first choice of available food; the mother comes second and the children last. Food taboos, unsound food beliefs and food practices are encountered: there are groups who have eggs but will not eat them, regarding egg eating as a sign of greed; the main and cheapest source of animal protein in some areas, dried fish, may be thought to cause worms and "bad eyes"; there are groups who believe that cow's milk is not a proper food for children; and in some communities the taking of milk by girls and especially by married women has powerful emotional connotations. Food habits also are affected by religion.

While awaiting the slow improvement in agriculture and economy, malnutrition can be alleviated by nutrition education. The fundamental aim of nutrition education should be to improve utilization of existing resources. Teaching and practical demonstration should aim at countering food taboos; increasing local production of food, use of appropriate methods of preserving foods, and selection of well-balanced low-cost diets composed of locally available foods; introducing methods for the preparation of food based upon good hygiene and sound nutritional principles; and preparing correct diets for infants and young children.

The predominantly cereal diets of many areas of the world also can be improved by enrichment with certain vitamins, minerals and certain amino acids such as lysine. In the past this was not feasible economically, but improvements in the production of many synthetic nutrients now make it possible. Thus, the protein of wheat and rice can be substantially improved by the addition of lysine, giving great promise for future decrease'in protein malnutrition.

See also DIET AND DIETETICS; NUTRITION.

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712 (1954); J. Mayer, "Physiological and Nutritional Aspects of Obesity," Borden's Review of Nutrition Research, 19:3, 35–55 (1958); Grace A. Goldsmith, Nutritional Diagnosis (1959). (F. J. SE.; D. L. B.)

MALOCELLO, LANCILOTO ("LANZAROTE, the 'Lancelot Maloisiel' of the French"), leader of the first of modern European oceanic enterprises. This was a Genoese expedition, which about 1270 seems to have sailed into the Atlantic, rediscovered the "Fortunate Islands," or Canaries, and made a settlement in one of the most northerly isles of this archipelago, still known (after the Italian captain) as Lanzarote. "Lancarote" is said to have been killed by the Canarian natives; but the castle built by him was standing in 1402–04, when it was utilized for the storage of grain by the French conquerors under Gadifer de la Salle. Malocello's enterprise is probably not unconnected with the great Genoese venture of 1291 in search of a waterway to India.

See the *Conosçimiento*, p. roo, ed. by Marcos Jimenez de la Espada in the *Boletin* de la sociedad *geográfica* de Madrid (Feb. 1877); Le *Canarien* in P. Margry, *Conquête* des . . . Canaries, p. 177; M. A. P. d'Avezac in vol. vi, part ii, of *L'Univers*, pp. 1–41 (*Iles* africaines de *l'océan* atlantique); C. R. Beazley, Dawn of Modern Geography, iii, 411–413, 449, 451 (1906).

MALOLOS, a municipality, capital of Bulacan province, Philippines, lies on a flat, poorly drained plain, about 20 mi. N.W. of Manila. During the revolution against the U.S. the insurgent congress met there and framed the "Malolos constitution," by virtue of which the constitutional Philippine republic was proclaimed on Jan. 23, 1899. The insurgent leader, Emilio Aguinaldo, established his headquarters in Malolos and it served as the insurgent capital until it was captured by U.S. forces in March 1899.

Malolos is an important trading centre in a heavy rice- and vegetable-producing region. Major fish-pond areas are located south and west of the administrative centre.

The municipality lies astride the main highway leading north through the central plain northward from Manila and is also bisected by the rail line to the Lingayen gulf. Pop. (1959 est.) 47,507. (R. E. HE.)

MALONE, EDMUND (1741–1812), Irish Shakespearian scholar and editor, was born in Dublin, on Oct. 4, 1741, the son of a barrister and a member of the Irish house of commons. He was educated at Trinity college, Dublin, and was called to the Irish bar in 1767. On the death of his father in 1774 he went to London, where he frequented literary and artistic circles. He frequently visited Samuel Johnson and was of great assistance to James Boswell in revising and proofreading his Life, four of the later editions of which he annotated. He was one of Sir Joshua Reynolds' executors, and published a posthumous collection of his works (1798) with a memoir. Horace Walpole, Edmund Burke, George Canning, Lord Charlemont and, for a time, George Steevens, were among Malone's friends. Encouraged by the last two he devoted himself to the study of Shakespearian chronology, and the results of his Attempt to Ascertain the Order in Which the Plays of Shakespeare Were Written (1778) are still largely accepted. This was followed in 1780 by two supplementary volumes to Steevens' version of Johnson's Shakespeare; and this again, in 1783, by an appendix volume.

The seven years (1785–92) were devoted to Malone's own edition of Shakespeare in 11 volumes.

Malone published a denial of the claim to antiquity of the Rowley poems (see CHATTERTON, THOMAS), and in this (1782) as in his branding (1796) of the Ireland manuscripts (see IRELAND, WILLIAM HENRY) as forgeries, he was among the first to guess and state the truth. His elaborate edition of John Dryden's works (1800) with a memoir, was another monument to his industry, accuracy and scholarly care. At the time of his death, on April 25, 1812, Malone was at work on a new octavo edition of Shakespeare, and he left his material to James Boswell the younger; the result was the edition of 1821 — generally known as the Third Variorum edition — in 21 volumes.

A memoir of Malone by James Boswell is included in the *Prolegonzena* to the edition of 1821. See also Sir J. Prior, Life oj Edmund *Malone* (1860).

MALONIC ACID crystallizes **in** large colourless plates, dissolving readily in water, alcohol or ether, and melts at 135.6° C. Although the sparingly soluble calcium malonate occurs in beetroot, the acid itself, $HO_2C.CH_2.CO_2H$, is generally produced by laboratory methods, such as the oxidation of malic acid or the hydrolysis of cyanoacetic acid, $CN.CH_2.CO_2H$. When carefully heated at 140°–150° C., malonic acid partly decomposes into acetic acid and water, but 10%–12% undergoes dehydration with formation of carbon suboxide, C_3O_2.

The outstanding importance of malonic acid in systematic chemistry arises from the varied syntheses which can be effected with its ethyl ester, diethyl malonate, commonly called malonic ester, $CH_2(CO_2C_2H_5)_2$. This ester, usually prepared by passing hydrogen chloride into a solution of cyanoacetic acid (obtained from chloroacetic acid) in absolute alcohol, is a colourless fragrant liquid boiling at 198° C. Its very reactive methylene group, CH,, is instrumental in effecting syntheses of higher mono- and dibasic acids. The replacement of one hydrogen of this methylene group by sodium gives sodiomalonic ester; this on treatment with an alkyl iodide gives the ester of the corresponding alkyl malonic acid. In the presence of sodium ethoxide the esters of malonic acid and diethylmalonic acid undergo condensation with urea to furnish respectively barbituric and diethylbarbituric acids, the latter being the well-known soporific drug veronal (see BARBITURATES). By a similar condensation with urea ethylphenylmalonic ester yields the drug phenobarbital.

MALORY, SIR THOMAS (d. 1471), translator and compiler of the famous English classic, the Morte *d'Arthur*. Previous to the publication of G. L. Kittredge's monograph, *Who* Was Sir Thomas *Malory?* the identity of this writer remained an unsolved problem. Of direct evidence we have very little; in the concluding passage of the book the author asks the prayers of the reader for "Syr Thomas Maleore knyght," and states that the book was ended "the ix yere of the reygne of Kyng Edward the fourth." Caxton, who printed Morte *d'Arthur* after Malory's death, in his preface (1485) says that he printed the book "after a copye unto me delivered whyche copye Syr Thomas Rlalorye dyd take oute of certeyn bookes of frensshe and reduced it in to Englysshe."

Kittredge identifies Caxton's Malory with Sir Thomas Malory, knight, of Newbold Revell (or Fenny Newbold), M.P. for Warwickshire in 1445. He had served in France, in the retinue of the earl of Warwick. He is almost certainly the "Thomas Malorie, miles," who, on account of his part in the Wars of the Roses was excluded with several others from the operation of a pardon issued by Edward IV. When Sir Thomas Malory's widow died in 1479 she was in possession of his hereditary estates in Northamptonshire and Warwick, so that it seems clear that Sir Thomas must have conveyed them to her in his lifetime probably for fear of confiscation.

On two occasions, in 1451 and 1452, Humphrey, duke of Buckingham was commissioned to arrest Thomas Malory, knight, and bring him before the king and council "to answer certain charges," in the first case with respect to the rights of the monks of Axiholme in Kirby Monachorum, the parish which contained Malory's estate of Newbold Revell. (See Calendar of Patent Rolls, 1446–52, p. 476, and 1452–61, p. 61.)

Malory's Morte *d'Arthur* is an abridged compilation of the great body of Arthurian romance in its latest form. The Merlin, Tristan, Lancelot, Queste and *Mort Artus* are all represented, the only branch omitted is that dealing with the "early history" of the Grail, the Joseph of *Arimathea* and Grand S. Graal. But we do not yet know whether Malory himself was responsible for this selection, or whether he found it ready to hand in a manuscript, the "Frensshe Booke" to which he often refers. Medieval copyists, at the instance of their patrons. did make compilations from the various romances within their reach, such as *e.g.,* the enormous codex 112 (*fonds Franç*) of the Bibliothèque Nationale, which includes large sections of the Tristan, the Lancelot, and the Merlin suite. Taking into consideration alike what Malory retains and what he omits. it seems most probable that he mas in possession, not of complete copies of the romances, but of one or more volumes of compilations from these sources.

The Morte *d'Arthur* represents the Arthurian cycle in the period of its decadence; nor does Malory in any way endeavour to overcome the difficulties caused by the juxtaposition of a number of independent (and often contradictory) versions; but the diversity of sources is harmonized and wrought into a whole by the great charm of Malory's style; simple, direct, idiomatic, yet musical and dignified, it has lent to the relations between Lancelot and Guenevere a character of truth and vitality lacking in his predecessors. Malory took the Arthurian story in its worst and weakest form, and he imparted to it a moral force and elevation which the cycle, even in its earlier and finer stage, had, save in the unique case of Von Eschenbach's *Parzival,* never possessed. *Morte d'Arthur* was the first English prose epic, and formed one of the chief foundations of English prose.

See G L Kittredge, "Who Was Sir Thomas Malory?", *Harvard Studies and Notes in Philology and Literature,* vol. v (1897); and *Sir Thomas Malory* (1925); *Morte d'Arthur,* ed by Oskar Sommer (an exact reproduction of the original text in 2 vol.)—vol iii a study on *The Sources of Malory.* The sections on *Lancelot* and *Queste* are unfcrtunately very inadequate; for these see *The Legend of Sir Lancelot,* Grimm Library, vol. xii. (J.L.W.; X.)

MALOU, JULES EDOUARD XAVIER (1810–1886), Belgian statesman, one of the leaders of the clerical party, was born at Ypres on Oct. 19, 1810. He mas minister of finance in the coalition ministry of J. B. Nothomb in 1844. and formed with B. T de Theux a Catholic cabinet in 1846, which was overthronn in the Liberal victory of 1847. Malou then became a member of the senate, and his party only regained ascendancy in 1870. The extreme clerical ministry of Baron d'Anethan retired in Dec. 1871 after serious rioting in Brussels, and Malou was the real, though not the nominal, head of the more moderate clerical administrations of De Theux and Aspremont-Lynden (1870–78). After the fall of the ministry in 1878 he adopted a·frankly clerical policy. and when he became chief of a new government in June 1884 he proceeded to undo the educational compromise of his predecessors in the Frère-Orban ministry. His legislation in favour of the Catholic schools caused rioting in Brussels, and in October the king demanded the retirement of Jacobs and Woeste, the members of the cabinet against whom popular indignation was chiefly directed. Malou retired. and died at Wolume Saint Lambert, in Brabant, on July 11, 1886. He was a financier of great experience. A list of his works is given in Koninck's *Bibliographie nationale de Belgique.*

MALOUET, PIERRE VICTOR, BARON (1740–1814), French publicist and politician, was born at Riom (Puy-de-Dôme) on Feb. 11, 1740. He entered the civil service and was employed successively at the French embassy in Lisbon, in the administrative department of the duc de Broglie's army, as commissary in San Domingo (1767–1774), and after his return to France, as commissary general of the marine. He was sent to carry out plans of colonization in French Guiana in 1776, but superseded in 1779. He became intendant of Toulon, and in 1789 nas returned to the states-general. He emigrated to England in Sept. 1792, but later tried and failed to obtain permission to assist in the defense of Louis XVI. In 1801 Napoleon restored him to his position in the civil service, and sent him to Antwerp as commissioner general and maritime prefect. He entered the council of state in 1810, but offended the emperor by his plain speech, and was disgraced in 1812. Louis XVIII made him minister of marine at the Restoration, and he died on Sept. 7, 1814.

For accounts of his domestic and colonial policy see *Collection de ses opinions a l'Assemblée Nationale,* 3 vol. (1791–92); and *Collection de mémoires et correspondances officielles sur l'administration et notamment sur la Guiane française et hollandaise,* 5 vol. (1802).

MALPIGHI, MARCELLO (1628–1694), Italian physiologist, the founder of microscopic anatomy, was born on March 10, 1628, at Crevalcore near Bologna, where he graduated in medicine in 1653 and where he became lecturer in 1656. A few months later he nas appointed to the chair of theoretical medicine at Pisa, but after four years he returned to Bologna. In 1662 he was appointed professor primarius at Messina. After a further four years he again returned to his native university, and spent the next 25 years there. In 1691 he moved to Rome as private physician to Innocent XII, and he died there on Nov. 30, 1694. Shortly before his death, he drew up a long account of his academic and scientific labours, correspondence and controversies, and committed it to the charge of the Royal Society of London, which published his autobiography in 1696.

Malpighi was one of the first to apply the microscope to the study of animal and vegetable structure, and his discoveries were of major importance. Although Harvey had correctly inferred the existence of the capillary circulation, he had never seen it; it was reserved for Malpighi in 1661 (four years after Harvey's death) to see for the first time the blood coursing through a network of small tubes on the surface of the lung and of the distended urinary bladder of the frog. This discovery was given to the world in two letters, *De pulmonibus,* published at Bologna in 1661 and often reprinted. These letters contained also the first account of the vesicular structure of the human lung, and they made a theory of respiration possible for the first time.

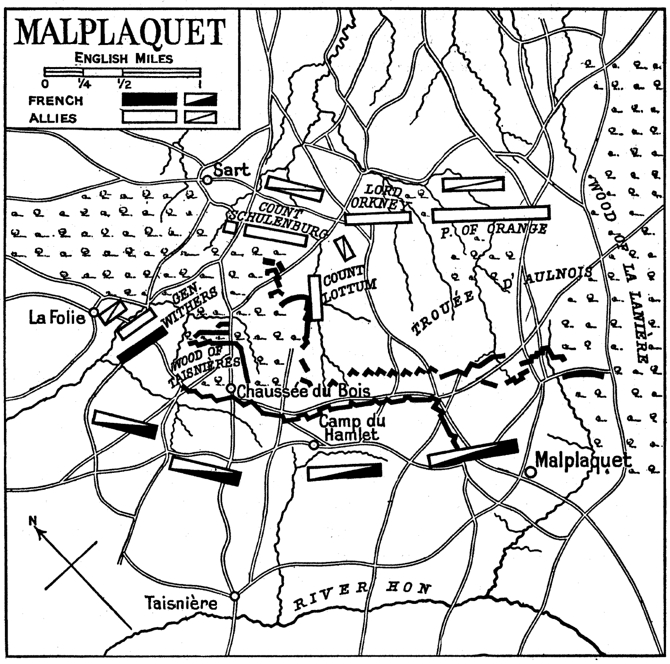
Malpighi's next achievement was a demonstration of the plan of structure of secreting glands. He maintained that the secretion was formed in terminal acini standing in open communication with the ducts. The name of Malpighi is still associated with his discovery of the mucous character of the lower stratum of the epidermis, of the vascular coils in the cortex of the kidney and of the follicular bodies in the spleen. He was the first to attempt the finer anatomy of the brain, and described the distribution of gray matter and of the fibre tracts in the cord, with their extensions to the cerebrum and cerebellum, with great accuracy, though from his microscopic study of the gray matter he concluded that it was of glandular structure and that it secreted the "vital spirits." At an early period he applied himself to vegetable histology, and became acquainted with the spiral vessels of plants in 1662. His *Anatomia plantarum,* published in 1672, included the *Observationes de ovo incubato,* which gave one of the best accounts (with good plates) of the development of the chick. His *Diss. epist. de bombyce* (1669) elaborately described the structure and metamorphosis of the silknorm.

Malpighi also wrote *Epistolae anatomicae Marc. Malpighii et Car. Fracassati* (1662), on the tongue, brain, skin, omentum, etc.; *De viscerum structura: exercitatio anatomica* (1669); *De structura glandularum conglobatarum* (1689). *Opera posthuma, et vita a seipso scripta* (1697) with preface and additions was published at Amsterdam in 1700. An edition containing all his works except the last two was published in London in 1686.

See Logan Clendening, *Source Book of Medical History,* pp. 209–217 (1942).

MALPLAQUET, a village of France in the Nord *département,* close to the Belgian frontier and about 10 mi. S. by E. of Mons, famous as the scene of the battle, Sept. 1709, between the Allies under the duke of Marlborough and Prince Eugkne and the French commanded by Marshal Villars, in which the former were victorious. The country to the west and south of Mons is enclosed by a semicircular wall of woods and broken ground, through nhich there are only two important gaps — that of Jemappes (*q.v.*) (famous in 1792) to the west, and that of Aulnois, in which stands the village of Malplaquet, to the south. In the latter gap and the woods on either side Villars took up his position facing northeastward, on Aug. 29 (Sept. 9). The forces present, over 90,000 on each side, were exceptionally large, and the French army in particular represented the spirit of its nation to a degree unusual in the armies of that time. Villars was the best general in the service of Louis XIV and the veteran Marshal Boufflers, though senior to him, had volunteered to serve as his second in command. Marlborough and Eugkne lay uith their army between Mons and the French camps, uhich were almost within cannon shot. Marlborough's own wish mas for an immediate battle, but he was opposed by the Dutch deputies at his headquarters, and even by Eugkne, so that it was only on Aug. 31 (Sept. 11) that the attack actually took place. Villars had made full use of his respite. The French right stood at the fringe of the wood of Lanière, the left was strongly posted in the midst of the wood of Taisnikre, and across the $2\frac{1}{2}$ mi. of open ground between the woods the position was entrenched with several successive lines of works. The troops were almost equally distributed along the whole line as usual, and the cavalry was massed in rear of the infantry. In the Allied army the mounted troops were also kept back, but for the most part distributed to the various infantry commands.

The intention of Marlborough and Eugkne, when on the morning of the battle they examined this formidable position, was to deliver the main attack upon the French left wing, combining the assaults of several columns on its front and flanks. In this quarter the French not only held the interior of the wood but also were thrown forward so as to occupy the edges of its north-eastern salient, and upon the two faces of this salient Count Lottum with the Prussians, and Count von der Schulenburg with the Austrian infantry were to deliver a convergent attack, while farther to the Allied right a column under the English general Withers was detached to make a wide turning movement through the woods. Marlborough took command on the right, Eugène on the left. The centre, which was intended only to observe the enemy until the decision had been forced at the wood of Taisniiire, consisted of Lord Orkney's British corps and the prince of



FROM FORTESCUE, "HISTORY OF THE BRITISH ARMY" (MACMILLAN)

PLAN OF THE BATTLE OF MALPLAQUET. SEPT. 9-10. 1709

Orange's Dutch contingent. The salient of the Taisniiire wood was duly attacked, after a heavy cannonade, on its two faces by the Prussians and Austrians about 9 A.M. They encountered a sterner resistance than in any of the battles and combats of the past seven campaigns, for on this field the defenders were fighting, not as hitherto for the interests of their king, but to defend their country, and the regiments of Picardie and Champagne which held the salient were the oldest and most famous of the French line. Lottum attacked again and again without success, until three British battalions had to be sent to reinforce him, and Marlborough placed himself with a corps of cavalry in close support. At last the entrenchments were stormed. Schulenburg had by this time fought his way through the woods and undergrowth, and the united force pressed back the French. Still, so stubborn was the defense and so dense the wood that the impetus of the assault died away and the troops on both sides broke up into small disconnected bodies, fighting too fiercely to be amenable to superior control.

But the French were not reinforced from their right wing as Villars expected. The prince of Orange, far from merely observing the hostile right as he had been ordered to do, committed his corps. very early in the battle, to a serious assault upon it, which Boufflers repulsed with enormous loss. The Dutch infantry never recovered from its casualties on this day, and the memory of Malplaquet was strong even at Fontenoy nearly 40 years afterward. The only advantage to the Allies was that Boufflers did not dare send reinforcements to the hard-pressed left wing. Because of this the attackers made steady progress in the wood of Taisnikre. Villars launched the "Irish brigade" to check the advance of the Allies, and this famous corps charged into the forest. Villars, Eugkne and Marlborough personally led their troops in the encounter which followed. Eugène was wounded, but refused to quit the field. Villars was more seriously hurt, and after trying in vain to direct the fighting from a chair was carried insensible from the field. At this crisis General Withers, who commanded the force that had been ordered to turn the French extreme left, appeared on the scene. The British 18th regiment (Royal Irish), encountering the French Royal Irlandais, put them to the rout, and Villars' counterstroke was at an end. The French maintained themselves on this side only by the aid of troops drawn from the centre and right, and this gave the Allied centre the opportunity which the prince of Orange had so rashly anticipated. The great attack over the open was carried out, in spite of the previous repulse, with the greatest determination. Preceded by 40 guns, the corps of the prince of Orange and Lord Orkney swiftly carried the first line of works. The Allied cavalry then pushed out to the front, and horse, foot and artillery were combined in the last advance. Boufflers's cavalry masses, coming into play for the first time, fought hard, and the struggle fluctuated with the arrival of successive reserves on either side, but in the end, shortly before 3 P.M., Boufflers (who had been in command since Villars's fall) decided to retreat. The Allies had no troops left intact for the pursuit, and those engaged had expended their last efforts. Moreover Boufflers, experienced soldier as he was, drew off his men before they had lost their order and discipline.

Thus this "very murdering battle" as Marlborough called it—the last and greatest pitched battle of the war—was almost barren of results. The Allies lost not less than 20,000 men, or nearly a quarter of the whole force, the 30 battalions of the Dutch infantry losing half their numbers. On the French side there were some 12,000 casualties.

MALT is a food product prepared from cereal grain by allowing partial germination to modify the seeds' natural food substances. Except for wrinkling of the husk, malt has mostly the physical appearance of the grain from which it was prepared. Malt itself is seldom a constituent of human food. It is rather an extract or the result of an enzymatic digestion by malt that is found in "malted" foods. Hence the term is frequently but erroneously applied also to a concentrated sirupy aqueous extract of malt. The starch of malt is mellower and more soluble than that of the original grain. Its protein has become partially hydrolyzed. The enzymes (*q.v.*) developed during the malting process are responsible for its industrial importance.

Any cereal grain may be converted to malt by germination but barley (*q.v.*) is the favoured grain and has been hybridized to improve its malting quality wherever it is grown. Rye, wheat, rice and, to an even lesser extent, corn are malted in some countries, usually as a result of tax complications or legal restrictions protecting native farm products.

Uses.—The largest bulk of malt is used in the manufacture of beer (see BREWING) and most of the extractives in beer are derived from malt. Hence the flavour of beer is predominantly the result of the malt from which it was made. From 30 to 50 lb. of malt are used to make a barrel of beer, depending upon its strength and the use of adjunct starches.

The next most important use of malt is in the production of distilled alcohol for both beverage and industrial purposes. It is used in this case almost entirely for its enzymatic ability and is hence specially prepared as a high-diastatic or distiller's malt. The diastase of malt converts starches, obtained from corn, potatoes or other economical sources, into sugars which are then fermented to alcohol and concentrated by distillation. Distiller's malt is also used in the production by fermentation (*q.v.*) of other solvents such as acetone, butanol and other higher alcohols.

Malt extracts are either sirupy concentrates or dry powders resulting from the evaporation of strained mashes of malt and water, sometimes including added starchy materials. The malt contributes maltose (a sugar not as sweet as cane sugar), dextrins, soluble protein and vitamins, especially of the B complex, to these materials. The extracts are used to impart a "malted" flavour to confections and food mixtures. Many special baby foods are prepared in a similar manner. If milk is added before drying the resulting powder is the familiar malted milk. Frequently these products are made so as to retain diastatic activity and are offered as aids to digestion. Diastatically active malt extract is used by bakers to improve the fermentation of their dough, thereby influencing the texture of their products.

While malt contains enzymes other than those capable of hydrolyzing starch. it owes its importance primarily to this ability. Starch sizing applied in the processing of textiles may be removed by enzymatic solubilization utilizing a malt extract as the source of amylase.

Method of Manufacture. — Malt production is a controlled and limited germination initiated by adding moisture and arrested by removal of the moisture before the young plant grows out of the seed covering. Production thus depends upon the life processes inherent in a dormant seed. The first step after the barley has been cleaned and sorted as to kernel size is to steep it in water for about 24 hours until the kernel has absorbed from 40% to 45% moisture. This absorption awakens the embryo and causes the life processes to begin. The dampened grain is then moved to a germinating apparatus, which may be a revolving drum or a rectangular open tank equipped with slow-moving agitators. In the second half of the 20th century a few smaller establishments still spread the grain on a floor and turned it by shoveling.

In either system a means is devised to conduct cooled and moistened air through the mass of sprouting grain and a gentle method of moving the grains is provided so as to prevent matting of the roots. Carbon dioxide is thus removed along with heat developed during the process. Growth and modification of the starchy constituents of the original grain are controlled through manipulation of temperature and moisture within the "piece," as the batch of grain is called.

During germination, enzymes are activated particularly along the scutellum, a membrane separating the embryo, which is largely proteinaceous, from the endosperm or starchy portion of the kernel. These enzymes include cystase, phytase, amylases, phosphorylases, proteases and, in fact, all those which the embryo plant will use in breaking down the food material stored in the endosperm and building it into root and eventually stem structures. These enzymes permeate the endosperm, converting the contained flinty starch into a softer and more soluble form. Some of this starch is hydrolyzed to maltose and dextrose, which are phosphorylated and then pass through the scutellum where they are reconverted to starch in the rootlets that push out at the bottom of the kernel. An incipient stalk called the acrospire also grows upward from the embryo along the side of the kernel inside the hull and will eventually erupt from the top of the kernel to become the aboveground structure of a normal plant if the process is allowed to continue.

Since it is the enzymes and the partially converted starch that are desired, rather than a new growing plant, the growth or germination is stopped in malting when the acrospire has grown to or slightly beyond three-quarters of the kernel length. During this time the rootlets have generally attained a length of about an inch and the endosperm has been rendered entirely mellow. This change may take from four to nine days depending upon the temperatures permitted and the use for which the malt is intended.

When the desired amount of modification has been attained the biological processes are stopped by the simple expedient of removing the moisture necessary to sustain them. This cutoff is accomplished in a kiln, the floors of which are perforated to permit an upward current of dry, heated air to dry the grain. There are many kiln designs and many ways of operating them to control the rate of moisture removal and the amount of heating that is given. Timing and heat intensity govern the amount of caramelization and other changes that are associated with the development of both flavour and colour. Additional flavours are often imparted by the character of the fire used. For example, malt intended for Scotch whisky is dried over a fire to which peat is added. The ensuing smoke is taken up by the malt.

Distiller's malts and others retaining highest enzymatic activity are kilned at low temperatures, around 120° F., to preserve as much of the biological ability as possible. Consequently such malts are pale in colour and have little flavouring value. Some kernels retain the ability to grow. Those malts that are to be used primarily for flavouring or colouring qualities are kilned at temperatures in excess of 200° F. and retain little enzyme action. Malt intended for both enzymatic and flavouring purposes is finished off at intermediate temperatures.

Historical. — The processes of malting, brewing and baking have been closely entwined for a longer period of time than is covered by recorded history. Each was well known and developed into a triple industry or special activity in Egypt at the time of the Pharaohs. Records left by all of the ancient agricultural civilizations indicate that these arts had developed long before. Consequently the origin is resigned to the realm of Egyptian mythology. Osiris, the god of light, health and agriculture, taught man to malt as a preliminary step to brewing an alcoholic beverage that might allow him to escape the woes of the world. Man simultaneously discovered the leavening power of fermenting beer.

Since the sprouting of grain and fermentation will occur even without man's guidance. it may be safely assumed that early man sampled and liked a fermenting watery supernatant that he found over stored grain that had become drenched by rains. By observation, many deductions, experiments and, no doubt, a few temporary illnesses he learned to control the process of malting.

Except for more accurate understanding of the biochemical changes involved, which led to better control, and for mechanical improvements, the malting process and its related processes of brewing and baking have remained unchanged.

In the period around 3000 B.C. spelt, wheat and barley were thrashed and winnowed by hand labour and stored in granaries for subsequent use. The biblical story of Ruth is a familiar reference to this though much more detailed and earlier information is contained in pyramid findings and in the Egyptian Book of *the Dead*.

To prepare malt from this grain it was spread upon a flat surface in a pile perhaps about knee high and watered liberally until rootlets began to appear — after about two days. Water would then be added only to keep the pile moist and the grain would be turned by wooden shovels to keep the pile from overheating. Exact elements of control are unknown but it is possible that traditional tests of biting, kernel flexibility, buoyancy and the like may have had their origin this far back.

The first processes probably utilized green or undried malt for further processing, and earliest attempts at drying must have included spreading in relatively thin layers in the sun. Certainly the arid climate of Egypt at least contributed to very early adoption of dry air currents.

Throughout ancient history and into the middle ages few changes in even the methods of manipulation occurred. The European monasteries and the princely households continued to malt the available grain and, with the necessity of using heated kilns to dry the product in colder and more humid environments, the control of flavour was introduced.

As in other arts, control did not really improve until adequate means of measuring conditions developed. Uniformly scaled thermometers were introduced in the early 18th century. Other instruments followed and were adopted by the maltster-brewers. Barley became the favoured grain to malt and was ruled the only permissible grain for beer in Hamburg in the 12th century.

Not until 1873 was a satisfactory substitute for the hand labour of floor malting devised. In that year Nicholas Galland introduced a mechanical system termed the pneumatic method. While power-driven machinery had been put to use in many other industries before this, even including other brewery operations, no device had been gentle enough to both agitate and protect the grain during its germinating. Galland provided a rectangular compartment having a perforated false bottom that would allow passage of water or air but not of grain. A series of revolving augers reached into the grain to turn it as a rope drive supplied power which also enabled the entire agitator assembly to traverse the length of the compartment on a rack-and-pinion arrangement.

Shortly thereafter the rotating-drum system was introduced. From that time on further improvements were rapidly adopted; electric power, controlled speeds, oil- and gas-fired kilns, artificial refrigeration and volume handling were among the major innovations. None of these have, however, contributed new biological processes. The methods but not the process changed.

These improvements have altered the complexion of the industry substantially. At one time every brewer malted his own grain. Now the greater number of them buy malt from large separate maltsters, although a few of the larger breweries continue to malt much of their own requirements. This specialization has led to expansion in the use of malt for other purposes, to the more economical accomplishment of the changes, to the establishment of research laboratories devoted solely to malting problems and to greater support for barley-improvement programs of benefit to the barley growers.

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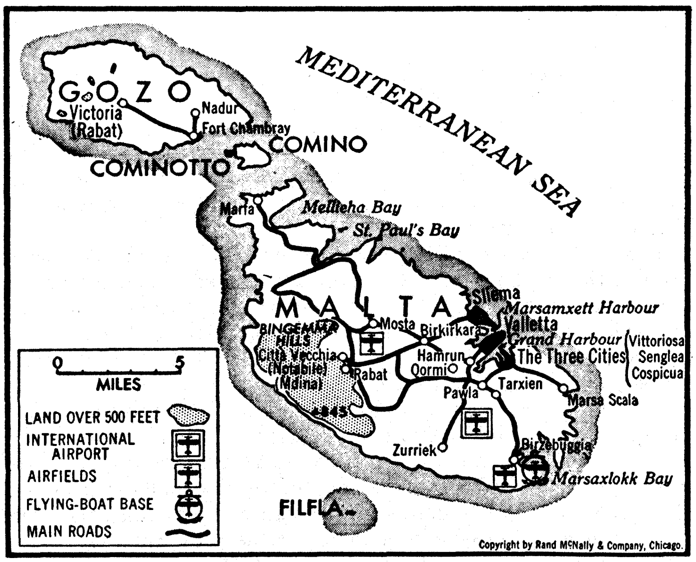
(R. I. T.)

MALTA. The Maltese islands are situated between Europe and Africa, in the central channel which connects the eastern and western basins of the Mediterranean sea. The group belongs to the British Commonwealth and consists of Malta. 95 sq.mi., Gozo (*q.v.*) 26 sq.mi., Comino, 1 sq.mi., and the uninhabited rocks called Cominotto and Filfla.

Malta (lat. of Valletta observatory 35° 53′ 55″ N.. long. 14° 30′ 45″ E.) is about 60 mi. from the nearest point of Sicily, 140 mi. from the mainland of Europe and 180 mi. from Africa; it has a magnificent natural harbour.

Malta is about 17 mi. long by 9 mi. wide; Gozo is 9 by $4\frac{1}{2}$ mi. This chain of islands stretches 29 mi. from northwest to southeast. On the southwest the declivities toward the sea are steep, and in places rise abruptly some 400 ft. from deep water. The general slope of these ridges is toward the northeast, facing Sicily and



PRINCIPAL TOWNS, ROADS AND AIR BASES OF THE MALTESE ISLANDS

snow-capped Etna, the source of cool evening breezes. The Bingemma hills, rising 750 ft., are nearly at right angles to the axis of the main island and the geological "Great Fault" stretches from sea to sea at the foot of these hills. The island has no river or lake. There are good anchorages in the channels between Gozo and Comino, and between Comino and Malta. In addition to the harbours of Valletta (*q.v.*), there are in Malta, facing northeast, the bays called Mellieha and St. Paul's, the inlets of Sliema, of Madalena, of St. Julian and of St. Thomas; on the southeast there is the large bay of Marsaxlokk (Marsa Scirocco). There are landing places on the southwest at Fomh-il-rih and Miggiarro. Mount Sceberras (on which Valletta is built) is a precipitous promontory, about 1 mi. long, pointing northeast. It rises out of deep water; well-sheltered creeks indent the opposite shores on both sides. The waters on the southeast of Valletta form the "Grand Harbour," having its entrance between Fort Ricasoli and Fort St. Elmo. The series of bays to the northwest, approached between the points of Tigné and St. Elmo, is known as Marsamxett (Marsamuscetto) harbour.

PHYSICAL FEATURES

Geology. — The Maltese islands consist largely of Tertiary limestone, with somewhat variable beds of crystalline sandstone, greensand and marl or blue clay. The series appears to be in line with similar formations at Tripoli in Africa, Cagliari in Sardinia, and to the east of Marseilles. To the southeast of the Great Fault the beds are more regular and descend from coralline limestone through greensand, marl or blue clay and sandstone to crystalline limestone. The lower limestone probably belongs to the Tongrian stage of the Oligocene series, and the coralline limestone to the Tortonian stage of the Miocene. The beds are not folded. The general dip of the strata is from west-southwest to east-northeast. North of the Great Fault and at Comino the level of the beds is about 400 ft. lower.

Mammalian remains found in Pleistocene deposits are of exceptional interest. Among the more remarkable forms are a species of hippopotamus, the elephant (including a pigmy variety), and a gigantic dormouse. In the coralline limestone the following fossils have been *noted: — Spondylus, Ostrea, Pecten, Cytherea, Arca, Terebratula, Orthis, Clavagella, Echinus, Cidaris, Nucleolites, Brissus, Spatangus;* in the marl the *Nautilus zigzag;* in the greensand shells of *Lenticulites cornplanatus,* teeth and vertebrae of Squalidae and Cetacea; in the sandstone, *Vaginula depressa, Crystallaria, Nodosaria, Brissus, Nucleolites, Pecten burdigallensis, Scalaria, Scutella subrotunda, Spatangus, Nautilus, Ostrea navicularis* and *Pecten cristatus.*

The blue clay forms, at the higher levels, a stratum impervious to water, and holds up the rainfall, which soaks through the spongy mass of the superimposed coralline formations. Hence arise the springs that run perennially, several of which have been collected into the gravitation water supplies of the Vigna-court and Fawara aqueducts. The larger part of the water supply is pumped from strata at about sea level.

Climate. — The climate is, for the greater part of the year, temperate and healthful. During the winter the weather is pleasantly cool and sometimes cold, owing to the strong winds, but there is much bright sunshine, and the air is clear and invigorating. The thermometer records an annual mean of 66° F. Between June and September the temperature ranges from 75° to 90° F.; the mean for December, January and February, the three coldest months, is 56° F., the mean maximum being 65.5° F. and the mean minimum 46.6" F. Pleasant northeast winds blow for an average of 150 days a year, cool northerly winds for 31 days, east winds for 70 days, west for 34 days.

The northwest "gregale" (Euroclydon of *Acts* xxvii. 14) blows about the equinox, and occasionally, in the winter months, sometimes with almost hurricane force for three days together; it is recorded to have caused the drowning of 600 persons in the harbour in 1555. This wind was a constant menace to shipping at anchor; the breakwater on the Monarch shoal was designed to resist its ravages. The sirocco, an enervating southeast wind, blows at intervals during the summer months, causing close, damp and misty weather.

The regular tides are hardly perceptible, but, under the influence of barometric pressure and wind, the sea level occasionally varies as much as 2 ft. Rainfall is irregular; it averages 17 in., varying from 12 to 27 in. in the year. However, rainfall is uncertain, and periods of drought have extended over three years. Snow is seen once or twice in a generation; hailstorms occur.

Flora. — The calcareous nature of the rocks and soils and the fact that the water contains lime excludes the calcifuges from the Maltese flora. Many of the plants are xerophytic. The vegetation is of the Mediterranean type, and most of the species found in the Maltese islands also occur in Sicily and Italy, though African and Iberian species as well are found. Of the trees, none of which grows to any great size, the commonest is the carob which is indigenous and was extensively cultivated in the first half of the 19th century but largely destroyed during World War I; since then it has had government protection. The elm, white poplar and some willows grow in the valleys with wild pear and hawthorn. The almond and prickly pear are naturalized, and on Gozo and Comino the chaste tree (Vitex *agnus-castus*) is a common native shrub. The fig is native in Malta and the vine, bay and olive have been cultivated for centuries. The many rock plants growing near the sea include Inula crithmoides, Crithmum *maritimum*, Crucianella maritima, saltwort, sea campion, sea heath, spurge and marram grass. On the rocks inland kidney vetch, medic, thyme, Lotus, *Cistus*, Helianthemum, etc. are found. After the spring rains Colchicum, Crocus and *Scilla*, buttercups and dandelions, etc., burst into bloom. and in the autumn lady's tresses and squills flower. The summer annuals include heliotrope, spurge, Linaria and Inula and, along the watercourses, Lythrum, *Polygonum*, convolvulus, etc. A plant endemic to Malta is Centaurea crassifolia. The parasitic "Malta fungus" (Cynomorium coccineum), which has bright red flowers and was once valued for medicinal purposes, is also found in Tunisia, Sicily, Crete, Iran and the Canary Islands.

Fauna. — The indigenous mammals consist of weasels, hedgehogs and bats (the little horseshoe and the long-eared); rabbits, rats and mice have been introduced. There are seals and porpoises in the surrocnding seas. Among the few indigenous birds are the blue solitary thrush, which is prized for its song, the spectacled warbler, two species of shearwaters and the jackdaw.

The great variety of bird visitors includes bee eaters, rollers and hoopoes, vultures, eagles, swans, ospreys, robins. blackbirds, thrushes, swallows, cuckoos and skylarks; among those that stay to breed are owls, linnets, buntings and the rock pigeon.

There are species of lizards, a turtle and a tortoise, two species of snakes (imported) and the painted frog, which is used for food. In the surrounding waters tunny, mackerel and bonito arrive at intervals in huge shoals; brill is the commonest of the flatfish; there are also herrings, sardines and anchovies, tench, flying fish, perch and mullet, remora and many kinds of gurnard.

The commonest of the 17 species of butterflies breeding in the islands is the cabbage white which often causes much damage and arrives in swarms in spring and autumn. Locusts migrate to breed where there is more moisture; large numbers of ladybirds often arrive in the spring from Sicily and other insects include cockroaches, beetles, plant bugs, grasshoppers, flies, dragonflies, moths, bees, Rasps and ants. Crabs, lobsters. crayfish and other crustacea, and mollusca, chiefly limpets, mussels, cuttlefish and octopus, are used for food. The commonest of many zoophytes (sponges, polyzoans and hydroids) is Anthea cereus. (ST.; X.)

ARCHAEOLOGY

There is no conclusive evidence for Palaeolithic man in Malta, since the identification of the two teeth from Ghar Dalam as those of Homo neanderthalensis is doubtful and at all events they do not seem to have been found associated with the rich Pleistocene fauna of hippopotamus and elephant in the cave.

The same site, however, produced shards of pottery which represent the earliest Neolithic colonists of the island, related to those from the Mgarr temple (see below) and to the Stentinello type in Sicily. Similar pottery occurs in the earliest Neolithic levels of the Arene Candide cave in Liguria. But the most notable evidence of prehistoric man in Malta is afforded by the monumental stone buildings usually known as temples and by the huge rock-cut collective tomb or hypogeum at Hal Saflieni. The best-preserved of the temple structures are at Hal Tarxien, Hagar Qim, Mnajdra and Mgarr in Malta, and at Ggantija on Gozo; less striking remains of similar buildings exist at Borg in Nadur, Kordin, Skorba and elsewhere.

The temples are built of the local limestone, though fine *Globigerina* limestone was sometimes brought from several miles away, especially where fine-dressed surfaces or decorative carvings were demanded. The plans of the buildings are based on the theme of apsidal chambers, usually in pairs, opening from an axial passage or central court, and the whole complex is enclosed in a massive stone revetment, roughly oval in plan, with a concave façade and forecourt at the entrance. The evidence implies that the majority of the apsidal chambers were roofed by first carrying several courses of corbelled vaulting above the slabs forming the walls and then laying large flat capstones across; but it is uncertain whether some of the very large chambers (*e.g.* at Mnajdra) were in fact roofed in stone, as the large span presents great technical difficulties, and it is likely that the courts giving access to the chambers were always open to the sky, though in both instances temporary coverings of hides or textiles could have been used. The standard of building, with its fine dry jointing and carefully dressed surfaces, is of high technical quality; and in certain of the temples, probably relatively late in any sequence of construction, there is elaborate surface decoration of low-relief carving (either as naturalistic animal friezes or as spiral patterning) or of close-set pitting apparently made with a drill. Although all the free-standing temples are now ruined and roofless, the interior detail of the rock-cut chambers at Hal Saflieni and models of temples or their façades from Mgarr and Hal Tarxien give evidence for reconstructing the roofs on the lines suggested.

In addition to the low-relief carving, there is a large series of figures carved in the round, usually representing obese females and ranging from specimens a few inches high to a statue (of which the lower part alone survives) of a woman in a flounced skirt at Hal Tarxien which is well over life-size; at Hal Tarxien too is an enormous bowl carved out of solid stone. There is evidence that much, if not all, of the carving and ornament was originally painted, and at Gigantia traces of interior wall plaster with red paint on it were recovered. In the Hal Saflieni hypogeum, elaborate spiral patterns are painted in red in certain of the chambers.

Although the hypogeum was certainly used for a vast series of collective burials, its function need not have been wholly or primarily sepulchral, and there is no evidence that the temples were used primarily for burial. But their affinities in architecture and in planning are certainly with collective burial vaults, either rock-cut or built above ground of large stones, which are known from many areas in the western Mediterranean and belong to the beginning of the 2nd millennium B.C. The Maltese temples have yielded a rich series of pottery finds, of which the earliest is the incised white-filled ware of Mgarr, allied to that of Stentinello. There follow wares with fine ornament scratched on them and filled with red or white colouring matter in techniques characteristic of early Southeast Italian, Ligurian and South French neolithic pottery, and this style may in part be an imitation of Italian neolithic painted pottery — shards of painted ware were indeed found at Mgarr and elsewhere. The latest neolithic pottery includes volute or spiral patterns, and these, especially the similar patterns in stone carving, seem likely to be related to the Mycenaean world in the late 17th or 16th centuries B.C. The figure-sculpture and animal reliefs again is something which points to the eastern Mediterranean for origins. The use of the sling in Neolithic Malta (attested by sling stones) may imply Aegean contacts.

At Hal Tarxien, at a period when the original temple was deserted, a cremation cemetery with many burials was established within the precincts. With the burials was pottery of a style quite dissimilar from that of the earlier sites; and there were also bronze or copper flat and flanged axes and flat riveted knife daggers. Although these metal types are primitive in themselves. a cremation cemetery in the central Mediterranean region can hardly be earlier than those which appear to be the prototypes of this form of burial, in Anatolia and Syria, belonging to the 14th century B.C. and later. This then would give some sort of a terminus ad quem for Hal Tarxien, likely to have been deserted by about the 12th or 13th century B.C. at the earliest; and this, taken in conjunction with the western Mediterranean affinities already mentioned, would seem to indicate that the whole range of Maltese neolithic temples and allied structures would lie within the centuries after 2000 B.C.

The Maltese Bronze Age is represented not only by the Hal Tarxien cemetery but also by pottery finds at Borg in Nadur, at Bahrija and at other sites in the island. The Borg in Nadur pottery, from a settlement site within a probably contemporary defensive wall across a promontory, is exactly paralleled by the Thapsos red ware of Sicily dated by Mycenaean imports to the 14th century B.C. and later. A shard of Late Helladic III pottery from Borg in Nadur confirms this dating.

There are rock-cut tombs attributable to the Maltese Neolithic period at Attard and at Busbisija (Mosta). A small inhumation cemetery of five graves at Ta Trapna iz-Zghejra (Zebbug) revealed a novel type of pottery not represented in the temples or in other tombs, but probably early in the local Neolithic sequence.

There is a blank in Maltese prehistory after the Bronze Age until the coming of Punic colonists in the second half of the 1st millennium B.C. Numerous Punic tombs show the island to have been an important colony; their range of date may extend to that of the Roman occupation.

A remarkable type of antiquity in the island is that of the so-called "cart-ruts," pairs of parallel grooves worn into the rock and having a span of about $4\frac{1}{2}$ ft. It seems that these ruts could not have been made either by cart wheels or, because of the relatively sudden curves in many of them, by sledges: the best suggestion is that they were worn by a primitive form of "slide car" of a type still surviving in parts of Europe, in which the load is dragged on a pair of poles joined at their forward end (water carried in skins would be a likely burden). At one point the line of a pair of ruts crosses the mouth of a Punic tomb shaft in such a manner as to suggest that the tomb was the later feature; this is the only piece of dating evidence that can be adduced, except that at Birzebbuga another pair runs under a shallow inlet of the sea, showing that some marine transgression has taken place since its use.

(S. PT.)

HISTORY

Until recent times Malta's megalithic monuments were considered to be the best proof of a Phoenician settlement in the islands. Although modern archaeology has established that these were built by prehistoric man, many historians still believe that the Phoenicians sought refuge or settled in Malta at some period of their travels throughout the Mediterranean. Up to a few centuries ago remains of two temples were extant; some held that these were Phoenician dedicated to Melkart (Hercules) and Astarte (Juno). The old temple of Juno was mentioned by Ptolemy, the geographer, Cicero and Valerius Maximus. Old historiographers record the existence of scattered remains of alleged Phoenician origin. but these have since disappeared. In Phoenician times Malta (Melita) must have been a prosperous trading centre and an independent colony. Greek inscriptions, coins and works of art found in the island induced authors to state that the Maltese islands passed through Greek hands after the Phoenician period. This theory has recently found many adversaries who are only prepared to admit a strong Hellenic influence over the islands.

In the 6th century B.C. the Carthaginians landed at Malta and several Punic coins and inscriptions seem to belong to this period. Historians write that Carthaginian rule was very harsh and that oppressive tribute was levied. This would explain why in 218 B.C. the Maltese gave up the garrison to T. Sempronius in circumstances described by Livy (xxi, 51). This led to Malta and Gozo being granted by the Romans the privileges of a *municipium*. Cicero refers to the Maltese as *socii;* they coined their own money, had the right of sending ambassadors to Rome and of controlling their own domestic affairs. The islands thus attained the highest form of liberal government known in those times and their prosperity is attested both by Cicero and also by Diodorus Siculus. The latter arites of the beauty and ornamentation of Maltese houses, and to this day remains of palaces and dwellings, foremost among which is the Roman villa at Città Vecchia, indicate a high degree of civilization and wealth. When forced to select a place of exile. Cicero was at first attracted to Malta (Ad *Atticum,* iii, 4; x, 1, 8, 9) over which he had ruled as quaestor in 75 B.C.

The most important event in Maltese history occurred in A.D. 60 when the apostle St. Paul was shipwrecked in the bay which now bears his name; according to tradition and to St. Chrysostom (*Hom.* 54) he converted the inhabitants to Christianity. Publius was "chief of the island" and is said to have become the first Christian bishop of Malta. The site where the cathedral at Citti Vecchia stands is reputed to have been the residence of Publius, where the first miracle was wrought (Acts xxviii, 7, 8). Outside the walls of Notabile there are the Maltese catacombs (4th and 5th century A.D.) which are strikingly similar to those of Rome and which were used as places of burial. Malta was not affected by the Greek schism and remained steadfast in its allegiance to Rome.

On the final division of the Roman dominions in 395, Malta was assigned to the empire of Constantinople and it seems to have undergone the same fate as Sicily; some hold that it was conquered by the Vandals and Goths in the 5th century-and reunited to the empire by Belisarius in 533. In August 870 the Arabs made themselves masters of Malta, massacred the Greek garrison and sold the Greek population to the native inhabitants. Unable to garrison the island with a large force, the Arabs cleared a zone between the central stronghold, Medina (Citti Vecchia), and the suburb called Rabat, to restrict the fortified area. Many Arab coins, some Kufic inscriptions and several burial places were left by the Arabs; they did not establish their religion but they gave to Malta their language, some place names and a few customs. The old belief that the Maltese language is a direct heritage of ancient Phoenician has been scientifically disproven by latest researches in Maltese linguistics. Since Arab times, however, Maltese has been so largely influenced by the Siculo-Italian and other European languages that it may be considered in many respects to stand alone as an independent language.

In 1091 Count Roger the Norman (son of Tancred de Hauteville), then master of Sicily, came to Malta with a small retinue and he was hailed as deliverer by the inhabitants. According to tradition, Roger gave the Maltese their national colours, the white and red. Under the Normans the dominion of the church was re-established and bishops were appointed. The Arabs were allowed to remain on the island as vassals until 1245 or 1249 when they were expelled by Frederick II, the Swabian; upon the extinction of the Norman line, the Swabian house of Hohenstaufen had succeeded to the throne of Sicily. Gradually, feudal customs asserted themselves, and from 1192 these islands were granted as a fief to great officers of state or illegitimate descendants of the sovereign. One of these officials was Henry Piscatore, count of Malta, grand admiral of Sicily, whose glorious exploits at sea are recorded by historians.

The battle of Benevento (1266) decided the fate of southern Italy, and Malta passed under Charles of Anjou. In Fort St. Angelo the revolt of the memorable Sicilian Vespers (1282) was planned out, and beneath the same fort the Angevin fleet was defeated (1283) by Peter III of Aragon to whom the Maltese transferred their allegiance. The Maltese suffered under the feudal lords who used to receive Malta as a marquisate or countship, and in 1397, at the request of the Maltese, King Martin I incorporated the islands in perpetuity in the royal desmesnes. When Alphonso V of Aragon was in urgent need of money, he broke Martin's charter by pledging the islands (1420) to a viceroy of Sicily, Antonio Cardona. for 30,000 gold florins. The Maltese paid the debt, but the islands were given to Gonsalvo di Monroy for the same sum in 1425. A revolt, organized and directed by the commune, against Monroy's rule (1427) led the king to incorporate Malta once more in the royal domains by a charter of June 20, 1428, and the Maltese were given authority to resist, by force of arms, any intermediate lord that the sovereign might attempt to impose.

The Normans had improved considerably the political and economic condition of Malta, and they raised it to municipal status. The political organization was similar to that of the large cities of Italy: the *università,* or commune, had a great deal of control over internal affairs. It was a representative body essentially constituted to defend the ancient laws and privileges of the Maltese. It had wide powers including the election of its officers (capitano di verga, jurats, etc.), the appointment of judges and the sending of ambassadors to the foot of the throne to treat with the king. as was done in the revolt of 1427; it even taxed itself and its members. It was as liberal and democratic a body as any in Europe in the middle ages.

The knights of St. John, having been driven from Rhodes by the Turks, obtained the grant of Malta, Gozo and Tripoli in 1530 from the emperor Charles V, subject to a reversion in favour of the emperor's successor in the kingdom of Aragon should the knights leave Malta, and to the annual tribute of a falcon in acknowledgment that Malta was under the suzerainty of Spain. The Maltese at first challenged the grant as a breach of the charter of King Alphonso, but eventually welcomed the knights. The grand master de l'Isle Adam, on entering the ancient capital of Notabile, swore for himself and his successors to maintain the rights and liberties of the hfaltese. The order took up its abode on the promontory guarded by Fort St. Angelo on the southern shore of the Grand Harbour, and. in expectation of attacks from the Turks, began to fortify the neighbouring town called the Birgu (Vittoriosa). The knights lived apart from the hfaltese and derived their principal revenues from estates of the order in the richest countries of Europe. They accumulated wealth by war or by privateering against the Turks and their allies. In 1551 the African Arabs ravaged Gozo after an unsuccessful attempt on Malta.

Soliman I then prepared to conquer Malta and exterminate the order; the knights and the Maltese were expecting the attack. The great siege of hfalta, which made the island and its knights famous and checked the advance of Mohammedan power in southern and western Europe. began in May 1565. The fighting men of the defenders are variously recorded as being between 6,100 and 9.121: the roll comprises one English knight. Sir Oliver Starkey. The Mohammedan forces were estimated as being between 29,000 and 38,500. The sultan placed his troops under the veteran Mustafa. and his galleys under his youthful relative Piali; he hesitated to make either supreme and ordered them to await the arrival of Dragut with his Algerian allies. before deciding on their final plans. Against Mustafa's better judgment. Piali induced the council of war to attack St. Elmo. in order to open the way for his fleet to an anchorage, safe in all weathers, in Marsamuscetto harbour. This strategical blunder was turned to the best advantage by the grand master. Jean Parisot de la Valette, who so prolonged the most heroic defense of St. Elmo that the Turks lost 8,000 killed, besides many wounded, before exterminating the 1,200 defenders, who fell at their post. In the interval Dragut was mortally wounded, the attack on Notabile was neglected, valuable time lost, and the main objective (the Borgo) and St. Angelo left intact. The subsequent siege of St. Angelo and its supporting fortifications was marked by the greatest bravery on both sides. The knights and the Maltese fought for death or victory, without asking or giving quarter. Finally. Mustafa abandoned the siege on Sept. 8. The order thus reached the highest pinnacle of its fame, and new knights from the flower of the nobility of Europe flocked to be enrolled therein; La Valette refused a cardinal's hat, determined not to impair his independence. He made his name immortal by making Valletta a magnificent example of fortification, unrivalled in the world.

Throughout the 16th and 18th centuries the knights harassed Turkish commerce and took part as an allied Christian power in the great victory of Lepanto (1571). With the growth of wealth and security the martial spirit of the order began to wane and so also did its friendly relations with the Maltese. The civil government became neglected and disorganized, licentiousness increased and riots threatened. In 1722 the Turkish prisoners and slaves, then very numerous, formed a conspiracy to rise and seize the island, but premature discovery was followed by prompt suppression.

In 1768 the Jesuits were expelled and their property confiscated; Grand hlaster Emmanuel Pinto converted their university into one of general study. Castle St. Angelo and the fort of St. James mere, in 1775, surprised by rebels clamouring against bad government; this rising is known as the Rebellion of the Priests, from its leader, Mannarino. The last but one of the grand masters who reigned in Malta, Emanuel de Rohan. restored good government. abated abuses and promulgated a code of laws. On the death of de Rohan the French knights disagreed as to the selection of his successor, and a minority were able to elect, in 1797, a German of weak character, Ferdinand von Hompesch, as the last grand master to rule in Malta. Napoleon Bonaparte had arranged to obtain Malta by treachery, and he took possession with little resistance in June 1798; after a stay of six days he proceeded with the bulk of his forces to Egypt, leaving Gen. Claude Henri Vaubois in command with 4,000 troops.

Toward the close of the rule of the knights in Malta feudal institutions had been shaken to their foundations, but the transition to republican rule was too sudden and extreme for the people to accept. Among other laws Bonaparte enacted that French should be the official language; that 30 young men should every year be sent to France for their education; that all foreign monks be expelled; that no new priests be ordained before employment could be found for those existing; that ecclesiastical jurisdiction should cease; that neither the bishop nor the priests could charge fees for sacramental ministrations, etc. Stoppage of trade and absence of work (in a population of which more than half had been living on foreign revenues of the knights) followed the defeat of Bonaparte at the Nile and the failure of his plans to make Malta a centre of French trade.

An attempt to seize church valuables at Notabile was forcibly resisted by the Maltese, and general discontent broke into open rebellion on Sept. 2, 1798. The French soon discovered to their dismay that, behind the rubble walls of every field, the Maltese were unassailable. The prospect of an English blockade of Malta encouraged the insurgents. of whom Canon Francesco Caruana became the most prominent leader. The Maltese formed a provisional government and an assembly. Lord Nelson was appealed to and he sent his Portuguese allies to blockade the island; later, the British fleet took over and. after visiting the island. Nelson left Capt. Alexander Ball, R.N. (later Adm. Sir Alexander Ball), in command. On Feb. 9, 1799, the Maltese assembly appointed Ball as its president and head of government and troops; the British flag was hoisted side by side with the Neapolitan. Nelson still upheld the contention that the king of Sicily (as successor to Charles V in that part of the former kingdom of Aragon) mas the legitimate sovereign of Malta. After 14 months British troops were landed and suffered no casualties. Few Maltese lives were lost in actual combat, but famine and sickness killed thousands. Finally, after a siege of two years, the Maltese with the help of their British, Portuguese and Neapolitan allies forced the French to surrender. The treaty of Amiens (1802) provided for the restoration of the island to the order of the knights of St. John; against this the Maltese strongly protested, realizing that it would be followed by the re-establishment of French influence. The assembly drew up its famous Declaration of Rights in the first article of which the king of Great Britain was acknowledged as sovereign of Malta on certain conditions, such as that he should maintain the Roman Catholic religion and observe the constitution to be established by the assembly. Sir Alexander Ball governed Malta as civil commissioner from 1802 until his death in 1809.

Rather than give up Malta, England renewed the war with France, and in 1813 the British government accepted the offer made by the Maltese and acknowledged them as British subjects; the treaty of Paris (1814) ratified the compact. Sir Thomas Maitland was appointed governor and commander in chief in the Mediterranean aith absolute powers and he introduced many important reforms. The Maltese continued to petition for political liberties, and trial by jury for criminal cases was established in 1829. An advisory council of government, composed of nominated members, was constituted by letters patent in 1835, but this measure only increased the agitation for a representative legislature. Freedom of the press and many salutary innovations were brought about by the recommendations of John Austin and George Cornewall Lewis (later Sir George Lewis), royal commissioners, appointed in 1836. The chief government posts in the civil service were opened to the Maltese. sinecures abolished, legal procedure was simplified and the police established on an English footing. Queen Adelaide visited Malta in 1838 and founded the Anglican collegiate church of St. Paul. Sir F. Hankey as chief secretary was for many years the principal official of the civil administration. In 1847 Richard More O'Ferrall was appointed civil governor. In June 1849 a legislative council was constituted with ten nominated and eight elected members. The Crimean War brought great wealth and commercial prosperity to Malta. The appointment of military governors was reverted to in 1858. The administration was largely confided to the chief secretary with real power, at times, in the hands of the crown advocate. Between 1854 and 1868 the criminal, commercial and civil laws were codified. Much of this work was carried out by the crown advocate, Sir Adrian Dingli, who later became chief justice and president of the court of appeal.

An executive council was established in 1881 and the franchise extended in 1883. The director of education was determined to carry out reforms prejudicing the privileged status of the Italian language in the island and he met with stiff opposition from Fortunato Mizzi, a lawyer, and his nationalist'party. Count Gerald (later Lord) Strickland joined forces with Mizzi and together they succeeded in obtaining for Malta the constitution of 1887, which established a legislative council consisting of 14 elected and only 6 official members. The Maltese were overjoyed to see the end of a period of government by presidential casting votes and official ascendancy. All those elected, including Strickland, were supporters of Mizzi's party. After a few months Strickland accepted a government post, and in 1889 he was made chief secretary. During the 1890s there was widespread agitation respecting the laws as to mixed marriages, the Maltese relying on the Roman canon law, part of the law of Malta, and the English on the common law of England. The Holy See was consulted on the subject of civil marriage, but the question could not be settled to the satisfaction of both parties. In 1898, on opposite sides of the table, Mizzi and Strickland headed violent disputes in the legislative council on the language question, taxation and other subjects. The bitter duel culminated in a council motion, passed by the elected majority. asking for the removal of Strickland from office. In 1902 he was promoted governor of the Leeward Islands. Mizzi would not yield ground on the language question, and when, in 1903, the constitution was repealed, bureaucratic government with an official majority was again fully re-established for all local affairs.

During World War I the Maltese provided a garrison for the island, many seamen for naval ships as well as labour battalions for service at Gallipoli and Salonika. In addition, Maltese did excellent work in various hospitals. Postwar economic difficulties and agitation for constitutional reform led to violent rioting in Valletta on June 7, 1919. A national assembly was constituted similar to that set up in 1798 against the French, and a draft constitution for responsible government was drawn up. In 1921 a self-governing constitution, based upon the dyarchical principle, was granted by letters patent. Members of the senate and house of assembly were to be elected by proportional representation; judges, appointed by the governor in council, could be removed only by a joint address from both houses of the legislature; debates might be conducted in English. Italian or Maltese, but all official entries were to be in English or Italian. English was declared the official language of the administration, and Italian the official language of record in the law courts. During the Nationalist administration the two sides of the dyarchy worked the constitution with little friction.

In 1927 the Strickland ministry took office. Serious politico-religious trouble arose between government and church, and this brought in the Vatican and the British foreign office. The constitution was suspended in 1930, but restored in 1932. The Nationalists were elected to power, letters patent amending the constitution provoked an atmosphere of recrimination. and in 1933 a second suspension followed. Then, by letters patent, Italian lost its position as an officiallanguage and as the language of the courts. In 1936 the constitution was revoked; powers were vested in the governor aided by an executive council of ex-officio and nominated members. until limited representation without responsibility was granted by the 1939 constitution. A council of government of 20 members was created, 10 being elected, with 2 nominated and 8 official members; the governor had a casting though not an original vote. Thus was the clock put back 90 years.

After Italy entered World War II in 1940 Malta became subject to ceaseless aerial attacks by both German and Italian bombers from bases in Sicily. nithin 20 min. flying time. The island, which was 1,000 mi. from the nearest British position. became of the very first importance as a base of operations. For three years Malta was defended by both the garrison and the people. At the height of the siege it was possible to send supplies of aviation gasoline and munitions to Malta only by submarine, while additional fighter aircraft of the Royal Air force were flown to the island from the decks of distant carriers; food became very scarce. Despite the hardships, civilian morale stood high. On April 15, 1942, George VI awarded the George Cross "to the Island Fortress of Malta to bear witness to a heroism and devotion that will long be famous in history." This was the first time that a medal had been conferred upon any part of the British Commonwealth. The siege ended in 1943: by June 30 of that year 1.436 civilians had been killed, 3,415 wounded or injured and about 37,000 buildings destroyed or damaged. The British government awarded more than £31,000,000 to Malta as compensation for war damage.

Government after World War 11.—In 1947 self-government was once more granted to Malta. As in 1921 the constitution was based on the dyarchical system. It provided for a legislative assembly of 40 members elected by proportional representation; suffrage was extended to women; the official languages were to be English and Maltese. In the first election, Labour obtained 24 seats and, among other innovations, introduced income tax.

In 1949, following a split within the Labour party, a Workers party was formed. This gave the chance to the Nationalists to secure at the next election the greatest number of seats in the assembly, although they did not obtain a working majority. From 1951 until 1954 the island was administered by a coalition government of members belonging to the Nationalist and Workers parties. The fifth election under the present constitution was held in Feb. 1955. The reunited labour front was returned to power with 23 seats, while the other 17 seats went to the Nationalists. These two parties were divided on a constitutional issue: the Labour party favoured integration with Great Britain, or, alternatively, self-determination; the Nationalist party aimed at fully responsible government within the British Commonwealth.

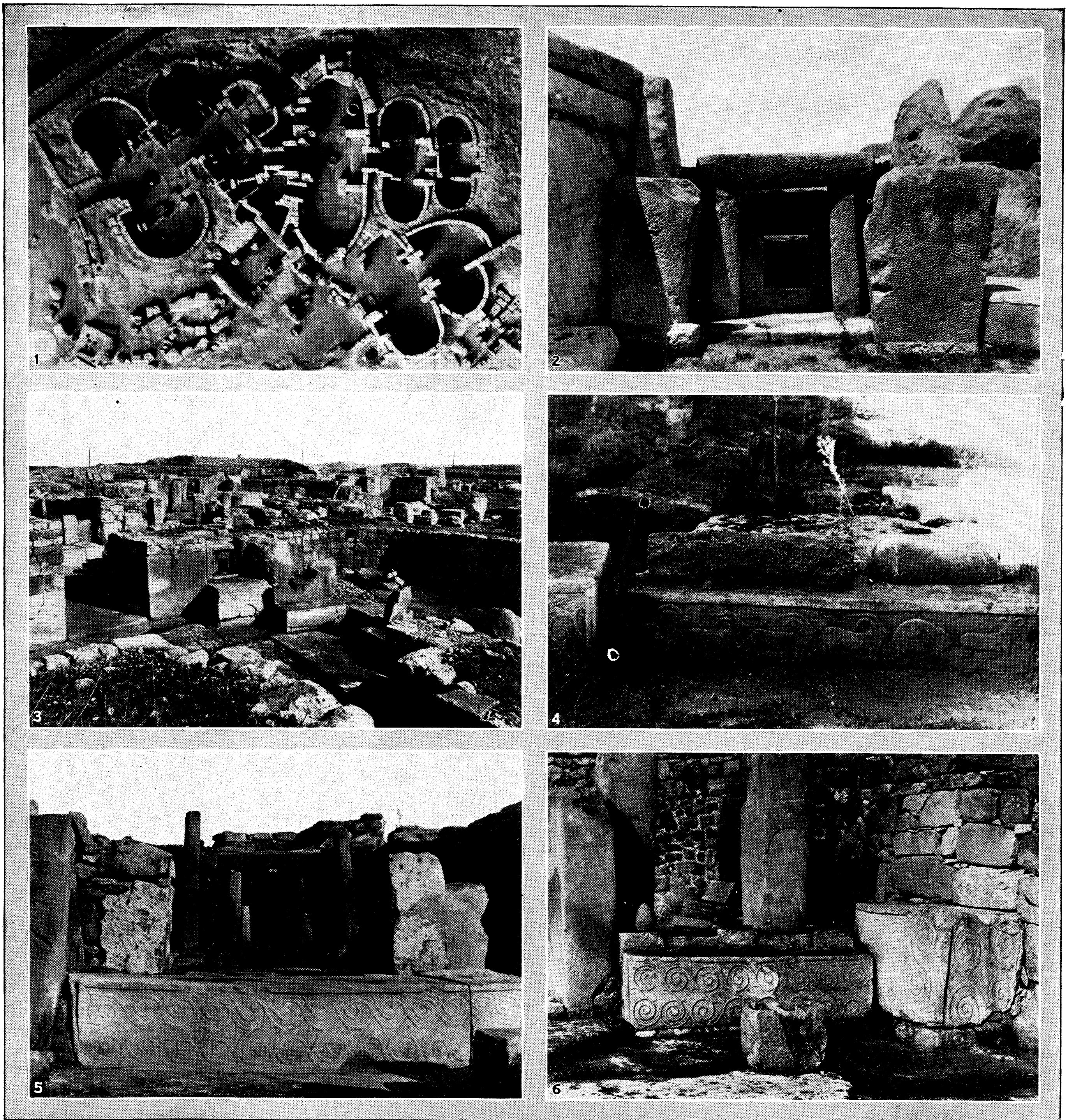
(W. B. Pn.; A. G.)

THE PEOPLE

The upper classes have Norman, Spanish and Italian blood. The knights of St. John, commonly called "of Malta," were drawn from the nobility of Roman Catholic Europe. They took vows of obedience and celibacy. At the time of the British occupation there mere about two dozen families bearing titles of nobility granted or recognized by the grand masters, and descending by primogeniture. No government has ever recognized papal titles in Malta.

In appearance the Maltese are a handsome race, about middle height, well built and sturdy; they are less dark than the southern Italians. The women are generally smaller than the men, with black eyes, fine hair and graceful carriage. Their national head-dress, called the faldetta, is like a large nun's hood made of black cloth stiffened with whalebone. It falls over the shoulders like a shawl. Its origin is Arabic. The Maltese are a thrifty and industrious people, prolific and devoted to their offspring, good-humoured, quick-tempered and impressionable. Their religion is Roman Catholic.

Language.——For the most part the people have no racial affinities in Europe and, high and low, all speak Maltese among themselves, a tongue akin to Arabic with a sprinkling of Sicilian vocabulary and idioms. It is, however, different from the Italian language; the latter is spoken with a peculiar intonation by about one-sixth of the population. However, although Maltese was the medium of daily intercourse and business in the island, it had no

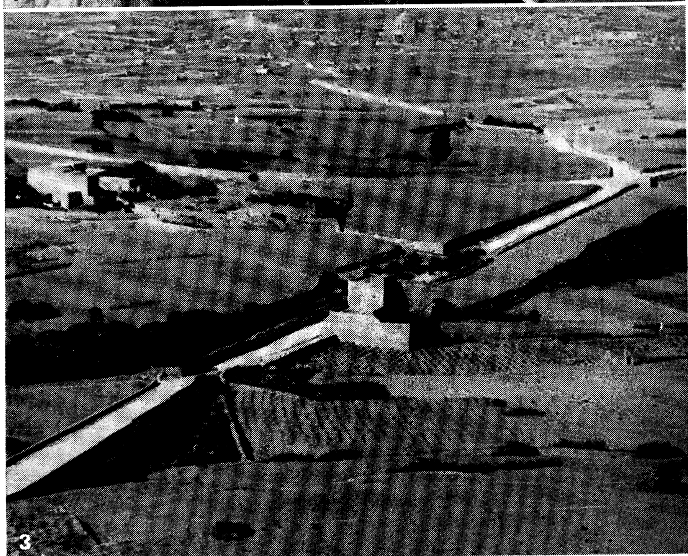


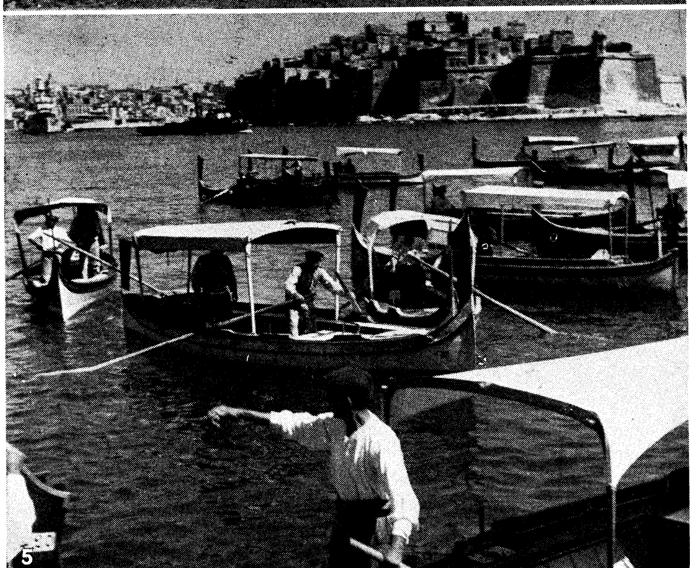
PHOTOGRAPHS, E. A. GOUDER

MEGALITHIC TEMPLES AND STONE ANTIQUITIES OF MALTA

1. Bird's-eye view of the temple of Hal Tarxien, from a model
2. The temple of Mnaidra, showing the entrance to the main shrine
3. General view of Hal Tarxien
4. Stones with animal frieze, from Hal Tarxien
5. Stone with spiral ornament, from Hal Tarxien
6. More examples of stones with spiral ornaments, from Hal Tarxien

MALTA





PHOTOGRAPHS, (1) EWING GALLOWAY, (2) PIX-RIEGER FROM PUBLIX, (3, 5) FRITZ HENLE FROM PUBLIX, (4) GEORGE FURST, MALTA, (6) FRITZ HENLE FROM BLACK STAR

VIEWS OF THE ISLAND OF MALTA

1. Overlooking Valletta from the ramparts of the fortifications that surround the city. Valletta is built on a promontory called Mount Sceberras
2. A street in Valletta. The capital was subjected to almost daily air raids during World War II
3. The interior of the inland. There are few trees. and the heat is intense
4. View of the Grand Harbour of Malta, showing the three cities of Vittoriosa, Cospicua and Senglea
5. Bargemen in the harbour
6. A street in Malta. The woman at the foot of the stairs wears the typical black dress of the islanders

official standing until 1933, the two official languages being English and Italian. In 1934 letters patent removed Italian from its position as one of the two official languages and provided that "the English language, as the official language of the British Empire, and the Maltese language, as the language of the people of Malta, shall be the official languages of Malta." (See History.)

Emigration. — The phenomenal congestion of population gives interest to records of its growth. In the 10th century there were 16,767 inhabitants in Malta and 4,514 in Gozo; estimates made at the arrival of the knights (1530) varied from 15,000 to 25,000, and at the end of their rule (1798) the population was estimated at 100,000. Subsequently the population more than doubled, and in the 20th century there was a net average increase of more than 2,500 a year. Including Gozo and Comino, the civil population in 1957 was 319,620 (1948 census: 305,991), giving a density of 2.620 to the square mile, as compared with 547 in the United Kingdom. Emigration, mainly to Australia and also to the U.K., Canada and the U.S., has reduced the overcrowding. (X.)

In 1948 a Passage Assistance agreement between the governments of Australia and Malta came into force, and between Jan. 1948 and Dec. 1953, 16,482 emigrants benefited by the assistance given under the agreement. In addition, the government of Malta assisted a further 6,121 emigrants to Canada and the United Kingdom. The net total number of emigrants during this period was 31,415, of whom 16.038 went to Australia, 6,357 to Canada, 6,450 to the United Kingdom, 4,442 to the U.S., and 118 to other countries. It has been estimated that 12,000 emigrants a year should leave the islands over a period of 10 years in order that Malta could overcome its serious economic difficulties.

Education. — Primary education is compulsory (since 1946) and free in government schools. In 1953 there were 112 government primary schools with an enrolment of 42,623, 6 government secondary schools (enrolment 1,837), 3 government technical schools (enrolment 347), 8 state-aided private schools (enrolment 2,675), and 6j other private schools (enrolment 11,516). The Royal University of Malta, founded in 1769, had an enrolment of 29j men and 32 women. It grants degrees in divinity, law, medicine. architecture, engineering, dental surgery, pharmacy, arts and science. There were three technical schools and one tailoring school and two teacher training colleges.

About the middle of the 19th century a mixed system of both English and Italian, called pari passu, was adopted as the basis of Maltese education. This was followed by a new system whereby the pupils were first taught to read, write and do arithmetic in Maltese and. at a senior stage, either English or Italian. Later, the teaching of Italian in all grades again became general, and it was not until 1923 that the teaching of that language was abolished in the infant schools and in the first and second years of the elementary schools. In 1933 the teaching of Italian was discontinued in all grades of the elementary schools, both Maltese and English being taught in all government educational institutions, and the department of education produced textbooks of Maltese history. told in the Maltese language. A British institute was founded in Valletta in 1939 to impart a knowledge of British history. language, literature and music, and British ways of living and thinking.

Towns and Villages. — The capital is named after its founder, the Grand Master de la Valette, but from its foundation in 1566 it has been called Valletta (pop. 1957 census, 18,202). It contained the palace of the grand masters, the magnificent auberges of the several subdivisions or "Langues" of the order, the unique co-cathedral of St. John with the tombs of the knights and magnificent tapestries and marble work, a fine opera house and hospital. During World War II attacks by Italo-German aircraft inflicted damage to these and other historic buildings beyond possibility of restoration. Before Italy surrendered in 1943, about three out of every four houses in Valletta were damaged or demolished.

Malta is an important naval and air base and one of the headquarters of the British Mediterranean fleet. There are great naval docks, refitting yards, magazines and stores in the Grand Harbour at Valletta.

Between the inner fortifications of Valletta and the outer works, across the neck of the peninsula. is the suburb of Floriana. To the southeast of Valletta, at the other side of the Grand Harbour, are the cities of Senglea. Vittoriosa and Cospicua; this group is often spoken of as "The Three Cities."

The old capital, near the centre of the island, is variously called Città Vecchia, Notabile and (in Maltese) Mdina (*q.v.*), (the population of Citta Vecchia was 823 and of its suburb Rabat 18,792 in 1957); there are the catacombs and the ancient cathedral of Malta.

Across the Marsamxett (Marsamuscetto) harbour of Valletta is a considerable modern town called Sliema with a population (1957) of 23,399.

Malta had eight hospitals and Gozo six in the mid-1950s. There are also district medical officers, health visitors and midwives.

ECONOMICS

Agriculture. — About a quarter of the population of the Maltese islands depend for their livelihood on agriculture. There is no room for heavy agricultural machinery or implements owing to the smallness of the plots cultivated. The hoe is therefore the most commonly used implement, but in 1943 the department of agriculture introduced threshing machines, which became popular, and the rotary cultivator made an appearance. For the most part the fields are composed of terraces around which the soil has been walled up along the contours of the hills, with enormous labour. to save it from being washed away. Owing to the operation of the laws of inheritance, farms are nearly always divided into separate strips of land not adjacent to each other.

The grain crops are wheat and barley (frequently sown together), and the principal fodder crops are green barley and a tall leguminous plant called sulla (Hedysarum coronarium), with beautiful purple blossoms. Vegetables of all sorts are easily grown, and a rotation of these is raised on land irrigated from wells and springs. Potatoes and onions are grown for export at seasons when they are scarce in northern Europe. Grapes are extensively cultivated (chiefly for wine making but also for table use). Cumin seed is produced for export, while tomatoes, oranges, figs, apricots, nectarines and peaches grow to perfection. Animal husbandry is also of some importance. The Large White pig population made the islands self-sufficient in regard to pork. A herd of pedigree cattle was flown from the United Kingdom in order to upgrade the local cattle, and British Saanen goats have been imported to improve the local breed. Fishing occupied about 1,000 persons in 1951.

Industries. — To assist exports and reduce the import of manufactured goods an Encouragement of New Industries act was passed in 1925 (later amended) granting certain concessions to new industries. The making of buttons, gloves, pipes, boots and shoes, meat products, crown corks, wadding, plastics, beer, nylon stockings and matches have been the main industries. Two very old ones, for which Malta has long been famous, lace and silver filigree work, have been hard hit by the purchase tax in the United Kingdom. Homespun cloth is still made locally.

Commerce. — The economy of Malta has grown much beyond its natural resources on account of its strategic importance and the commercial value of its harbours and airports. The requirements of the ever-increasing population have nearly all to be imported. Food, drink and tobacco account for almost half the imports, while raw materials and manufactured articles make up the balance. By far the most important export item is potatoes (about £250,000 sterling annually); others include gloves, buttons, pipes, crown corks and beer. The main overseas markets are Italy and the United Kingdom.

The small area of the Maltese group of islands, the limitations of their agriculture and the inevitably restricted nature of their manufacturing activities combine to preclude any very large economic development. The agricultural produce of the island can support the dense population only for three months in the year; the balance of foodstuffs and necessaries has to be paid for by the purchasing power of the armed forces stationed there, and by work done for the forces in the dockyard and elsewhere and for visitors and tourists. Relatives at home also receive large remittances from Maltese abroad; and interest from investments outside the islands and accumulated capital furnish margins to adjust the adverse balance.

Money, Weights and Measures. — Government of Malta currency notes and British coin are the sole legal tender. Bank of England notes ceased to be legal currency in 1939 The chief banks are the National Bank of Malta, Barclays bank and Scicluna's bank (a private institution). Local weights and measures include the ratal or rotolo. 1.75 lb.; the wizna. 8.75 lb.; the qantar, 175 lb.; the qasba. 82.5 in.. the xiber, 10.3 in.; the tomna, .278 ac. The tomna is also a measure of capacity for dry goods (.0625 quarters). Imperial measures are used for most commercial purposes.

Communications. — Malta is an important shipping centre. There are two main ports, Grand Harbour and Marsamxett. The R.A.F. aerodrome at Luqa and R.A.F. flying-boat base at Marsaxlokk (Marsa Scirocco) are used also for civilian air services. There are small airfields at Hal Far and Ta Qali. In 1955 there were 423 mi. of first-class roads. and there is a ferry service between Malta and Gozo.

The only railway line ceased operation in 1931 and motor omnibuses serve all towns and villages.

Telegraphic communication is maintained with Europe and the rest of the world. There is a government-controlled telephone service in Malta and Gozo. See Index references under "Malta" in the Index volume. (W. B. PN.; W. H. IS.)

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MALTA FEVER or MEDITERRAKEAN FEVER is an infectious disease prevalent for many centuries in Mediterranean countries. Mortality is not high, but prolonged and exhausting fever, tendencies to chronicity and relapse and disabling sequelae make it a dreaded disease. Decimation of military garrisons on Malta and Gibraltar led many British physicians to study this illness. In 1887 David Bruce discovered the causative organism in the spleen of a patient who died and named it *Micrococcus melitensis.*

In 1905 T. Zammit, a member of the Mediterranean Fever commission headed by Bruce, found the infection prevalent in goats and transmitted to man by milk.

In 1918 Alice Evans, noting similarities between the organism causing Bang's disease or contagious abortion in cattle (then called *Bacillus abortus*) and that causing Malta fever, predicted a human disease caused by *Bacillus abortus.* In 1924 Chester Keefer reported a case of Malta fever caused by *Bacillus abortus,* thus confirming Evans' prediction. Subsequently, these organisms were reclassified as species of the genus *Brucella,* the organism of Malta fever being named *Brucella melitensis* and that of Bang's disease *Brucella abortus*. *Brucella suis,* a third species, causes disease primarily in swine.

All three species cause similar human disease. The infection in both man and animals is called brucellosis (*q.v.*).

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MALTE-BRUN, CONRAD (MALTE CONRAD BRUUN) (1775–1826), one of the leading French geographers and the author and co-author of several extensive geographies, was born on Aug. 12, 1775, at Thisted, Den. A supporter of the French Revolution, he was banished from Copenhagen in 1800 for his political verses and pamphlets. Eventually he established himself as a journalist and geographical writer in Paris. His writings include volumes one through six of the *Précis de la géographie universelle* (1810–29). He originated the *Annales des voyages* in 1808. Malte-Brun took a broad view of geography, regarding it as complementary to natural history and as intimately related to the history. customs and institutions of mankind.

Malte-Brun was a founder of the Société de Geographie of Paris in 1822, the first modern geographical society. He died in Paris on Dec. 14. 1826.

His second son. Victor Adolphe Malte-Brun (1816–1889), followed his father's career of geographer. His special interest was the course of exploration, especially in Africa and the arctic. (G. R. CE.)

MALTESE CROSS: *see* CROSS AKD CRUCIFIXION.

MALTESE LANGUAGE, the only Semitic tongue officially written in the Latin alphabet, is a modern Arabic vernacular closely related to the western (Tripolitan, Algerian) Arabic dialects. In its phonetics, morphology, syntax and vocabulary it shows the strong influence of an earlier, later and continuing Sicilian (Latin) form of speech (cf. Maltese: *il-maktur*, "the handkerchief"; Sicilian: *maccaturu*). The contention that Maltese is descended from an ancient native Phoenician tongue current in the island at the time of the Roman occupation in 216 B.C. and continuing until A.D. 870, the date of the Saracen conquest, is completely untenable on cultural, historical and linguistic grounds.

The Maltese of Gozo has interesting archaisms.

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MALTHUS, THOMAS ROBERT (1766–1834), English economist, was born in 1766 at the Rookery near Guildford, Surrey, a small estate owned by his father, Daniel Malthus, d~was a friend and one of the executors of Rousseau. After being privately educated, Malthus entered Jesus college, Cambridge, where he was a contemporary of S. T. Coleridge. He was ninth wrangler in 1788 and was elected to a fellowship in 1793.

Malthus took orders in 1797, and held for a short while the curacy of Albury in Surrey. In 1798 he published the first edition of his great work, *An Essay on the Principle of Population as It Affects the Future Improvement of Society, with Remarks on the Speculations of Mr. Godwin, M. Condorcet, and Other Writers*. This was followed five years later by the second greatly enlarged and amended edition of his work in 1803; he published several subsequent revised editions, the sixth and last during his lifetime appearing in 1826. In 1805 Malthus married, and soon after, was appointed professor of modern history and political economy in the East India company's college at I-Iaileybury.

He died there on Dec. 23, 1834.

Malthus' *Essay on Population* grew from some discussions with his father respecting the perfectibility of society. His father shared the theories on that subject of Condorcet and Godwin, but his son maintained that the realization of a happy society will always be hindered by the miseries consequent on the tendency of population to increase faster than the means of subsistence. His father, struck by his views, asked him to put them in writing, and then, after he had done so, recommended that the manuscript be published.

The first edition is in the nature of a long pamphlet, brilliantly written and with a marked felicity of phrase and illustration. It put forward the view that population. when unchecked, increases in a geometrical ratio while subsistence increases only in an arithmetical ratio, and Malthus asserts as a fact that population always increase's up to the limits of the means of subsistence. Population is prevented from increasing beyond these limits by the positive checks of war, famine and pestilence and by the influence of misery and vice. From this theory Malthus drew the important practical conclusion for the England of his day that the existing poor-law system, with its indiscriminate doles and bounties upon large families, was utterly to be condemned as tending to aggravate the very evils which it was supposed to remedy. The publication of the *Essay* roused a storm of controversy, and bitter abuse was hurled at Malthus from the most diverse quarters. Undaunted by the attacks to which he was subjected, he set to work to collect material bearing on the rates of increase of population in all times and countries, and five years later published the second edition of his *Essay* in an entirely different form. In its new guise the *Essay* is a long, soberly worded and scholarly treatise, full of detailed facts and statistics and abundantly documented. Nor was it the form alone that underwent a change. While maintaining his "principle" of population—the universal tendency of population to outrun the means of subsistence—he allowed the question of the mathematical ratios to fall rather into the background. But, above all. he introduced a most important modification into his original doctrine by recognizing the existence, in addition to the positive checks to the increase of population, of a preventive check which he termed "moral restraint." By this term Malthus understood the postponement of the age of marriage, accompanied by strict sexual continence. It may be noted that the views and methods advocated by those modern upholders of small families, who call themselves Neo-Malthusians, would have received nothing but condemnation from Malthus. The introduction of the notion of moral restraint, coupled with the realization that subsistence did not necessarily mean merely the bare necessaries for existence, give a more hopeful colour to Malthus' views as set out in the later editions of his work. Nevertheless. he remained rather pessimistic in his general outlook on the possibilities of the future progress of mankind. for he lacked complete confidence that the human race would be willing to regulate its numbers by the exercise of prudence and restraint. Failing that, the positive checks which had operated in the past. with all the vice and misery that follow in their train, would continue to do so in the future.

It would be scarcely fair to convict Malthus of error on the ground that he failed to foresee the astonishing development of transport and colonization which took place in the 19th century and nhich increased so enormously the area from which foodstuffs and raw materials could be drawn during that period or that he underestimated the importance of the reactions of industrial progress upon the output and cost of production of agricultural produce. He does, however, appear to have supposed that the great increase in British population taking place in his time was caused by a supposed increase in births resulting from bounties and other economic changes; subsequent research has shown that the birth rate was not rising and that the great increase of population was solely the result of the fall in the death rate. His view that an improvement in standards of living will cause a geometrical increase of population. and thus a subsequent reversion to subsistence conditions, may be accepted, subject to the proviso that the birth rate remains at its previous level. Thus, in many parts of the east the Malthusian "principle" is still in operation. But his view that better conditions mould, besides reducing deaths. also stimulate births has not been borne out by experience. In many parts of the world the birth rate. despite the existence of living conditions far more favourable than those in the England of Malthus. has fallen below the replacement level, and in these parts the preoccupation is not the chance of overpopulation but that of race extinction. This error does not, however, diminish the importance of Malthus' work. He remains the pioneer in the fundamental treatment of demographic problems; certain of his assumptions have to be modified, but the new situation is likely to increase, not diminish, the esteem in which his work is held and the amount that it is studied.

A chance reading of the *Essay,* in which the phrase "struggle for existence" struck an answering chord, stimulated Charles Darwin to find the key to biological change in the process of natural selection brought about by this struggle for existence.

Malthus was also a writer of considerable importance for the development of economic theory. The close friend and correspondent of David Ricardo, he not merely stimulated the latter but himself made independent contributions to the theory of value. He is generally credited with being the first writer to formulate the law of diminishing returns as applied to agriculture. though he did not call it by this name and perhaps himself failed to realize the full significance of this conception. He combated the rigid Ricardian labour cost theory of value. Although it is the general view that he was not the equal of Ricardo in his power of economic analysis and that his thinking in this field was at times confused, he has supporters who claim to find in his work an anticipation of the modern theory of "effective demand."

Besides his great work, the first edition of which was reprinted by the Royal Economic society in 1926, Malthus wrote *Observations on the Effect of the Corn Laws: An Inquiry into the Nature and Progress of Rent; Principles of Political Economy; and Definitions in Political Economy.* His views on rent were of real value.

(C. W. G.; R. F. H.)

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MALTON, a market town and urban district in the North Riding of Yorkshire, Eng., 16½ mi. N.E. of York, stands on rising ground on the north bank of the river Derwent and is connected by bridge with Norton on the opposite bank in the East Riding. Pop. (1951) 4,236; area 6.3 sq.mi. Malton lies in the Malton or Kirkham gap between the Vale of Pickering and the Vale of York.

A Roman camp east of the town, occupied from A.D. 72 to the end of the 4th century, has been identified with Derventio of the Antonine Itineraries. Excavations after World War II revealed the remains of a Romano-British village. Malton has a museum of Roman and pre-Roman remains found locally. The church of St. Mary at Old Malton. 1 mi. N.E. of the town, was attached to a Gilbertine priory founded in 1150; the magnificent nave is mainly transitional Norman and Early English.

Agricultural equipment is manufactured, and there is brewing and flour milling. Important race-horse training stables are in the neighbourhood, and there are limestone quarries. Cattle markets dating from the 13th century and still belonging to the lord of the manor are held on Fridays and Saturdays, and a fair is held at Michaelmas.

Six miles southwest of Malton are the small but beautiful remains of Kirkham priory, an Augustinian foundation of 1121. Castle Howard, designed by Sir John Vanbrugh as a seat for the Howard family. lies 5 mi. to the southwest.

MALTZAN, HEINRICH VON, BARON ZU WARTENBURG UND PENZLIN (1826–1874), German traveller. was born on Sept. 6, 1826, near Dresden. After extensive travels in North Africa and the Levant, he succeeded in 1860 in making the pilgrimage to Mecca, which he afterward described in *Meine Wallfahrt nach Mecca* (Leipzig, 1865), but had to flee for his life to Jidda without visiting Medina. He died by his own hand at Pisa.

His works include *Drei Jahre im Nordwesten von Afrika* (Leipzig, 1863); *Reise nach Sudarabien* (Brunswick, 1873); *Reise in Tunis und Tripolis* (Leipzig, 1870), which contains a collection of Punic inscriptions; and an edition of A. von Wrede's *Reise in Hadramaut* (Brunswick, 1870).

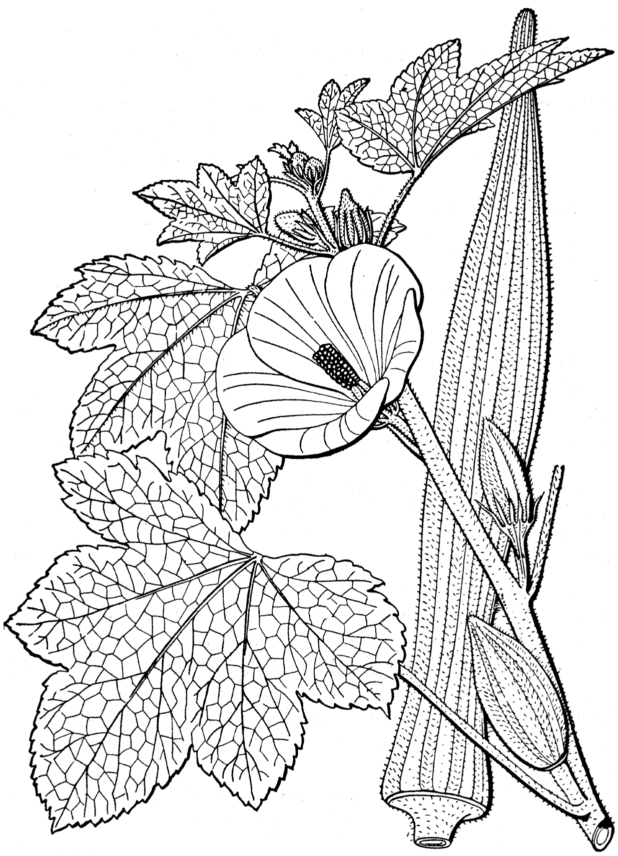
MALUS, ÉTIENNE LOUIS (1775–1812), French physicist, who made important discoveries concerning the polarization of light, was born at Paris on June 23, 1775. Dismissed without receiving a commission from the military engineering school at Mézières. because he was regarded as a suspected person (1793), Malus entered the French army as a private soldier. He was later sent to the newly established École Polytechnique in Paris, and after three years at the school was admitted into the corps of engineers. In 1798 he joined the Egyptian expedition, remaining in the east until 1801.

After his return, he held official posts successively at Antwerp, Strasbourg and Paris and did research in optics. He published a paper in 1809 covering his discovery of the polarization of light by reflection. The discovery gave impetus to the optical investigations of natural crystals by Sir David Brewster and others. In the following year Malus published a memoir on the theory of double refraction in crystals.

Malus died in Paris on Feb. 23, 1812.

MALUS: *see* APPLE; CRAB APPLE.

MALVACEAE, a large and economically important family of flowering plants. It contains 4j genera with about 900 species, and occurs in all world regions except the coldest. the number of species increasing toward the tropics. The most conspicuously useful plant is cotton *(Gossypium)*. It is represented in Britain by three genera: *Malva,* mallow; *Althaea,* marsh mallow; and *Lavatera,* tree mallow. In the United States there are about 20 genera, the best-known ones, after *Gossypium,* being *Althaea* (marsh mallow and hollyhock), *Malva* (mallow). *Sida Abutilon* (Indian mallow or velvet-leaf), and *Hibiscus* (rose mallow, and also okra or gumbo). The plants are herbs, as in the British mallows, or, in the warmer parts of the earth, shrubs or trees. The leaves are alternate and often palmately lobed or divided; the stipules generally fall early. The leaves and young shoots often bear stellate hairs and the tissues contain mucilage-sacs. The



HIBISCUS (HIBISCUS ESCULENTUS), SHOWING UPPER PART OF FLOWERING PLANT (ANNUAL) AND AN UNRIPE FRUIT

regular, hermaphrodite, often showy flowers are borne in the leaf-axils, solitary or in fasicles, or form more or less complicated cymose arrangements. An epicalyx formed by a whorl of three or more bracteoles is generally present just beneath the calyx; sometimes, as in *Abutilon,* it is absent. The parts of the flowers are typically in fives; the five sepals, which have a valvate aestivation, are succeeded by five often large showy petals which are twisted in the bud; they are free to the base, where they are attached to the staminal tube and fall with it when the flower withers. The very numerous stamens are united into a tube at the base, and bear kidney-shaped one-celled anthers which open by a slit across the top. The large spherical pollen-grains are covered with spines. The carpels are one to numerous; when five in number, as in *Abutilon,* they are opposite the petals, or, as in *Hibiscus,* opposite the sepals. In the British genera and many others they are numerous, forming a whorl around the top of the axis in the centre of the flower, the united styles rising from the centre and bearing a corresponding number of stigmatic branches. In *Malope* the numerous carpels are arranged one above the other in vertical rows. One or more anatropous ovules are attached to the inner angle of each carpel; they are generally ascending but sometimes pendulous or horizontal; the position may vary, as in *Abutilon,* in one and the same carpel.

The flowers are protandrous; when the flower opens the unripe stigmas are hidden in the staminal tube and the anthers occupy the centre of the flower; as the anthers dehisce the filaments bend backwards and finally the ripe stigmas spread in the centre. Polination is effected by insects which visit the flower for the honey, which is secreted in pits one between the base of each petal and is protected from rain by hairs on the lower margin of the petals. In small pale-flowered forms, like *Malva rotundifolia,* which attract few insects: self-pollination is found, the style-arms twisting later to bring the stigmatic surfaces' into contact with the anthers.

Except in *Malvaviscus* which has a berry, the fruits are dry. In *Malva (see* MALLOW) and allied genera they form one-seeded schizocarps separating from the persistent central column and from each other. In *Hibiscus* and *Gossypium* (the cotton-plant), the fruit is a capsule splitting loculicidally. Distribution of the seeds is sometimes aided by hooked outgrowths on the wall of the schizocarp, or by a hairy covering on the seed, an extreme case of which is the cotton-plant where the seed is buried in a mass of long tangled hairs—the cotton. The embryo is generally large with much-folded cotyledons and little endosperm.

The largest genus, *Hibiscus,* contains 160 species, which are widely distributed chiefly in the tropics; *H. Rosa sinensis* is a well-known greenhouse plant. *Abutilon* (*q.v.*) contains 120 species, mainly tropical; *Lavatera,* with 20 species, is chiefly Mediterranean; *Althaea* has about 15 species in temperate and warm regions, *A. rosea* being the hollyhock (*q.v.*); *Malva* has about 30 species in the north-temperate zone. Several genera are largely or exclusively American.

MALVASIA (Gr. *Monemvasia,* "city of the single approach"; Ital. *Napoli di Malvasia;* Turk. *Mengeshe* or *Beneshe)* on the east coast of the Morea, Greece, contiguous to the site of the ancient Epidaurus Limera, of which it took the place; one of the principal fortresses and commercial centres of the Levant during the middle ages, still represented by considerable ruins and a town of about j50 inhabitants. So extensive was its trade in wine that the name became familiar throughout Europe as that of a special kind—Ital. *Malvasia;* Span. *Malvagia;* Fr. *Malvoisie;* Eng. *Malvesie* or *Malmsey.* The wine was not of local growth, but came from the Cyclades, and Malavisi province of Crete.

The Byzantine emperors valued Malvasia as a fortress in the Morea, and rewarded its inhabitants for their fidelity by unusual privileges. The emperor Maurice made the city (previously dependent in ecclesiastical matters on Corinth) an archbishop's see, and Alexius Comnenus, and more especially Andronicus II (Palaeologus) gave the Monembasiotes freedom from all sorts of exactions throughout the empire. It was captured after three years' siege by Guillaume de Villehardouin in 1248, but retained its liberties and privileges, and was restored to the Byzantine emperors in 1262. It placed itself under Venice from 1463 to 1540, when it was ceded to the Turks. In 1689 it was the only town of the Morea which held out against Morosini, and his successor Cornaro only succeeded in reducing it by famine. In 171j it capitulated to the Turks, and on the failure of the insurrection of 1770 the leading families were scattered abroad. As the first fortress which fell into the hands of the Greeks in 1821, it became in the following year the seat of the first national assembly.

See Curtius, *Peloponnesos*, ii, 293 and 328; Castellan, *Lettres sur la Morée* (1808), for a plan; Valiero, *Hist. della guerra di Candia* (Venice, 1679), for details as to the fortress; W. Miller in *Journal of Hellenic Studies* (1907).

MALVERN, an urban district in the South Worcestershire parliamentary division of Worcestershire, Eng., 9½ mi. S.W. of Worcester by road. Pop. (1951) 21,505. Area 11.6 sq.mi. It lies mainly on the eastern slopes of the Malvern hills, which run north and south for 9 mi. and rise from the Severn valley to a height of 1,395 ft. in the Worcestershire Beacon. The hills are administered by the Malvern Hills conservators and part of the southern end of the range is under the protection of the National Trust. Malvern chase, originally a crown land and forest, was granted to the earl of Gloucester by Edward I. An ancient trench along the summit of the hills, known as the Red Earl's dyke, is the boundary between Worcestershire and Herefordshire.

The name Malvern is collectively applied to a number of former villages and hamlets built around the hills. The principal town is Great Malvern, lying beneath the Worcestershire Beacon. In early times Malvern was an ecclesiastical settlement, and at Great Malvern was the Benedictine priory which arose in 1085 out of a hermitage endowed by Edward the Confessor. The priory church of SS. Mary and Michael is a cruciform Perpendicular building, with a Norman nave and font. It is famous for its 15th-century glass and encaustic tiles; the great window in the north transept was presented by Henry VII in 1502.

Little Malvern, with remains of a Benedictine priory, now a parish church, lies at the foot of the Herefordshire Beacon, which is crowned by extensive and well-preserved hill fortresses of Iron Age date. Maivern Link, West and North Malvern, on the hills, and Malvern Wells! are also in the district.

Malvern is now an educational centre, with Malvern college for boys founded in 1862, a college for girls and a school of art. It is also a health and holiday resort with a theatre and winter gardens (in which is a large ballroom often used for conferences) and with a swimming pool in the park adjoining. Among its few industries, the chief one is the manufacture of mineral waters.

MALVY, LOUIS JEAN (1875–1949), French Socialist-Radical politician, was born at Figeac, Fr., Dec. 1, 1875. In 1906 he entered the chamber as a Socialist-Radical and was an under-secretary in the Monis and Caillaux cabinets (1911), minister of commerce and postal services under Doumergue (Dec. 1913) and minister of the interior in the Viviani ministry (June 1914). He retained this post under Briand and Ribot. On July 22, 1917, Clemenceau charged him with lax administration in dealing with defeatists and agitators, and he resigned on Aug. 31. His resignation brought about the fall of the Ribot cabinet. In October Léon Daudet brought against him a general accusation of treason. A commission, appointed at Malvy's own suggestion, decided on behalf of the chamber that the senate, sitting as a high court, should pronounce judgment on all the stated charges. On Aug. 6, 1918, the high court acquitted Malvy of the charge of treason, but found him guilty of *forfaiture* (*i.e.*, culpable negligence in the performance of his duties as minister of the interior from 1914–17) and sentenced him to banishment for five years, which he passed in Spain. Re-elected to the chamber in 1924, he represented France at the negotiations with Spain (June–July 1925) for joint action against Abd el-Krim; and in Oct. 1925 he became president of the finance commission of the chamber.

Malvy again became minister of the interior in the Briand cabinet of March 1926; but his appointment roused old and bitter controversies and, although the deputies voted in support of the government after attacking Malvy in a stormy sitting, he resigned on the ground that his presence in the cabinet deprived it of support.

Malvy was elected chairman of the finance committee of the chamber in 1928 and again in 1932, serving until 1940. He died in Paris, June 9, 1949.

See Albert, *Le Procès Malvy* (1920); and E. Gomez Carillo, *Mystère de la vie et de la mort de Mata Hari* (1925).

MALWA, a historic province of India, which gave its name to one of the political agencies into which Central India was divided under British rule. Strictly, the name is confined to the hilly tableland, bounded south by the Vindhya range, which drains north into the Chambal river; but it has been extended to include the Narbada valley farther south. From the Junagadh rock inscription it may be inferred that, in the 2nd century A.D., Rudradaman, the greatest of the western satraps, ruled over Avanti, that is, both eastern and western Malwa. It formed part of the Gupta empire and was later annexed by Harsha. In the 9th century it was absorbed by the Gurjara-Pratiharas between whom and the Rashtrakutas of the Deccan the Narbada formed a fluctuating frontier. The first records of a local dynasty are those of the Paramaras, a Rajput clan, who ruled for about four centuries (800–1200) with their capital at Ujjain and afterward at Dhar.

The Mohammedans invaded Malwa in 1235 and in 1401 Dilawar Khan Ghori founded an independent kingdom, which lasted till 1531. In 1561 Malwa was annexed to the Mogul empire by Akbar. On the break-up of that empire, Malwa was one of the first provinces to be conquered by the Marathas, when it became a cockpit for fighting between the rival Maratha powers, and the headquarters of the Pindaris or irregular plunderers. The Pindaris were extirpated by the campaign of Lord Hastings in 1817, and the country was reduced to order by Sir John Malcolm.

Malwa is traditionally the land of plenty, in which sufferers from famine could take refuge. But in 1899–1900 it was visited by drought, followed by plague.

MALWA is also the name of a large tract in the Punjab, south of the Sutlej river, which is one of the two chief homes of the Sikhs, the other being known as Manjha. It includes the districts of Ferozepore and Ludhiana (Punjab state, India), together with the cis-Sutlej states of Patiala, Jind, Nabha and Maler Kotla (now districts of Punjab). (C. C. D.)

MAMARONECK, a village in Westchester county, N.Y., U.S., is located on Long Island sound, about 5.5 mi. N.E. of the Bronx. Its name derives either from Mamaronock, a Wekquaeskeck (Mohican) chief, or from an Indian word meaning "where the fresh water meets the salt." Although part of a larger area acquired by the Dutch West India company in 1640, the site of Mamaroneck was resold by its Indian inhabitants on September 21, 1661, to John Richbell, an English merchant from Massachusetts bay. In 1698 Caleb Heathcote, later mayor of New York city, purchased Mamaroneck from Richbell's widow. More than a century iater James Fenimore Cooper resided in Heathcote Hill (De Lancey manor house) for several years and there wrote The Spy, Mamaroneck is a suburban community, with a fine marina and Harbor Island park. Major manufactures include metal-spraying equipment, electronic components, water heaters and tanks; lighting fixtures and metal stampings. It became an incorporated village in 1895 and adopted a mayor-village manager system of local government in 1931. For comparative population figures see table in NEW YORK: Population. (M. D. HH.)

MAMELI, GOFFREDO (1827–1849), Italian poet and patriot, born at Genoa of a noble Sardinian family, studied law and philosophy at the University of Genoa. He was wholeheartedly devoted to Mazzini; among other patriotic poems he wrote a hymn to the Bandiera brothers, and in the autumn of 1847 a song called "Fratelli d'Italia," which as Carducci wrote, "resounded through every district and on every battlefield of the peninsula in 1848 and 1849." Mameli served in the national guard at Genoa, and then joined the volunteers in the Lombard campaign of 1848, but after the collapse of the movement in Lombardy he went to Rome, whence he sent the famous despatch to Mazzini: "Roma! Repubblica! Venite!" Although wounded in the engagement of April 30 for the defense of Rome, he at once resumed his place in the ranks, but on June 3 he was again wounded, and died in the Pellegrini hospital on July 6, 1849. Mameli was called "the Tyrtaeus of the Italian revolution."

MAMELUKE, or MAMLUK, the name given to a series of Egyptian sultans, originating (1250) in the usurpation of supreme power by the bodyguard of Turkish slaves first formed in Egypt under the successors of Saladin. See EGYPT: History.

MAMERTINI, or "children of Mars," the name taken by a band of Campanian (or Samnite) freebooters who about 289 B.C. seized the Greek colony of Messana at the northeast corner of

Sicily, after having been hired by Agathocles to defend it (Polyb. i. 7. 2). The members of the expedition are said to have been the male children born in a particular spring of which the produce had been vowed to Apollo (see SAMNITES), and to have settled first in Sicily near Tauromenium. An inscription survives (R. S. Conway, Italic Dialects, 1), which shows that they took with them the Oscan language as it was spoken in Capua or Nola at that date, and the constitution usual in Italic towns of a free community (*touta*) governed by two annual magistrates (meddices). On the Roman conquest of Sicily the town secured an independence under treaty (Cicero, *In* Verr. 3. 6. 13). The inhabitants were still called Mamertines in the time of Strabo (vi. 2. 3).

See also Mommsen, *C.I.L.* x.

MAMERTINUS, CLAUDIUS (fl. c. A.D. 360), Roman official, was the author of a panegyric on the emperor Julian delivered at Constantinople in A.D. 362 in the form of a gratiarum actio (thanksgiving) for the orator's elevation to the consulship. Mamertinus had already held high office under Julian's patronage, and later he was governor of Italy, Africa and Illyria under Valentinian, but his career was terminated in A.D. 368 by a charge of embezzlement. Two earlier speeches in the collection of *Panegyrici* Latini (*see* below) are ascribed in certain manuscripts to a Mamertinus who cannot possibly be identified with Julian's Claudius Mamertinus. These were delivered, probably at Trier, in honour of the emperor Maximian; the first, probably in A.D. 289. on the anniversary of the foundation of Rome, the second, a birthday panegyric. in A.D. 291. All three speeches are important historical documents for their periods.

See W. Baehrens (ed.), *XII Panegyrici Latini* (1911); *E.* Galletier, *Panégyriques latins,* vol. iii (1955) and vol. i (1949) in which the two panegyrists are discussed respectively. (W. S. Ms.)

MAMMALIA, a term invented by Linnaeus (1758) to include that class of animals in which the young are brought forth alive and nourished with milk from the mother's breasts (mammae). Typical examples are the dog, cow, rabbit, monkey, man. Whales are also mammals, although externally fish-like in appearance. Hair (*q.v.*) is a typical mammalian structure. Mammals, like birds, are "warm-blooded" or homoeothermal animals, that is, they differ from "cold-blooded" or poecilothermal forms, such as fishes, amphibians and reptiles, in their superior ability to regulate their own body temperature, so that in spite of wide variations in the temperature of the surrounding medium the body temperature of a typical mammal is maintained in health at a high level and within the relatively narrow limits that are best adapted to the needs of the animal. Some of the most characteristic features of mammals are the expression of the relatively high pace maintained by the vital processes. Here may be mentioned the flexible skin, together with the sweat glands and sebaceous glands, the diaphragm; the complex lungs and heart.

The origin of the mammals lies among the extinct mammal-like reptiles of the Triassic age. The subject may be divided into the following headings, I. Nutrition; II. Locomotion; III. Control Systems; IV. Reproduction; V. Rise of the Mammalian Orders; VI. Continental Dispersal of Orders.

NUTRITION

Jaws and Teeth. — The main divisions of the digestive tract (see GASTROINTESTINAL TRACT) are already established in the vertebrates below mammals; indeed the digestive organs and processes (see NUTRITION and DIGESTION) in the most primitive mammals have been inherited directly from their premammalian ancestors. In typical mammals the most striking morphological advances beyond the reptilian grade are the jaws and teeth.

Mammals are distinguished from lower vertebrates by the fact that the mandible, consisting on each side of a single element (corresponding with the dentary bone of lower vertebrates), articulates directly with the squamosal without the intervention of the quadrate and articular which form the functional mandibular joint in the lower vertebrates. Early embryos of man, and many other mammals, show the dentary of each side forming on the outer side of the stout cartilaginous lower jaw, which corresponds with the Meckel's cartilage or core of the lower jaw of lower vertebrates. The back of this in the embryo mammal ends in a well-developed joint corresponding to the joint between the quadrate and articular elements of the lower vertebrates. As development proceeds the dentary grows upward and establishes a new joint with the squamosal bone of the skull, while the old reptilian joint dwindles in size, pulls away from the dentary bone, and gives rise to the joint between the malleus and incus of the middle ear, which are thus vestiges of the articular and quadrate of lower vertebrates.

In the higher mammal-like reptiles of the Triassic of Russia and South Africa the adult dentition was already differentiated into four kinds of teeth: incisors, canines, premolars and molars; the premolars and molars were cuspidate and in some genera had acquired accessory basal spurs and additional cusps; moreover, the teeth were set in sockets and in some the cheek teeth show an incipient division of the single roots, while the dentition as a whole was reduced to two sets corresponding to the deciduous and permanent dentitions of mammals.

Specialization of Teeth. — The food of mammals, like that of lower vertebrates, may be either chiefly proteids, or chiefly carbohydrates, or a mixture of the two. The pure proteid eaters are typically fierce rapacious forms, in which the digestive tract, the prehensile and masticatory apparatus and the locomotor machinery are all designed for aggression. On the other hand, the carbohydrate feeders are peaceful herbivorous creatures, who spend most of their time in consuming and storing away great quantities of relatively innutritious food.

The anatomical and physiological differences between these two extreme types, *e.g.,* the cat and the cow, are largely correlated with this fundamental contrast in food habits. The cat as a proteid eater receives its food in a highly concentrated and elaborate form. Consequently its digestive tract is relatively short and simple, the stomach is not subdivided and the gastric juice shows a high percentage of hydrochloric acid.

On the other hand, the cow, representing the extreme carbohydrate-feeding type, normally has in its stomach from 14 to 18% of its own total weight in bulky herbaceous food, which contains a great amount of cellulose. The cow's digestive juices are unable to dissolve this indigestible food, but the cow produces an enormous quantity of saliva, which softens the food. By regurgitating and chewing the cud it mashes up the food in preparation for the fermentation caused by the anaerobic bacteria and infusoria in its stomach. In this way the mass gradually becomes fit for digestion by the long digestive tract.

The differences in diet between the cat and the cow are reflected in the differences in their dental mechanism and associated parts of the skull, as set forth in the following table.

	Cat	***Cow***
Jaws:	Short, powerful, wide, for strong vertical movements	Long, slender, narrow, for oblique side swing
Incisor teeth:	Present in both jaws	Absent in upper jaw, replaced by pad
Lower incisors:	Sharp, for piercing, holding and tearing flesh	Blunt, opposed to pad, for cropping grass
Canines:	Prominent, for killing and dragging the prey	Upper canines absent; lower canines incisor-like, for cropping grass
Crowns of premolars and molars:	Compressed, blade-like, for shearing flesh and cutting bones	Crescentic, long-crowned for chewing the cud
Articular condyle of lower jaw:	Placed far down, on level with teeth; to produce a scissors effect, the back teeth engaging first	Placed far above the level of teeth; to bring all the cheek teeth on one side into play at once
Ascending branch of lower jaw:	Very large, for attachment of powerful temporal muscle	Slender, for small temporal muscle
Body of jaw:	Massive, for attachment of powerful masseter muscle	Slender, for attachment of slender masseter muscle

	Cat	Cow
Method of cutting up food:	Into large chunks, with a few powerful bites	Into many very small bits, with many strokes of the jaw

Relatively few mammals attain either of these extreme specializations, the majority subsisting on a more or less mixed diet.

Incisors and Canine Teeth.—The front teeth of mammals are adapted, according to the nature of the food, into insectivorous, carnivorous, gnawing, omnivorous, frugivorous, browsing, grazing, piscivorous and various derived and mixed types.

In the more primitive insectivorous forms the incisors ($\frac{3}{3}$ on each side in primitive placentals and $\frac{5}{4}$ in primitive marsupials) are small nipping teeth, suitable for catching insects, the lower centrals slightly procumbent, the crowns simple with blunt points or slightly sharp edges. In the cat the incisors are fairly primitive in form but are nearly vertical, so giving a more powerful bite.

In rodents the incisors become long-crowned. curved, flattened cylinders with chisel-like edges growing continuously from persistent pulps. In the lower Oligocene forerunners of the Proboscidea (*q.v.*) or elephants (*Moeritherium*), one pair of upper incisors and one pair of lowers are moderately enlarged and adapted for cutting and plucking vegetation from the ground. In *Palaeomastodon* the next higher stage, the upper incisor tusks are much enlarged; through the development of a proboscis, they no longer oppose the lower incisors but function as levers and weapons. In certain later mastodons and elephants the lower incisors are gradually eliminated and the upper incisors attain great size, reaching in the extinct *Elephas ganesa* to 10 ft. 8½ inches.

A reduction or loss of the incisors has frequently occurred in animals with a protrusile tongue, as in the sloths, anteaters, etc

In the horse family, which are grazers, both the upper and lower incisors have become long-crowned, with cup-like insinkings from the incisal surface of the crown. This arrangement strengthens the tooth for cutting off siliceous grass stems, while the long crown insures a long period of use.

In the cow, representing the browsing and grazing ruminant artiodactyls. the upper incisors and canines have been replaced by a horny pad, the lower incisors and lower canines have spatulate cro ns arranged in a semicircle, adapted, with the horny pad above, for plucking herbage.

The canine teeth of carnivores are peculiarly fitted for killing living prey. This type of tooth culminates in the great canines of the extinct sabre-tooth tigers. On the other hand, in herbivorous forms the canine teeth are either reduced or adapted to some other function, as in the lower canines of ruminants above mentioned, or the upper canines or fighting tusks of the boar.

Deciduous or Milk Teeth.—In mammals the true molars, although erupting late, appear to belong to the same series as the deciduous incisors, canines and premolars, but have long lost their permanent successors. Since as soon as the young animal is weaned it usually feeds upon the same food as its parents, it will be obvious that it usually needs a functional set of teeth of the same general kind as those of its parents but smaller. Thus the milk teeth are usually not notably different from the permanent set The presence of the milk teeth makes it possible for the permanent teeth to grow to any desirable size before eruption, teeth once erupted no longer grow except at the roots. Usually the hindmost milk teeth are more molariform than the permanent teeth that replace them, apparently because the young animal needs such teeth where the bite is the strongest.

Dental Formulae.—With few exceptions the right and left sides of the jaws have the same numbers of incisors, canines, premolars and molars respectively. Consequently the "dental formula" as ordinarily written represents only one side of the whole dentition and the total number of teeth is equal to twice the sum of the numbers in the "formula." The adult dental formula of man, for example:

$\left(I\frac{2}{2}\ C\frac{1}{1}\ P\frac{2}{2}\ M\frac{3}{3}\right)$, is simply an abbreviated form of:

Incisors: upper, 2 / lower, 2 Canines: upper, 1 / lower, 1 Premolars: upper, 2 / lower, 2

Molars: upper, 3 / lower, 3

The following dental formulae illustrate the progressive reduction as we pass from the more primitive forms to the highly specialized dentition of the cat:

Typical pantotherian mammal of Jurassic age	$\left(I\frac{?4}{4}\ C\frac{1}{1}\ P\frac{4}{4}\ M\frac{7?}{8?}\right)\times 2=66$
Typical polyprotodont marsupial (Opossum)	$\left(I\frac{5}{4}\ C\frac{1}{1}\ P\frac{3}{3}\ M\frac{4}{4}\right)\times 2=50$
Modern insectivore (Gymnura) . .	$\left(I\frac{3}{3}\ C\frac{1}{1}\ P\frac{4}{4}\ M\frac{3}{3}\right)\times 2=44$
Modern dog	$\left(I\frac{3}{3}\ C\frac{1}{1}\ P\frac{4}{4}\ M\frac{2}{2}\right)\times 2=40$
Modern cat	$\left(I\frac{3}{3}\ C\frac{1}{1}\ P\frac{3}{3}\ M\frac{1}{1}\right)\times 2=32$

On the other hand, a secondary increase in number of molars occurs in several groups. Thus in anthropoids and man a fourth molar is sometimes developed. The high number of simple teeth in the toothed cetaceans is the result'of degenerative specialization.

Molars.—Primitive insectivorous molars are small and bear V-shaped cusps with sharp little blades; in shearing types the molars are reduced in number but are large, with one or two long blades; in omnivorous types either the cusps become rounded, often connected with other cusps by low ridges as in anthropoid apes and man, or they become conic and multiplied in number as in the wart-hog; or the whole crown becomes a swollen mass with low cusps as in the bear; in herbivorous types the molar crowns acquire crests and hillocks, arranged in patterns characteristic of the different species.

In 1883 E. D. Cope observed that the teeth and skeletons of the carnivores and primitive ungulates of the Lower Eocene were far less dissimilar than those of their modern descendants, and especially that, while the patterns of their upper molars were already diversified, there were three main cusps or elevations, two on the outer and one on the inner side of the upper molars, evidently homologous in both carnivores and herbivores. This mas the "tritubercular" upper molar type of the Eocene mammals. A fourth main cusp on the hinder inner side of the upper molars could be seen in earlier stages of evolution in the carnivores and in more advanced stages in the primitive herbivorous mammals.

In the lower jaws Cope observed that in both carnivores and herbivores each lower molar tended to conform to a type in which the tooth crown was divided into two moieties arranged in tandem: the first or anterior moiety (the *trigonid)* elevated and supporting a triangle of cusps, of which the chief lay on the outer side of the crown, the other two on the inner; the second or posterior moiety (the *talonid*) depressed below the trigonid, consisting chiefly of a central concavity flanked on the inner and outer sides by single cusps. This central type of lower molar Cope called *tuberculo-sectorial.* Among recent mammals the tuberculo-sectorial pattern may still be seen in the lower molar teeth of civets, opossums, hedgehogs and other flesh-eating and insectivorous mammals.

H. F. Osborn (1558) gave names to the principal cusps of the upper and lower molars, as follows:

Upper Molar		*Lower Molar*	
Trigon		*Trigonid*	
Antero-internal: (pr)	Protocone	Antero-external: (prd)	Protoconid
Antero-external: (pa)	Paracone	Antero-internal: (pad)	Paraconid
Postero-external: (me)	Metacone	Postero-internal: (med)	Metaconid
		Talonid	
Talon		Pcstero-external: (hyd)	Hypoconid
Postero-internal: (hy)	Hypocone	Postero-internal: (end)	Entoconid

Both Cope and Osborn sought to trace the origin of the tritubercular molars of Eocene mammals back to the "single reptilian cone" of the earliest reptiles. For details of molar evolution *see* H. F. Osborn, *The Origin of the Mammalian Molar Teeth to and from the Trtiubercular Type* (1907) and W. K. Gregory, *The Origin and Evolution of the Human Dentition* (1922).

LOCOMOTION

Origin of the Mammalian Locomotor Apparatus.—The locomotor machinery of mammals, like that of other vertebrates, involves four closely interconnected systems: (1) the motor elements proper; (2) the passive or supporting elements; (3) the combustion; (4) the activating, controlling and directive system.

The motor elements include the striped or red muscle cells and the parts built up from them, muscle fibres, muscles and muscle systems (*see* MUSCLE AND MUSCULAR SYSTEM). The supporting elements include: *(a)* the sheaths and connective tissue surrounding the active elements; (b) the tendons that attach the muscles to the bones; (c) the ligaments that tie the parts of the skeleton together and (d) the articulated bony skeleton, including the backbone, skull, ribs, sternum, pectoral and pelvic girdles and limb bones. The locomotor apparatus of mammals, like that of lower vertebrates, is typically adapted for quadrupedal progression by running on relatively open ground, though many forms have learned to progress in special ways: leaping, climbing, volplaning and even flying, swimming, digging, tunneling. But no matter how elaborate the locomotor mechanism may be, it has all been evolved from the simple crawling mechanism of the earliest amphibians, and this in turn from the undulatory movements of certain air-breathing, lobe-finned fishes of Devonian age.

When the earliest amphibians crawled up out of the water the fore and hind paddles were bent downwards to assist the wriggling movement of the body. At first, the limbs sprawled widely. In such forms the humerus, or first segment of the skeleton of the forelimb, had a very short shaft and widely-expanded ends. There was a sharp bend at the elbow and the radius, or front forearm bone, articulated on the under side of the humerus rather than on its further end. Similarly in the hind-limb, the femur was short and was held widely out from the body.

But in the extinct mammal-like reptiles of the Permian and Triassic of South Africa and Russia the skeleton of the pectoral and pelvic girdles and limbs progressively approaches the mammalian type. Their limbs were adapted for running rather than crawling; the body was lifted well above the ground and the trackway became narrower so that the feet gave a more direct support to the weight. In the later mammal-like reptiles the feet were small and short, and from the reduction in the number of phalanges or toe-joints, to the mammalian number (three in each toe, except the first, which has two) we may infer that the fore-feet were at least partly "digitigrade," *i.e.*, raised off the ground at the wrist. So too the humerus of the cynodonts, or higher mammal-like reptiles, approached the lower mammalian types, and from the form and position of its joint surfaces we may infer that the angle at the elbow was opening out toward the mammalian condition.

The Fore-Limb.—The typical mammalian shoulder-girdle exhibits a distinct advance beyond that of the cynodont reptiles in the following features: (1) complete loss of all parts of the outer shoulder-girdle except the clavicles; (2) the scapula has an anterior shelf or extension supporting the supraspinatus muscle; (3) the dorsal part of the supracoracoid muscle mass has extended upward on to the scapula to give rise to the supraspinatus and the infraspinatus muscles; (4) the coracoid has become greatly reduced and has lost its contact with the sternum; (5) the anterior coracoid plate has disappeared or become vestigial; (6) the interclavicle has disappeared. All these changes have been associated with the raising of the body and the drawing-in of the fore-limbs so that the feet could be planted beneath the body. The egg-laying monotremes now the lowest of existing mammals, are still largely reptilian in the anatomy of the shoulder-girdle.

The remaining elements of the primitive mammalian fore-limb, the humerus, radius and ulna, carpus, metacarpus and digits, were derived with only minor changes from those of the cynodonts.

The Hind Limb.—The primitive mammalian ilium has apparently been derived from that of the cynodonts through the pronounced narrowing of the region above the root of the tail, accompanying the reduction of the tail muscles. The result of this and other changes has been to narrow and lengthen the gluteal area on the back of the ilium and to extend the area on the front inner surface for the origin of the iliacus muscle, so that the primitive mammalian ilium has become a narrow trihedral rod, with well defined iliacus, gluteal and sacral planes.

Meanwhile the femur has undergone corresponding changes in the passage from crawling to running habits. In the primitive crawling types the short stout femur projected widely from the body, its head, or surface for articulation with the pelvis, was a broad oval set directly on top of the shaft; there was a large deep pit for the insertion of the obturator muscles on the under-side of the femur below the head, and a high ridge for the adductor muscles, also on the under-side of the shaft. In primitive mammals, the femur is long, slender, with a cylindrical shaft, the head is globular, set off at a sharp angle and separated from the shaft by a well-defined neck; there is a large flange (greater trochanter) on the outer upper part of the shaft, the proximal pit (or digital fossa) is small, the primary adductor ridge is lost and there is a process, the lesser trochanter, not found in reptiles.

In primitive reptiles the bend between the lower end of the shank and the foot was not sharp; the two main bones of the tarsus, the astragalus and calcaneum, were flat, more or less circular elements located in the same general plane; the calcaneum did not project backward to form a heel-bone. In the running foot of the typical mammal, on the other hand, there is a sharp bend between the shin-bone and the instep, the astragalus and calcaneum are highly differentiated, the former resting upon the latter, the one forming a pulley for the tibia, the other a heel or lever for the powerful muscles of the shank.

Adaptive Radiation of the Limbs.—Among existing mammals the monotremes are adapted for burrowing and swimming but these are the habits of refugees from direct, above-ground competition with higher types. Among marsupials the primitive forms were arboreal, much like the existing opossums, and these gave rise to the numerous ground-living forms adapted for running, leaping and digging. W. D. Matthew has argued that the little-known primitive placental mammals of the early Cretaceous were also arboreal, inasmuch as many of their descendants in the Lower Eocene had five-toed spreading hands and feet, partly divergent thumbs and great toes, and a primitive skeleton not unlike that of an opossum. However, the evidence for arboreal derivation is less decisive than in the marsupials.

Scampering Types.—Small mammals in general have what may be called the scampering habit,—the ability to scurry away quickly in time of danger, without any pronounced specializations of the skeleton for running; and it seems safe to assign this habit to the pre-Eocene insectivorous ancestors of the placentals. From such a scampering type, with small semi-plantigrade hind feet and semi. digitigrade forefeet, adaptive radiation for different habits has brought about profound modifications of all parts of the skeleton.

Cursorial Types.—In quadrupedal running or cursorial forms length and rapidity of stride, combined with strength and endurance, are the great desiderata. The lower segments of the limbs become long, rod-like, angulated compound levers for striking the hard ground and catapulting the body forward; the principal muscles are bunched at the upper parts of the limbs and transmit their pulls through long cord-like tendons that pass over smooth pulley-like surfaces and are inserted into the lower segments of the leg. In extreme forms the foot is longer than the humerus, which gives great speed but requires great muscular strength.

The long narrow feet in running forms have parallel rather than spreading digits; rising on its toes, the animal finally runs on its enlarged hoofs alone. The thumb and great toe are reduced in size and raised off the ground; later they disappear, as do the fifth or outer digits of the fore- and hind-feet. In the perissodactyls or odd-toed ungulates the middle or third digit in both feet becomes predominant, in the horses finally forming the sole functional axis of the foot, the second and fourth digits being reduced to slender splints. In the artiodactyls, on the other hand, after the loss of the first digit the others become paired, the inner and outer digits, II. and V., being smaller, while III. and IV. are larger; in the final stages II. and V. become reduced and almost disappear, while III. and IV. become very long and fuse into the cannon-bone.

As the fore-and-aft movements of the limbs become emphasized, the elbows and knees are turned outward as little as possible; twisting movements diminish. Consequently the shoulder-girdle tends to lose the clavicle and the acromial process of the scapula disappears. In connection with the predominant fore-and-aft movements there are hinge-like joints between the humerus and the forearm, at the wrist and between the metacarpals and the digits.

The scapula is variously shaped: V-shaped in the swift-running artiodactyls, with vertically extended fossa for the infraspinatus muscle; it is usually at least as long as the humerus, which is relatively short with a projecting greater tuberosity for the attachment of the powerful shoulder muscles. The olecranon process of the ulna becomes a broad thickened lever for the insertion of the massive and powerful triceps; the strong tendon of the biceps passes through a broad channel in the humerus.

These and many other detailed adaptations for swift running have been worked out independently in many families and even in different orders of mammals, notably among the numerous plains-living ungulates, as in the horses of the northern world, the extinct pseudo-horses or smaller litopterns of Patagonia, the antelopes and deer. The less advanced stages are seen among the carnivorous hunters such as wolves and certain of the extinct creodonts, as well as in the marsupial wolf (Thylacinus) of Australia. Even some of the plains-living rodents, such as the chinchilla, show cursorial adaptations in the limbs. The ilium in cursorial types is a strongly braced T-shaped bone supporting the thick deep gluteal muscles which are inserted nearly at right angle to the long axis of the femur.

Graviportal or Strzding Types.—Given an abundant food supply, many lines of evolving animals exploit the opportunity of becoming larger, living longer and leaving a larger progeny. These conditions have tended to transform slender speedy animals into great lumbering brutes. In these heavy-bodied forms the lateral or transverse growth components increase relatively faster than the linear ones; slender bodies and narrow limbs and feet become broad and robust. This is clearly seen in such races as the extinct titanotheres, the rhinoceroses and other lines of ungulates, in which the earlier forms have slender narrow feet, the later ones broad short feet.

In such cases the extent to which the earlier cursorial adaptations are disguised by the overlying graviportal changes depends inter alia upon how early the graviportal tendencies gain the ascendancy. When the graviportal tendency supervenes immediately upon the short-footed scampering stage, so that the cursorial stage is passed by, we have the extreme graviportal modifications illustrated in the Eocene Amblypoda and to a less extent in the elephants. The excessively short-toed feet, instead of catapulting the body, roll forward on a great elastic cushion and the straightened legs, with long humeri and femora, swing forward like massive beams. The ilium widens transversely into a huge fan.

Saltatorial or Leaping Types are usually developed from the scampering or cursorial types. In the jerboas and kangaroo rats, which have evolved from scampering rodents, the animals leap on their powerful hind-limbs, holding the body erect and using the fore-limbs chiefly in manipulating the food. The tail is used as a balancing organ in leaping. The kangaroos have doubtless been derived from arboreal phalangers, in which the fourth digit of the hind-foot was already enlarged, the first digit divergent and prehensile, the second and third small and closely appressed or syndactylous. The early hopping stage is illustrated by the tiny musk kangaroo (*Hypsiprymnodon*), in which the great toe is still present though reduced. In later stages the great toe disappears and the fourth digit becomes enormously enlarged, forming the lower joint of a catapult, the power for which is supplied by the massive muscles of the buttocks, thigh and shank. The tail acts as the third leg of a tripod. Bipedal leaping is convenient for hurdling obstacles in sudden alarms, but for heavy animals it is uneconomical for long distances.

Fossorial or *Digging* Types have been developed usually from scampering short-footed types with short powerful arms. In the mole, an extreme and unique fossorial type, the fore-limbs have been moved forward under the neck to enable the enormous, wide hands to reach in front of the nose. The humeri have acquired a secondary contact with the clavicles, which have become solid blocks that form the pivots of the forearm and rest on a keel-shaped forward extension of the sternum. The scapulae are elongate, to give long shoulder muscles and a long reach of the humeri; the enormous triceps is inserted into a great hooked olecranon process of the ulna, the lower surface of which supports the powerful flexors of the carpus. The hind limb is small and not much modified.

The Cape golden moles (Chrysochloridae) differ widely from the true moles. Their forefeet are very narrow and adapted for digging in hard soil, with one or two sickle-like claws. The armadillos and many rodents dig with their large claws and powerful fore-limbs.

Natatorial or Swimming Types have been developed in many orders, although the extreme form of aquatic adaptation is limited to the Cetacea and Sirenia (*q.v.*). The end-results of prolonged aquatic adaptation naturally depend partly on what type of terrestrial forms the given aquatic types took rise from. Thus among the marsupials the aquatic opossum or yapok is simply an opossum with webbed feet. Among the Mustelidae the ordinary otter, the African Aonyx and the sea otter *(Enhydra)* represent progressive adaptation to aquatic life, in which the feet become webbed and enlarged. The sea lions carry this line of adaptation much further, greatly enlarging the hands and feet into flippers, but retaining the power to support the body on all four limbs. Finally, the earless seals (Phocidae) have lost the power of bringing the hind limbs forward under the body and all four feet are specialized paddles. The body, enclosed in a thick layer of fat, has become streamlined and in the cetaceans becomes fish-like. These specializations were already under way in the oldest known whales, the Eocene Archaeoceti. Nevertheless, evidence from comparative anatomy and embryology proves that the Cetacea have been derived from terrestrial, quadrupedal placentals, perhaps allied with the stem of the insectivores and carnivores. The manatees and dugongs (Sirenia) approach the Cetacea in aquatic specialization, but the resemblance is due to convergence as the anatomical differences indicate that the Sirenia have been derived from herbivorous ancestors, possibly related to the ancestral elephants.

Scansorial or Climbing Types.—Many small mammals with well-developed claws and spreading hands and feet supplied with interdigital pads can climb tree-trunks. In the marsupials the opossums afford an example of a primitive stage of arboreal specialization. The phalangers illustrate a more advanced type of highly specialized hind feet; the great toe is strongly divergent and flattened, the second and third toes slender, closely appressed and enclosed in a common skin, the fourth and fifth enlarged and forming the outer fork of a clamp, the great toe forming the inner.

The tree shrews (Tupaidae), which are probably very primitive Primates, give the initial stages of arboreal adaptation in that order. The pen-tailed tree shrew (Ptilocercus) of Borneo has small spreading hands and feet and a generalized skeleton. The lemurs and their Eocene forerunners Adapidae and Notharctidae, have grasping hind-feet with a wide flat nail on the large great toe; the digits are elongate, slender with small nails, except the second digit, which bears a small claw. Lemurs are essentially arboreal quadrupeds, running along the tops of the branches, and the same is true of the typical monkeys. The Kew World monkeys, which have a prehensile tail, can also hang and swing from the branches. The monkeys, especially those of the Old World division, sit upright, or partly so, resting on the ischial callosities. The hands are used in manipulating the food.

Brachiating or Acrobatic Forms.—The gibbons do not run on all fours but hold the body erect, raising the long arms above the head. They make long leaps through the air, catching the branches. In their skeleton as well as in their internal anatomy they are closer to man than to the lower primates.

Of the larger anthropoids the orang-utan (*q.v.*) is extremely specialized for arboreal life, using the suspension grasp of the hands and feet. The arms are excessively long, with enfeebled thumbs, the legs very short. Progression on the ground is awkward, the long arms being used as crutches.

The chimpanzee (*q.v.*) is a moderately heavy-bodied brachiating form, iess specialized than the orang. In running on the ground a secondarily quadrupedal gait is employed, the weight of the heavy forepart of the body resting on the bent knuckles. Nevertheless tame chimpanzees, when carrying large objects in their arms, walk erect.

Old male gorillas are gigantic, extremely massive animals which run on the ground on all fours upon bent knuckles. Nevertheless the locomotor skeleton as a whole is surprisingly close to that of man, except in certain parts such as the ilium and the great toe, in which the brachiating features are conspicuous.

Biped Type.—This is exemplified by man and the adaptations are treated elsewhere (see MAN, EVOLUTION OF).

Volplaning Types.—Certain active climbing types with long limbs, leaping boldly from the trees skim downward easily by holding extended their patagium, a fold of skin stretching from the neck outward and from the arms to the legs and sometimes from the legs to the tail. Such an adaptation has been acquired independently among marsupials in the flying phalangers, among rodents in the flying squirrels and in the anomalures, and also in the colugos ("flying lemurs"), an isolated type remotely related perhaps to the tree-shrews and lemurs. No marked skeletal specializations except the lengthening of the limbs distinguish the volplaning types from their arboreal relatives.

Flying Types.—The Chiroptera or bats (*q.v.*) are the only mammals to achieve true flight. Their wings are enormously elongated hands and arms covered with thin skin. The hind legs are weak and mostly used for suspension. It is supposed that bats have been derived from skimming forms in which the web of skin extended between the long fingers.

The Backbone.—In the line of ascent to the mammals there was a tendency toward simplification of the complex eight-piece vertebrae (see AMPHIBIA), with progressive reduction of certain elements, until in the dorsal vertebrae of the mammal-like reptiles four of the original eight pieces were nearly or quite eliminated, and we have left a vertebra composed of two main parts: (a) the neurocentrum, an inverted Y-shaped piece, arising from the fusion of the opposite "basidorsals," which cover the spinal nerve cord and afford origin for the spinal muscles; (*b*) the centrum proper, a short cylinder somewhat constricted in the middle, consisting of the opposite pleurocentra, or interdorsals, of earlier vertebrates and serving for the insertion of the ribs and for the support of the body as a whole.

In the oldest Amphibia there was a gradual regional differentiation of the backbone as we pass from the neck to the tail; in the mammal-like reptiles, especially in the cynodonts, regional differentiation is pronounced though not sudden. The ribs of the cervical or neck region are short, but still have shafts, while at least in the higher mammals these shafts are lost. The cynodonts were progressing in the direction of the mammals in the fact that their lumbar ribs were suturally connected with the sides of the vertebrae as in some very young marsupials. In many more advanced mammals the lumbar ribs are completely replaced by transverse processes which grow out from the sides of the vertebrae. Similarly in the sacral region the cynodonts and less specialized mammals had free sacral ribs, whereas in more specialized mammals the rib elements of the sacrum are replaced by transverse processes.

In the older mammal-like reptiles the condyle was median and ball-like as in typical reptiles, but in the cynodonts the lateral parts grew outward while the median part retreated so that a double condyle almost of mammalian type was attained.

The mammalian atlas-axis complex is a contrivance of great functional and morphologic intricacy, the purpose of which is to provide a wide range of movement combined with automatic checks, to prevent sudden stresses from dislocating the joint and squeezing the spinal cord. One of the most essential morphological features of the atlas-axis complex of cynodonts and mammals is that the paired occipital protuberances are received into the upper or neural arches of the atlas or first vertebra and that the centrum or body of the atlas becomes a buffer which in the adult is closely united to the centrum of the second vertebra or axis, of which in adults it forms the odontoid process. Meanwhile the neural spine of the second vertebra becomes enlarged vertically to give origin to some of the powerful muscles that raise the head.

In the dorsal vertebrae the stout neural spines act as levers for the powerful spinal muscles in extending the back, while the transverse processes and centra serve as bases for the movable ribs enclosing the heart, lungs and diaphragm.

The contour of the vertebral column in the standing pose in the side view differs widely in accordance with the habits. In scampering types with short legs the column is usually strongly arched in the mid-dorsal region. This culminates in the short-footed carnivorous types such as weasels. In long-limbed running types, especially those with a long neck or a heavy head, the backbone may bear long stout spines on the neck and forepart of the back, to which are attached the heavy ligaments of the neck and the deeper muscles of the occiput.

A profound difference between a typical reptile and a typical mammal is that in the former the great muscles on the lower side of the tail act powerfully in pulling the hind limbs backward in running. In mammals, on the contrary, the tail muscles are greatly diminished and of slight importance in locomotion.

Skull.—The mammalian skull is here treated under the section locomotion because the vertebrate skull in the first place arose as a fulcrum or thrust-block to withstand the forward thrust of the locomotor muscles acting through the vertebral column in the rear and the resistance of the water in front. Hence even in the oldest known chordates, the ostracoderms, the skull consists of two parts: (1) a wedge-like sloping roof and sides, forming a bony *dermocranium* and (2) a cartilaginous or partly ossified inner skull or endocranium, comprising (a) the capsules surrounding the olfactory, optic and balancing organs and (b) the central brain-trough or trabecular region.

Modifications of the jaws and teeth in the mammals, in adaptation to different food habits, have a profound effect upon the form of the skull as a whole, since the jaws usually form the greater part of the bony face, while the jaw muscles cause the upgrowth of ridges on the top and sides of the braincase and condition in many ways the form of the base of the skull.

On the whole the mammalian braincase has advanced beyond that of primitive reptiles in the following features:

(1) The elimination of several dermal bones of the circum-orbital and occipito-temporal series, the tabulars, supratemporals, postorbital, postfrontal, prefrontals;

(2) The widening-out of the brain-trough through the widening of the brain; the change of the reptilian epipterygoid into the mammalian alisphenoid;

(3) The elaboration of the turbinate bones, scroll-like outgrowths from the median cartilaginous septum of the nasal chamber;

(4) The consolidation of the bony elements surrounding the inner ear into a single dense bone, the periotic, and the fusion of this with the squamosal;

(5) The shifting of the inner ear from the side to the base of the skull.

CONTROL SYSTEMS

The mammalian nervous system, which reaches unprecedented complexity in man, can scarcely be understood apart from other regulating devices or control systems, which greatly condition its activities. In all vertebrates the ductless or endocrine glands play an important part in the production and maintenance of the specific and individual patterns of growth and behaviour, since they pour into the blood-stream certain hormones which give the chemical impetus to particular changes in the direction of growth. (See ENDOCRINOLOGY.)

On the whole there is a marked contrast, however, between chemically and nervously determined functions. Chemical regulation (as from the ductless glands) tends to be rigid and determinate. Nervous regulation, on the other hand, has tended toward flexibility, modifiability, choice of several courses of action. Mammals, especially man, have achieved extraordinary adaptability to wide ranges of environmental changes largely through the greater flexibility and range of response of their nervous system.

The nervous system of mammals (more fully treated in the article BRAIN), like that of other vertebrates, comprises the following elements: (1) paired organs of smell, sight, balance, hearing; (2) numerous organs of touch and taste and "somesthetic" sense (organs which convey sensations of bodily posture and movement); (3) "motor nerves," which release the activities of glands and muscles; (4) innumerable connecting tracts, relay stations and control systems of amazing intricacy.

In general the mammalian brain differs from that of lower vertebrates in the fact that the upper part and sides of the endbrain have grown outward into sack-like expansions, which form the neopallium or cerebral cortex of mammals. In the lower mammals this new part of the brain is but moderately developed and the localization of functional areas is at best incipient but in the higher mammals, including man, the neopallium becomes enormously complex, dominating the entire organism and tending to differentiate the cortical "centres" described in the article BRAIN. Meanwhile the thalamus and the "brain stem" have likewise become extremely complex, developing a bewildering maze of connections with other parts of the brain. The result of these expansions and complications is that the old primary control systems pass under the dominance of the newer and higher centres.

REPRODUCTION

In all mammals except the aberrant monotremes the embryo develops within the mother's body, and special arrangements for nourishing the embryo and eliminating its wastes are necessary. Certain fetal membranes unite with the lining of the mother's uterus to form a complicated structure called the placenta. The placenta contains blood vessels from both the fetal and maternal circulations. Thus a metabolic interchange between the blood streams of mother and fetus is made possible (see VERTEBRATE EMBRYOLOGY). The fetus absorbs foods and oxygen from the maternal blood and eliminates carbon dioxide and nitrogenous wastes into the maternal blood. At birth the placenta is shed.

After birth the development of higher mammals is prolonged over the period corresponding in man to infancy, childhood and adolescence; the delayed maturity affording opportunity for long-continued growth and differentiation of the brain, with a correspondingly extended period of learning.

In wide contrast with this are the conditions found in the lowest existing mammals, the egg-laying mammals of Australia (see MONOTREMATA) While these lay eggs, like reptiles, the embryo nevertheless derives some of its nourishment from the uterine wall as well as from the yolk stored in the egg.

In typical placental mammals the right and left uteri are fused in the mid-line, making a single uterus. In the lowest mammals, the monotremes, the right and left uteri are entirely separate as in reptiles. Various intergrading conditions between these extremes occur in the marsupials, edentates and rodents.

The milk-glands of female mammals are highly characteristic of the whole class. They are arranged in pairs on the ventral surface of the body, varying in number from one pair in man and other primates to eleven pairs in the insectivore Centetes. They are usually surmounted by nipples, raised folds of skin with a central tunnel for the passage of the milk. In the placental mammals the milk is actively sucked or pumped by the young but in the monotremes the nipples are represented only by depressed glandular areas with raised borders and the milk is said to be licked by the young from the base of the hairs in the mammary field. This condition may well give the clue to the origin of the milking habit, which must have originated after the sebaceous glands of the skin had developed an albuminous secretion, which may have served originally either to attach the eggs to the under-surface of the brooding mother, or to anoint the eggs with a heat-retaining coating. At any rate, the habit of milking in its initial stages seems to require some voluntary action by the young, such as licking.

THE RISE OF THE MAMMALIAN ORDERS

During the Triassic, Jurassic and Cretaceous, the fossil record of the mammals is meagre; later it is relatively abundant; but even then there are blank intervals and imperfectly preserved records. As many existing orders of mammals began to diverge during the Age of Reptiles, when the record is most imperfect, it is difficult to reconstruct the earlier history of the mammalian orders from present data.

Probably by Upper Triassic times some of the smaller mammal-like reptiles, a group already almost mammals, had crossed the line by acquiring a hairy covering and a new contact between the dentary bones of the lower jaw and the squamosal bone of the skull. With the coming of Lower Jurassic times the mammalian stock had split into three distinct groups: (1) the Allotheria or Multituberculata (q v), rodent-like mammals with gnawing front teeth and many-cusped grinding teeth; (2) the Triconodonta, small carnivorous forms with triconodont molar teeth, each crown consisting typically of three cusps in a fore-and-aft line and (3) the Pantotheria, or Trituberculata, very small insectivorous mammals typically with sharp-cusped lower molars of the most primitive tuberculo-sectorial type The Allotheria were probably not closely related to any other order of mammals but were a peculiar, now wholly extinct group extending in time from the Upper Triassic to the summit of the basal Eocene. The Triconodonts also appear to be an isolated and extinct group, but certain of the Pantotherians, such as *Amphitherium*, appear sufficiently generalized to be the potential ancestors of all later mammals except the recent monotremes which at present show distant relationships with the marsupials, but are still without known fossil ancestors, the features they share with the Allotheria being offset by many others that indicate wide differences. The marsupials may well be the descendants of some of the Pantotheria but actual connecting links are wanting. The same is true of the Placentals, which are first known in abundance in the basal Eocene of North America Recently, however, the field parties of the American Museum of Natural History in Mongolia have discovered several incomplete skulls of small mammals which appear to represent some of the Cretaceous forerunners of the centetoid insectivores and perhaps also of the most primitive carnivores or creodonts.

From comparison of the osteology and anatomy of the recent monotremes, marsupials and placentals, however, we may infer with high probability that the ancestral mammal was an egg-laying vertebrate that retained a primitive reptilian type of shoulder-girdle with two complete coracoid plates on either side and with the beginnings of the neopallium in the brain From such primitive types the marsupials (see MARSUPIALIA) evolved by developing, among other characters: (1) a three-way, vaginal passage; (2) the true or allantoic placenta was early replaced by a false or yolk-sack placenta; (3) the corpus callosum or great cross-band between the opposite halves of the neopallium was not developed; (4) all the milk teeth were suppressed except the hindermost premolars and (5) the dental formula of the adult dentition was reduced from a higher number to $I\frac{5}{4}\,C\frac{1}{1}\,P\frac{3}{3}\,M\frac{4}{4}$. On the other hand, the primitive placentals apparently never developed either the three-way vagina, or the yolk-sack placenta, but their true placenta early became highly developed, as did the corpus callosum; the entire set of milk teeth was retained and the dental formula was early reduced to $I\frac{3}{3}\,C\frac{1}{1}\,P\frac{4}{4}\,M\frac{3}{3}$ The marsupial group may have been dominant in the Lower Cretaceous, when fossil records are practically blank. By the Lower Eocene the marsupials were already a defeated group which took to the trees and persisted in North America only in the form of the opossums, among the most primitive of all living animals; in South America, however, they gave rise to several extinct families (Borhyaenidae, Caenolestidae, Didelphidae) and in Australia they became the dominant mammalian forms and gave rise to a great series of families, including the dasyures, bandicoots, phalangers, kangaroos and others.

The placental group is first known from primitive insectivorous representatives from Mongolia, as already noted, apparently it originated somewhere in the north and by basal Eocene times its diversified descendants are found in western North America and western Europe but as yet nowhere else. These were small-brained forms, many belonging to families that became extinct before the close of the Eocene. Here belong most of the archaic carnivores or creodonts, amblypods, tillodonts and others. Besides the "archaic" placental families that became wholly extinct were others apparently related to later groups. Here belong (1) the Plesiadapidae (apparently related to the tree-shrews and thus representing an early phase in evolution of the primates); (2) early forerunners of the tarsioid primates; (3) the insectivore *Palaeoryctes,* representing a primitive phase of the modern centetoid insectivores; (4) the progressive creodont *Didymictis* (in or near to the ancestry of the modem carnivores); (5) the palaeanodonts, including primitive relatives of the armadillo group of edentates. The bats (*q.v.*; Chiroptera), too, appear to be an old group, possibly dating back to the Basal Eocene or even earlier. Conspicuously absent from the Basal Eocene are the modernized or caeneutherian placental orders, including especially the perissodactyls, the artiodactyls, the rodents, the Proboscidea.

The condylarths or primitive ungulates of the Basal and Lower Eocene are not regarded by modern authorities as ancestral either to the perissodactyls or artiodactyls; it is however probable that some of the condylarths gave rise to the peculiar South American orders of litopterns, toxodonts, etc. By the Lower and Middle Eocene we find in Europe and western North America, side by side with the later families of meseutherian placentals, the earliest known representatives of the more progressive modern families: *Eohippus,* representing the horses (Equidae); *Hyrachyus* and other genera, forerunners of the lophiodonts and rhinoceroses; *Trigonolestes,* a primitive representative of the artiodactyls; *Metachiromys,* a specialized armadillo-like edentate; *Viveravus,* close to the ancestors of the later carnivores; *Paramys,* a forerunner of the sciuroid rodents; *Pelycodus* and *Notharctus,* early lemuroids, and the numerous anaptomorphids, relatives of the primate *Tarsius.* Even the Cetacea were represented by the peculiar zeuglodont group. During the Lower Eocene, western Europe and North America had several fossil genera in common (including the earliest stages of the horse family) which may perhaps have spread from central Asia.

In many cases the molar teeth of the Eocene placental mammals, while variously specialized, still retained distinct traces of derivation from an earlier tritubercular type characteristic of the basal Eocene; the hands and feet were either five-toed or bore clear traces of derivation by reduction from the five-toed type; the humerus had an entepicondylar foramen and the femur a third trochanter. So that it seems reasonable to infer that all the varied placental orders of Eocene times were descendants of some group that lived perhaps in the Lower Cretaceous; but as to the more precise interrelationships of the mammalian orders, extended research on the anatomy and osteology of the recent forms and on the osteology and dentition of the fossil forms has so far rather revealed the complexity of the problem than solved it. From present evidence the tree-shrews, lemuroids and primates, with *Galeopithecus* and the bats, appear to form one great superordinal assemblage, probably derived from arboreal Cretaceous insectivores. On the other hand, the old order of ungulates, formerly supposed to be a natural group, seems to consist of a heterogeneous assemblage of orders (condylarths, taligrades, amblypods, perissodactyls, hyracoids, proboscideans, sirenians, artiodactyls, notoungulates, arsinoitheres, etc.), related chiefly by descent from various as yet unknown protoungulates.

The aardvarks, formerly classed with the edentates, may prove to be highly specialized descendants of the condylarths, while the edentates themselves are probably the descendants of the palaeanodonts, which in turn may be remotely related to the insectivore-creodont stock. The earliest known cetaceans, the zeuglodonts, were not directly ancestral to the true cetaceans; nevertheless they tie in that order with the insectivore-creodont division of the placentals. On the other hand, the Sirenia, although resembling the cetaceans in general body-form, are herbivores and their real affinities are with the ungulates.

CONTINENTAL DISPERSAL OF MAMMALIAN ORDERS

From the studies of palaeontologists and mammalogists emerge the following among other general results bearing on geographic dispersal of the mammalian orders:

(1) At various times during the Age of Mammals pathways were opened by which a given group of mammals, acquiring its special characters in regional isolation, could pass from central Asia westward to Europe or eastward to North America, or from either Europe or America to Asia. Among the orders and families of placental mammals that may have originated in the northern realm (including Europe, Asia, North America) may be mentioned the perissodactyls and artiodactyls, the insectivores, the fissipede carnivores, the rodents, the edentates, the lemuroids, catarrhine primates, anthropoids and probably man. The families of rhinoceroses, lophiodonts, titanotheres and camels afford examples of the more or less free intercontinental commerce at certain periods.

(2) South America was early in contact with North America; then the contact was broken and for millions of years the country was left to develop its own fauna of litopterns, toxodonts, ground-sloths and other strange beasts. In late Tertiary times the way was again opened and mastodons, camels, tapirs, deer and other animals streamed in from the north, while South America sent platyrrhine monkeys, ground-sloths and other animals northward.

(3) Africa, especially in the north, was frequently in contact with the northern land mass but in late Eocene and early Oligocene times the Fayum district in Egypt may have been an outlier of some central African region which seems to have produced the Proboscidea, arsinoitheres, hyracoids and sirenians. The most primitive known cetaceans (*Pappocetus, Protocetus, Prozeuglodon)* are also found there. Madagascar, possibly part of a broad archipelago formerly connected with India, was the centre of peculiar families of carnivores (viverrids) lemuroids, insectivores (centetoids). Broadly, Africa's mammalian fauna to-day represents Europe and Asia of Miocene and Pliocene times.

(4) Australia, receiving its original marsupials at some early date, was then cut off from Asia and developed one of the most interesting mammalian faunas of all time, in which the marsupial stock was fashioned into herbivorous, carnivorous and rodent-like mammals, strangely similar in habitus to their analogues of the placental world and yet always preserving their marsupial heritage in brain and reproductive system and in the deeper characters of the skull and skeleton. At times during this long period placental invaders from the north managed to get in; first a peculiar family of rats and much later the dingo or native dog, together with that most devastating of all placentals, man. Australia, on the other hand, succeeded in sending some marsupials into New Guinea and as far northwest as Celebes. Some hold also that from Australia by way of Antarctica came the extinct carnivorous marsupials and caenolestoids of South America. (*See* MARSUPIALIA.)

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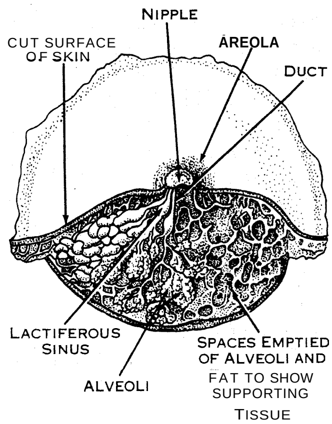
(W. K. G.)

MAMMARY GLAND, the milk-secreting organ that. together with hair. furnishes the prime distinguishing characteristics of mammals. Such glands are present in both sexes. but in the male the organ is incompletely developed.

Anatomy. — In the human female the breast extends vertically from the second to the sixth rib, and transversely from the edge of the breastbone into the territory of the armpit. A little below the centre of the glandular swelling is the somewhat cylindrical nipple, whose rounded top bears minute pores where the milk ducts open; deep within is involuntary muscle that causes the nipple to erect in response to stimulation. Surrounding the nipple is a pigmented, circular patch called the areola, which is studded with slight nodules produced by from 10 to 15 underlying rudimentary milk glands (areolar glands). During the second or third month of pregnancy the areola darkens, but after lactation ceases, this added pigmentation fades. The glandular mass proper is composed of from 15 to 20 lobes, and these subdivide into smaller lobules that contain the secretory endpieces and lesser, branching ducts. Each lobe is drained by a single excretory lactiferous duct, which swells into a reservoir (lactiferous sinus) and then dwindles again and finds an outlet on the nipple. The endpieces (alveoli) are scarcely recognizable as entities before pregnancy, and the entire gland has a blighted appearance Connective tissue and fat comprise by far the greatest bulk of the inactive organ. During pregnancy the duct system extends and alveoli appear as minute vesicles. expanding the lobules. During lactation the alveoli become relatively prominent sacs, which are packed closely together. The secretory cells of the sac wall are cuboidal in shape. and the milk secreted by them collects in the relatively capacious cavity of the sac itself. The ending of lactation is accompanied by regressive changes that return the gland to the previous inactive state.



ADAPTED FROM MORRIS, "HUMAN ANATOMY"

THE BREAST DURING LACTATION. DISSECTED TO SHOW ITS SECRETORY ALVEOLI AND DUCTS

The glands of both sexes remain equal until the approach of puberty. Then the female breast increases suddenly and continues to grow for some time. During pregnancy it augments further and after childbirth still more. Growth is largely (and possibly wholly) a response to the ovarian hormone. estrogen, whereas a pituitary hormone. prolactin. brings about actual secretion. When lactation ceases. the gland returns to approximately its former size. At the end of the childbearing period of life, the glandular tissue atrophies greatly. but compensatory deposition of fat may maintain the size of the breast. which often becomes pendulous. The two breasts are seldom equal in size, the left tending to be somewhat larger. Suppression of a nipple or of the breast itself occurs at times. Supernumerary nipples or even small glands are relatively common; they usually lie along a line that corresponds to the position of the embryonic mammary ridge and represent extra developments from that tissue. Occasionally the male breast will simulate the female breast on one or both sides (gynecomastia).

Embryology. — The mammary glands are highly modified sweat glands; transitional stages are seen in the glands of the areola and armpit. In the sixth week of human development a thickened epidermal band appears in the pectoral region, much less extensive than the axilla-to-groin mammary ridge of many lower mammals. Each future gland begins as a local thickening on this ridge. the remainder of the ridge vanishing. This lens-shaped thickening becomes a globular mass from which 15 to 20 cords grow into the deeper regions of the skin; these cords are the primary ducts and they continue to grow and branch throughout fetal life. The exposed. free surface of the original thickening hollows into a pit, and at about the time of birth this area elevates as a nipple, bordered by an areola. The further history, folloning birth, has been summarized in the preceding paragraphs. Since these glands evolved late in the history of vertebrate animals, it is remarkable that they arise so early in the mammalian embryo.

Comparative Anatomy. — Both the number of glands developed in the different mammalian groups and their locations vary widely. In general, the number corresponds to the number of young ordinarily produced at one birth. This agreement is not always exact, as in evidence are the extra glands of sheep and cattle; moreover, since the glands occur in pairs, the minimal number of two is in excess of single human births. Actually, the number of glands is not entirely constant in individuals of the same species. The position of the glands seems to bear a relation to convenience of suckling. Mammals that have many young at birth, as the sow, most carnivores, many rodents, etc.. have as many as 11 pairs of glands distributed along the wall of the underbody. In the pouched mammals (monotremes and marsupials) inguinal mammae are found, and the same is true in most ungulates as well as in the Cetacea. In sloths, elephants, Sirenia, Chiroptera and primates. on the other hand, they are confined to the pectoral region, and this is also the case in some rodents; *e g*, the jumping hare. The outcome depends on the development of glands along localized patches of the embryonic mammary ridges, while the intervening parts of the ridges disappear.

In the monotremes a pair of pits within the longitudinal, pouch-like skin fold receive 100 or more separate mammary tubules. Milk is conducted from these openings along hairs. whereupon it is licked off or sucked up by the nursing young. In all other mammals the glands open in relation to nipples. The primary type is a pseudo nipple, as illustrated by the teat of cattle and other ruminants. in which the skin around the openings of the glandular ducts grows upward so as to surround a very deep pit; in the bottom of this canal the glandular ducts open. In the true nipple the gland surface itself is elevated into a papilla. and the ducts then open at its apex. In monotremes the glands are equally developed in both sexes, and it has been thought that among bats the male often assists in suckling the young. These facts, together with the occasional occurrence of functional activity of the organ in the human male, make it probable that among ancestral mammals both sexes participated in lactation and nursing. (L. B. AY.)

Diseases. — The breast is the seat of various disturbances, all of which are worrisome and some of which are fraught with danger.

Mastodynia.—Mastodynia, or persistent pain in the breast. intensified before the menstrual period, is relatively common in mature women. The pain is often referred to a lump that is tender to the touch. These symptoms usually disappear spontaneously after months or years, but the possibility of infection or cancer must be considered.

Cysts of the *Breast.*—A galactocele is a tumour due to the locking up of milk in a greatly dilated duct. Other forms of cystic disease are usually special modifications of chronic mastitis. Such cysts are best treated by free incision, and by passing a gauze dressing into their depths. If the tissue is occupied by many cysts, it is well to remove the whole breast.

Acute ,Mastitis. — This is a temporary inflammatory condition of the breast. It is apt to occur in a woman who is suckling, and is due to the presence of septic microorganisms. which, as a rule, have found their way into the milk ducts, the lymphatics or the veins through a crack or other wound in a nipple that has been made sore by the infant's vigorous attempts to obtain food. Especially is this septic inflammation likely to occur if the nipple is depressed or so badly formed that the infant has difficulty in feeding from it. The inflamed breast is enlarged, tender and painful, and the skin over it is hot. and perhaps reddened. The woman feels ill and feverish, and she may shiver or have a definite rigour if the inflammation is passing on to the formation of an abscess. The abscess may be above or beneath the breast, but it is usually nithin the breast itself. In the early stages, cold packs and the cessation of nursing may abort the infection. The response to sulfa drugs and penicillin therapy is excellent. If pus collects. applications of heat are administered to localize the abscess, followed by incision and drainage.

Chronic Mastitis.—This condition is not uncommon in women who are past middle age. The symptoms may have been present for months to many years. The part of the breast involved is enlarged, hard and more or less tender and painful. It is sometimes impossible clinically to distinguish this disease from cancer. True, the tumour is not so definite or so hard as a cancer, nor is it attached to the skin, nor to the muscles of the chest wall, and if there are any glands secondarily enlarged in the armpit they are not so hard as they may be in cancer. But all these are questions of degree, and the indications given for a diagnosis of cancer indicate also that the disease is so advanced as to have reduced the chance of successful operation to a minimum. Moreover, it is highly inadvisable to leave it to time to clear up the diagnosis, for a chronic mastitis, innocent at first, may become cancerous, while cancer and chronic mastitis often coexist in the same breast. Hence the only safe course is removal of the breast.

Fibro-adenoma.—A simple fibro-glandular tumour may be found in the breasts of younger women, who may possibly give an account of some blow or other injury; there may, however, be no history of injury. The tumour is smooth, rounded or oval, and lies loose in the midst of the breast; as a rule it is not tender. It is not associated with enlarged glands in the armpit. The tumour, though innocent, should be removed promptly, for such growths may enlarge rapidly and become cancerous later.

Cancer.—This is the commonest disease of the breast. It occurs chiefly among women between 40 and 60 years of age, but men are not entirely immune and women older or younger than the ages mentioned may suffer. The early symptoms are given elsewhere (see CANCER), and the later symptoms are those of cancer in general; viz., local spread, destruction of normal tissue, ulceration, early extension to the nearest group of lymphatic glands (in this case, axillary) and from these to neighbouring groups of glands (in this case, supraclavicular) and formation of secondary growths in skin, liver, bones, muscle, indeed in any tissue of the body. With the exception of melanotic sarcoma the secondary growths in cancer of the breast are more widely spread than in cancer affecting any other primary site. Probably this is in part due to the fact that the natural duration (*i.e.,* duration apart from all treatment) of breast cancer is relatively long, viz., about three and a quarter years. The pain and distress are usually great, particularly in the later stages when probably ulceration will have occurred and pressure of the cancerous mass in the armpit on the veins and lymphatics may have led to great swelling of the arm. Death may be brought about in various ways, the immediate cause often being some intercurrent disorder which the patient, enfeebled by absorption of toxic material from the ulcerated surface, anemia and pain, cannot resist; or by extension of the growth to the pleura and lung, with coincident pleurisy and pneumonia.

Cancer of the breast is usually spheroidal cell carcinoma, but the columnar cell type also occurs, notably in so-called "duct carcinoma," which is a less malignant variety. Sarcoma is also met with. Carcinoma is either hard and fibrous (scirrhous) or highly cellular (encephaloid), but many intermediate forms occur even in different parts of the same breast. A scirrhous growth is relatively smaller and runs, locally, a less rapid and extensive course than encephaloid, but as regards extension from the primary focus and the occurrence of secondary growths there is little difference between them. Sarcoma of the breast locally forms a large growth and the secondary growths have a somewhat different distribution. Speaking generally, scirrhous is associated with an atrophied and shriveled breast and retraction of the nipple.

It is often said that cancer runs a more rapid course in the young; statistical evidence does not support this view, though many cases in the very aged progress slowly. On the other hand during pregnancy a cancer of the breast participates in the rapid growth of the organ. But there is no evidence that suckling conduces to cancer; on the contrary, abeyance of the natural function seems to be related to the occurrence of chronic mastitis and consequently to local cancer after a longer or shorter interval.

The treatment of cancer of the breast depends to an overwhelming extent upon the stage at which the disease comes under full and proper treatment. If cancer of the breast is dealt with by the modern complete operation while the growth has not extended beyond the limits of the organ, approximately 90% of the patients are alive and well ten years later and their expectation of life is not materially different from that of women of the same age who have not suffered from cancer. But if the cancer has extended beyond the limits of the gland, a matter of a few weeks from the time when it first becomes recognizable, the case is very different. In spite of the same operative treatment, 90% of the patients will be dead by the end of ten years. No better evidence could be given for the paramount value of early and adequate operation, but the surgeon is dependent upon the patient and there is evidence that about half the number of patients dying with cancer of the breast do not seek medical treatment at all till the last days of life; of the remainder who seek advice, an average period of six months or more has elapsed between their first noticing that something was wrong and consulting a surgeon. There may be many explanations of this delay, but the fact remains that with each hour they have been throwing away a good chance of healthy life.

In cancer of the breast early and complete operation easily holds the first place for success so far as present knowledge goes. Radium and X-ray treatment, though highly valuable in some other sites, are far inferior to surgery as curative agents in cancer of the breast with the present technique. Possibly it will remain so even with improved technique because of the special peculiarities appertaining to cancer of this organ. Upon this point no confident opinion can be given. When the disease is beyond operative treatment, radiation methods may afford palliative relief. (See CANCER; CANCER RESEARCH.)

Chronic Eczema.—Chronic eczema around the nipple of a woman late in life, with perhaps, localized ulceration, is known as Paget's disease and has a sinister significance, for it indicates that the superficial layers of the fibrous dermis are in all probability infiltrated uith cancer. Hence, when eczema about the nipple refuses to clear up in a few days under the influence of soothing treatment, the usual recommendation is the removal of the entire breast. The nipple is retracted in most of these cases, which, however, are not often met with.

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(W. S. L.-B.; L. B. AY.)

MAMMEE APPLE, MAMEY or ST. DOMINGO APRICOT, the fruit of Mammea *americana,* a large tree of the garcinia family (Guttiferae), with opposite leathery gland-dotted leaves, white, sweet-scented, short-stalked, solitary or clustered axillary flowers and yellow or russet fruit 3 to 6 in. in diameter. The bitter rind encloses a sweet aromatic flesh, which is eaten raw or with sugar, and is also used for preserves. There are one to four large rough seeds, which are bitter and resinous, and used as anthelmintics. An aromatic liqueur distilled from the flowers is known as eau de *Créole* in the West Indies, and the acrid resinous gum is used extensively for destroying the chigoes which attack the naked feet of the natives.

MAMMOTH, an extinct elephant (*q.v.*) about the same size as the existing Indian form, characterized by possessing a short, high and pointed skull, which supported a pair of tusks unique in their spiral curvature, the roots diverging from one another, the middle part of the tusks turning upward and outward, and the tips being directed toward one another. Mammoth tusks (well known in fossil form), although they may be extremely long, possibly reaching a maximum length of 10 ft. 6 in. from the socket, are usually rather slender, and must from their shape have been incapable of being used as pickaxes, as are those of an Indian elephant. The tusks of the frozen mammoths of Siberia are so well preserved that they can still be used industrially, and fossil ivory has been exported from Siberia to China and Europe since medieval times.

The molar teeth of the mammoth are variable in character but the number of plates is always large. The teeth are deep and wide, so that in dentition the mammoth reached perhaps the highest point in the evolution of the elephants.

The mammoth is found only in deposits dating from Pleistocene times and is in Europe always associated with a fauna whose character indicates a cold or arctic climate. It was the only one of the elephants adapted to life in cold climates. When. as in England, warm interglacial periods intervened, the mammoth and its associates migrated to the north, following the retreating ice field.

The mammoth was hunted by late Paleolithic man, and drawings and statuettes representing the animal are found in French caves. From these drawings it is apparent that the creature was covered with hair so long that it almost reached the ground, and that the body mas shaped into a great hump at the back of the neck; the ears were small. The accuracy of these drawings has been confirmed by the evidence afforded by frozen mammoths discovered in the tundra of northeastern Siberia. These animals, because of their great weight, became bogged in marshy plains, sinking down into ice-cold mud, which subsequently became frozen and has so remained. The specimens show that the whole body was covered with an undercoat of yellowish-brown wooly hair through which projected long black thicker hairs which formed patches on the cheeks, flanks, abdomen, etc. The tail was short and, like that of a modern elephant, provided with a terminal tuft of long, stiff bristles. The small ears were covered with fur.

It is not known when the mammoth became extinct, but it survived in France to the extreme end of the glacial period, and may have lived on in Siberia to a much more recent period.

Closely related to the mammoth are several species of elephant found in warmer areas of Europe, India and North America. The American mammoths attained a gigantic size, being perhaps the largest of all elephants, attaining a height of 14 ft.

(D. M. S. W.; X.)

MAMMOTH CAVE, a cave in Edmonson county, central Kentucky, U.S.A.. 37° 14′ N. lat. and 86° 12′ W. longitude. It is a distinct part of an extensive system of caves in the soluble St. Louis limestone, overlain by the Chester (Mauch Chunk) sandstone both of the Mississippian or Lower Carboniferous series. The area of the cave-bearing formation is over 8,000 sq.m. in southern Indiana, through central Kentucky and into northern Tennessee. The cave is said to have been discovered in 1809, when a hunter named Hutchins is reported as having pursued a bear into its entrance; but it must have been known earlier, for its entrance was designated in the county records of 1797. Readily accessible to the majority of the Eastern States it is visited by many tourists. It is now a national park.

The St. Louis limestone throughout the cave-bearing area is massive and homogeneous, lying almost horizontal and showing few traces of tectonic or structural deformation. Owing to its relative purity and consequent solubility, it has been carved, chiefly since the Miocene period, by underground waters percolating and flowing along its joint and fracture planes, into a great series of caves. Where its cap of Chester sandstone has given way it has been perforated by hundreds of "sink-holes," more or less funnel-shaped depressions distinctive of the landscape of the region, and interrupted by scarp-rimmed valleys with little or no relation to surface erosion. The depth to which the cavern has been cut has been determined by the level of Green river, to which the Mammoth cave system is tributary by subterranean passages opening along its banks. As Green river graved itself deeper into its bed, the dissolving and eroding waters passing through the limestone were enabled to proceed with their carving deeper and deeper. The thickness of the St. Louis limestone approaches and in places exceeds a thickness of 300 ft. The sections of the cave ordinarily traversed have been surveyed by civil engineers and geologists; but owing to insurmountable difficulties, many avenues are still unexplored. The temperature of most of the cavern and its passages is fairly uniform at 54° F. Just within the entrance a noticeable draught sweeps, outward for most of the year when the exterior air is the warmer, inward occasionally in winter when the exterior air is the colder. The upper galleries are dry; the lower damp owing to streams and pools, and the air is pure and wholesome.

The entrance is 118 ft. below the summit of a limestone bluff and 194 ft. above the level of Green river, but a half mile distant. The arch at the entrance has a span of 70 feet. The vestibule within the entrance rapidly contracts 300 ft. within to a passage called the Narrows where a gateway has been built. A short distance beyond the Narrows the passage opens upon the Rotunda, the first notable chamber of the main cave. It was in the Rotunda where during the War of 1812 and at other times nitre was prepared for powder, from the guano, chiefly the excrement of myriad bats. By crude processes calcium nitrate worth $20,000 was obtained in 1914, when the industry reached its peak The main cave is from 40 to 300 ft. wide and from 35 to 125 ft. high. It extends through the Rotunda, thence by Star Chamber, Chief City and minor chambers connected by long passages or narrow defiles to its rather abrupt termination 4 m. from the entrance. Though the entire cave extends under an area but 10 m. in diameter, the main cave and the accessible tributary passages with their domes and chambers on its five different levels aggregate a length of at least 150 miles. The extent charted includes 225 avenues, 47 domes, 23 pits, eight cataracts, three rivers, two lakes and one sea. Streams and pools contribute to the majesty of the cave. They are navigable from May to October when Green river, with which they are connected, subsides. The Dead sea is a pool walled by cliffs 60 ft. high and in length 100 ft., along which a pathway runs to a stairway leading downward to the River Styx, a body of water 40 ft. long, crossed by a natural bridge. Lake Lethe, in a broad basin with mural cliffs 90 ft. high, becomes shallow and turbid at times. Many blind fish have been taken from it. A narrow path along Lake Lethe leads to a pontoon at the neck of the lake, and beyond it, a beach of fine yellow sand to Echo river, a stream or pool $\frac{3}{4}$ m. long, 20 to 200 ft. wide and 10 to 40 ft. deep, with a symmetrical arched roof, varying in height from 19 to 35 feet. It is famous for the resonance of the tones given out by its vibrant stone which reverberate for from 10 to 30 sec. along its vaulted gallery. Other streams and pools, some of them even miles in length, occupy some chambers and galleries. They are fed by surface waters, which in the rainy season percolate and cascade into the cave in great volume, and collect in River Hall. For about seven months of the year these streams are unnavigable. When Green river is in freshet the waters in the cave become connected, sometimes rising 60 ft. above low-water mark.

Four main routes through the cave are summarized below.

Route No. 1.—Echo River; Mammoth Dome with six majestic columns, royally fluted, 80 ft. high and 25 ft. in diameter; Gorin's Dome, 217 ft. high, the walls of which are draped with three immense calcic curtains of exquisite tint and texture; River Hall, by which the gardens of crystal roses are approached; Grand Crossing; and the Natural bridge.

Route No. 2.—Rotunda, with its ruins of the nitre works; Banquet Hall, equipped with tables, seats, lights and table service; Olive's Bower; Gothic Avenue, where the mummies of a race reputed to antedate the Indians were found; the Pillars of Hercules, gigantic columns; the Bridal Altar, a majestic shrine where many weddings have taken place; the Arm-chair; Elbow Crevice; Annetta's Dome; the Giant's Coffin 40 ft. long, 20 ft. wide, and 8 ft. deep, resembling a sarcophagus; Martha Washington's statue, a lighted silhouette in fancied resemblance of the first First Lady of the Land; and the resplendent Star Chamber, a hall of sable walls and ceiling thick set with immaculate patens of magnesium sulphate efflorescence gleaming by lantern light.

Route No. 3.—Violet City, the new section discovered and explored in 1908, comprising the resonant Chimes, the glorious Marble Temple. Albert's. Stairway, the Grand Portal, Elizabeth's Dome and Valhalla; Proctor's Arcade, a symmetrical chamber, near the Star Chamber and one of the sensations of the cave when lighted by blue flares; Indian Relics; Wright's Rotunda, 400 ft. in its shortest diameter; Chief City, two ac. of troglodytic grandeur where Indian chiefs gathered in council and by blazing flambeaux and faggot fires smoked the calumet and decided for peace or war: cataracts. of impressive beauty: Waldach's Dome; the Epsom Salts deposits, their drifts of snow-white crystals; Haines Dome; the Grand Portal and the Marble Temple.

Route No. 4.—Echo river; the Valley of Flowers; the Snowball Room; Cleveland Avenue; Florist's Garden; Donna's Garden; Diamond Grotto; the Rocky Mountains; Dismal Hollow; the Maelstrom; Ganter Avenue: and the Corkscrew.

The biota of the cave is distinctly subterranean in character. All the known forms of plant life are either fungi or allied to them, many but microscopic. (W. E. E.)

MAMORÉ, a river of Bolivia formed by affluents rising on the slopes of the Cordillera Real and flowing northward to join the Guaporé river and subsequently the Madeira river. The Mamoré is the central and most significant river in the system of waterways which drain the northern plains region of eastern Bolivia and ultimately converge into the Madeira in the northeastern section of the country. Its complex of affluents includes the Chaparé, originating to the north of the city of Cochabamba, the Isiboro, the Ichilo, the Yapacani and its tributary the Piray and the Río Grande. The latter, also known as the Guapay, rises in the cordilleras of Cochabamba and Sucre. Starting out directly east, the Río Grande then sweeps northward, northwest, and after executing a semicircle for a distance of about 600 mi. unites with Mamoré a few miles below the confluence of the latter with the Chaparé.

Most of the upper tributaries of the Mamoré are navigable by some type of craft, depending upon the season; consequently, the Mamoré is an important route from the north and east as it provides access to Cochabamba from both Trinidad and Santa Cruz. Fluvial travel from Cochabamba to the lowlands is accomplished by way of the Chaparé, Chimoré and Isiboro utilizing rafts as far as the confluence of these rivers with the Mamoré, where larger craft are operative. The Mamoré can be descended without difficulty as far as Guayaramerín, a point about 36 mi. from Villa Bella where the first rapids of the river are encountered. The Amazon river is reached by way of the Madeira and the Madeira-Mamoré railway via Pôrto Velho. The Guaporé river, or Iténez, the largest affluent of the Mamoré, is navigable along its course of 1,000 mi. at any season by vessels of light draft.

Starting from the edge of the mountains to its confluence with the Madeira, the Mamoré flows due north for about 1,000 mi. passing close by the town of Trinidad midway and absorbing several tributaries as it progresses. The downward slope to the north is so gradual in this section of the lowlands that the rivers are slow, shallow and irregular in their courses. This feature, together with the flatness of the land, results in the inundation of much of El Beni during the rainy season. The Mamoré is about 1,200 mi. long and in part constitutes the northeast boundary of Bolivia and Brazil. (J. L. Tr.)

MA'MUN (*c.* 786–833), originally 'Abdullah, surnamed AL-MA'MUN ("in whom men trust"), the seventh of the Abbasid caliphs of Baghdad, was the second son of Harun al-Rashid and successor-designate to his brother Amin. A five years' struggle between the two ended in the death of Amin and the proclamation of Ma'mun as caliph (Sept. 813). A serious rebellion, the result of his countenancing the heretical sect of 'Ali, soon after threatened his throne. In the succeeding period of tranquillity Ma'mun, who had already founded a college at Khurasan, did much to foster literature and science. The first Arabic translation of Euclid was dedicated to him in 813. He founded observatories at Baghdad and Kassium, determined the inclination of the ecliptic, caused a degree of the meridian to be measured on the plain of Shinar and constructed wonderfully accurate astronomical tables.

In 827 he adopted and gave state support to the heterodox tenets of the Mu'tazilites (*see* ISLAM). In his last years he took personal command of expeditions in Egypt and Asia Minor; and in 833, when marching against the Greeks, he died near Tarsus.

See CALIPHATE.

MAN, EVOLUTION OF. From the point of view of the biologist, the problem of the evolutionary origin of man is only one of the many problems of mammalian evolution; for, in his physical structure and physiological functions, man falls within the biologists' definition of a mammal, and thus may be presumed to be the product of an evolutionary process similar to that which is now known from the fossil record to have occurred with other groups of mammals. At the time of the publication of Charles Darwin's Origin of Species (1859) there was considerable opposition to the conception of evolution as a whole, mainly because the idea of the fixity and immutability of the different species of animals and plants was very prevalent at that time. In part, this opposition was no doubt due to the influence of the biblical story of the creation and to the fact that the teleological "argument from design" for the existence of a divine intelligence was superseded by the hypothesis of adaptation through natural selection, but it was also due to the purely scientific evidence adduced by taxonomists that species are clear-cut and sharply defined categories which are not linked by intergradations. As is well known, the cumulative evidence advanced by Darwin, reinforced by his exposition of the process of natural selection (a conception which had also occurred independently to the great naturalist Alfred Russel Wallace), eventually compelled acceptance of the main hypothesis of organic evolution. But general acceptance was certainly delayed by the circumstance that the hypothesis inevitably involved the consideration of man's relationship to lower animals, and the implied conclusion that man is also the product of an evolutionary process (and not a unique and special creation) dominated the minds of antievolutionists for a considerable time. It is possible that some of the more bitter controversies in the early days of evolutionary discussion might have been avoided if a clear distinction had been made between what may be termed "anatomical and physiological man" (*i.e.,* the biological species *Homo sapiens*) and the concept of Man in its wider philosophical context, for it is certain that misconceptions have arisen in the past, and even today still arise from time to time, from the use and misuse of the colloquial terms "man" and "human" in discussion of evolutionary origins.

The difficulties involved in achieving a precise definition of these terms are discussed in HUMAN NATURE—an article that includes also an outline of the Encyclopedia *Britannica's* treatment of the efforts of scientists and philosophers to explore the nature of human nature.

Not even anthropologists always employ the terms "man" and "human" consistently, but the main difficulty is that they are terms which in ordinary usage are commonly taken to imply very much more than the meaning attached to them by anatomists and biologists when they are considering man only in a strictly anatomical or biological sense. It is, in fact, almost impossible to give a satisfactory definition of man which will satisfy all schools of philosophy. The anatomist is not qualified as an anatontist to define man as *Man;* he is competent only within his own special field of study to define man in anatomical terms as one of the species of the animal world—Homo *sapiens.* For this reason, it is a matter of importance that in discussing the evolutionary origin of our own species we should so far as possible avoid the terms "man" and "human"—except only when there can be no possible misunderstanding as to what is meant by them. undoubtedly we can approach the whole problem with much greater objectivity if we confine ourselves rather strictly to the scientific terms of zoology, such as Homo (meaning the generic group of which H. *sapiens* is one of the species—in fact, the only surviving species) and the Hominidae (an inclusive term meaning the zoological family of which *Homo* is one of the genera). It has been suggested that, as a matter of convention, the terms "man" and "human" may reasonably be applied (and limited) to those representatives of the family Hominidae which acquired a level of intelligence enabling them to fabricate tools and implements.

As a broad generalization there is much in favour of such a definition. for the ability to design and manufacture tools for different purposes, even if they are of quite simple construction, involves mental powers of visualization and abstraction far beyond anything found in the rest of the animal world. But it is a definition which is not always applicable to extinct types of hominid, for the evidence of toolmaking capacities in such cases may not always be forthcoming.

GENERAL EVIDENCE FOR EVOLUTION

There is no need here to enter on a detailed discussion of the evidence for evolution as a whole, for this will be found in another article (see EVOLUTION, ORGANIC). But we may summarize briefly the different lines of evidence, in order to see how far they are applicable to the special problem of the evolutionary origin of the Hominidae. The evidence falls within the following main categories.

Comparative Anatomy of Living Types.—The unity of design shown in the anatomical structure of different animals (even when they appear superficially to be strongly contrasted) suggests a genetic relationship; *i.e.,* that the common structural pattern has been inherited from a common ancestry, and that the superimposed differences have been developed as the result of a gradual process of evolutionary diversification. On this hypothesis degrees of relationship are indicated by degrees of resemblance in anatomical structure. Thus, if two types very closely resemble each other in a complex pattern of anatomical details. it is inferred that their genetic relationship is correspondingly close. Considerations such as these provide the basis for modern classificatory systems in zoology. and taxonomists aim at a natural classification of animals which expresses real evolutionary relationships. The fact that it is often possible, in the study of modern types, to arrange the latter in a gradational series connecting those of simpler with those of more complex organization, or, in other words, to demonstrate what the older French naturalists called *l'échelle* des *êtres,* does indeed suggest that they are the products of an evolutionary process. For such a series demonstrates that there are links of an approximate kind in the animal kingdom even as it exists today, and such links may evidently represent the modified survivors of an actual evolutionary sequence in the past.

Geographical Distribution.—The geographical distribution of different types of living creatures is most easily explained on an evolutionary basis. This argument is particularly convincing in the study of animal and plant communities isolated by geographical or other factors. In an island population, for example, the degree to which local varieties, subspecies or species differ from each other and from those on the adjacent mainland appears to be directly related to the length of geological time during which they have been isolated and thus prevented from interbreeding with parent groups.

Vestigial Structures.—Detailed anatomical study of an animal often reveals degenerate and useless relics of some organ or structure which are explicable only on the supposition that it was fully developed and of functional importance in a past ancestry. The remnants of eyes in naturally blind animals, of wings in flightless birds and of the limb skeleton in functionally limbless creatures are examples of such vestiges.

Embryology.—The temporary appearance of certain structures during the development of the individual from a fertilized ovum (ontogeny) is difficult to explain unless it has reference to stages of evolutionary development in the past. For example, in embryos of those mammals in which, in the adult, certain elements of the skeleton or dentition have been lost, transitory traces of these elements may be found during embryonic development.

Genetics.—The study of the cytological basis of hereditary variations (mutations) demonstrates that the latter have their origin in definite changes involving the hereditary units (genes) which are located in the chromosomes of the cell nucleus. Such variations may lead either to large and abrupt or small and closely graded changes in the structure of an organism, and, in either case, they provide a theoretically adequate basis for structural modifications which may be stabilized by the cumulative effect of selective processes.

Potentialities of Selection.—The experience of animal breeders and plant cultivators makes it clear that a diversity of new varieties can be produced from common parent stocks by artificial selection, and field studies demonstrate by population surveys that the genetic make-up of a local group may undergo a gradual transformation under natural conditions of isolation and a changing environment; *i.e.,* that natural selection, as well as artificial selection, is an effective agent in altering the distribution of gene frequencies in a local population. Further, statistical studies have shown that with a known mutation rate exposed to selective influences of a given intensity, natural selection is in fact adequate for the production of structural changes such as those which have been postulated to have occurred in evolution in a known period of geological time.

Evidence of the Fossil Record (**Palaeontology**).—The fossil record provides in a number of cases a direct demonstration of a succession of closely graded intermediate types which form a temporal sequence and which thus provide concrete and objective evidence of the gradual transformations which have been postulated on the basis of indirect evidence to have led to the evolution of a whole series of types from a common ancestral stock.

EVIDENCE THAT MAN IS THE PRODUCT OF AN EVOLUTIONARY PROCESS

These different lines of evidence for evolution, which have been briefly listed above. are applicable to man as well as to other types of mammal, and some of them may now be considered in this particular context.

Comparative Anatomy.—Anatomically speaking, *Homo sapiens* belongs to the mammalian order of the Primates. This classification carries the implication that, in common with other representatives of the order, he belongs to a natural group whose members have become gradually diversified during the course of evolution from a common ancestral stock. The living Primates are characterized (and distinguished from other groups of mammals) by the fact that they have avoided structural specializations of an extreme type. Rather, they have preserved a somewhat generalized structure which confers on them a very considerable degree of functional plasticity. The order can be defined on the basis of the prevailing tendencies which have dominated its evolutionary development, and which include the following: the preservation of a generalized structure in the limbs associated nith a free mobility of the digits (especially the thumb and big toe) and the replacement of sharp compressed claws by flattened nails; the elaboration of the visual powers and a corresponding reduction in the apparatus of smell; and the progressive development of a large and complicated brain. In the Hominidae these same tendencies have manifested themselves and (particularly in the expansion of the brain and the reduction of the jaws) have advanced much further than in other Primates; this zoological family also shows a unique specialization in the "hind limbs." for the latter have become transformed into "lower limbs" for supporting the rest of the body in the erect position, while the mobility of the foot and toes (so characteristic of the Primates in general) has become secondarily lost. The justification for the inclusion of the Hominidae in the order Primates is not only based on these general considerations, it is still further emphasized by a detailed anatomical comparison with some of the other members of the order.

The Primates that exist today comprise a rather remarkable gradational series which serve to link Homo anatomically uith small mammals of a very primitive type. The most lowly representatives of the living Primates are the tree shrews, small squirrel-like creatures which have a wide distribution in southeast Asia. So primitive are the tree shrews that some authorities are reluctant to include them in the Primates. But even these authorities would also agree that they are at least very closely related to the ancestral stock from which the Primates in general have been derived in their evolutionary history. The fact is that in many of their anatomical characters the tree shrews show such a close resemblance to undoubted Primates (*e.g.,* some of the lemurs) as to amount in certain details to an identity of structure. The lemurs, again, show in their more advanced anatomical structure a mixture of characters which indicate an intermediate position between tree shrews and monkeys. The curious little tarsier (which inhabits Borneo and the Philippines) is in some respects even more monkeylike. The various types of tailed monkeys represent a still higher grade of organization and, through the small gibbon, are linked with the large, tailless anthropoid apes, the chimpanzee, orangutan and gorilla. As their colloquial name implies, these anthropoid apes are very "manlike" in their anatomical structure. Their brain, although much smaller than a modern human brain, is relatively well developed as compared with lower Primates. It also shows the same pattern of convolutions as a human brain (though in a simplified form), and the similarities in many details of its intrinsic structure (including the cerebral cortex) are astonishingly precise. These anatomical resemblances in the brain have been found by experimental observation to be correlated with physiological similarities. Thus, the sensory and motor mechanisms fulfil functions which so closely reproduce those of the human brain that for experimental studies anthropoid apes have been found to be far more reliable than any other mammal in their application to problems of cerebral function and dysfunction in man. Many features of the skull and skeleton of the large apes approximate very closely to those of the Hominidae, particularly if account is taken of certain primitive hominids which are now extinct. Some of the structural similarities in the skeleton of the trunk and limbs are in part related to posture, for the chimpanzee and gorilla are capable at times of balancing themselves on their hind limbs in a manner which suggests an approach (though a rather distant one) to the erect posture which is so characteristic of the Hominidae. In their dentition, particularly in the molar teeth, the anthropoid apes also show a close resemblance to the Hominidae. Indeed, it may sometimes be a matter of considerable difficulty to determine whether certain isolated fossil molar teeth belong to apes or hominids, for the distinctions which exist between the teeth of apes and man are in general far less obtrusive when fossil types are considered. Many of the muscles of the human body have the same disposition and attachments as those of the anthropoid apes.

For example, it is particularly noteworthy that in the sole of the human foot the same muscles are found which are used for the mobile functions of the ape foot, even though in man this mobility has been lost. The disposition of the thoracic and abdominal viscera in apes corresponds quite closely with that of man, and even in their microscopical details some of the organs of the body show a remarkable resemblance. These examples of anatomical and physiological similarities between the large anthropoid apes and the Hominidae could well be multiplied, and their implications for a real phylogenetic relationship are further supported by reference to similarities in the serum precipitin reaction of the blood. the similarity of some of the blood groups, similarities in parasitic infestation and in susceptibility to certain diseases and so forth.

So far as anatomical resemblances are concerned, it was stated many years ago by T. H. Huxley that "Whatever system of organs be studied, the comparison of their modifications in the Ape Series leads to one and the same result—that the structural differences which separate Man from the Gorilla and Chimpanzee are not so great as those which separate the Gorilla from the lower Apes" (by "loner Apes" Huxley was referring to the catarrhine monkeys). This proposition was subsequently labelled by E. H. Haeckel the "pithecometra thesis," an unfortunate term since it might have been taken to imply that the degrees of structural differences between man, anthropoid apes and lower Primates were capable of expression in strictly quantitative terms. But, though it is possible to express quantitatively individual measurements considered as isolated abstractions, or even combinations of measurements by the technique of multivariate analysis, it is not yet possible with present knowledge to give a quantitative value to different morphological characters according to their relative taxonomic importance for the assessment of degrees of phylogenetic relationship. Thus, while it is possible to state that in certain of its dimensions, or in the degree of complexity of some of the cerebral convolutions, the anthropoid ape brain is morphologically closer to the human brain than it is to the brain of catarrhine monkeys, it is not feasible to state in quantitative terms just how much more closely the ape brain *as a whole* resembles the human brain. Still less is it possible. of course, to state in quantitative terms how much more closely in his anatomical structure as a nhole man resembles the large anthropoid apes than the latter resemble the catarrhine monkeys. Another difficulty arises from the fact that, so far as concerns the soft structures of the body which are not preserved in fossils, it is of course possible to compare only *modern* apes with *modern* man (*i.e., Homo sapiens*); in other words, in respect of these components of their anatomy it is not possible to include extinct types and thus to compare the anthropoid ape family as a whole with the Hominidae as a whole. However, with the data of comparative anatomy of living types and those so far available of extinct types (known from fossil remains), it can be affirmed that, on purely morphological criteria, the Hominidae show closer affinities with the anthropoid apes than with any other group of mammals. and with increasing accessions to the fossil record the morphological boundary line bet een the two families is becoming more and more difficult to define.

Notwithstanding the numerous structural resemblances between the Hominidae and the large anthropoid apes, there are, of course, quite pronounced differences which (as already noted) are mainly related to the size of the brain and the adaptations to an erect posture and gait, as well as certain characteristic features of the dentition. These differences (and certain others) have from time to time been stressed by those who claim a certain uniqueness for *Homo sapiens* as a biological species and argue therefrom that the phylogenetic sequence of which he represents one of the terminal products must have had an extremely long history of evolutionary independence. Indeed, some have gone as far as to claim that most of the anatomical resemblances between man and apes are the result of evolutionary parallelism or convergence, and that the phylogenetic relationship between the two is far more remote than is commonly supposed. But there is little doubt that the significance of the morphological differences has been grossly exaggerated, for, in fact, they are no greater than equivalent differences ahich are to be found in many other groups of mammals known from the fossil record to be by no means very distantly related. Anatomically speaking, *Homo sapiens* is unique among mammals only in the sense that every mammalian species is in some features unique among mammals. The results of the study of comparative anatomy can be fairly summed up by the statement that, in morphological characters, the Hominidae are not sharply separated from other Primates by any major feature of either a quantitative or qualitative kind, and it is a reasonable assumption, therefore, that this zoological family like other zoological species is the product of an evolutionary process.

Embryology. — The evidence from comparative anatomy for the evolutionary origin of man receives further support from the study of ontogenetic development. As is well known, each individual begins his existence as a single (fertilized) cell, the ovum. This becomes converted into a mass of cells as the result of progressive division and multiplication, the mass of cells undergoes a gradual differentiation to form the various tissues, and the tissues become gradually moulded into all the definitive organs of the body. This whole process of ontogeny in some sense reflects the evolutionary history of the individual, but also, apart from such considerations, it is quite clear that it has a very direct bearing on the conception of human evolution as a whole. For it may well be argued that if man as an individual, with all his unique qualities of mind and spirit, can come into being as the result of the proliferation and differentiation of a single cell of microscopic dimensions, there can be no possible philosophical objection to the main thesis of evolution that mankind as a whole has come into existence as the result of a progressive evolutionary development initiated in the primary stage of a simple unicellular organism and passing through successive stages leading from simple multicellular organisms to organisms of an increasing complexity of organization. The suggestion that, in a modified form, ontogeny repeats phylogeny has been termed "recapitulation. But here it is necessary to avoid misconceptions by emphasizing that this does not mean (as it is sometimes popularly supposed to mean) that the successive stages of embryonic development in any way represent the mature forms of successive stages of the evolutionary history of the individual. It means only that, broadly speaking, in his ontogeny the developmental stages through which man passes reproduce the embryonic form of certain ancestral types. It is a fact, for example, that in the early human embryo a foundation of gill arches is laid down in the neck region, precisely similar to that which, in fishes, finally leads to the establishment of functional gills. But in the human embryo (as in the embryos of other mammals) the elements of these gill arches become completely reorganized so as to form not the gills for which it seems certain they were originally intended in past evolutionary history but quite different structures such as the skeleton of the larynx, muscles of the face and so forth. This transformation of the gill arches involves a most remarkable rearrangement of skeletal elements. muscles, nerves and blood vessels, and it seems impossible to explain such a profound modification unless it is supposed that the gill arches have been inherited from a remote ancestor of fishlike form. Some of the skeletal elements, for example, become displaced from their original position and rearranged to form the small ossicles of the middle ear through which sound vibrations are conducted to the cochlea, and it is particularly interesting to note that structural stages demonstrating this transformation have actually been followed in the fossil record of mammalian evolution. Examples of similar kinds of transformation in ontogenetic development are to be seen also in other systems of the human embryo. For example, the muscles of the trunk are at first laid down in a regular segmental arrangement as they are in the adult form of primitive vertebrates, and subsequently become rearranged to form the definitive pattern of musculature characteristic of the human adult. The early human embryo shows a distinct, projecting tail, but this becomes secondarily withdrawn into the pelvic cavity to be represented finally by degenerate vertebral elements which form the coccyx. The heart is not laid down de *novo* with the four chambers which are characteristic of the mammalian heart; the partitioning takes place secondarily, so that for a time in the human embryo the heart is constructed on the same plan as that of lowly vertebrates. The formation of the definitive kidney is preceded by the appearance of kidney tissue corresponding to that which becomes functionally mature in lower vertebrates; but in the human embryo this tissue only puts in a transitory appearance and in the course of development disappears again. The arteries of the limbs are at first disposed in a pattern similar to that of lower vertebrates, but this pattern subsequently becomes rearranged in a new pattern which is functionally more suitable for limbs of human structure. The fact that in the development of the human embryo the various tissues and organs do not proceed directly to the patterns of organization adapted to the functional requirements of the mature individual, but follow (as it were) a circuitous route which leads them through stages of development characteristic of lower forms of life and which involves the "scrapping" of many temporary structures so that the latter can be replaced by structures of a very different pattern—all this obviously provides very strong additional evidence in support of the thesis of man's evolutionary origin from lower forms of life.

Vestiges. — The functionless remnants of vestigial structures normally found in the human body, or relics which appear occasionally in individuals as abnormalities, are also explicable only on the assumption that Homo sapiens has an evolutionary past. Reference has already been made to the vestigial remains of a tail which are represented by the small nodules of bone which form the coccyx, and it is interesting to note that in relation to the latter even some of the caudal musculature has persisted in a rudimentary or modified form. The human ear has attached to it a number of muscles whose existence is very difficult to understand unless it is assumed that they are the relics of muscles which controlled the movements of a mobile ear in some ancestral stage of evolutionary development. The canine tooth is often sharply pointed and projects beyond the level of the adjacent teeth, and it is provided with an unusually strong root; this, again, is explicable only if we suppose that in some ancestral stock the canines were used for the special functions which they commonly have in lower mammals, for in modern man these teeth have no special functions to perform. In the routine examination of the human cadaver by dissection (in medical schools) it is by no means uncommon to find the remains of abnormal muscles which are not normally present in the human body; but they may be normally found in lower Primates in which they are required for particular activities such as those associated with arboreal life. An example of this is the dorsi-epitrochlearis muscle which extends down the inner side of the arm and which is normally present in the lower Primates. The occasional reappearance in the human body of an anatomical structure which was presumably present in an ancestral form is termed an atavistic variation. It is an example of the astonishing conservatism of morphological elements as the result of which the genetic basis of the latter may persist for millions of years after they have ceased to be of any real functional importance.

Human Genetics. — The study of hereditary traits by the analysis of pedigrees has demonstrated that the mechanism of hereditary transmission is the same in man as in other mammals and that the ultimate basis of mutational variations is similar in its genetic organization. In other words, there is no reason for doubting that these variations arise as the result of alterations in the gene complex of the chromosomes precisely as they do in other animals, and that in the same way they provide the raw material for evolutionary modifications under the influence of selection. Some of the characteristic differences which distinguish the various races of mankind, such as skin pigmentation and hair form, are apparently based on genetic differences which are by no means simple, for they depend on the interaction of a number of genes. It should be emphasized that the study of human genetics is a peculiarly difficult one, and the genetic analyses of racial traits are still very incomplete.

Geographical Distribution of Human Races and Adaptive Racial Characters — Homo *sapiens* is a polytypic species; that is to say, it comprises a number of different geographical varieties or subspecies which are commonly termed the races of mankind. As is well known, the major races have a fairly well-defined geographical distribution, the Caucasoid or White peoples in the European area, the Mediterranean type extending from southern Europe and northern Africa through southwestern Asia into India, the Australoid people in Australasia, the Negroids in central and southern Africa, the Mongoloids in eastern Asia and the American continent, and so forth. This type of geographical distribution is most easily explicable on the basis of an evolutionary diversification following the migration of representatives of a common ancestral stock to different parts of the world. Such migrations would lead to geographical segregation and genetic isolation which in the course of time have provided the opportunity for structural modifications in adaptation to different environments. For example, the Australian aboriginals have distinctive characters which presumably became stabilized during a long term of isolation in Australasia following a migration from southeastern Asia, where certain peoples are still found (*e.g.,* the Veddas of Ceylon) which show similar characters but in a less extreme form. Again, the highly characteristic features of the Negroids must have developed during a period of isolation — probably in central Africa. That natural selection has played an important part in the evolutionary development of racial characters may be inferred from the fact that some of these can be shown to be directly related to particular environments. Thus, the dark pigmentation of some of the tropical peoples provides a protection against exposure to strong sunlight; the width of the nose is closely related to the prevailing temperature and humidity and almost certainly has an important physiological significance in respiratory functions; and the type of bodily physique (*e.g.,* the contrast between races of long, lanky physique and those of short, stocky build) can also be correlated with environmental differences. Observations of this sort are consistent with the hypothesis that the different races of mankind, like the different varieties of animal species generally, are the product of a gradual process of evolutionary diversification.

RELATIONSHIPS OF THE HOMINIDAE

Even the antievolutionary biologists of past days classified man as one of the Mammalia, but they emphasized his apartness by placing him in a separate order, or even a separate subclass, of mammals. This distinction was influenced by the general view held at that time that man is the product of a special creation and unique in characters other than those of a purely anatomical or physiological kind. But while it may be readily conceded that modern man has such unique qualities. it has to be recognized that the problem of his zoological classification and phylogenetic relationships. as in the case of the Mammalia in general, is primarily a morphological problem and must be approached on a morphological basis. The intensive studies of comparative anatomy after the beginning of the 20th century, together with the evidence of the fossil record that accumulated later, made it clear that the Hominidae (*i.e.,* the zoological family which includes not only Homo *sapiens* but also his extinct precursors) are more closely related to the anthropoid ape family (Pongidae) than to any other group of Primates. This view was expressed in the now generally accepted scheme of classification which includes both the Hominidae and the Pongidae in a common superfamily, Hominoidea, and thus contrasts them both with the catarrhine monkeys which comprise the superfamily Cercopithecoidea. Some systematists would go even further in this taxonomic approximation of the two groups by including them in the same zoological family, but so far this view has found but few adherents.

If the taxonomic approximation of the Hominidae and the Pongidae in a common superfamily represents a natural classification, the assumption follows that these two families have ultimately been derived from a common ancestral stock by an evolutionary process of divergent modification. And, if this is so, it might be expected that, in tracing back the ancestry of the two groups in the fossil record, the morphological distinctions between the two would be found to become less and less obtrusive. This, indeed, is the case, for we now know from fossil material that the geologically earlier representatives of the Hominidae approximated much more closely to a simian level of development than modern man, while the earlier representatives of the anthropoid ape family. in so far as they had not at that time developed all the specializations characteristic of the modern apes, showed a lesser degree of morphological divergence from the Hominidae.

PALAEOANTHROPOLOGY

Palaeontology, or the study of fossils, provides the really crucial evidence for the evolution of the Hominidae in the past. For. however extensive and compelling it may be, the evidence for evolution based on the study of creatures living today can be only indirect evidence. Direct evidence, on the other hand: must depend on the actual demonstration from the fossil record of a succession of transitional stages representing the transformation in geological time of an ancestral into a descendant type. It may perhaps be put this way: The evidence from comparative anatomy of living forms, together with the geographical distribution of local species and varieties which exists today, suggests that evolution *might* have occurred. The evidence provided by a study of the process of natural selection, experimental genetics, population statistics and so forth establishes quite clearly that the machinery exists whereby evolution *could* have occurred. But that evolution did occur can be scientifically established only by the discovery of the fossilized remains of representative samples of those intermediate types which have been postulated on the basis of indirect evidence. The field of palaeontology which is related to the study of the origin of man is termed palaeoanthropology. It is concerned not only with the actual fossilized remains of early representatives of the Hominidae and of those groups of extinct Primates from which this family may have been derived, but also with the relics of the cultural activities of ancient man and the nature of the environment in which he lived. Here, however, attention will be confined almost entirely to the evidence of skeletal remains. Broadly speaking, the main features of the evolutionary succession of the Primates are now known from the fossil record. and they conform in a remarkable way with inferences already reached by a consideration of the scale of living Primates as they exist today (*see* above). At the beginning of the geological era called the Tertiary period—that is to say, about 70,000,000 years ago—there were in existence the most primitive of the Primates, small tree shrewlike creatures called the Plesiadapidae. So primitive are their anatomical characters that it might be impossible to determine that they actually were Primates but for the fact that they mark a gradation toward more highly organized creatures which definitely come within the category of Primates as these are ordinarily defined. Early in the Tertiary period, during the Palaeocene and Eocene, more advanced Primates appeared which belong to the same zoological groups as the modern lemurs and tarsiers. Somewhat later, in the Oligocene (probably about 45,000,000 years ago), there came into existence primitive monkeys and exceedingly primitive anthropoid apes. In the succeeding Miocene (30,000,000 years ago or so). anthropoid apes of a generalized type appeared in great diversity in different parts of the world, and their remains have been found in considerable quantity in East Africa, Europe and India. Some of these early types, so far as can be ascertained from teeth and jaws and fragmentary limb bones, might possibly have provided the basis for the evolutionary origin of the Hominidae, but the fossil evidence is still too meagre to make possible any positive conclusion on this question. The earliest hominids so far known date from near the beginning of the Pleistocene (about 1,000,000 years ago), but the fact that these ancient types were already well advanced along the direction of hominid evolution makes it certain that still earlier representatives of the Hominidae must have existed in the preceding Pliocene period. Here there is a conspicuous gap in the fossil record which still remains to be filled by future discoveries.

ESTIMATION OF GEOLOGICAL ANTIQUITY

Before the evolutionary history of man, so far as this may be determined by the examination of fossil remains. is traced back in further detail: it is desirable to say something about the geological changes which marked the passage of time in the Pleistocene period. As already noted, the Pleistocene period of geological time may be regarded as having started about 1,000,000 years ago. The date of the transition from the Pliocene to the Pleistocene period is no more than an arbitrary point of time, and geologists have not found it easy to agree on the definition of this arbitrary point. Broadly speaking! it was marked by the gradual onset of a cooler climate in many parts of the world; and the general lowering of the temperature finally led to the Great Ice Age during which, in the temperate zones, ice caps and glaciers, originating on high levels, spread out for considerable distances over lowlands. This process of glaciation was a recurrent phenomenon which extended throughout most of the Pleistocene period, and it is now generally agreed that there were four main glacial periods, of varying duration and different degrees of severity, separated by interglacial periods during which the climate became warmer and in some cases (even in Europe) almost subtropical. Evidence of the successive glaciations can be detected by study of the characteristic geological deposits left by melting ice and so forth, and also by reference to the fossil remains of the arctic or subarctic types of animals and plants which inhabited the neighbourhood of the glaciated regions. By the determination of the rhythmical succession of glacial and interglacial phases during the Pleistocene period, geologists have been able to provide a time scale by reference to which it is possible to infer the relative antiquity of the fossil remains of prehistoric hominids or of the stone implements which they left behind. For if the deposits laid down during the successive glacial and interglacial periods can be placed in a regular temporal sequence on purely geological evidence, any fossils found in these deposits can likewise be placed in their proper sequence. It may be noted, also, that even in those parts of the world (*e.g.,* equatorial regions) where there was no actual glaciation, climatic fluctuations of a different type occurred, for in those regions there was a succession of alternating rainy and dry periods. There is some evidence that these pluvial and interpluvial phases can be equated with the glacial and interglacial periods in the northern and southern hemispheres, a matter of importance for determining the time relationships of fossil hominids found in widely separated parts of the world.

The recurrent glaciations in Europe and elsewhere were accompanied by considerable falls in the sea level. and this had a profound effect on the formation of river valleys. With the fall in sea level the erosive power of the rivers was increased so that they cut their valleys deeper. On the other hand, with the rise in sea level during the interglacial periods the rivers flowed more sluggishly and laid down stratified deposits of gravel and sand, etc., over their alluvial plains. As the result of these alternating periods of erosion and deposition, series of terraces were formed along the river banks, and it is in these river terraces that some of the oldest remains of Palaeolithic man and his stone implements have been found. The time relationship of the terraces to the rhythmic succession of glaciations has been worked out in some detail by geologists. and it is largely on this basis that the relative antiquity of the fossils which they contain can be established.

The relative age of fossils may be determined by purely geological data — that is to say, it may be inferred from the stratigraphical level of the deposit in which the fossils are indigenous— and in the case of skeletal remains embedded in sedimentary formations which have been deposited layer by layer under the influence of agents such as running water or in stalagmitic formations in caves, the more ancient fossils are found in the deeper layers and vice versa. As has been noted, these deposits in some cases can be assigned to one of the several glacial or interglacial periods, and a relative dating can thus be obtained in relation to the rhythmical succession of climatic changes which characterized the greater part of the Pleistocene. Another method depends on the analysis of the fluorine content of fossil bones. The fluorine content increases with geological age, for by a process of ionic interchange this element is slowly taken up from the soil and becomes fixed in bony tissue in the form of a very stable compound, fluorapatite. The amount of fluorine in a fossil bone thus increases with time and gives an indication of the period over which it has lain in position in a particular deposit. However, the amount of fluorine taken up also depends on the amount of fluorine in the soil, and it does not therefore permit a comparison of the relative antiquity of fossilized bones derived from different deposits in which the fluorine content of the soil may vary widely. But in a case where in the same geological deposit a hominid skull is found in association with the remains of extinct mammals of known antiquity, the fluorine test may provide evidence of the utmost importance for determining whether they are all contemporaneous or whether the hominid remains may be the result of (say) an artificial interment at a much later time. A further method, the radiometric method, depends on the observation that fossil bones and teeth often show some degree of radioactivity, a result of the gradual absorption of uranium from percolating ground waters, and the degree of radioactivity of a fossil therefore depends partly on its geological age. But it also depends on the permeability of the deposit in which the fossil lies and on the uranium content of the percolating waters in past ages. Thus, like the fluorine test. the radiometric assay is of value only for determining the relative age of fossils found in the same or strictly equivalent geological formations.

The absolute antiquity of a fossil in terms of years can be determined only rarely with the methods at present available. One of these methods depends on the estimation in organic material of the relative quantities of radioactive carbon (C^{14}) and ordinary carbon (C^{12}), of which the former is an isotope. Radioactive carbon is assimilated into the substance of living organisms from the atmosphere (directly or indirectly), and at death it undergoes a gradual disintegration at a known rate. The proportion of radioactive carbon thus progressively diminishes in dead organic material in proportion to its antiquity, and it is estimated that after a period of 5,600 years the ratio of radioactive carbon will have dropped to half the value found in living material. With modern techniques, the accuracy of the method is limited to estimations of a period of not more than about 50,000 years. Lastly, reference should be made to the method of varve analysis — that is. a method which depends on counting the annual layers of deposits (varves) laid down seasonally by the melting of the glaciers as they gradually receded at the end of the Ice Age. But this method is applicable only for the determination of the rate of climatic change in the final stages of the Pleistocene period, and the estimations based on it are complicated by the fact that the varves may not always be strictly seasonal in their sequence.

ANTIQUITY OF HOMO SAPIENS

The biological species *Homo sapiens* (of which the modern human races comprise a number of different subspecies or geographical varieties) is defined in terms of the anatomical characters which all its members possess in common. So far as prehistoric representatives of the species are concerned, the definition must necessarily be limited to skeletal characters, for such individuals are to be identified only by their bony remains. The definition of H. *sapiens* (which will not be given in detail here) includes such features as a mean cranial capacity of about 1,350 c.c., an approximately vertical forehead, a rounded occipital region of the skull with a relatively small area for the attachment of the neck musculature, jaws and teeth of reduced size, small canine teeth of spatulate form, the presence of a chin eminence. limb bones adapted to the mechanical requirements of a fully erect posture and gait, and so forth. Any skeletal remains of ancient man which conform to this morphological pattern, or which do not deviate from it to an extent comparable with that which is accepted as adequate for specific distinctions in other groups of higher Primates, must be assumed to be those of some variety of *H. sapiens.* It is necessary to emphasize this rather obvious point, for in the past there was a most unfortunate tendency to create entirely new species of *Homo* on the basis of fragments of prehistoric human skeletons, even though it might not be possible objectively to demonstrate any significant difference from modern man. This tendency was no doubt partly the result of subjective impressions influenced simply by the supposed antiquity of the remains, or of a failure to realize how variable some features are even in modern *H. sapiens.* One of the best examples of this kind of fallacy is the famous Galley Hill skeleton. which was discovered in 1888 in the Thames valley and was supposed to be of very great antiquity. Some anatomists persuaded themselves that they could recognize very primitive features in this specimen. particularly in the shape of the lower jaw. Moreover, an apparently exhaustive study of the thighbone, involving an elaborate statistical comparison of a number of measurements and indices, even led to the conclusion that it was quite distinct from modern man. But in later years it was determined, largely as a result of the analysis of its fluorine content, that the Galley Hill skeleton was a burial of comparatively recent date — perhaps the remains of a Neolithic man or possibly even a later interment. How is this discrepancy of evidence from the statistical side to be explained? This is rather an important question, for statistical tables (particularly to anyone who is not a statistical expert) are apt to convey an impression that conclusions based on them are final and indisputable. But it has come to be realized that the application of statistical methods to the study of zoological relationships of fossil remains is open to rather serious fallacies, depending on the statistical methods used, on the actual number of measurements taken, on whether the measurements compared are really strictly equivalent in the morphological sense, on whether they are taxonomically relevant and so forth. It has also been demonstrated that if the individual characters and measurements of a bone or a tooth are compared independently one by one, as isolated abstractions. instead of in their totality as integral components of a total pattern (which can be done by the very complicated method of multivariate analysis), entirely different and sometimes very misleading conclusions may be reached. In the case of the Galley Hill thighbone, the answer is fairly simple, for in the statistical study of this bone comparison was made with only a very limited sample of modern thighbones, and it seems to have been assumed that these could be taken as representative of H. *sapiens* as a whole. But obviously the comparison must be made with adequate samples of all the main varieties of *H. sapiens* before it can be legitimately concluded that there is a distinction from "modern man."

If the history of mankind is traced back beyond the ages of metal into the Neolithic period, a period which began about 7,000 years ago, it is found from the numerous examples of the skeletal remains which have been excavated that these show no significant difference from modern man. Indeed, much of the Neolithic population in Europe was probably indistinguishable from the modern types of European which inhabit the Mediterranean area. Still further back in time. in the latter part of the Palaeolithic period, the human remains discovered are also those of H. *sapiens.* This is the case. for example, with the Magdalenian period, which lasted during the terminal stages of the last glaciation of the Ice Age and which is sometimes referred to as the "Reindeer period" for the reason that reindeer were characteristic of the local fauna at that time. The Magdalenian people were very skilful in the production of a great variety of beautifully made flint implements and also instruments of bone, ivory and reindeer antler. They are also noted for their mural art, represented in cave paintings of great artistic merit which have been found chiefly in the caves of southern France and northern Spain. In some of the most famous of these caves. those at Lascaux in the Dordogne region of France, pieces of charcoal were found which are believed to be contemporary with the paintings, and a sample tested by the radioactive carbon method gave a dating of about 15,000 years ago. The Magdalenian period was preceded still earlier in Europe by the Aurignacian period of Palaeolithic culture, and as is known from a number of skulls and skeletons of the Aurignacian people these were also of modern type. Moreover, although in many respects they were culturally inferior to the succeeding Magdalenian people, they had already developed a fairly complex civilization. Now, the geological evidence indicates that the Aurignacian period, at a conservative estimate, could hardly be less than about 20,000 years old. and if men of modern type had already developed well-organized communities with an elaborate culture in Europe at this early date the presumption is that. as a zoological species, H. *sapiens* must have been in existence considerably earlier. There is indeed palaeontological evidence for this inference. But before some of the evidence for the earlier existence of H. *sapiens* in Europe is considered, the fossil evidence of his wanderings in other parts of the world may be briefly referred to.

Several remains of early man, some unfortunately very fragmentary, have been discovered in Africa, which can with reasonable certainty be assigned to a cultural stage equivalent to the Upper Palaeolithic of Europe. In all cases these remains appear to be indistinguishable from H. *sapiens.* One skull, found at Florisbad in South Africa, is of particular interest, for it was embedded in deposits containing layers of peat, and a sample of the peat closely associated with the skull was used for dating by the radioactive carbon method. According to this estimate the peat was probably deposited at least 40,000 years ago, and it has therefore been inferred that the skull is of like antiquity. In the far east, Upper Palaeolithic remains of H. *sapiens* were reported from cave deposits near Peking, associated with a stone culture corresponding to the Aurignacian or Magdalenian in Europe. In America remains of the species also were described from deposits which were dated on geological evidence to the terminal part of the last glaciation, and the antiquity of this was estimated in a very general way at 10,000 years more or less. One well-preserved skull found at Tepexpan in Mexico was assigned to such an antiquity, and this may well prove to be justified, for the radioactive carbon dating of organic material from an overlying deposit (which must have been laid down long after the skull was in position) gave an antiquity of certainly more than 4,000 years. There are two other relevant carbon datings which indicate an antiquity for *H. sapzens* in America of at least 10,000 years; one of these was based on the analysis of charred bison bones associated with stone implements of the Folsom type (in Texas) and the other on the analysis of woven rope sandals found in Oregon buried beneath pumice deposited by a prehistoric eruption.

From this short account, it is evident that H. *sapiens* had spread over most parts of the world at a very remote time, carrying with him types of Palaeolithic culture which provide evidence of their common origin while at the same time showing local differentiations. It is unfortunate that the place of their origin is not yet certainly known, for this might give a useful clue to the geographical area of origin of the species. Various claims have been put forward on behalf of one area or another, mainly on the basis of fossilized skeletal remains which have been assigned to an antiquity far greater than is known in other regions of the world. But the evidence for this supposed greater antiquity has not in all cases been sufficiently convincing. So far as Europe is concerned, there is good evidence that primitive types of H. *sapiens* were already in existence before the last glaciation of the Ice Age—that is to say, during the last (or third) interglacial period —and this could hardly have been less than 50,000 years ago. Examples of such early representatives of the species have been found at a number of different Palaeolithic sites (*e.g.,* Fontéchevade, Ehringsdorf, Krapina, Saccopastore, etc.). Some of these skulls are very fragmentary, and although some show an accentuation of certain primitive features, such as strongly developed brow ridges, this is not the case in all the specimens. The significance of these features tends to be overemphasized if comparisons are made only with modern European skulls, but they appear far less obtrusive when compared with the other varieties of modern H. *sapiens* such as the Australian aboriginal. and they are not sufficiently marked to warrant a taxonomic distinction from this species. There are at least two fossil specimens identifiable as H. *sapiens* which date back to the second interglacial period—an almost complete skull from Steinheim. Ger.. and a very fragmentary skull from Swanscombe, Kent. Eng. Because of their importance for determining the antiquity of the species, further reference to these two fossils is desirable. The Steinheim skull was discovered in 1933 near Stuttgart in interglacial gravels containing remains of extinct mammals such as *Elephas antiquus* and *Dicerorhinus merckii.* There had been some doubt whether these gravels were laid down in the second or third interglacial period, but later studies make it reasonably certain that they belong to the older of these two phases. The skull has rather a low cranial capacity (1,100 c.c.), but the latter comes well within the range of modern man. The brow ridges are strongly developed, but it is doubtful whether they exceed in size those occasionally to be found in some of the modern races of mankind. The anatomical evidence of the skull as a whole, indeed. permits the inference that it may be attributed to a primitive type of H. *sapiens.* The Swanscombe skull consists of only two of the cranial bones. the left parietal and the occipital. both of which are exceptionally well preserved. They were discovered in 1935 and 1936, 24 ft. below the surface in well-stratified gravels forming part of the 100-ft. terrace of the Thames. These are definitely interglacial deposits, and the associated fauna includes *Elephas antiquus, Dicerorhinus megarhinus* and *Megaceros.* Also associated with the skull bones were found flint implements which can with certainty be assigned to the Middle Acheulean hand-axe industry. The geological, archaeological and faunal evidence is all consistent with the conclusion that the skull bones date back to the second interglacial period. Finally. this received confirmation from an analysis of the fluorine content of the bones and of their radioactivity. A most detailed anatomical and biometrical study of the bones (and of the endocranial cast) failed to show any feature in which they could be distinguished from the corresponding bones of modern human skulls. It was inferred, therefore, that they provide unusually convincing evidence of the existence of H. *sapiens* in the second interglacial period, a period to which conservative estimates based on geological considerations give an antiquity of not less than 100,000 years. While this inference regarding the antiquity of the Snanscombe skull bones may be provisionally accepted, it should be regarded as no more than a provisional inference pending the accession of further and more complete material. But, taken with the evidence of the Steinheim skull, it does at least indicate a high degree of probability that the species H. *sapiens* has an antiquity of this order.

NEANDERTHAL MAN AND NEANDERTHALOIDS

It is known from many fossilized remains discovered in different parts of Europe that there existed during the first phase of the last glaciation a rather peculiar type of the genus *Homo* commonly known as "Neanderthal man," and it is generally accepted that the type is referable to a distinct species. *H. neanderthalensis.* In the early days of palaeoanthropological discovery, H. *neander-*

thalensis was commonly assumed to represent the ancestral type from which *H. sapiens* was derived in late Pleistocene times. This assumption was based partly on morphological arguments; for in a number of features, such as the flat and retreating forehead, the low height of the cranium, the massive brow ridges, the robust and chinless jaws, the large teeth and so forth, the skull of Neanderthal man certainly presents a somewhat simian appearance. But the accumulation of further discoveries made it clear that these apparently primitive features are secondary—the result of a "retrogressive" evolution from still earlier types which (as seen above) do not appear to be specifically distinguishable from H. *sapiens.* The brain was, surprisingly, rather large, for the mean cranial capacity actually exceeded that of modern human races. Neanderthal man was contemporaneous with the latter part of the Mousterian period of Palaeolithic culture, and his remains have been found at various sites in Europe (*e.g.,* in France, Germany, Italy and the U.S.S.R.) as well as in North Africa and Palestine. The species evidently disappeared from Europe rather abruptly after the climax of the last glaciation, when he was replaced by an Upper Palaeolithic population of completely modern type. It is probable that, with the first recession of the ice following the last glaciation, Europe was invaded (probably from some region in the near east) by the more highly cultured Aurignacian people and that the latter displaced and exterminated H. *neandertlzalensis.*

Remains of early man have been found in Java, Rhodesia and South Africa which in the general appearance of the skull show a strong resemblance to H. *neanderthalensis,* and by many authorities they are regarded as geographical variants of this species. However, they show differences in certain morphological details, so that their taxonomic relationships are somewhat doubtful. For this reason they are commonly referred to by the rather informal term "Neanderthaloid." The remains from Java were found in terrace deposits related to the river Solo and are of Upper Pleistocene date (probably corresponding in time to the last glaciation). They consist of 11 skulls (all lacking the facial skeleton) and two shinbones. In the heavy brow ridges, the thick cranial walls and the flattened skull vault they approximate closely to H. *neanderthnlensis.* On the other hand, the cranial capacity was smaller, and the shinbones are similar to those of H. *sapiens.* The Rhodesian fossils were found in the course of open-cast mining of lead and zinc ores at Broken Hill in Northern Rhodesia and consist of a skull (almost complete except for the mandible), a maxillary fragment, a sacrum and portions of the pelvis and limb bones. The skull is of unusually massive appearance, with huge brow ridges, a strongly retreating forehead and a large palate. The sacrum. pelvis and limb bones. on the other hand. are not distinguishable from those of H. *sapiens* and show none of the features commonly regarded as characteristic of *H. neanderthalensis*. The artifacts found with these remains indicate an Upper Pleistocene date. A second skull of the Rhodesian type (almost identical in its cranial features) was later discovered at Hopefield, north of Cape Town. and from the geological evidence it probably somewhat antedates the Rhodesian skull. The significance of "Solo man" and "Rhodesian man" in the problem of human evolution is uncertain. If these types represent variants of Neanderthal man, it must be assumed that the latter wandered widely over the earth's surface. It has also been postulated that they represent local developments in the areas where their remains were found, and that they were either aberrant types which became extinct or they provided the ancestral stock from which the Australoid and Negroid races of modern mankind were derived. However, there is no convincing evidence for this last view, and in any case it would appear that they existed too late in time.

If we accept that, on the fossil evidence so far available. H. *sapiens* certainly extended back to the third and almost certainly to the second interglacial period, the question now arises—is there any evidence that he existed anywhere on the earth at a still earlier date? In spite of reported discoveries for which a greater antiquity has been claimed, the answer to this question in the later 1950s still remained entirely negative. If the term "man" is taken to connote toolmaking hominids, then it is correct to say that man has been in existence since at least the early part of the Pleistocene period—that is to say (on the basis of indirect geological evidence) 500,000 years ago or more—for his stone implements have been recovered in great numbers from deposits going back to this remote time. The advanced culture of Aurignacian times was preceded by more primitive cultures termed the Mousterian and Levalloisian, and these again were preceded by populations which were responsible for the Acheulean hand-axe industry. The latter persisted into the last interglacial period in Europe, but it extended back through the whole length of the prolonged second interglacial period, a matter of many thousands of years. Still earlier was the primitive Abbevillian industry, characterized mainly by large hand axes of a rough and unfinished type. Lastly, the very crude pebble-tool industry has left its traces in deposits dating from the earliest part of the Pleistocene and found in many different parts of the old world. The only certain evidence of fossil man antedating the second interglacial period bears witness to hominids which, on morphological criteria. were very different from *Homo sapiens,* and they have been referred to as a separate genus altogether, *Pithecantlzropus.*

PITHECANTHROPUS

The first discovery of the remains of the genus *Pithecanthropus,* made at Trinil in central Java in 1891, consisted of a skullcap and thighbone. These were found in alluvial deposits on the bank of the Solo river at a stratigraphic level which (it is now generally agreed) is of middle Pleistocene age, and they were probably laid down at a time corresponding to the second glaciation of the Ice Age in other parts of the world. The skullcap is astonishingly small and presents a remarkably simian appearance. So much so, indeed, that some anatomists at first refused to recognize it as a hominid skull at all and supposed it to be the remains of a giant gibbon. By contrast, the femur is entirely similar to that of *Homo sapiens,* and some doubt was expressed whether it really belonged to the same creature as the skull. However, portions of other thighbones of modern type have also been recovered from the same series of deposits, and that they are properly attributable to *Pithecanthropus* has been confirmed by fluorine tests and by the fact that thighbones of similar type have also been found in association with the remains of the same genus *Pithecanthropus* in China. That the skullcap belongs to a true hominid (and not to a large ape) is shown by the cranial capacity, which exceedsconsiderably that of any known ape, and by further discoveries in Java of other skulls and of jaws and teeth. These later discoveries include the remains of three adult skulls and the cranium of an infant. an upper jaw and the adjacent part of the facial skeleton, some fragments of lo er jaws and a number of teeth. One of the lower jaw fragments, distinguished for its great size, has been referred to a new genus of extinct hominid, *Meganthropus,* but there is no convincing evidence that it is other than an unusually large jaw of *Pithecanthropus.* It should also be noted that some of these remains were found in deposits underlying the Trinil horizon, and this makes it clear that *Pithecanthropus* was already in existence in Java during the early Pleistocene.

From all this fossil evidence it has been established that the Javanese type of *Pithecanthropus* shows very primitive characters in the skull and dentition. The mean cranial capacity was probably rather less than 1,000 c.c., the forehead region is flat and retreating, the brow ridges project forward as a shelf of bone overhanging the orbits, the cranium is extremely flattened and in its general contour very simian in appearance, the area on the back of the skull for the attachment of the neck musculature shows that the latter must have been po erfully developed, the nasal aperture is very broad, the palate and jaws are massive, there is no chin eminence, the molar teeth are exceptionally large. and (in some individuals) the upper canine tooth projects beyond the level of the adjacent teeth and interlocks to a slight degree with the lower canine tooth. The infant skull, found at Modjokerto in eastern Java, is of particular interest, for although it belonged to an individual of perhaps not more than two or three years old, already at that early age it shows the incipient development of some of the characteristic features of the adult *Pithecanthropus* skull; *e.g.*, the retreating forehead and the strong brow ridges. The cranial capacity of the skull is about 700 c.c., and from this it has been estimated that in the fully grown individual it would not have exceeded 1,000 c.c. The study of endocranial casts has further emphasized the primitive character of this extinct hominid. for in its proportions and dimensions the cerebrum shows an approximation to that of the apes, as also in the convolutional pattern of the frontal lobe of the brain. Apart from the size of the canine tooth in some individuals, the dentition is entirely hominid in its general characters. No stone artifacts have been found in the strata from which remains of *Pithecanthropus* were recovered in Java, but stone chopping tools and primitive hand axes occur in deposits of a slightly later age, and it is not improbable that such tools were actually made and used during the middle Pleistocene by hominids of the *Pithecanthropus* type in that region. The thighbones provide evidence of a height of about 5 ft. 8 in. and, since (as already noted) they are not distinguishable from the thighbones of *Homo sapiens,* it may be inferred that *Pithecanthropus* had already developed an erect posture and gait quite similar to those of modern man. It is for this reason that the Javanese type of the genus has been called by the specific name *P. erectus*. It may be noted that some authorities have interpreted the large mandibular fragments as evidence for the existence in Java during the Pleistocene of "giant" hominids. But this is a misapplication of the term "giant," which is commonly taken to refer to stature. A large jaw does not necessarily imply a giant individual; on the contrary, so far as the available palaeontological evidence goes, there is some reason for assuming a negative correlation between the size of the mandible and the total stature in primitive hominids. Certainly, as has been seen. the thighbones from the Trinil deposits provide no evidence of great height.

The Chinese representatives of *Pithecanthropus* (usually assigned the specific name *P. pekinensis)* are known from skeletal remains discovered at Choukoutien near Peking. The first find was made in 1927 and consisted of a lower molar tooth. Two years later, a well-preserved cranium of very primitive type was found at the same site. These remains were at first given a different generic name. *Sinanthropus,* but their close relationship to the Javanese *Pithecanthropus* soon became evident, and the term *Sinanthropus* has been discarded. *P. pekinensis* is now known from the remains of 14 skulls. as well as portions of the facial skeleton. several mandibles, many teeth and a few limb bones. The cranial capacity has a mean value of rather more than 1,000 c.c., but it seems to have been remarkably variable. for in four individuals it shows a range from 850 c.c. to 1,300 c.c. The latter figure comes well within the range of variation of H. *sapiens*. • the skulls show a marked flattening of the cranial vault, heavily constructed brow ridges and thick bony walls. The facial skeleton is strongly built, the jaws and teeth are large, and the mandible lacks a chin eminence. The forehead region is rather better developed than in *P. erectus,* and, with the somewhat larger cranial capacity, this has been taken to indicate that *P. pekinensis* was a slightly more advanced type. The teeth, in spite of their large size. conform in all essentials to the hominid pattern and the canines. though in some individuals large and conical, do not project to any marked degree beyond the level of the adjacent teeth. The limb bones found at Choukoutien comprise portions of seven thighbones, two upper arm bones, a collarbone and one of the small bones of the wrist. In no character has it been satisfactorily demonstrated that any of these limb bones are distinguishable from those of H. *sapiens.*

In the same deposits yielding remains of *P. pekinensis,* crude cores and trimmed flakes of quartz and silicified rocks were found, comprising a local Palaeolithic industry of an archaic but fairly uniform character. Some animal bones were also found which had evidently been broken and shaped for use as implements. Finally, the deposits contained the remains of hearths and quantities of charred animal bones, evidence that these ancient hominids were skilful hunters and had learned the use of fire for domestic purposes. From all this evidence, it seems clear that, in spite of their very primitive morphological characters, the Chinese representatives of *Pithecanthropus* had already developed a communal life of a very active kind.

The geological evidence makes it fairly certain that they lived during the middle Pleistocene, probably at a time corresponding to the second interglacial period.

The question arises whether the geographical range of *Pithecanthropus* extended outside the far east. There is no certain evidence of this. but reference may be made to the massive, chinless jaw found in 1907 in a sand pit at Mauer, near Heidelberg. Ger. The jaw is very simian in appearance, but the teeth. though large, are typically hominid. This specimen is usually referred to the species *Homo heidelbergensis,* but it may equally well belong to the genus *Pithecanthropus.*

The identification of the specimen is hardly possible in the absence of the skull. The fossil was found in association with *Elephas antiquus* and other extinct mammals characteristic of the early part of the Pleistocene; it probably dates from the commencement of the first interglacial period, which would give it an antiquity of several hundred thousand years. No stone implements were found at the site. Two lower jaws, quite similar to the Heidelberg fossil and possibly also belonging to a type of fossil hominid not taxonomically distinct from *Pithecanthropus,* were found in Algeria in 1954, in association with stone artifacts of an early hand-ax industry.

The geological and archaeological evidence suggests that these specimens date from a period of the Pleistocene slightly later than Heidelberg man.

The palaeontological evidence so far available indicates that *Pithecanthropus* lived long before *Homo sapiens* came into existence. He was therefore a precursor of *H. sapiens* and the conclusion naturally suggests itself that he was actually ancestral to this species. Here it is necessary to draw attention to a misunderstanding which frequently arises in discussions on probable ancestors.

When it is suggested that *Pithecanthropus* may have been ancestral to *H. sapiens* (and the evidence of palaeontology and comparative anatomy lends considerable support to this thesis), it is not of course meant to be implied that the actual individuals whose remains have been found in the far east were themselves the ancestors: nor even that the local groups or species which they represent were so. It only means that the genus as a whole may have provided the ancestral basis from which modern types of man were initially derived. Other representatives of *Pithecanthropus* than those already known, and perhaps a different specific group of the genus may have provided the actual ancestors. This problem will be settled only when much more palaeontological evidence has accrued.

The most that can be said at the present time is that. considered together, *Pithecanthropus,* primitive types of *H. sapiens* such as those known to have existed in pre-Mousterian times. and modern *H. sapiens* provide a gradational series which is also a temporal sequence, and this is highly suggestive of the conclusion that they represent an actual evolutionary lineage.

Perhaps the most striking feature of the archaic *Pithecanthropus* is shown in the combination of very primitive and almost simian characters of the skull, jaws and brain with a dentition which is fundamentally of the hominid type (contrasting very strongly with the dentition of all anthropoid apes, whether Recent or extinct) and with limb bones which, so far as they are known from rather fragmentary remains. are no different from those belonging to modern man.

It seems clear, therefore, that in evolutionary development of the Hominidae, the adaptation of the limbs for an erect posture and gait and the acquisition of the hominid type of dentition began earlier and proceeded more rapidly than the modification of the skull and jaws or the expansion of the brain to the form and proportions characteristic of *H. sapiens*. There is some reason to suppose that the expansion of the brain to modern proportions must have been a rather rapid process compared with evolutionary rates in general. Certainly there is no evidence at all that the brain had begun to approach modern dimensions before the Pleistocene, and it is a matter of some importance that this should be recognized. For the consensus among palaeoanthropologists was (at mid-20th century) that the Hominidac. as an evolutionary radiation distinct from the evolutionary radiation of the anthropoid apes, probably became segregated not later than the Miocene or the early Pliocene; that is to say, several million years before the commencement of the Pleistocene. If this mere so, it means that the earlier representatives of the Hominidae must have retained brains of simian proportions for a prolonged interval of geological time.

But during this interval they were presumably already differentiated from the ape family by progressive modifications of the limbs for the erect posture. which is one of the outstanding diagnostic characters of the Hominidae as a whole, and by the development of the hominid type of dentition (both of which features, as we have seen, were already well established in the early Pleistocene by the genus *Pithecanthropus*). By a consideration of the comparative anatomy of man and the modern apes, and by reference to the palaeontological evidence recounted above. it is clear that the initial differentiation of the Hominidae and the anthropoid ape family from a common ancestral stock was related to divergent trends of evolution which, in the limbs and dentition, were rather strongly contrasted. and there is some reason to suppose that, more than anything else, it was the divergent modification of the limbs for very different modes of life which determined the initial segregation.

If these general inferences regarding the early evolutionary development of the Hominidae are correct. it must be presumed that the *Pithecanthropus* phase of hominid evolution was preceded by a phase characterized by a still smaller brain but in 'nhich the limb structure and the dentition might be expected to shon at least some degree of modification in the direction of evolution which has characterized the Hominidae. The interesting question now arises —is there any fossil evidence that such a type ever existed? The answer to this question is to be found in the remarkable discoveries made in South Africa of the remains of creatures to which (as a group) the somewhat cumbrous name Australopithecinae has been given. Unfortunately it is difficult to give them a less pedantic name without misleading implications, though, because of the curious mixture of anatomical features nhich characterize these creatures, they are sometimes referred to as "man apes" or "near men."

. AUSTRALOPITHECINAE

The first fossil evidence of the existence of these creatures was obtained from the discovery at Taungs in Bechuanaland in 1924 of the skull and a natural endocranial cast of an immature individual. This specimen shows a number of features (particularly in the milk dentition) in which it approximates much more closely to the Hominidae than any of the known anthropoid apes do. But, because the distinguishing characters of the skulls of apes and of the Hominidae are not so conspicuous in immature as they are in adult individuals, considerable doubt was at the time expressed regarding the significance of the apparently hominid features of the Taungs skull.

Later. from the year 1937 onward, considerably more remains of the same type were discovered in the stalagmitic deposits of ancient caves and fissures formed in dolomitic limestone at various sites in the Transvaal. As the result of excavations extending over a number of years, a great quantity of important fossil material mas collected. consisting of a number of skulls of immature and adult individuals, many upper and lower jaws, numerous examples of the permanent and deciduous dentition. several specimens of the limb skeleton. three examples of the bony pelvis and the greater part of a vertebral column. which was found still in an articulated condition.

With this material, more information is available about the anatomy of the Australopithecinae than about that of almost any other extinct group of the higher Primates. Their outstanding characters are (1) a small cranial capacity equivalent to that of the modern large apes (but in some examples probably exceeding it, at any rate in relation to body size), (2) massive projecting jaws, (3) large molar and premolar (or bicuspid) teeth but remarkably small incisors and canines and (4) pelvis and limb bones constructed on the hominid plan (but showing significant differences from those of modern Homo sapiens). The combination of a small brain case nith large jaws gives to the skull a most "apelike" appearance, and largely for this reason some authorities at first took the view that the creatures were really "apes" in the taxonomic sense.

However. on the other hand, a critical analysis of the cranial and dental characters, and especially the evidence of the pelvis and limb skeleton, seemed to make it clear that the total morphological pattern nhich they present conforms to the pattern diagnostic of the hominid sequence of evolution and certainly not of the anthropoid ape sequence.

It is not surprising that this remarkable combination of characters provoked rather acute controversies regarding their precise taxonomic position. Unfortunately, the discussions were at first somewhat confused by exaggerated claims on both sides. Thus, claims that the Australopithecinae were capable of fabricating bone tools and that they had even learned the use of fire were based on evidence which proved to be quite inadequate. On the other side, it was claimed (mainly on the basis of the rather scanty earlier discoveries and partly from the application of inadequate statistical methods) that some of the skeletal and dental characters were no different from those of modern apes. The later accession of further and much more complete material showed that these latter claims had been put forward too hastily. For example, the dental morphology is now completely known, and it became evident that it conforms in all fundamentals to the hominid type of dentition.

The canine teeth are consistently small, of spatulate (instead of sharply conical) form and they became worn down flat from the tip so that (as in modern man) the biting surface at an early stage of attrition was brought level with the biting surface of all the other teeth. They never overlapped and interlocked in occlusion as they do in anthropoid apes. The front lower premolar tooth is consistently bicuspid in shape as in *Pithecanthropus*, and entirely different from the pointed. "sectorial" type of tooth which is consistently found in all known apes, Recent and extinct. The molar teeth are not easily distinguishable in their cusp pattern from those of *Pithecanthropus* and, though large, in many individuals their size comes within the range of this genus of hominids. Lastly, the teeth are consistently arranged in an even arcade of elliptical or parabolic form. nith no gap (or diastema) between the canines and adjacent teeth—a disposition which, once again. is hominid and in marked contrast with the ape type of dentition.

It may be noted, also. that application of careful statistical methods has demonstrated that the taxonomically relevant dimensions of the canine teeth lie far outside the range of variation of modern apes.

So far as the skull is concerned, it presents a number of features which, taken in combination, are never found in apes but which are characteristic of the hominid skull. These include the cranial height. the low position of the occipital protuberance (at the back of the skull). the detailed conformation of a number of features in the cranial base. the shape of the mandible and so forth. In a few of the largest australopithecine skulls the vertex of the skull is marked by a lon median crest which is related to the growth of the large temporal muscles that moved the massive jaws. In one of the earliest of these skulls to be discovered, the occipital region at the back of the skull was missing, and it was argued that the median crest must have extended back into a high transverse nuchal crest on the back of the skull just as it does in gorillas (implying an exceptionally ponerful development of the neck musculature).

However. other skulls with a median crest on top and with the occipital region preserved shon that there was no high nuchal crest of the gorilloid type—the muscular markings for the neck muscles are situated low down in the typical hominid fashion. This observation has an important bearing on the poise of the head, for the reduction of the neck musculature in the Hominidae is related to the fact that with the development of an erect posture the skull becomes more evenly balanced on the top of a vertical spine, and a powerful neck musculature is no longer required for holding up the head on the end of a forwardly sloping spine. The contour of the back of the australopithecine skull, combined with certain details of the articular condyles on the cranial base. led to the inference that the Australopithecinae must have been adapted to an erect posture and gait approximating that of *Homo*. This inference received remarkable corroboration from the discovery of portions of thighbones and of three pelvic bones. The latter are of particular importance, for the total morphological pattern of the bony pelvis of the Hominidae is perhaps the most characteristic skeletal feature of this family and, indeed, distinguishes it from all other Primates (including the anthropoid apes). This pattern, moreover, represents in its major components an adaptation to the mechanical requirements of an upright or erect posture.

These components include the great breadth of the iliac blade, lengthening of the iliac crest for the more extensive attachment of the powerful back muscles needed to support the trunk in the vertical position, the backward displacement of the area of attachment of certain of the buttock muscles so that they can be effectively used in upright walking, the rotation and downward shifting of the joint through which the weight of the body is transferred from the spinal column to the lower limbs. the development of a very distinctive bony eminence marking the attachment of a powerful ligament which is required to stabilize the hip joint in the erect position. and so forth. Not one of these features is found in combination — or, indeed, even singly — in the ape type of pelvis.

On the other hand, pelvic bones of the Australopithecinae all show every one of them consistently; in other words, the pelvis is constructed fundamentally on the hominid plan, and this makes it perfectly clear that it was adapted for an erect. bipedal posture and gait. It is interesting to note that the anatomical evidence of bipedalism is entirely consistent with the geological evidence of the environment in which the creatures lived, for this shows quite positively that they were not forest dwellers but lived in open country very similar to the veld of the Transvaal today—an environment quite unsuitable for anthropoid apes of the modern type.

The decision as to the taxonomic status of a previously unknown fossil — nhether it is a primitive type of small-brained hominid or a member of the anthropoid ape family — must depend on a recognition of the fundamentally different trends which have characterized the evolution of these two families and which are diagnostic of each of them as a natural taxonomic group. As noted above, the indirect evidence of comparative anatomy and (so far as it goes) the direct evidence of palaeontology lead to the conclusion that the anthropoid ape family and the Hominidae represent divergent lines of evolution deriving from a common ancestry. and that only toward the terminal stages of the hominid line did the brain expand to the large size characteristic of the terminal species *Homo sapiens.*

The anthropoid ape sequence of evolution became adapted for a quite specialized kind of arboreal life with accompanying specializations in the limbs, skull and dentition. The hominid sequence, by contrast, became adapted for terrestrial progression with profound modifications of the pelvic and limb skeleton (and also the skull) for erect bipedalism, and was also characterized by the replacement of sharp interlocking canines by blunt spatulate teeth and of pointed "sectorial" lower front premolars by bicuspid teeth, as well as rather numerous other associated structural changes.

So far as Australopithecinae are concerned, a careful appraisal of their anatomical structure makes it clear that, in spite of the primitive characters mhich they still retained in the size of the brain and jaws, they had already advanced a considerable way in the direction of the hominid sequence of evolution and quite opposite to the direction which was followed by the anthropoid ape sequence. For example, in those features in which the pelvic bone has undergone modification away from what must be presumed to have been the type of pelvis in the common ancestral stock, the modification has in every respect followed the direction of hominid evolution. Thus by definition the Australopithecinae must be classified zoologically in the family Hominidae. But it is important to note that this does not mean that the terms "man" and "human" can be appropriately applied to them, at any rate in the sense in which these terms are ordinarily used, for there is so far no evidence that they had any of the distinctively human attributes such as the faculty of speech or the ability to fabricate implements. They are to be regarded, rather, as representatives of the prehuman phase of hominid evolution.

The question arises whether the Australopithecinae could have been the evolutionary ancestors of later hominids, including *Pithecanthropus* and *Homo sapiens.* There appear to be no sound morphological arguments against such an inference; indeed, it is a perfectly valid interpretation of the morphological evidence, for the Australopithecinae conform very closely indeed to theoretical postulates for the phase of hominid evolution which. it must be presumed, preceded the *Pithecanthropus* phase. But the australopithecine individuals whose remains have so far been discovered in South Africa probably existed too late in time to be regarded as representatives of the ancestral stock, for the geological evidence indicates that they lived in the early Pleistocene more or less contemporaneously with *Pithecanthropus* in the far east. On the other hand, the Australopithecinae were already at that time differentiated into at least two varieties or species, and it is thus certain that the group as a whole must have been in existence at a still earlier date, at least at the end of the Pliocene. So far as the time factor is concerned, therefore. the group as a whole could certainly have provided the matrix from which more advanced types of hominid became differentiated by a process of evolutionary development.

In this brief survey of the fossil evidence for human evolution a rather remarkable gradational series has been traced, leading from modern H. *sapiens* to primitive types of apparently the same species living many thousands of years ago in the Ice Age, from the latter to the archaic *Pithecanthropus,* which still preserved a number of anatomical characters approximating to a simian level of development, and finally to the still more apelike Australopithecinae of South Africa. The simian characters to which reference is here made do not necessarily indicate a very close relationship to the modern anthropoid apes, for they are to be regarded rather as primitive characters which were derived in the distant past from a common ancestry and which have been ketained in the modern apes but became subsequently lost in the *later* stages of hominid evolution.

Therefore, although in a certain sense it might appear that the primitive characters of the Australopithecinae — such as the small brain and large jaws--emphasize the closeness of man to the apes in their evolutionary relationship, these extinct creatures were in fact already at that early time very different from apes in many fundamental hominid characters of the skull, teeth and limbs. And, from what we know of the rates of evolutionary change in general, this makes it certain that the line of hominid evolution must have become a separate and independent line at a much more remote time.

ORIGIN OF THE HOMINIDAE

At what point in geological time the Hominidae, as a separate and independent line of evolution, became segregated from the anthropoid ape family is still not certainly known. No fossil hominid remains have so far been discovered which antedate *Australopithecus* and *Pithecanthropus;* indeed, this is at present the most serious gap in the fossil record of the Hominidae. Remains of several types of fossil apes are known from Pliocene and Miocene deposits in Europe, Africa and Asia, but they consist almost entirely of teeth and fragments of jaws. Morphologically, these approximate quite closely to those of the modern apes, but at least some of the genera were more primitive in a number of features.

The very few remains of the skeleton which have been found also indicate that the limbs had not at that time developed the specialized modifications which are characteristic of the modern apes, for in many respects they were more like those of the cercopithecoid monkeys.

All these primitive characters of the Miocene and Pliocene apes are particularly relevant to the problem of the origin of the Hominidae. It has been seriously argued that the latter could hardly be derived from an anthropoid ape ancestry because anthropoid apes are too specialized in their limb structure and limb proportions. But there is a remarkable fallacy in such an argument—the assumption that extinct anthropoid apes of earlier times must necessarily have shown the same degree of structural specialization as do the end products of the pongid sequence of evolution which are represented today by the gorilla, chimpanzee and orangutan.

It later became known that (as of course might have been expected) this was certainly not so. Indeed, on the purely morphological evidence there is no improbability in the thesis that one of the known genera of Pliocene or Miocene apes may represent the common ancestral stock nhich gave rise by different and contrasting kinds of adaptive modifications to the two divergent evolutionary sequences of the Pongidae and Hominidae. It has indeed been proposed, and by some even taken for granted, that such features as the sharp overlapping canines, the moderately "sectorial" first lower premolars and certain quite minor features of the cusp pattern of the molars constitute "specializations" which, so to speak debar these early apes from any consideration as possible ancestors of the Hominidae. But this is to make assumptions on the "irreversibility of evolution" which are not only groundless but are demonstrably untrue.

In genetic studies it has been shown that single mutations can be reversible in direction, and in phylogenetic studies there are many examples of what may be termed '.negative reversals"; *i* e., the retrocession of characters previously well developed. So far as the canines and premolars are concerned, there are in fact strong morphological reasons for inferring that the hominid characters of these teeth have been secondarily derived from those of the pongid type.

It may be noted here that the palaeontologist has frequently to consider the question whether certain extinct types had already attained to such a degree of structural specialization that they must be regarded as a divergent or aberrant group having no ancestral relationship to modern types. The answer to this question must depend on the assessment of the total morphological pattern in terms of the probable complexity of its genetic constitution and the probable complexity of the selective influences mhich have determined its initial evolutionary development, and also on gauging the degree to which morphological changes have committed the group to a mode of life which has restricted too far the opportunities for selection in other evolutionary directions

We have referred above to the morphological gap which at present separates the most primitive of the known hominids (*Australopithecus*) from the known fossil apes of the Miocene and Pliocene. The temporal gap is also large—a matter of at least several million years. From what is known of rates of evolutionary development in other groups of mammals there is certainly no difficulty in postulating a transition from one to the other in this time period.

But such a transition, the approximate period in geological time during which it took place and the region where it actually occurred can of course be demonstrated only by the discovery of the relevant fossil material.

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(W. E. L. G. C.)

MAN, **ISLE** OF (Manx-Gaelic, ELLAN VANNIN), one of the British Isles situated in the Irish sea, roughly equidistant from England, Ireland, Scotland and Wales. It is a lozenge-shaped island about 30 mi. long and 10 mi. wide. its main axis being southwest to northeast. Area 221 sq.mi. The capital is Douglas (*q.v.*).

The island is not a part of the United Kingdom, nor is it a "foreign dominion" of the crown; it is a dependency, with a considerable degree of self-government, administered by the home office in a manner comparable with the Channel Islands. It is not exempt from the power of the English court to issue a habeas corpus.

PHYSICAL FEATURES

The island consists of a central mountain mass culminating in Snaefell (2,034 ft.) and extending north and south in low-lying agricultural land. There is fine cliff scenery along both sides of the central massif, whose slate peaks are smooth, rounded and grass covered, the result of ice action during the various glacial periods.

The landscape is treeless except in sheltered places; the many glens are not glacier formed. The island is almost bisected between Peel and Douglas by a narrow lowland tract which is in fact a double river valley, the rivers, all of which are small, running in opposite directions from the centre, The chief rivers are the Sulby, flowing north and east to enter the sea at Ramsey; the two-branched Douglas at Douglas; the Santan at Cas-ny-howin; the Silverburn at Castletown; and the combined Neb-Rhenass at Peel

There are no lakes, but the Douglas corporation constructed a large reservoir in the west Baldwin valley. To the southwest is a small islet, the Calf of Man, with precipitous cliffs, similar in structure to the main island, leased by the National trust of Great Britain to the Manx National trust, consisting of one farm and a strictly kept bird sanctuary.

Geology.—The central mass consists of Manx slates, flags, grits and conglomerates in which there is an almost complete absence of recognizable fossils. The slates, provisionally classed as Cambrian, have been much folded and crushed; they overlie the granite mass which has been denuded at Foxdale, the Dhoon and Oatlands (Kirk Santan).

Located in the south is a tract of about eight square miles of Carboniferous limestone which was formerly of great economic importance, providing building material for Rushen castle, the old houses of Castletown, King William's college and the quay walls of all the island ports. The quarries are no longer used for building stone, but there are extensive limekilns. Beneath the limestone is a basalt conglomerate, well exposed on Langness with some interesting "fault arches," and good examples of unconformable strata of conglomerate on the tilted slates. The Carboniferous limestone shows two main series, the lower, Castletown series, the upper, Poylvaish, both rich in fossil forms. Flags overlying the upper series were formerly polished and known as Castletown marble; they made good fireplace surrounds, but as tombstones they quickly weathered. At Peel an exposure of a dark red sandstone, attributed to the basement beds of the Carboniferous limestone series, provides picturesque building stone uhich gives the town, its cathedral and castle their rose-red coloration. The northern part of the island is a roughly triangular plain uith its apex pointing northeast. This plain is based upon the limestone on which lies a thin band of Permian sandstone covered by a much wider band of Triassic sandstone, all deeply covered by a mass of glacial and alluvial material forming a marshland (curragh) formation of great floral and faunal interest. Toward the apex of the triangle (Point of Ayre) are the Bride hills, a mass of glacial drift, and beyond, along the northwestern coast, is a region of bloun sand called the Ayre. The soil in the south is mainly of glacial gravel with local lacustrine and river deposits; from Derbyhaven to Port St. Mary there is blown sand upon which the aerodrome and golf links are situated. To the south of Cregneish are signs of heavy earth movements in the faulting of the slate cliffs, which are rent by chasms and fissures running the whole height of the zoo-it. cliffs. To the southwest of Castletown stands the Stack of Scarlett, possibly a basaltic volcanic side cone, and around it for a considerable area are lava overlays, with basalt sills, and volcanic ash. There is a long history of mining activities—lead, zinc, copper and haematite having been worked—but by the mid-1950s all the mines but two were derelict. They mere centred around Laxey and Foxdale, with a few isolated mines in the south.

Climate.—The prevailing winds are from the southwest and the climate is equable. The mean annual temperature is 46.6" F., the average mean temperature in February is 40.9° and in August 57.8°; the average annual mean daily sunshine is 4.31 hours; the average annual rainfall is 41.2 in. Fogs are common, snow and frosts are rare and of short duration. Thunderstorms are rare.

Flora and Fauna.—The flora of the island is small, and its main interests lie in its varied associations and a comparison of its species with those of the surrounding countries. With the end of the glacial periods the land link was soon destroyed so that comparatively few plants were re-established. Fewer than 700 species have been recorded as compared with about 1,200 in Cumberland and the southern counties of Scotland. There is a profusion of ferns. Subtropical shrubs. such as the fuchsia, hydrangea, myrtle, Escallonia and Clianthus, flourish out-of-doors, while a prominent feature of the coastal landscape is the abundance of dragon palm (Dracaena).

There are no snakes or toads, few frogs and two lizards (common and sand). There are no badgers, foxes, moles, voles or squirrels. The mountain hare grows more and more scarce; rabbits. formerly a pest, were very greatly reduced by myxomatosis. Hedgehogs, accidentally introduced from a wrecked ship at the beginning of the 19th century, are plentiful. The pygmy shrew (Sorex arenaeus) is abundant, as is the long-tailed field mouse (*Mus sylvaticus*); the black and the brown rat and the house mouse are too well established; the stoat (*Mustela* arminea) is not common. The gray seal (Phoca vitulina) breeds on the Calf. There are three bats, the pipistrelle (Vesperugo *pipistrellus*), Natterer's bat (Murina natteri) and the long-eared bat (Plecotus *auritus*). Across the land bridge following the retreating ice came the giant Irish stag (Cervus gigantaeus), of which many skeletons have been found. There is only one species of freshwater fish, the perch, much localized. The fish indifferent to salt and fresh water—salmon, brown trout, eel and stickleback—are present. The Manx cat, without a tail or with a greatly reduced tail, is common as a domestic pet in the island but is not indigenous. There is still one small flock of Manx loghtan sheep, a handsome four-horned breed. The main faunal interest is in the bird life, as the central position of the island makes it ideal for the study alike of sea and land birds and their migrations. Of the nonmigrants the magpie, introduced in the early 18th century, has attained the rank of an insular species. Birds not recorded are the jay and the woodpeckers. The chough is much less common than formerly; ravens are plentiful. The buzzard is a rare visitor, and the peregrine falcon is becoming rarer. Only two peculiar Lepidoptera have been recorded, Dianthaecia caesia and D. *capsophila.*

HISTORY

Prehistory.—A11 traces of Palaeolithic inhabitants were destroyed during the glacial periods. There are many and varied evidences of Mesolithic civilizations, including Tardenoisian and the Bann type of northern Ireland. The Neolithic also has two aspects, one culture being associated with the megalithic monuments (c. 2000–1500 B.C.); the other, the highly individual Ronaldsway culture (named after a domestic site excavated in 1943), is apparently a Manx equivalent of the late Neolithic of Orkney (Skara Brae). The three chief megalithic monuments are: Cashtal yn Ard, near Kirk Maughold, a gallery grave with a noble forecourt; King Orry's grave, near Laxey, a "double" long cairn cut in two by a road and further mutilated by 19th-century houses; and the Meayl (or Mull) circle, near Cregneish. a unique structure comprising six pairs of chambers disposed on the circumference of a circle.

The Bronze Age is represented mainly by graves containing food vessels, several of Irish type (only one Beaker burial is recorded), and the subsequent cinerary urns, and by surface finds of bronze tools and weapons. Groups of circular house foundations at Ronaldsway (excavated 1935–37, later destroyed) may belong to the late Bronze Age.

The early Iron Age is marked on the one hand by hilltop forts like some Celtic strongholds in Wales (South Barrule is the largest) and on the other by large, circular, wooden farmhouses, undefended and often sited in lowland meadows (notably Ballakeigan, excavated 1941–44 by G. Bersu), assigned to the 2nd century A.D.

History.—The island became the home of many Irish missionaries in the centuries succeeding the teaching of St. Patrick. This period was marked by the building of oratory chapels or *keills,* and by gravestones with incised crosses of varying artistic merit, many of which are to be seen in the parish churches and in the museum. The Scandinavian invasions began about A.D. 800 and the first phase lasted till after the Norman Conquest of England, during which time the vikings came mainly for plunder but slowly began to settle. Already settlements had been made in the Nordreys (Orkney and Shetland) and the Sudreys (the Western Isles of Scotland). Such history of the period as is known is recorded in the sagas of the period. The second viking period began with the arrival of Godred Crovan in 1079 and lasted till 1266. Its history is recorded in the Chronicon Manniae (British Museum), written by the monks of Rushen abbey (founded 1134). Fourteen kings and 15 bishops are recorded, and Godred Crovan appears to be the King Orry or Gorry of Manx legend. During this period the island was controlled by a Scandinavian system of government which has remained practically unchanged. Godred's son Olaf (1113–52) was the first king to style himself Rex Manniae et *insularum.* His son Godred II became the vassal of Henry II of England, and from that time the island became a pawn in the game of war between Scotland and England. Reginald I of Man paid homage to the king of England, 1187. Memorials of the Scandinavian age, apart from the ancient Tynwald parliament and many place names, are to be found in the remains of farm fortresses on the cliff edge, as well as in ship burial mounds at Balladoole (Arbory) and Knock-y-dooney (Andreas). In 1229 Bishop Simon was sent from Trondheim (Nidavos) to be bishop of the Sudreys, and under his episcopate the building of the cathedral was begun and the tower of Bishopscourt built. In 1266 the king of Norway sold his suzerainty of Man and the isles to Alexander III of Scotland. This suzerainty had long been repudiated by the kings of Man. Magnus, king of Man at the time, sent an army to assist an invasion of Scotland by the Norwegians. The battle of Largs found Alexander triumphant, and he demanded from Magnus the Sudreys, which were ceded, and from Magnus' son Godred he bought all Godred's claims as king of Man, thus becoming king of Man by purchase. With the rise of Edward I Man changed hands and became an appanage of England. Edward II lost it to Bruce, who came to the island in person and conquered it, capturing King Orry's tower on the site of the present Rushen castle. But Edward III, by beating Scotland, won back Man, after which time all its kings were English. Edward III gave the kingship to William de Montacute, 1st earl of Salisbury, and from him the title passed to his son, who sold it and his "crowne" to Sir William le Scrope. During the kingship of the Montacutes, Rushen castle, a typical castle of the period, was rebuilt round King Qrry's to er at Castletown (*q.v.*). It became the home of the Manx kings and the seat of government. Scrope built a small castle beside the cathedral on Peel (*q.v.*) Island, but he was attainted and executed by Henry IV, who in 1406 granted the island to Sir John Stanley, his heirs and assigns to be called "kings of Mann." The Stanleys refused to be called "kings" but adopted the title of "lord of Mann," which title still holds.

With the Stanley regime came a much more stable period of government. The lords rarely visited the island, but they appointed wise governors and sent strong garrisons from Lancashire. Thirteen members of the Stanley family were lords in succession, with two brief interludes. Queen Elizabeth I in 1594 took over the lordship when Fernando Stanley died leaving only daughters. It was retained by James I till 1607 when he gave it to the earls of Salisbury; but in 1609 it was returned again to the Stanleys. During the Commonwealth, James, the 7th earl, the "Great Stanley," left the island in charge of his countess, Charlotte de la Tremoille, whose military commandant, William Christian (Illiam Dhone), surrendered it to the Roundheads when the earl was executed after the battle of Worcester. Lord Fairfax was made lord of Man. but at the Restoration the young earl Charles resumed the lordship and undid a great amount of his father's good work, chiefly by disputing the permanent tenancies of the farmers, who held their lands under the Scandinavian system of permanent freehold upon payment of the lord's rent and not under the Norman feudal system as in England. As a result of a lasting quarrel with their lord, the farmers neglected the land and turned their attentions to fishing and the contraband trade. The island had no fiscal laws, and spirits, tobacco and silk could be legally imported into the island from which they were re-exported to Great Britain by a fleet of fast clippers with skilful crews. The land question was ultimately put right by the influence of Bishop Thomas Wilson in 1745 in an act of settlement, by which tenants receive their lands in perpetuity on payment of a fixed rent, and a fine on succession or alienation. With the death of the 10th earl the male line of the Stanleys came to an end, but the claim of the daughter Charlotte, Baroness Strange and duchess of Athol. to the sovereignty of Man was upheld, and in 1764 the Athols became lords of Man.

The chief feature of the Athol rule was the gigantic increase in the contraband trade, which became a serious menace to British revenue, and parliament resolved to suppress it. A Revesting act was passed in 1765 purchasing for the crown the sovereignty of Man for the sum of £70,000 together with an annuity to the duke and duchess of £2,000. The Athols still retained their manorial rights and the patronage of the see. These were bought by the British parliament from the family in 1828 for the very high sum of £417,144. The 4th duke of Athol, who built Castle Mona (now a hotel) at Douglas, as the official residence of the lords of Man, in 1804, remained as governor appointed by the crown. The Revesting act interfered to a considerable extent with the home rule of the island, but constant representations, specially in 1837. 1844 and 1853, produced alleviations, and in 1866 a good measure of home rule was restored to the island.

PEOPLE

The earliest inhabitants in historic times were Celtic in speech. both British (Brythonic) and Gaelic (Goidelic) being spoken in the 6th century A.D. Gaelic (Manx) became dominant and remained the everyday speech of the majority until the first half of the 19th century. Racially the population is mixed, the most important types being described as "Mediterranean" and "Nordic," respectively. In 1961 the population of the island was 48,150, that of Douglas 18,837.

The Church. — The first organized church was the Scandinavian church which was based on "treen" churches or *keills*, in which a priest had charge of a tiny church and burial ground, living himself in a small cell usually beside a holy well. Later. 17 parishes were organized, their *keill* churches being enlarged from age to age. But the church buildings maintained the constant type, a nave without transepts, side aisles or chancel, usually whitewashed and with a western bell turret and west door. In general they stand at some distance from the villages. The diocese was organized in Scandinavian times (see SODOR AND MAN). During the same age, too, were built the cathedral of St. German (now ruined and roofless); Rushen abbey (also in ruins), a branch of the abbey of Furness, which was the controlling factor of the religious life; and Bishopscourt, built as a fortress tower with a moat, and extended later. Of the nunnery near Douglas and the Franciscan friary at Bemaken, Kirk Arbory (founded in 1373 for 12 brethren), nothing remains except the chapels. Since the Reformation the church has retained its ancient organization and has formed a diocese of the northern province of the Church of England. In 1880, by act of Tynwald, four rural deaneries were formed and commissioners appointed to take charge of church endowments. In 1895 a cathedral chapter was authorized, consisting of the bishop (himself to be the dean of his cathedral), the archdeacon, four canons and the vicar-general.

The churchmanship of the island is traditionally evangelistic John Wesley, on his visits, won the affection of the Manx, and as a result the Wesleyan Church is very well established. There are Roman Catholic churches in all the larger towns.

Education. — Bishop Isaac Barrow in 1667 made education compulsory and founded a system of parish schools run by the clergy — the earliest scheme of compulsory education in the British Isles, In 1872, when the insular legislature passed the Elementary Education act establishing a board of education and local school committees, the state undertook direct responsibility for education. It became free in 1892 and a higher grade school was established in 1894. An act of 1907 established a system of secondary education. Parish boards were abolished in 1920 and one education authority took their place. The Education act of 1949 is based upon the English act of 1944. There are 31 primary schools (one Church of England, two Roman Catholic). Secondary school reorganization was completed in 1948, based on the bilateral system (combined grammar and modern sides), there being separate secondary schools for boys and girls in Douglas and mixed secondary schools in Ramsey and Castletown. There is a small public school for girls (the Buchan school) at Castletown. and a public school for boys, King William's college, founded from the funds of Bishop Barrow's charity in 1832. Among its famous alumni have been Dean Farrar, Field Marshal Sir George White. J. Ellerton the hymnologist, Sir W. H. Bragg and T. E. Brown the Manx poet.

For the language see MANX LANGUAGE AND LITERATURE.

GOVERNMENT

The government consists in a lieutenant governor, appointed by the monarch as lord of Man; a council or upper house; and a house of keys or lower house. The two houses sit separately as legislative bodies but come together to form a Tynwald court for certain business. The governor presides over the council and Tynwald; the house of keys elects a speaker. The Tynwald court and the house of keys constitute one of the most ancient legislative assemblies in the world. In the Tynwald court the two houses sit and vote separately but transact business and sign bills together. Tynwald controls revenue and appoints boards (education, agriculture and fisheries, local government, etc.). Customs duties are still controlled by parliament, but Tynwald can "impose, abolish or vary" customs duties. subject to parliamentary approval. The approval of the governor and the assent of the sovereign are necessary for every legislative enactment, and until lately such enactments were enforceable only after public proclamation from Tynwald hill in English and Manx. Acts of the imperial parliament are enforceable in the island only if the island is directly named in them. The lieutenant governor is the supreme legislative authority, chancellor of the exchequer and commandant of military forces and police. An executive committee (constituted in 1946) acts as an advisory council on all matters of government and consists of the chairmen of spending boards and other members of Tynwald up to a total of seven members. The governor presides, and the government secretary, attorney general and clerk of Tynwald are in attendance. There is little trace of party government and no party "whips," and the majority of members are independent. The house of keys is elected for five years but may be dissolved by the governor; there is universal suffrage for men and women above the age of 21. The island is divided into six sheadings (administrative subdivisions); four of these elect three members each and the other two elect two. The towns of Castletown, Peel and Ramsey each elect one member, and Douglas has five members.

The annual reading of the laws passed during the year is carried out on old midsummer day, July 5, on the Tynwald hill at St. Johns in the centre of the island. The day is a holiday and all inhabitants are bidden to attend. The Tynwald court assembles in the church of St. John for a short service after uhich it proceeds to the "hill," a mound of earth distant about zoo yd., preceded by the coroners, captains of parishes, clergy and other dignitaries. Only the titles of the acts are now read, first in English, then in Manx.

Law. — Until 1920 the governor was president of the high (supreme) court of justice, but after that date he had no judiciary powers. There are now two judges of the high court, called "deemsters," and they have complete jurisdiction covered by the general jail delivery. queen's bench, chancery, admiralty, probate and divorce divisions. There is no regular assize; deemsters' courts are held every week of the legal term in one of the court towns of the island. The senior deemster is also clerk of the rolls; both deemsters can be called upon to act as judges of appeal in cases in which they have not been concerned, and another judge of appeal is appointed from the English bar. Magistrates (justices of the peace) sit in the four court towns, uhere also the high bailiff (stipendiary magistrate) holds courts; he also acts as coroner in the matter of inquests, etc. The Manx coroner, one in each sheading, holds a less exalted position; he is a court officer, empanels juries, serves summonses, collects fines and acts as a bailiff in cases of unpaid debt. The Manx bar differs from the English in that its members (advocates) act as solicitors and barristers.

There are peculiarities in the laws of real property, but otherwise the laws are practically identical with those in England.

Arms. — The arms of the island are "Gules, three legs armed, conjoined in fesse at the upper part of the thighs, flexed in triangle, proper booted and spurred, or." The earliest appearances of the "three legs of Man" are on the hilt of the Manx sword of state (A.D. 1300), on the market cross of Kirk Maughold (*c.* 1350) and of more definite date on the shield of Henry de Bello Monte (1310) and the earl of Moray (1313). The origin is Sicilian.

The motto, *Quocunque* jeceris *stabit* ("It will stand wherever you throw it"), first appears on the coinage of 1668, jeceris being misspelled as gesseris.

ECONOMICS

Fishing. — The local fishing industry is almost dead, but a Scottish fleet lands herring in the summer at Peel, Port St. Mary and Douglas, where large quantities are kippered. The Manx kipper is famous and is the most valuable export. There is a profitable scallop fishing (Manx tanrogan) off Bradda head. Sizable salmon run up the larger rivers and there is a government salmon and trout hatchery at Kirk Michael. Liverpool university maintains a biological station at Port Erin which does scientific work in all phases of marine life.

Agriculture. — The central massif is not cultivated but is used as grazing ground for sheep. The northern and southern plain lands and the central valley have mixed and dairy farms. Of the chief crops (1955) about 17,000 ac. are occupied by cereals (mainly oats, a valuable export), 2,000 by potatoes and 12,000 by hay. There are extensive market gardens but not enough to supply the demands during the holiday season. The aim of the island is to be self-supporting in agricultural produce and a great deal is exported.

Industries. — By far the most important industry is the "holiday" trade; 500.000 persons, on an average, visit the island yearly from all parts of the British Isles. There are flourishing woollen mills producing Manx tweeds, and there are modern flour mills.

Communications. — There is a civil airport (with modern buildings, 1953) at Ronaldsway, near Castletown, which handles many planes daily from all parts of the British Isles. Packet boats maintain a daily service to and from Liverpool all the year round. The railway has two narrow-gauge single-track lines running, one from Douglas to Port Erin via Castletown, the other to Peel and Ramsey via St. Johns. The electric railway has a wide-gauge double-track line from Douglas to Ramsey via Laxey, with a branch to the top of Snaefell. There is a motorbus service from Douglas to all parts of the island.

The Isle of Man has taken a great part in the development of the gasoline engine by passing an act in Tynwald every year since 1904 closing the roads to ordinary traffic in order to allow the running of Tourist Trophy races for motorcycles and cars over a 37-mi. course from Douglas to Ramsey and back over the mountain road. These races test the engines, frames and accessories under very severe conditions. The car race began in 1904, the motorcycle in 1907. The motorcycle Tourist Trophy race has been continuous except for the war years, but the car race is intermittent.

Finance. — The finance of the island is based on a "common purse" agreement with Great Britain, by which duties imposed in Great Britain are also imposed in the island and amounts of duty paid for dutiable goods purchased in the island are credited to the insular exchequer from London on a basis calculated as the amount of consumption per head in Great Britain. There are no death duties, and income tax is lower than in the rest of Great Britain,

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(E. H. S.)

MANA is a word meaning "occult power" and occurs in many languages of Oceania. It is of uncertain origin, though probably introduced by immigrants from the west. While having also a wider and vaguer application, it stands for the "divine right" of the aristocratic class to wield authority and to enforce religious prohibitions. The sanction behind the taboo is the mana of the governing class, while conversely that taboo serves to keep the tribal mana intact; that is, ensures the good luck for all that waits on sound government. As a term of general anthropology mana may be treated as the positive while taboo is the negative aspect of the occult. In other words, the occult as such is taboo, or "not to be lightly approached," because it is mana, or charged with wonder-working power.

Noa Contrasted. — In the Pacific region the word "noa" is used to signify the opposite kind of object or situation which is "common"; that is, ordinary. The man who wields mana with impunity must abstain from all that is sordid. There are two worlds, a low-level and a high-level condition of spiritual activity, and a man cannot dwell in both at once. Thus by the very virtue of his profession the medicine man or the divine king must hold himself apart from those who by status or by choice are noa, laymen. The latter may live in brutish contentment; but to the end they lack enlightenment, participating in the highest mysteries at best from without. Every member of a primitive society is in some degree versed in experience of the occult, though for the most part some better-qualified person is present to help him through it.

The Crises of Life. — The initiation of youths, puberty, marriage, a battle, a hunt may all lead to privations whereby one may acquire mana, "a strong heart," "uplift." Tradition has devised very efficient means of coping with crises, whether of organic or circumstantial origin, by laying down a prescribed discipline which as it were enables the sick soul to go into retreat, so as by concentration on its inner resources to obtain an access of strength and comfort. (See PASSAGE RITES.)

Mana and Ritual.--Old-world religion is inarticulate, and mana stands for the power set in motion by ritual (q v.), almost regardless of the intention behind the ritual, which among savages is always apprehended rather than comprehended. Thus when the ritual is of a public nature and guaranteed by custom and tradition. the mana therefrom resulting is felt by all to be a good mana. Such and such is known to be the ceremony proper to the occasion, and everyone is sure that the society will be the better for it. If, on the other hand, a private individual in overt and sinister fashion trafficks with the occult, everyone is equally sure that a bad mana liable to afflict all and sundry will be unloosed. Sometimes, too. it is rather difficult to know which way a professional wonder-worker will use his power; for if he can heal he can also hurt, and it might occur to him to hurt if one did not make it worth his while to play the healer. Or, again, a man in authority will certainly use his mana to blast the public enemy, or even to suppress the unruly within his own society, and so far he will be acting legitimately.

Ambivalence.—Mana, then, is an "ambivalent" notion; it cuts both ways, implying alike divine and diabolic effects as possible manifestations of the awful power lurking in the occult. It is thus equally the root idea of religion and of black magic, since both equally use rites that, duly performed by the expert, bring mana into play; and the procedure will electrify or electrocute according to the will of the operator. In a dim way the primitive mind perceives, if it hardly conceives, that intention or will has to be incorporated in the notion of mana before its moral value can be expressed. Thus not only from the Pacific but from many other parts of the norld. Australia, for example, and North America, evidence is forthcoming of a tendency to split the notion into two, and distinguish a good and a bad kind of mana; as, for instance, orenda and *otgon* in the Huron dialect. For the Huron everything had its modicum of orenda — the deer, for instance, that might be clever enough to escape the hunter and thus outmatch his luck by greater luck of its own; but in this world of relative powers there were some that transcended man's so completely that in regard to them he must "lay down his orenda," which simply meant that he must "pray." Moreover. in such a warfare of competing agencies many might be expected to display otgon, the bad kind of orenda. If the primitive mind were clearer about the direction in which to turn for help in what is a pandaemonic rather than a pantheistic universe, the moralization of religion would correspondingly be brought about. As it is, the notion of the divine power would seem to be historically prior to that of the divine goodness, whether displayed as justice or as love.

Pervasiveness. — In particular. the very fluidity of mana makes it hard for religion to identify it with the good will of a personal god. It is all-pervasive. manifesting itself here. there and everywhere in the most momentary experiences of the occult. Or, even when, as in the case of the living medicine man or king, it can be referred to a definite owner, it is apt to discharge itself through anything that has been in contact with him; so that, with so many transmitters in the shape of his bones or other belongings, secondary storage cells of divine energy are distributed in all directions. Mana thus implies a religious experience that is primarily of the perceptual order, a frame of mind in which the sacred is simply "sensed." A conceptual attitude is not likely to come into being until the manifestation is individualized by being invested with a proper name. A god or even the merest demon who can be propitiated by name, has a chance of acquiring a personality and a moral character

The "Numinous." — It may be, however, that little more than the binding force of the bare name is involved in the ritual invocation, as when the Roman ejaculated a number of preposterous vocables corresponding to the parts of the door that he wished to construct "rite," "according to form." When *nomina* are thus *numina* and no more, the stage of mana has not been left behind; and indeed the word "numinous" has been suggested to cover the sacred in its more impersonal forms. It only remains to add that the mana-taboo formula, together with animatism, preanimism, dynamism. numinism or any other terms — the now discarded word "fetishism" is one of them — that have been used by theorists in the same connection, may or may not apply closely to the beliefs and institutions of some particular people, and may or may not be represented by appropriate words in a given language. Their value consists entirely in such help as they may afford in describing generally a phase of the religious life in which the need of coming to terms with the mysteries that beset life at once from within and without is satisfied mainly by ritual action, running ahead of articulate and reasoned doctrine, but none the less powerfully moving.

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MANAAR, GULF OF, a portion of the Indian ocean lying between the coast of Madras and Ceylon. Its northern limit is the line of rocks and islands called Adam's Bridge. Its extreme width from Cape Comorin to Point de Galle is about zoo mi.

MANABÍ, a province in the coastal lowland and hilly belt of Ecuador. bounded west by the Pacific ocean, north by Esmeraldas, east by Pichincha and Guayas and south by Guayas. Area 7,306 sq.mi.; pop. (1950) 401.378 Its capital is Portoviejo, pop. (1950) 16.300. The province is occupied chiefly by lowland Indians, who have successfully withstood the advance of the Negroes from the north. The chief products are cotton, coffee, sugar cane, rice, beef cattle and goats. From the fibre of the toquilla palm. a plant that grows wild in the semiarid scrub woodland. the Indian women weave Panama hats. The forests also yield balsa wood, tagua nuts and fine cabinet moods.

Connections are by sea through Manta and Bahia de Caráquez or in dry weather by road from Quevado. (P. E. J.)

MANACOR, a town of Spain in the island of Majorca. Pop. (1950) 18,702 (mun.). Nearby are the caves of Drach. with underground lakes, Els Hams and Arta, one of the largest and finest groups of stalactite caverns in western Europe.

MANADO, formerly a residency of the island of Celebes (*q.v.*), Netherlands Indies, comprising the northeast peninsula and the coast of the Gulf of Tomini; area 34,203 sq.mi.; pop. (1930) 1,138,65j.

MANAGEMENT SCIENCES is a phrase intended to represent a common and mutually accepted concern on the part of a number of scientific disciplines with the study and solution of the problems of management. World War II and the period after saw a great increase of interest on the part of the applied scientist in the management problems of the military and of industrial firms. Recognition of this common interest led to the formation of new societies in the Gnited Kingdom, the United States, and throughout Europe. Asia and Australia: such as the Operational Research society (U.K.). the Operations Research Society of America, The Institute of Management Sciences and Société Française de Recherche Opkrationelle. The phrase "operations research" which appears in some of these titles, was originally used by the military agencies in the U.K. and the U.S. to designate teams of scientists who studied military operations. but has since come to designate the application of science to any operations initiated and controlled by managers. Hence the phrases management science and operations research are often used interchangeably, although the latter sometimes refers to applied research conducted under contract. Similarly. because of a mutual interest in the process of decision making, decision theory and organization theory frequently have the same connotation as the management sciences. The scientists. in the typical fashion of such cases where the object under investigation is not easily susceptible to recognized methods of science, are groping for names that will adequately portray their interests.

Definition. — The management sciences are bound together by more than a common intellectual interest; they also share a common philosophy of method: namely. the need ior more rigorous analysis of the complicated problems of management. This need can often be satisfied by the use oi mathematics or of carefully controlled observation and experiment. Opinions about the importance of mathematics vary among those who recognize themselves to be management scientists, but most if not all would admit that science connotes among other things the attempt to become as precise as possible and that mathematics is one of the chief resources of the mind in this endeavour. Differences of opinion usually reflect different judgments about the possibility of reaching refinement oi language in specific projects, and the relative importance of research problems. Sometimes the management scientists try to characterize their aims in terms of quantification of managerial activities, because they feel that this term connotes the refinement and rigour they aspire to, and not because they feel any importance attaches to numbers as such.

In order better to understand the goals that hold this community of scientists together and motivates them to form associations, one has to examine the concept of management with some care. Any such scrutiny reveals the confusion that attaches to the word in the English language. Often management has a very special connotation; for example, the class of rulers in a society as opposed, say. to labour. Often the phrase is used in a very general way to connote rational behaviour. as when we say that a man manages his affairs very well. Neither connotation represents what the management scientist has in mind. For him, examples of managers are to be found among those who act as administrators or executives in firms, unions, city, state or federal governments, military agencies, churches and educational institutions.

Thus it is not too difficult to point to specific examples of managers. But it is clear that persons who are called managers do not always manage, and it is almost as obvious that many persons who are not called managers are really a part of the management process. Hence, there is a need to define management as a certain kind of activity, rather than a certain kind of person. Most management scientists would agree that this activity must take place within human organizations. Even this minimal agreement is at variance with some common usage; it precludes talking about the management of a beehive. for example, or the management of one man's affairs. But when scientists band together under a common name, this kind of opposition to common meanings is quite usual.

Next, the community of management scientists would also recognize that the activity or management in organizations includes at least the following: (a) discovering, developing. defining and evaluating the goals of the organization and the alternative policies that will lead toward the goals, (b) getting the organization to adopt the policies, (c) scrutinizing the effectiveness of the policies that are adopted, (d) initiating steps to change policies when they are judged to be less effective than they ought to be. Activity (a) is often called planning and is essentially a cognitive activity carried on by individuals or by committees, who use iniormation collected for them by their staffs. It has become convenient to characterize planning as short range and long range. Long-range planning emphasizes the fact that management may be obliged to consider the survival and growth of the organization over many years, and hence may have to consider many social and intangible goals not usually relevant in short-range plans. Activity (b), the adoption of plans. is an extremely difficult one in large organizations. A paper-and-pencil plan, no matter how attractive to the manager, often cannot be put into action by a simple order. Elaborate communication systems may have to be designed to get a large body of persons moving in the planned direction, and the many subleties of persuasion and motivation are involved as well. Activity (c), the "on-going" scrutiny of the effectiveness of adopted plans, is often called control, and is a function that in some instances is the responsibility of accounting staffs. Activity (d), the process of changing plans once they are deemed ineffective, requires not only a designed data processing system, but it also entails the search for the mean between the extremes of changing too oiten and not changing often enough.

If management is characterized in this manner, it is a term which is applicable to any organized, goal-seeking group of persons. Hence the phenomenon of management may occur in national governments. civic governments, labour unions, schools, universities, business firms and even in scientific research establishments. One should recognize that management does not connote rigid control; an organization may be managed best by permitting maximum freedom of decision among its members.

Further, it should be noted that management as defined above will oiten include the activities of staff as well as line personnel in an organization, and may in many cases include some aspect of the activities of every member of the organization. Indeed, as in the case of any teleologically defined activity, it is usually not possible to separate management behaviour from nonmanagement behaviour or managers from nonmanagers. A foreman of a shop may in the same act be serving the function of management and the iunction of production. On the other hand, it oiten happens that the owners of a firm, members of a union or the citizens of a country do not manage the organizations that supposedly serve their interests. The management of these organizations seeks to determine the goals of the interested parties and tries to make these goals a part or whole of the evaluation basis of their plans, but the interested parties themselves may contribute very little to the management of the enterprise.

The definition of management does not imply that all forms of management are good, but the community of management scientists does have a strong interest in establishing criteria of good and bad management. In this sense, the management sciences are not primarily descriptive, although detailed descriptions of management processes may be quite important. Instead, they are predictive. But interest lies not only in predicting what a given management will do in a certain circumstance, but more fundamentally in predicting what would occur if certain activities mere adopted. The outcomes of these predictions are then evaluated, and an attempt is made to rank management activities in terms of better and worse, and if possible to discern the best. Evidently, this evaluation is based on a decision as to whose interests are to be served by management or, more precisely, how various competing interests are to be weighted.

The community of management scientists is largely made up of persons from various disciplines; very few claim this field as their sole area of expertise. Interest in and conceptualization of management problems depends on the background of the scientist, so that the management sciences inevitably display radically different emphases. In true academic style, the more vocal management scientists are apt to argue that their own approach and emphasis is fundamental, thus giving rise to the healthy disputes that constitute intellectual growth.

One description of the composition of the community of management scientists follows a traditional classification of the sciences that leads from logic and mathematics through the physical and engineering sciences to biology. psychology and the social sciences, culminating in ethics. But it may be noted that this classification is at best arbitrary, reflecting as it does but one structure of the sciences. Indeed. the adequacy of a classification of the sciences is itself a problem oi the management of science, so that members of the community might well be expected to differ on this score as well.

Logic. — Logicians find in the study of management a fertile field for axiomatic theory. The post-World War II trend in the management sciences emphasized both mathematical models and the development of precise measurements. In either case, there was a clear need ior a rigorous iormulation of the underlying language. This need was especially true in the case of measurement. a term nith many historical meanings. The tradition in the management of firms has been that some aspects of the activity are measurable (*e.g.,* a cash balance) and some, called intangibles, are not (*e.g.,* good will). On the other hand, pure scientists observing the vagueness of discourse that surrounds business research often have been inclined to say that in this area nothing is ever really measured. The logicians' task has been to state in as unambiguous a manner as possible what measurement is, what kinds of measurement there are and what can be said in terms of each kind. Of particular importance to the management sciences has been the axiomatic treatment of utility and subjective probability. In the case of utility, an attempt has been made to state in unambiguous terms a theory of preferential choice in decision-making situations. Formal studies of subjective probability try to define precisely a decision maker's beliefs in the likelihood that a certain outcome will follow upon a choice; these studies are based on the observation that even the most carefully educated man does not behave in accordance with the principles of objective probabilities. For example, it has been found that in relatively simple gambling situations involving the toss of a coin, persons typically believe heads (or tails) will be more likely to occur. No doubt this bias in favour of certain kinds of events is also displayed in the attitudes of many managers as well. The scientific task is to measure the attitude in order to better understand the subtle ways in which subjective probabilities influence decisions.

Mathematics — Interest in the mathematics of management increased tremendously after World War II, although a number of notable treatises had appeared before. This interest resulted in new fields of mathematical research, fields whose titles reflect the potential application to management problems: inventory theory, waiting line (queuing) theory, linear and nonlinear programing, dynamic programing, game theory. Many of the traditional fields of mathematics have been the bases of these developments, but maximization theory and probability theory are extremely important in this connection, because almost all criteria of evaluation are expressed in terms of maximizing some variable, and because almost all management decisions are based on probabilistic forecasts. The nature and diversity of the mathematics of management can be suggested by brief characterizations of some of the more important examples.

Inventory Theory. — This provides a language for describing the status of a system that is subject to a pattern of demand and has available resources for building up supplies. The demands may be probabilistic and may vary in kind. The replenishment may be subject to delays and uncertainties. The reservoir may be depleted by obsolescence and deterioration. Management costs include cost of shortages, cost of replenishment, cost of holding the supplies. Many studies have been made of inventory problems; it has been found possible to predict the demands on inventory within statistical limits and to estimate the net costs of adopting various inventory policies, even when there are many kinds of inventory, seasonal fluctuations and unpredictable demands. Mathematical language is not restricted to the original intent of its designer. Thus inventory theory may be applied to many problems where the term inventory would not normally be used, such as planning of personnel assignments, parking facilities and cash flows.

Waiting Line Theory. — The language of a system of service units, this describes how customers arrive for service. how service meets their requirements in terms of average service time and variation in service time, how long the customer may have to nait, how long the service unit may be idle.

Linear *Programing*.—A language of activities which describes how these activities utilize their resources in order to accomplish certain prescribed tasks; linear programing also describes how these activities operate within the limitations of time and space. The term linear reflects the fact that the basic descriptions must take the form of linear algebraic equations (or inequations). Nonlinear programing permits a relaxation of this requirement. The language of Iinear programing is astonishingly versatile. In addition to its obvious use in the planning of production schedules, it has been employed in such areas as military logistics, transportation and traffic, personnel assignments and salary levels.

Dynamic Programing. — This maximization theory, among other uses, permits one to maximize over a whole series of states where each state depends on decisions that have been made in earlier states. This language allows one to state in rigorous terms the period-by-period consequences of decisions and to calculate the desirability of incurring temporary losses, say, for the sake of long-run gains.

Game Theory.—A language for describing competitive strategies when the opponents can influence the probability of success of the other "players" under prescribed rules, and can form coalitions to thwart the activities of others. This language therefore is well adapted to the study of competition, but its application has not been extensive because in many realistic problems it is difficult to ascertain what the players really want and the rules that govern their plays. (See GAMES, THEORY OF.)

In addition to these languages, the following can also be mentioned: theories of search, replacement, communication, information and decision making.

All these languages enable the scientist to state in rigorous terms the nature of the problem as he sees it, and the consequences of alternative decisions even when the situation is extremely complicated. Many management problems continue to defy the best efforts of mathematicians to describe them, so that the management sciences devote a great deal of effort in searching for even richer languages than those developed thus far. The complexity and subtlety of many management problems have quite naturally led the unwary to force the problem to fit an existing mathematical model, a procedure that is certainly not unique to this field of science.

Mathematical Statistics. — From the 1920s and 1930s, this discipline has attempted to formulate its foundations in terms of the utilization of information for decision making under uncertainty; it therefore shares a common concern with the management sciences, despite differences in terminology. In a sense, the manager of an organization is a statistician, since he gathers data and attempts to test hypotheses, while taking cognizance of the risks and losses associated with wrong decisions. Mathematical statisticians have tried to give a precise formulation of this process, and to determine optimal solutions in cases where the data can be assumed to come from some random source. Of course, in most management problems it is difficult to ascertain the random characteristics of the data, and it is not generally possible to set up experimental designs to test for randomness. But there can be little doubt about the usefulness of a number of statistical models in management studies, and especially models of control and stability.

The physical sciences would normally be expected to have only an indirect interest in management problems, although in the postwar period a number of physicists and chemists applied their research abilities in this area.

Engineering Sciences. — On the other hand, engineering shares many problems with management sciences. For example, the engineer is often concerned with systems in which human beings are links. These systems are goal directed and must include devises that enable one to adjust the activity when it deviates from the goals significantly. It is clear, therefore, that the manipulation and control of an engineered system (*e.g.,* a chemical plant or a guided missile) has many characteristics in common with the management of a human organization. The chief difference seems to be one of degree: the importance of motivation, status, persuasion may be less in the engineered system. But some engineers have quite naturally wanted to apply their knowledge to the area of management. This interest goes back at least as far as the "scientific management" movement, which, in its earlier development, seems to have been chiefly concerned with the control of procedures, especially those of the shop. This movement showed little inclination to develop mathematical models of these procedures, but rather tried to use careful observation and physical measurement to discern how improvements could be made. In this regard, the scientific management movement differs radically in its philosophy from the management science movement. Perhaps this difference can be clarified by saying that scientific management was not interested in trying to develop a model that would reveal all alternatives and provide a criterion for the selections of the optimal choice. Those who, like some "systems-and-procedures" or "time-and-motion" engineers, followed the scientific management movement have been somewhat apart from the community of management sciences, a segregation that may very well be a phase in the maturation of each group.

However, systems engineers who design electronic systems must construct models of the system and it is natural to associate themselves with the management sciences movement. Many industrial engineers have also approached the problems of the scientific management movement from a mathematical point of view.

One output of the systems engineer has been of great importance to all the management sciences: the development of high-speed computers. Evidently the problems of management may involve many variables. and the solutions thus require quite elaborate computations. Such has been especially the case with linear programing models. where several algarithms have been developed which can most economically be solved by computers. Furthermore, the management sciences have found the simulation of a system to be enormously helpful in understanding its complexities, and computers frequently provide the means for simulating. Finally, in the early 1960s there was considerable interest in "business games" and "military games." These games partially simulate an organization in a specially constructed competitive environment. The computer enables the researcher to structure the environment in rather complicated ways, and yet to derive the consequences of the managerial decisions of the teams in a short time. These simulations differ from simulations of a model in that they include human inputs which the experimenter does not control, whereas in model simulation every input is a decision of the experimenter. The games provide the management scientist with an opportunity of performing controlled experiments with more and more complicated structures.

Biology. — One might expect some coalition of biologists and management scientists, because (1) the analysis of the concepts of organism and organization clearly share a common ground and (2) the central nervous system seems to display a managerial activity. In the early 1960s, however, there were only a few instances of this mutual sharing of intellectual ideas.

Psychology. — Psychologists have studied management from several points of view. Some have concentrated on intense experimental studies of decision making, where the choices are relatively simple and the relevant variables can be controlled. These studies are intended to investigate the utilities of the decision maker and to relate these utilities to other personality variables or to his material or social environment. Some experimental studies have observed the effect of communication patterns, psychological variables and the social environment on the performance of groups who have been given specified tasks to perform. According to one viewpoint, these small group studies are a logical prelude to controlled observation of larger organizations.

Learning and problem solving are psychological concepts that are extremely important for management and hence for the management scientist. It would be unrealistic to picture the manager as a person who knows all the alternatives and merely tries to select the best from the available. Instead, the manager searches for new alternatives and for new goals. He is presumably engaged in a gigantic learning process by which he hopes to make his activities better. Thus the management scientist may try to understand not only what is optimal. but also how one may move most adequately in an optimal direction. Many management problems entail a fantastic number of discrete alternatives. In some of these situations the important problem may be the learning process and not the direct selection of the optimal choice. Hence management scientists share with some psychologists an interest in developing more rigorous models of learning.

Many psychologists have been willing to sacrifice precision in order to gain a broader view of management: *e.g.,* to study conscious and unconscious motivations, status or the "actual" way in which decisions are made. It must be admitted that the management scientists have not been in agreement about the importance of these studies, primarily because although their general value may be apparent, the manner in which they fit into more rigorous models of management is not clear. Similar remarks apply to social psychology and sociology. No doubt here too both the management sciences and the social sciences are in a period of transition; the one may tend to relinquish its rigid and often naïve insistence on precision, while the other will come to recognize the great research power provided by the mathematical languages.

Economics. — During the 20th century, economists have shown a divided opinion on the importance of rigour in economic studies. Some have felt that emphasis on rigour may sacrifice significance. But the econometrician and mathematical economist are clearly allied with the management scientist. Indeed, many such economists view the work of the management sciences in business firms as a logical development of micro-economics. It is true that much of the mathematics of management has come from economics; queuing, search and replacement theory being important exceptions. Although systems engineering and human motivation other than that expressible by utility functions have not been the concern of the traditional economists, some economists think that both these areas are of dubious importance at best to the development of the management sciences. In any case, in the years following World War II, the mathematical economist came to play a central role in the management sciences. Some economists have called themselves managerial economists, to emphasize the fact that the studies of management problems belong in a subclass of economic studies.

Business Administration. — Tending to regard itself as a profession prior to World War II, business administration's chief method of research and instruction depended on detailed descriptions of cases. As would be expected, the management scientist does not look upon the case method as a scientific method. partly because the language of the case studies is not precise, but mainly because there appears to be no basis for relating the case to the population of which it is presumably a sample. After World War II, a number of business administration faculty joined the management sciences. In some instances, these researchers found it possible to develop mathematical models of marketing behaviour or financial policy making or production planning, that satisfied the criteria of the scientific community and were at the same time useful to managers. In other instances (especially in accounting), the management sciences have presented new problems to an old profession. Although managerial accountants sometimes speak as though certain types of accounting data could be used for planning, a careful scrutiny often reveals that the data must be presented in an entirely different way, and that additional data have to be obtained, before an optimal decision be estimated. Many accountants point out that accounting has other functions to perform besides that of aiding the manager in his decisions. But it is natural to expect that the growth of the management sciences will attract the interest of research minded accountants. The term administration has raised semantic problems for the management scientist. Many would prefer to use it instead of management because it is less apt to reflect the unintended connotations of rigid control or of management v. labour. Others feel that administration should be restricted to the execution of plans and not to their origination.

Organization Theory. — This sometimes refers to a set of principles that are intended to predict how effectively a social group will behave when given an organized structure of lines of authority, responsibility, control, etc. In the 1960s, many students of organization theory tried to develop rigorous models and to incorporate the findings of the behavioral sciences. Thus the intellectual objectives of the management sciences and organization theory are quite similar, especially because organization theorists emphasize the role of management in organization designs.

Other Disciplines. — Law, political science, anthropology, city planning, education and history have a research interest in the study of management, but few of their representatives believe strongly in the feasibility of developing rigorous models of and applying precise measurements to the phenomena they study. This condition seems to be true of ethics and epistemology as well. One would expect that a community of scientists whose chief interest lies in the study of optimal plans and procedures would inevitably find itself deeply concerned with ultimate values. But management scientists tend not to translate this concern into research activity, but rather to accept the value of an enterprise as "givens," no doubt because they are skeptical of the possibility of precise methodology in the area of ethics. Similarly, epistemology could be interpreted rather easily as the study of the management of groups whose aim is to acquire knowledge; *i.e.,* epistemology could be understood as the theory of the management of science. though the use of such terminology might be undesirable in view of the connotations of rigid control that are often associated with the concept of management. But if one keeps in mind the much more general characterization given above, then a plausible case can be made for the position that pragmatism is the philosophy of management (or more generally perhaps, of decision theory). But most pragmatists have not shonn a strong interest in the management sciences.

As would be expected, it is not at all clear when a study should be regarded as belonging within the purview of management science. Perhaps the only operational criterion is whether or not the study would have been accepted in any of the existing journals that clearly publish in this field. But such a criterion would ignore the rather rapid changes that are taking place in the management sciences: changes which will bring about a recognition that many studies of the so-called less exact disciplines are really instances of management science.

Importance. — From this account of the sciences one can readily understand that the phenomena of management is pervasive both in the engineering and the social sciences. Furthermore, few can deny the importance of management for the human race, especially in an age when almost all major social problems are studied and resolved within an administrative framework. But until the post-World War II period there was no strongly discernible trend to bring this common interest under one discipline. Thus management is sometimes viewed as the control of a system or as a set of interacting psychological forces or as an economically directed activity or as an activity directed toward the public welfare or as an ethical activity. Each discipline has looked at the phenomena through its own spectacles. The management scientists have tried to bring about a coalition which may eventually lead to an established discipline. They have often done this under the banner of a methodological adherence to the value of rigour and therefore at some risk to their entire efforts. for those who prefer not to march under this banner are bound to declare that one's choice in this area is to be precisely insignificant or vaguely significant. And those who prefer the foundations of their own disciplines are bound to find any proposed coalition both dangerous and needless, no matter how much they sympathize with the attempt to become precise. Like all movements, this one will have to develop with due regard to its dilemmas.

Nothing has been said so far about those who are called managers. The management sciences are unique in this respect: the subjects whom they investigate (1) are very vocal and critical, (2) maintain persistent pressure on the scientists to produce something "useful" and "intelligible" and (3) often support the research. These facts sometimes make it difficult for the management scientist to be "pure," even if he is so inclined. Furthermore, the dilemma of precision *v.* communication is especially acute when the scientist must talk to the manager. Also, the manager may try his best to influence the direction the field will take. All of which leads one to conclude that the management sciences in all likelihood will have to develop their own peculiar methodology, and will not be able in time to rely on the traditional successful means of other disciplines.

See also PRODUCTION MANAGEMENT; MASS PRODUCTION; JOB EVALUATION; CYBERNETICS; COST ACCOUNTING; OFFICE MANAGEMENT; AUTOMATION.

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MANAGUA, a small department in Nicaragua, bordering three sides of Lake Managua. Area 1,332 sq.mi.; pop. (1950) 161,513. The population is 71% urban and is concentrated in the volcanic zone southwest of Lake Managua. With fertile volcanic soils. the department is important in producing coffee. dairy products. vegetables and fruits. Managua city, the departmental capital. is located on the southeast shore of Lake Managua, in view of smoldering Mt. Masaya and the extinct volcanoes of Momotombo and Momotombito. (C. F. J.)

MANAGUA, capital of Nicaragua and of the department of Managua. is the largest city in the Central American republic. Pop. (1950) 109,352. The city lies on the southeast shore of Lake Managua (Xolotlán), which is 38 mi. long and 16 mi. wide, the lesser of the two great lakes which are one of the chief physical characteristics of the country. It is on the Pacific railroad, 87 mi. from the port of Corinto, and on the Pan American highnay. It is connected with the important cities of the world by airlines and has tno airports. Las Mercedes (International) and Xolatlán (local). Managua is the industrial and commercial centre of Nicaragua; its factories produce cotton fabrics, beer, cigarettes and matches. It is also the centre of an important agricultural region which produces cotton. rice and coffee; cattle are also raised and exported.

The city is located in beautiful surroundings between Lake Managua and the tiny lakes of Xsososca. Nejapa and Tiscapa. Its climate is rather hot and humid during most of the year but many residents have built homes on the hills around the city, where the temperature is cooler. There are many new buildings of modern architecture, among them the communications palace and the social security building. The presidential palace and the U.S. embassy are on the southern outskirts of the city.

Managua's importance began in the late 1840s when it was used as a compromise capital in order to avoid the rivalry between Granada and Leon; it was established as the final site of the capital in 1855 after the war against William Walker (*q.v.*). The city was occupied almost continually between 1912 and 1933 by U.S. marines. In 1931, it was almost completely destroyed by earthquake and fire.

In addition to being the political capital of the country, Managua has been the religious capital since the beginning of the 20th century. when it was made the site of an archbishopric of the Roman Catholic Church. (M. F.-G.)

MANAKIN, applied to the small birds which form the family Pipridae, a passerine family allied to the Tyrannidae. They are peculiar to the neotropical region, living in deep forests. associating in small bands, and keeping continually in motion, but feeding almost wholly on the large soft berries of the different kinds of *Melastoma.* The manakins are nearly all birds of gay appearance, generally exhibiting rich tints of blue, crimson, scarlet, orange or yellow, in combination with chestnut, deep black. black and white or olive green; among their most obvious characteristics are their short bills and feeble feet, with the outer and middle toes united for a good part of their length. P. *leucilla,* one of the best known, has a wide distribution from the Isthmus of Panama to Guiana and the valley of the Amazon; but it is one of the most plainly coloured of the family, being black nith a white head. They are often kept in captivity.

MANASSAS, a town and seat of Prince William county, Va., U.S., 25 mi. S W. of Washington, D.C. The town, first known as Manassas Junction, came into being in 1853 when the Manassas

Gap and the Alexandria. Orange and Midland railroads were joined. During the American Civil War this strategic junction afforded a direct connection between the Shenandoah valley and the railroad from Washington to Richmond. Confederate forces won the battles of First and Second Manassas (Bull Run, *q.v.*) nearby; the battlefields are preserved by the national park service. Manassas was incorporated as a town in 1873 and in 1892 it became the county seat, Prince William's fifth. It adopted a city-manager form of city government in 1927 and was rechartered in 1938.

Manassas with a population of about 3,500 is a trading centre for a general farming. dairying and stock raising area. Brushless generators are manufactured there. Many residents are government workers and skilled craftsmen who commute to Washington. the marine base at Quantico and other government installations. (G. M. BE.)

MANASSEH (in the Douai version of the Bible, MANASSES), king of Judah, succeeded his father, Hezekiah (*q.v.*), and reigned about 692–638 B.C. That he maintained his position so long is a tribute to his statesmanship, and probably his kingdom prospered materially. Very little is heard about him, however, because his recognition of alien cults was a grave offense in the eyes of those who edited the historical writings. He is, indeed, held responsible for the ultimate ruin of the kingdom. He was very much under the influence of Assyria, and documents from his reign unearthed at Gezer disclose the presence of Assyrians in his realm, the use of their language and method of dating. No doubt his introduction of the worship of the host of heaven and other Assyrian cults was dictated by political rather than religious motives. He may well have been involved in the conspiracies of Shamash-shum-ukin, the rebellious brother of Ashurbanipal. If so, the account of his deportation to Babylon, and subsequent return (II Chronicles xxxiii, 11–13) may be historical. Manasseh appears in inscriptions of Esarhaddon and Ashurbanipal as an Assyrian vassal. (W. L. W.)

MANASSEH, a tribe of Israel, was descended, according to the traditions. from Manasseh, the elder of the two sons born to Joseph by his Egyptian wife Asenath, the younger being Ephraim. Numbers xxxii states that half the tribe received an allotment of territory in the conquered land of Gilead, east of Jordan. In Joshua iv, 12 it is stated that this part of Manasseh joined with Reuben and Gad in support of the tribes who mere fighting for a foothold on the west of the river. But other traditions tell of a Manasseh tribe settled west of the Jordan. In Joshua xvi–xviii Manasseh, regarded as forming with Ephraim a single tribe, is settled in the hill country south of the fertile Plain of Esdraelon and cut off from it by a strong chain of fortified Canaanite towns. Its western border is the Mediterranean; but the territory occupied by it cannot be defined with precision. Machir, the "son" of Manasseh, seems to represent sometimes that part of Manasseh dwelling in central Palestine, sometimes an element of that part of the tribe dwelling east of the Jordan. and sometimes the whole tribe. Machir appears in the ancient poem Judges v as taking part in the struggle against Sisera, and seems to have Zebulon on the one side, Ephraim and Benjamin on the other. as neighbours. From I Chronicles vii, 14 it may be deduced that the tribe contained some Aramean elements. The various traditions are so confused that certainty in detail seems unattainable. To Manasseh belonged the deliverers Gideon and Jephthah. (W. L. W.)

MANASSES, CONSTANTINE (d. 1187), metropolitan of Naupactus, was an author of Byzantine "political" (*i.e*, 15-syllable) verse and of prose works. At the request of Manuel I's sister-in-law, he wrote a verse chronicle *(Synopsis historike)* from the creation to 1081. His verse romance on Aristander and Callithea survives in fragments only. He wrote a variety of other poems, as nell as descriptive pieces in prose (some on works of art), and a number of orations, including an address to Manuel I and a funeral eulogy of Nicephorus Comnenus. Much of his work is unedited.

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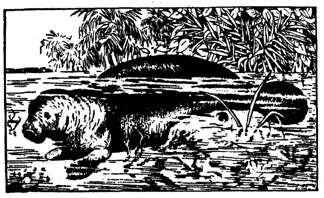
MANASSES, PRAYER OF, a short apocryphal book of the Old Testament. It purports to be the prayer of the Judaean king Manasseh (*q.v.*) referred to in II Kings xxi, 1–18 and in II Chron. xxxiii, 1–20. This fine penitential prayer seems to have been modeled after the penitential psalms. It exhibits considerable unity of thought, and the style is, in the main, dignified and simple. The date of its writing is unknown. Some scholars assign it to the Maccabaean period (2nd century B.C.), but its eschatology and doctrine of "divine forgiveness" may point to an earlier date; on the other hand, there are some indications of a doctrinal character which point to post-Maccabaean times. The book was used in the early Christian Church, but was never included in the Vulgate Bible.

For the text, *see* H. B. Swete, *The Old Testament in Greek,* vol. iii (1894). *See* also H. E. Ryle in R. H. Charles (ed.), *The Apocrypha and Pseudepigrapha* of *the Old Testament,* vol. i (1913).

MANATEE or MANATI, the name of the American representative of a small group of herbivorous aquatic mammals, constituting the order Sirenia (*q.v.*). Manatees are somewhat whalelike in shape, with a similar horizontally expanded tail fin; but here the resemblance to the Cetacea ceases. The American manatee, *Trichechus manatus,* inhabits the rivers of Florida, Mexico, Central America and the West Indies and measures from 9 to 13 ft. in length. The body is somewhat fishlike, but depressed and ending posteriorly in a broad, shovellike, horizontal tail, with rounded edges. The head is of moderate size, oblong, with a blunt muzzle, and divided from the body by a slight constriction. The forelimbs are flattened oval paddles, placed rather low, with no external signs of division into fingers, save three diminutive flat nails near their extremities. No traces of hind limbs are discernible either externally or internally. The mouth is peculiar, the snollen upper lip being cleft in the middle line into two lobes, each of which is separately movable. The nostrils are two valvelike slits at the tip of the muzzle. The eyes are minute and nearly circular with wrinkled margins; external ears are wanting. The skin is dark grayish and finely wrinkled. There is a scanty covering of delicate hairs, and both lips are supplied with short, stiff bristles. Manatees have a number — as many as 20 pairs in each jaw—of two-ridged teeth, of which, however, comparatively few are in use at once. They lack the large tusks of the male dugong (q v.). In life the palate has a horny plate, with a similar one in the lower jaw.



FROM VOGT AND SPECHT, "NATURAL HISTORY OF ANIMALS" (BLACKIE)

THE MANATEE (TRICHECHUS INUNGUIS) OF THE AMAZON

Manatees inhabit bays, lagoons, estuaries and large rivers but not the open sea. As a rule they prefer shallow water, in which, when not feeding, they lie near the bottom. In deeper water they often float, with the body much arched, the rounded back close to the surface and the head, limbs and tail hanging downward. They feed below water on aquatic plants. They are slow of movement and perfectly harmless but are persecuted for the sake of their oil, skin and flesh. From the shoulder joint the flippers can be moved in all directions, and the elbow and wrist permit of free extension and flexion.

In feeding, manatees push the food toward their mouths by means of the hands and introduce it without the assistance of the lower lip, the action of the upper lip recalling that of the mandibles of caterpillars.

The Amazonian manatee (T. *inunguis)* is smaller, not exceeding 8 ft. in length, nith less well-developed lip pads and without nails to the flippers. It ascends most of the tributaries of the Amazon until stopped by rapids. The West African T. *senegalensis* extends about 10° S. and 16° N. of the equator and ranges into the continent as far as Lake Chad. From 8 to 10 ft. appears to be the normal length; the weight of one specimen was 590 lb. The colour is bluish black, with a tinge of olive green above and yellow below.

The manatee is said to be the origin of many legends of mermaids, while the Amazonian species is the object of superstitious reverence by the Indians.

MANATÍ, a town of Puerto Rico, situated in the northern part of the island, about 3 mi. from the Atlantic ocean. Pop. (1960) 9,682 (mun. 29,354). Manati is located in a beautiful valley drained by the Manati river. The name is of Indian origin and refers to a sea mammal called manatee in English. The soil of the rural area around the town is very fertile. Sugar cane and pineapple are extensively cultivated; coffee, grapefruit, oranges and bananas are also produced. Several important industries, including a shoe factory, have been established in the town.

(T. G. Ms.)

MANAUS (MANÁOS), a city and port of Brazil and capital of the state of Amazonas, is on the left bank of the Rio Negro, 12 mi. above its junction with the Amazon (Solimões) and 900 mi. above the mouth of the Amazon in the heart of the Amazonian rain forest. Pop. (1956 est.) 164,799 (mun.). Manaus stands on a Tertiary terrace overlooking the river, 106 ft. above sea level, traversed by several *igarapés* (canoe paths) or side channels that are spanned by bridges and divide the city into separate compartments. The climate is less oppressive than is commonly believed—the annual average temperature is 81° F., relative humidity 82% and average rainfall 75 in.

hlanaus has a famous botanical garden, a zoological garden. a museum and a tropical research institute. Its majestic public buildings and homes, including the ornate opera house, where Caruso sang on opening night, date from the period 1890–1920 when the rubber boom brought wealth and luxury to hlanaus. The port, which is the commercial hub of the entire upper Amazon region, was nothing but a river anchorage before 1902. In that year, an English corporation began improvements which included a stone river wall or quay, storehouses for merchandise and floating wharves or landing stages connected with the quay by floating bridges. The floating wharves and bridges are made necessary by the rise and fall of the river, the range between high and low waters reaching jo ft. under extreme conditions. The principal exports are rubber, Brazil nuts, rosewood oil and jute; a host of minor forest products also move through the port. Cordage and coffee sacks are made in Manaus from locally grown jute. The city receives its beef from the savannas of the upper Rio Branco and from that region also come hides and horns for export.

Manaus is a regular stop on the shortest north-south air route between Miami, Fla., and eastern Brazil. It also serves as the hub of the well-developed air service of the Amazon valley. The port has direct steamship connections with New York and Great Britain and with all ports of the Amazon river system. A 5,000-bbl. refinery, built on a bluff below the city in 1956, refines crude oil barged down the Amazon from Peru. In 1955, oil was discovered at Nova Olinda, which is on the lower Madeira, about 110 mi. S.E. of hlanaus.

The first European settlement on the site of Manaus was made in 1660, when a small fort was built there by Francisco da Motta Falcão and named São José do Rio Negro. The mission and village which followed were called Villa da Barra or Barra do Kio Negro ("barra" referring to the bar or mouth of the Negro). Manaus succeeded Barcellos as the capital of the old *capitania* of Rio Negro in 1809 and became the capital of Amazonas when that province was created in 1850, its name being then changed to Manaus after the principal tribe of Indians living on the Rio Negro at the time of its discovery.

In 1892, Manaus became the see of the new bishopric of Xmazonas. (Js. J. P.)

MANBHUM, a former district of the Chota Nagpur division of Bihar state, India. Area, 4,129 sq.mi.; pop. (1951) 1,547,559. In 1956 Manbhum district was transferred to West Bengal; Bihar state retained the Chas and Chandil thanas and Patamda police station.

Manbhum district forms the first step of a gradual descent from the tableland of Chota Nagpur to the delta of lower Bengal. In the northern and eastern portions the country is open and consists of a series of rolling donns dotted here and there with isolated conical hills. In the western and southern tracts the country is more broken and the scenery much more picturesque. The principal hills are Dalma (3,038 ft.), the crowning peak of a range of the same name; Gangabari (Gajburu or Gorgaburu) (2,220 ft.), the highest peak of the Baghmundi range; and Pachet (2,110 ft.), on which stands the old fort of the rajahs of Pachet. The hills are covered with dense jungle. The chief river is the Kasai, which flows through the district from northwest to southeast into Midnapore. A large proportion of the population is of aboriginal descent, the chief tribes being the Santals, the Bhumij and Bauris; the latter two have adopted Hindu customs and are fast becoming Hindus in religion.

Containing the Jharia coal field and part of the Raniganj coal field, Manbhum is the chief colliery district in West Bengal. The growth of the industry is comparatively recent. In 1894 the railaay was opened from Barakar to Dhanbad, and in the 20th century coal mining developed rapidly, especially after the Bengal-Nagpur railway was extended to the Jharia coal field in 1904. The public health of the coal fields, and indeed of the whole Dhanbad subdivision and of a small area to the south, with a total area of 790 sq mi. and a population of 731,700, is in the charge of the mines board of health, which has done admirable aork.

Besides the administrative headquarters, Purulia (pop., 1951, 41,461), which is at the junction of the narrow-gauge line to Ranchi, the only town is Dhanbad (pop. [1951] 34,077), the headquarters of a subdivision and a railway settlement.

MANCE, SIR HENRY CHRISTOPHER (1840–1926), British scientist and engineer who invented the heliograph. was born in London in 1840. He joined the Persian gulf telegraph department of the government of India in 1863 and was employed on laying the first submarine telegraph cables in the Persian gulf. He was the originator of the Mance method for detecting and localizing faults on submarine cables and wrote several papers dealing with this subject. He also invented the modern heliograph, which was used successfully during the Second Afghan War and subsequently adopted for general use in the British army. Mance was made a companion of the order of the Indian empire in 1883 and was knighted on his retirement in 1885.

A member of professional and scientific bodies, Mance was president of the Institution of Electrical Engineers in 1897. He died at Oxford on April 21, 1926. (G. R. M. G.)

MANCHA, LA (Arabic, AL MANSHA, "the dry land" or "milderness"). in its nidest sense denotes the bare and monotonous elevated plateau of central Spain that stretches betneen the mountains of Toledo and the western spurs of the hills of Cuenca, being bounded on the south by the Sierra Morena and on the north by the Alcarria region. Altitude about 2,000 ft. It thus comprises portions of the modern provinces of Toledo, Albacete and Cuenca, and the greater part of Ciudad Real. Down to the 16th century the eastern portion was known as La Mancha de Montearagon or de Aragon, and the western simply as La Mancha; afterward the northeastern and southwestern sections respectively were distinguished by the epithets *Alta* and *Baja* (upper and lower). La Mancha remains almost exactly as Cervantes described it. Many villages. such as El Toboso and Argamasilla de Alba, both near Alcázar de San Juan, are connected by tradition with episodes in *Don Quixote.*

MANCHE, a *département* of northwestern France, made up chiefly of the Cotentin and the Avranchin districts of Normandy, and bounded nest, north and northeast by the English channel (Fr. La *Manche*), from nhich it derives its name, east by the department of Calvados, southeast by Orne, south by Mayenne and Ille-et-Vilaine. Pop. (1954) 446,860. Area 2.476 sq.mi. The department south of Coutances and St. Lô is composed of folded Palaeozoic rocks of the Armorican system, with east and west zones of granite. rising in the southeast to 1.200 ft. There are younger and softer deposits on the east. The west coast is an ancient structural line from north to south and is marked by cliffs up to 420 ft. alternating with bays, at the south end the great bay of Mont St. Michel, with its famed abbey surmounting a rock 400 ft. high. Reefs off the coast make navigation perilous, the chief forming Les Iles Chausey. The north coast also seems to be a structural line and is marked by the great roadstead of Cherbourg. The greater part of the department may be described as a dissected plateau with deeply cut valleys. The chief streams are the Vire, running northward past St. Lô, and the Sienne, running northwestward just south of Coutances. The climate of Manche is mild and humid; myrtles flourish in the open air. The characteristic industry of the department is horse and cattle rearing, carried on especially in eastern Cotentin; sheep are raised in the west. Wheat, buckwheat, barley and oats are cultivated. Manche is a foremost department for the production of cider apples and pears; plums and figs are also largely grown. Butter, poultry and eggs are important sources of profit. Flourishing market gardens are in the west. The department contains valuable granite quarries in the Cherbourg *arrondissement* and the Chausey Islands; building and other stone is quarried. There are metal industries, and the weaving of osiers is a local feature. Oyster beds are on the coast (St. Vaast, etc.); and the maritime population, besides fishing in home and distant waters, collects seaweed for manure. Coutances is the seat of a bishopric of the province of Rouen. The north of the department forms part of the region of the 3rd (Rouen) and the south of the 10th (Rennes) army corps and of the circumscriptions of the *académie* (educational division) and appeal court of Caen. Cherbourg (*q.v.*), with its important port, arsenal and shipbuilding yards, is the chief centre of population. St. Lô (*q.v.*) is the capital; there are four *arrondissements* (St. Lô, Avranches, Cherbourg and Coutances), comprising 48 cantons and 648 communes. Valognes, Mortain, Coutances, Granville and Mont St. Michel are also important. At Lessay and St. Sauveur-le-Vicomte there are the remains of ancient Benedictine abbeys, and Torigni-sur-Vire and Tourlaville (close to Cherbourg) have interesting châteaux of the 16th century. Valognes. which in the 17th and 18th centuries was a provincial centre of culture, has a church remarkable for its dome, the only one of Gothic architecture in France.

MANCHESTER, EARLS AND DUKES OF. The Manchester title. in the English peerage, belongs to a branch of the family of Montagu (*q.v.*). The first earl was SIR HENRY MONTAGU (c. 1563–1642), grandson of Sir Edward Montagu, chief justice of the king's bench 1539–45. He was born at Boughton, Northamptonshire, was educated at Christ's college, Cambridge, and, having been called to the bar, was elected recorder of London in 1603, and in 1616 was made chief justice of the king's bench, in which office he passed sentence on Sir Walter Raleigh in 1618. In 1620 he was appointed lord high treasurer, being raised to the peerage as Baron Kimbolton of Kimbolton, Huntingdonshire, and Viscount Mandeville. He became president of the council in 1621, and Charles I created him earl of Manchester in 1626. In 1628 he became lord privy seal, and in 1635 a commissioner of the treasury. He was a judge of the Star Chamber, and one of the most trusted councillors of Charles I. In conjunction with Coventry, the lord keeper, he pronounced in favour of the legality of ship money in 1634. He died on Nov. 7, 1642.

EDWARD MONTAGU, 2nd earl of Manchester (1602–71), eldest son of the 1st earl by his first wife, was educated at Sidney Sussex college, Cambridge. He was member of parliament for Huntingdonshire 1624–26, and in the latter year was raised to the peerage as Baron Kimbolton of Kimbolton, but was known generally by his courtesy title of Viscount Mandeville. At the beginning of the Long parliament he was one of the recognized leaders of the popular party in the upper house, his name being joined with those of the five members of the house of commons impeached by the king in 1642. At the outbreak of the Civil War, having succeeded his father in the earldom in Nov. 1642, Manchester commanded a regiment in the army of the earl of Essex, and in August 1643 he was appointed major general of the parliamentary forces in the eastern counties, with Cromwell as his second in command. He became a member of the "committee of both kingdoms" in 1644, and was in supreme command at Marston Moor (July 2, 1644); but subsequently he disagreed with Cromwell, and in November 1644 he strongly expressed his disapproval of continuing the war. Cromwell brought his shortcomings before parliament in 1644; and early in the following year Manchester resigned his command. He took a leading part in the frequent negotiations for an arrangement with Charles and was custodian with William Lenthall of the great seal, 1647–48. He opposed the trial of the king, and retired from public life during the Commonwealth; but after the Restoration, which he actively assisted, he was honoured by Charles II. In 1667 he was made a general. He died on May 7, 1671. Manchester was made a K.G. in 1661, and became F.R.S. in 1665.

CHARLES MONTAGU, 1st duke of Manchester (c. 1662–1722), son of Robert, 3rd earl of Manchester, was educated at St. Paul's school and Trinity college, Cambridge, and succeeded to his father's earldom in 1683. He fought under William at the Boyne, became a privy councillor in 1698, and held various important diplomatic posts between that date and 1714, when he received an appointment in the household of George I, by whom in 1719 he was created duke of Manchester. He died on Jan. 20. 1722.

GEORGE MONTAGU, 4th duke of Manchester (1737–88), was the son of Robert, the 3rd duke. He was a supporter of Lord Rockingham, and an active opponent in the house of lords of Lord North's American policy. In the Rockingham ministry of 1782 he became lord chamberlain. He died in Sept. 1788.

WILLIAM MONTAGU, 5th duke of Manchester (1771–1843), third son of the preceding, was educated at Harrow, and entered the army. He became a colonel in 1794 and was appointed governor of Jamaica in 1808. Here he remained, except for a visit to England (1811–13), until 1827, doing much to prepare the way for emancipation of the slaves. From 1827 to 1830 he was postmaster general in the cabinet of the duke of Wellington.

See G. E. C[okayne], *Complete Peerage,* vol. viii, rev. ed. (London, 1932).

MANCHESTER, a cathedral city and county borough in Lancashire, Eng. Pop. (1961) 661,041. Area 42.6 sq.mi. The city of Manchester stands at the junction of the rivers Irwell, Irk and Medlock, 189 mi. N.W. of London and 31 mi. E. of Liverpool by road. Before the last Ice Age, a range of high mountains closed the approaches to Manchester's site on the north and east. Glacial action ground down and flattened them to a height of 1,000–2,000 ft. and glacial streams carved deep clefts and valleys whose streams converge on the area that is now the Manchester district. Here. where nature had laid down its own lines of communication, and where the high land gave way to estuarine marshes, making a natural defensive position, the settlement of Manchester first arose. The city varies from 100 ft. above sea level in the south to 400 ft. in the north, the height at the centre being 133 ft. Bordering the south of the city is the fertile Cheshire plain; to the east, north and west is the remainder of the huge east Lancashire industrial area.

Manchester is built on Triassic. Permian and Carboniferous rocks, which often reach the surface, but which are usually overlaid with thick deposits of glacial drift-sands, gravel and boulder clay. The heavily faulted rocks, particularly the Pendleton fault, give rise to occasional earth tremors. Industrial water is obtained in part from wells in the Triassic rock, but the bulk is piped from lakes in Cumberland and Westmorland, and the Longdendale valley in the Pennines. The whole region is seamed with coal and one of England's largest coal mines lies within the city boundary. The city enjoys a temperate climate varying from 2j° F. to 72" F. It is damp rather than wet, with an average rainfall of less than 30 in. each year, but with sunshine somewhat reduced by the industrial smoke pall and by the prevalent cloudy conditions.

History.—An early name for Manchester—Mancenion—is believed to have been taken from that of a Celtic settlement on the site. known as "the place of tents." One of the principal Roman roads from Chester northward passed through Manchester—a portion of it is still known as Watling street—and the Romans established in A.D. 79 a fort, small portions of which still remain, to safeguard military and trading traffic through the area.

The Romans gave to Mancenion their own version of the name —Mancunium. They were in occupation for about 350 years, and from then onward there was little of note to relate until 870, when the Danes destroyed the town, except for the fact that the place was brought under the dominion of the Saxons early in the 7th century and named, in various forms "Mamecaster" or "Memcestre." In addition. mention is made of the district in the Domesday and other surveys. Edward the Elder rebuilt Manchester in 920 and the right to coin money was granted to Manchester's citizens by King Canute. In the Domesday survey of 1086, Manchester is mentioned as an area poor and sparsely populated.

It was not until the 13th century that the first signs were visible of the Manchester of today. In 1229. the town was granted an annual fair by Henry III, and immigrant Flemish manufacturers chose the area for the establishment of their textile industry in 1330, thus giving the first evidence of the suitability of the area for textile production. The introduction about 1500 of vegetable cotton. known as cotton wool, must have been a stimulus to trade, for the antiquary. John Leland, reported to Henry VIII that Manchester was "the fairest. best builded, quikkest and most populous towne in all Lancashire." It is quite evident that Manchester's industry at the time was confined entirely to textiles, for a publication dated 16jo lists the town's manufactured products as "woolens, frizes, fustians, sack-cloths: mingled stuffs, inkles, topes and prints," and in 1690 the art of calico printing was introduced from France.

Present-day blanchester is one of the results of the Industrial Revolution which transformed the place, in a generation, from a market town to a thriving industrial centre. The discovery and exploitation in the late 1700s of steam power, and the opening up of road, river and, later. rail communications went hand in hand with the invention of devices for the mechanical manufacture of textiles. In 1761 the first English "navigation" or canal was opened to bring coal into Manchester from the duke of Bridgewater's estate at Worsley. In 178j the culminating invention of the power loom for weaving was made and in 1789 the first steam engine for spinning cotton was erected in Manchester. The *Manchester Guardian* newspaper which began publication in 1821 became, under the editorship of C. P. Scott (*q.v.*), one of the leading journals of the day. of Liberal views. hlanchester is a centre for journalism second only to London and also is the headquarters of the north regional branch of the British Broadcasting corporation.

Manchester's rise to municipal borough status in 1838 was probably due more to the efforts of one single man, Richard Cobden, than to anything else. Although of Sussex birth, Cobden had established himself in business in Manchester as a calico printer by 1829. when he was only 25 years of age. It was in 1837 that he emerged as a public figure, both when he stood unsuccessfully as a parliamentary candidate for Stockport, and when he led the struggle for bfanchester's incorporation as a borough. His being summoned as a juror to the manorial court leet led to his becoming aware of the hopeless inadequacy of manorial rule in an industrial town. Two days later he had drawn up a declaration, later signed by his fellow jurors, which criticized the existing system of local rule and was followed by his celebrated pamphlet "Incorporate Your Borough." This movement for incorporation resulted, at the beginning of 1838, in a public meeting at which Cobden was the principal speaker, to discuss the advisability of petitioning the queen for a charter of incorporation. Despite much opposition and the forgery of signatures to an anti-incorporation petition, the charter was eventually granted in Oct. 1838; Richard Cobden was elected as councillor for the St. Michael's nard, and elevated to the aldermanic bench after one day's service as councillor. He remained on the borough council until 1844. After the incorporation of the borough. Cobden became closely associated with John Bright? the son of a Lancashire cotton spinner, in the formation of the National Anti-Corn-Law league. While Bright was famous as a national figure, his local connection with Manchester was confined to representing the borough in parliament in the 1847 and 1852 elections. A statue of Richard Cobden stands in St. Ann's square, and one of John Bright is in Albert square; busts of both are in the town hall.

Other notable occasions in Manchester's history are the opening in 1851 of what is now the University of Manchester, the rise to city status in 1853, the completion of the Manchester Ship canal in 1894, the commencement of the city's new town at Wythenshawe in 1929 and the opening in 1938 of Manchester airport at Ringway.

In World War II the oldest part of the city — that around the original market place — together uith the warehouse quarter near Piccadilly, the assize courts, the royal exchange and the Free Trade hall, were bombed in air raids nhich damaged 30,000 houses and killed more than 600 citizens, but by 1954 few signs remained in Manchester of the scars of war.

Until the Reformation Manchester lay in the diocese of Lichfield, but in 1541 Henry VIII founded the diocese of Chester which included the whole of Lancashire. Owing to the increase in population caused by the Industrial Revolution. a new see of Manchester was formed in 1847. This diocese covered the greater part of Lancashire and the collegiate church became the cathedral. The northerly part was transferred in 1926 to the new diocese of Blackburn. Hulme and Middleton are bishoprics suffragan.

From 1921–29 William Temple (*q* v.), who was translated to York and later to Canterbury, was bishop of Manchester.

Architectural Features. — Of mediaeval Manchester, few traces remain. Chetham's hospital and library occupy stone-built mediaeval buildings which were the ancestral home of the Grelle (Gresley, Grelley) and de la Warr (Warre) families, and were presented to the church of Manchester when it became collegiate in 1421; they were purchased by the Chetham trustees in 1653.

Manchester's cathedral is not externally imposing, but its history as parish church, college of priests and cathedral is long and interesting. An important church is thought to have stood here in the 10th century, and Domesday Book records that "the church of St. Mary and the church of St. Michael hold in Mameceaster one ploughland, free from all burdens save Danegeld." There are no relics of Norman work, but there is evidence of a large Early English church. In 1421, chiefly through the efforts of Thomas de la Warr, who was rector and lord of the manor, a royal licence and charter was obtained. making the church collegiate, with a warden, eight fellows, four clerks and six singing boys, and endowing it with extensive lands. U'arden James Stanley, afterward bishop of Ely, built the present choir in 1485. During the 15th and 16th centuries nine chapels were built. During air raids of Dec. 1940 one corner of the cathedral. containing the Regimental chapel, Ely chapel, Lady chapel and Jesus chapel, was totally destroyed and serious damage was done to the roof, fabric and organ. Repairs were complete with the exception of the Lady chapel by the end of 1954. The cathedral is the widest in Great Britain.

The Wellington inn in the market place, the Rovers Return in Withy grove and Wythenshawe hall at the southern edge of the city are the only remaining half-timbered buildings. Of the Georgian period, though only St. John street and Ardwick green retain their period character, there are a number of notable buildings: Heaton hall, in Heaton park, is a splendid example of the work of James Wyatt and is furnished in the character of the time. Platt hall. Rusholme, was the home of the Carrill-Worsley family. St. Thomas' Church, Ardwick, and the Church of the Holy Family are fine Georgian; St. Ann's church is thought to be the design of Sir Christopher Wren or a pupil. The City Art gallery and the adjoining Manchester Athenaeum building are to the design of Sir Charles Barry, and the Portico library, the Friends' Meeting house, the District bank and the Bank of England also belong to Georgian days. On the whole, however, Manchester is a Victorian and modern city: visitors from the United States comment that it has much of the character of the larger American towns. Notable Victorian buildings include the town hall, in ornate neo-Gothic style built in 1877 to the design of Alfred Waterhouse. In the fine great hall are frescoes by Ford Madox Brown of incidents in the history of, or connected with, Manchester. The university main buildings are by the same architect. The John Rylands library, designed by Basil Champneys, is in severe Gothic revival style. The Manchester Royal ex:hange, built in 1874 and extended in 1914–21, is in Italianate classical style; the floor of the great hall accommodates more than 1,000 members at "high 'Change." It was severely damaged in U'orld War II but has since been rebuilt internally and was reopened in 1953.

Of Manchester's 20th-century buildings, among the finest are the town hall extension and Central Library; the latter, in Early English Renaissance style, was opened in 1934. The Midland bank building. to the design of Sir Edwin Lutyens in a severe modern adaptation of the classical style, stands at the upper end of King street and with the adjoining Ship Canal house forms a fitting climax to a street described as "worthy of Stockholm in its architectural excellence and variety." The modern concert hall, rebuilt in 1951 within the walls of the bombed Free Trade hall of 1856, was designed by Leonard C. Howitt in a style to harmonize with the classical exterior; the acoustics are particularly satisfactory.

Administration.— In 1301 the lord of the manor, Baron Thomas, Lord Grelle, yielded to the pressure of the burgesses a charter appointing town's officers, making rules for the management of the town and defining the functions of the courts. Even so, the courts remained under the thumb of the Grelle family and it was not until the late 18th century that centrally appointed town's commissioners took over the local government of the place. They failed to govern the town satisfactorily and when the Municipal Corporations act of 1835 offered opportunity, a movement led by Richard Cobden and other notable reformers secured the incorporation of Manchester as a municipal borough.

The city council is no composed of 38 aldermen and 114 councillors with jurisdiction over 43 sq.mi. and more than 700,000 people. The municipal markets at Smithfield and elsewhere distribute foodstuffs throughout the northwest of Britain. The southerly suburb of Wythenshawe, transferred from Cheshire to Manchester in 1930, was planned as a "new town" whose population would total nearly 100,000 when complete, with its own industrial areas and civic centre; as opportunity afforded, the central areas would be rebuilt to modern ideas of planning. The city's parks have an acreage of 2,290 in which are included Heaton park of 638 ac. and Wythenshawe park of 251 ac. Manchester was the first city to put into effective operation a smokeless zone, 412 ac. in 1955. As capital city of northwest England, Manchester houses the regional offices of 16 government ministries and the local offices of 41 other government departments; there is a court of assize and a district registry of the high court of justice, and seven other courts of law. Twenty countries have consular representation in Manchester.

With the exception of the parliament of 1654, Manchester had no representation until the Reform bill of 1832 when it sent two representatives. In 1868 this was increased to three. In 1885 the city was divided into six divisions and in 1918 into ten divisions, each returning one member. By the Representation of the People act, 1948, the number was reduced to nine: Blackley. Clayton, Gorton, Ardwick, Withington, Moss Side, Exchange, Cheetham and Wythenshawe. In 1955 Openshaw replaced Clayton.

Cultural **Life.**—Manchester is famous for its many private, public and specialized libraries. The municipal libraries, with 32 branches, have as their focus the building in St. Peter's square opened in 1934. This central building is the home of a reference library which includes the Greenwood library for librarians, a commercial library and a technical library to serve the industrial and commercial interests of the region, a lending library, and the music library presented to the city by Henry Watson in 1902. The music library, which includes the Chapman collection of musical instruments, contains a comprehensive selection of rare and early music. The total number of volumes in the municipal libraries is more than 1,080,000.

The John Rylands library in Deansgate was built by Mrs. Rylands in memory of her husband, a Manchester merchant. Opened to readers on Jan. 1, 1900, the library is a place of pilgrimage for scholars and bibliophiles the world over. Its basis is the Althorp library collected by the 2nd Earl Spencer, and the earl of Crawford collection of manuscripts, together with incunabula, bibles from the Gutenberg Bible onward, works of the 16th-century scholar-printers and the de luxe printers of the 17th and 18th centuries and of modern times. It also contains historical' pamphlets of the 17th and 18th centuries; records on clay, bark, bamboo, papyrus, parchment and other materials in 50 languages from the 3rd millenium B.C. onward; legal documents and family muniments from the 11th to the 20th centuries; mediaeval jewelled bindings; and extensive collections of historical, political and literary papers including 3,000 letters of the Johnsonian circle and of Charles Dickens, John Ruskin and other well-known figures.

The University of Manchester has its own library with a special one for the education of the deaf. Chetham's library, at Chetham's hospital. Fennel1 street, founded in 1653 under the will of Humphrey Chetham, a Manchester merchant, was the first free public library in England, if not in Europe, and is substantially in its original setting. At first the books were chained and the stools used by readers in those days are still preserved. Its great strength lies in the collections of printed books of the 16th, 17th and 18th centuries, and in both old and modern books on local history and related subjects. The Portico library in Mosley street was opened in 1806; the first secretary was Peter Mark Roget. the author of the *Thesaurus of English Words and Phrases.* Among the members down the years were John Dalton the physicist, and the Rev. William Gaskell, whose wife wrote *Cranford* and other novels of Victorian life. The library contains'an unusual collection of rare historical treatises, ancient medical tracts and curiosities of many kinds.

The City Art gallery, formerly the Royal Manchester institution, was opened to the public in 1829 and presented to the corporation in 1882, together with the nucleus of the present art collection. Subsequent purchases have been supplemented by numerous gifts and bequests, notably that of contemporary works presented by the late Charles L. Rutherston in 1925 for use as a lending library from which pictures and sculpture could be borrowed by schools, colleges of art and galleries in the north of England. There are a number of branch galleries. The gallery of English costume at Platt hall, opened in 1947, is the first institution in Britain to be solely concerned with that art and is based on the fine collection of Englishwomen's costume formed by C. Willett Cunnington. Heaton hall contains a display of Georgian painting, furniture, pottery, silver, porcelain and glass, as well as a fine Georgian two-manual organ. At Queens Park gallery a display of pictures, maps, models and other objects illustrates the past history of Manchester. The Manchester Whitworth institute, now the Whitworth Art gallery, Rusholme, was founded in Oct. 1889 under the will of Sir Joseph Whitworth, the industrial magnate, inventor and standardizer of screw-thread measurements. It contains early textiles and embroideries, and a collection of English water colour drawings illustrating the history of the art of water colour.

Upon the choral singing and brass bands of south Lancashire, which amount almost to a folk tradition, was superimposed, in the middle of the 19th century, a foreign musical culture arising from the immigration of German and central European merchants. From this period survives the Hallé Concerts society, formed in 1898 to keep in being the orchestra inaugurated in 1858 by Sir Charles Hallé. The Hallé orchestra, under its conductor Sir John Barbirolli, has become an international orchestra. The Tuesday Mid-Day Concerts society has given weekly concerts since 1916 at which many artists, later to become world-famous, have been introduced to the public. The Manchester Royal College of Music is the only body outside London whose diplomas are recognized as qualifying the holder for a professional career in music.

There is a wealth of private bodies for the furtherance of literature, art and kindred subjects, notable among which are the Ancient Monuments society, the Chetham (Printing) society, the Classical association, the Academy of Fine Arts and the Literary and Philosophical society (which has a long and notable history and among whose past members mere John Dalton who died in Manchester and Thomas De Quincey who was born there).

Manchester has two theatres, two variety palaces, two resident repertory companies, the first of which was instituted in 1907 by Miss Annie Horniman, and a municipal "little theatre" at the central library. At the racecourse at Castle Irwell the principal meeting is the November handicap. The Manchester Athletic club at Fallowfield promotes athletic events of every kind: there are two first-division Association football clubs and one Rugby league football club, and at the ground of the Lancashire County Cricket club, Old Trafford, a test match is played against overseas cricket teams visiting Britain. At Belle Vue, West Gorton, is a large zoological gardens and amusement park.

Education and Religion. — The oldest educational institution in Manchester is the grammar school, founded in 1515 by Hugh Oldham, bishop of Exeter. Moved to new buildings at Rusholme in 1931, it now accommodates more than 1,200 boys. Another ancient educational foundation is that of Humphrey Chetham whose Bluecoat school, founded in 1653, is housed in the building formerly occupied by the college of clergy. The boys, who number about 100, dress in a 17th-century style on ceremonial occasions. The educational charity of William Hulme (1631–91) is administered under a scheme drawn up in 1881 and supports a grammar school. The College of Technology was founded as a mechanics' institute in 1824; the College of Art has been redesignated the Regional College of Art. Schools for the deaf and dumb are situated at Old Trafford next to the blind asylum, to which Thomas Henshaw left a bequest of £20,000. There is also an adult deaf and dumb institution and a branch of the National Library for the Blind.

The Victoria University of Manchester has developed from the college founded by John Owens, who in 1846 bequeathed nearly £100,000 to trustees for an institution in which should be taught "such branches of learning and science as are usually taught in the English universities." It was opened in 1851 in a former residence of Richard Cobden (now the Manchester county court) in Quay street, but such was the expansion of the college that a new building was erected in Oxford road and opened in 1873. In 1880 a university charter was granted and the Owens college was constituted a college of the university. In 1884 University college, Liverpool, was admitted and in 1887 the Yorkshire college, Leeds. The federal institute thus created lasted until 1903, when a separate university was established in Liverpool. In 1904, when the Yorkshire college was raised to university rank, the Owens college was incorporated with the Victoria University of Manchester by act of parliament. Though the Victoria University in its curriculum tends to serve the scientific, industrial and commercial interests of the area of which Manchester is the focal point, this statement is true quantitatively only; qualitatively, Manchester is as strong as ever in the humanities. The chairs instituted since 1945, which include psychiatry, astronomy, social anthropology, Arabic and town and country planning, indicate the vitality of the university. There are in Manchester a number of denominational colleges and many of the students preparing for the ministry receive their arts training at the university.

Manchester is a notable centre of research. The Shirley institute at Didsbury deals with the problems of the cotton industry, the Cotton Board Colour, Style and Design centre in York street co-ordinates the many facets of the design of fabric patterns and of the styling of cotton materials into women's wear and household materials; the university and the College of Technology join in industrial research with the chamber of commerce and the Lancashire and Merseyside Industrial Development association, a body representing local government and trade interests in south Lancashire. The United Manchester hospitals, a group separate from the national scheme and centred round the Manchester Royal infirmary, join with the university in medical research; at the Christie cancer hospital and Holt radium institute, Didsbury, is the largest centre of cancer research in the British Commonwealth; a research fellowship in poliomyelitis was set up by the university in 1954. At Jodrell Bank, Cheshire, the department of astrophysics of Manchester university has established a pioneer radio-astronomy observatory and in 1954 it was building the world's biggest radio-telescope, about 260 ft. across and on a movable track.

Manchester is the seat of an Anglican bishopric: the Roman Catholic community is large, but their cathedral is in the neighbouring city of Salford and the principal Roman Catholic church is the Holy Name church. The city has long been a stronghold of nonconformity, and the Baptist, Christian Science, Congregationalist, Jewish, Methodist, Presbyterian, Unitarian and Free Christian congregations are considerable.

Industry, Commerce and Transport. — Manchester's importance arises primarily from the textile industry. In the 12th century locally produced wool was made up into cloth and garments until the introduction of cotton as a wool substitute, when the wool industry gradually moved into Yorkshire. The spinning, weaving, bleaching, dyeing, printing and finishing of the cloths is now carried out in the towns of south Lancashire, after which it comes to Manchester for warehousing, packing and shipping.

Manchester is, therefore, not only the office and warehouse of Lancashire's textile industry, but also provides banking, insurance, marketing and shipping facilities for the whole of south Lancashire's industry. On its own account it has extensive businesses of heavy and light engineering, factories for clothes, chemicals and dyestuffs, oil refining and food processing, which now make it less vulnerable to fluctuations in the prosperity of the cotton trade.

The total population within a 10-mile radius of Manchester centre was 2,220,944, and within 25 mi. 4,614,500, in 1951.

The development of local industry was paralleled by the establishment of a network of road, rail and canal transport to bring in the raw materials and to take away the finished products. The first railway, the Manchester-Liverpool line of 1830 (of which the Liverpool road station still remains as the oldest railway station in the world), was followed by lines to Birmingham, London, Yorkshire and the north; Manchester now has four major main-line stations. The canal system began in 1761 with the Bridgewater canal, designed by James Brindley, and was followed in 1767 by a second length dug from Stretford to Runcorn. A third section joined the canal with the Leeds-Liverpool canal early in the 19th century. Since the opening of the Manchester Ship canal (*q.v.*) in 1894, the barge canals have fallen into disuse, but the access to Manchester, via the Ship canal, of ocean-going vessels of up to 15,000 tons dead weight has made the inland town of Manchester the third port of the United Kingdom, and laid the foundation of the region's continued prosperity.

The port of Manchester should be regarded as an elongated harbour, including as it does the whole of the 36-mile Manchester Ship canal from the entrance locks at Eastham on the Mersey estuary to the terminal docks in Manchester. It is now the nearest port (54 mi. from the open sea) for an area containing the main mass of British industry and extending as far as Birmingham to the south, and Wakefield in Yorkshire to the east. In that first year of 1894, the cargo entering the port amounted to 925,000 tons; in 1954 it totalled nearly 16,500,000 tons and, with the other Merseyside port of Liverpool, handled one-third of the imports and exports of Great Britain. With the coming of the oil industries to Stanlow early in the 20th century, Manchester has become Britain's second oil port. In 1896, Trafford park, a country estate adjoining the Manchester docks, was purchased to become the first and greatest planned industrial estate in Britain.

The first municipal airport in the world was established at Wythenshawe in Manchester in 1929. The present Manchester airport at Ringway dealt with 238,102 terminal passengers and more than 14,000,000 lb. of freight in 1954. It became a transatlantic airport in 1953. By the end of 1954 Manchester airport had five direct transatlantic services to North America.

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MANCHESTER, largest city in New Hampshire, U.S., and one of the seats of Hillsboro county, is located in the centre of the state at Amoskeag falls on the Merrimack river, midway between Nashua and Concord, and 54 mi. N. of Boston. The Amoskeag falls, originally Namoskeag, Indian for "place of much fish," drop from a ledge 85 ft. high across the Merrimack river providing water power for industrial developments.

The first white settlers (Scotch-Irish) came in 1722–23. Through its early years the settlement was known for its fisheries. First called Old Harry'stown, it became Tyngstown after 1735 when it mas granted to Capt. William Tyng's men by the Massachusetts .Bay colony. In 1751 the settlement was incorporated as Derryfield. It was apparently renamed Manchester in 1810 at the suggestion of Samuel Blodget, who had seen the barge canals at Manchester, Eng., and who after 16 years of effort and aided by lotteries planned and constructed (1794–1807) the first canal around the falls, which together with the Middlesex canal in Massachusetts made navigation possible all the way to Boston.

It was chartered as a city in 1846. The Scotch-Irish community of potato and flax-raising farms emerged into a rapidly growing metropolis with riverside factories whose principal industry, the Amoskeag Manufacturing company with 18 mi. of water rights and numerous mills, employed 15.000 persons and reached a peak production of 360 mi. of cotton cloth a day, a prosperity augmented by the manufacture of shoes, cigars, locomotives and fire engines.

The downfall of Manchester's textile industry in 1935 caused by shrinking markets, foreign competition and the advent of silk and rayon, together with the disastrous floods of 1936 and the hurricane of 1938 awakened the city to the need for rehabilitation. In 20 years as a result of energetic action by civic leaders who bought the Amoskeag mills and leased many of them to small business enterprises, metropolitan Manchester was planned and rebuilt, and became an industrial and shopping centre for more than 106,000, with about 25% of the state's population residing within a radius of 20 mi. By the early 1960s Manchester had more than 200 industrial establishments manufacturing textiles, leather goods, rubber, automobile accessories, electrical instruments, confectionery, beverages and dairy products.

The city has 479 ac. of public parks, including Stark park, the burial place of Gen. John Stark (*q.v.*), and within its limits is Massabesic lake, the source of its water supply. It is the home of the Manchester Institute of Arts and Sciences, the State Industrial school, Currier Gallery of Arts, Manchester Historic association, St. Anselm's college (Roman Catholic; 1889) and the John Stark Homestead.

The Manchester city population, mainly of English, Irish, Scotch, French-Canadian, German, Greek and Polish ancestry, was 88,282 in 1960; the standard metropolitan statistical area which includes Goffstown had a population of 95,512. (E. M. Hu.)

MANCHESTER SHIP CANAL, an important artificial waterway affording passage for ocean-going vessels between the Mersey estuary (opening into the Irish sea) and the inland city of Manchester, Eng.

By the second half of the 19th century it had become essential that Manchester should be made into a port. This situation arose from the development of the city's cotton industry, from the high cost of carriage on existing routes to the coast and from the ruinous dock dues at Liverpool. The promoters of the ship canal, led by Daniel Adamson, had to meet stiff opposition from the barge-navigation proprietors, the railway, the Liverpool dock board and other hostile interests; and it was only after two bills had been thrown out (1883, 1884) that the project received parliamentary assent in 1885. The canal was begun on Nov. 11. 1887, with Edward Leader Williams (later knighted) as engineer in charge. Despite financial difficulties, floods and freeze-ups, the canal was opened to traffic on Jan. 1, 1894. Its completion was encouraged by immense popular interest, and 90% of the original shareholders were middle- and working-class persons. Queen Victoria formally inaugurated the canal on May 21, 1894. One of the most striking features of Williams' design was his method of getting the old Bridgewater canal across the ship canal at Barton, by the first navigable swing aqueduct in the country.

The canal is $35\frac{1}{2}$ mi. long. It begins on the south bank of the Mersey estuary 25 mi. from the sea at Eastham, where locks keep the canal at mean tidal high-water level. Thence it runs in a southward curve near the estuary waters to a point east of Runcorn ($13\frac{3}{4}$ mi.); thence inland; straight and almost due eastward, at the same water level to Latchford ($8\frac{1}{4}$ mi.), where locks stop all tidal action; thence, fed by the fresh water of the hlersey and Irwell, into Manchester ($14\frac{1}{2}$ mi.). The minimum depth is 28 ft.. the minimum bottom width 120 ft. except (in 1955) for a $\frac{3}{4}$-mi. section east of Latchford (90 ft.). There are extensive docks, dry docks, uharfs and warehouses at Manchester; and other important installations owned or operated by the Manchester Ship Canal company are the Stanlow oil docks, Ellesmere Port and Queen Elizabeth II dock at Eastham (opened in Jan. 1954), connected to the Stanlow refinery by a 6-mi. pipeline.

The ship canal company bought out the Bridgewater Navigation company before the ship canal was begun, and now operates the Bridgeaater canal (Manchester-Stretford-Runcorn and Stretford-Leigh; 4 ft. 3 in. minimum draft) through a separate department.

MANCHOUKUO, a former state, created as nominally independent in 1932 by the Japanese out of old Manchuria and Jehol. Dissolved after World War II and subsequently divided by the Peking government into the provinces of Heilungkiang, Kirin, Liaoning and Jehol and the Inner Mongolian Autonomous region. In 1955, Jehol was abolished and absorbed into Inner Mongolia, Liaoning and Hopeh.

See MANCHURIA and articles on the political divisions.

MANCHU LANGUAGE. Manchu belongs to the southern group of the Tungusic languages (*see* URAL-ALTAIC LANGUAGES). Tungusic peoples probably inhabited the present Manchuria by the 3rd century B.C. The predecessors of the Manchus were the Nü-chên (Džürčen, Ju-Čen), who usurped the empire of the Liao dynasty in 1115 and ruled as the Chin dynasty until 1234, being overthrown in turn by the Mongols. The real founder of Manchu power was Nurhachi, who proclaimed himself emperor in 1616 and established his capital at Mukden in 1625. Under his reign the Manchus adopted for their own use the Mongolian alphabet which they inherited from the Uighurs. In the course of time changes were made in order to adapt this writing to the Manchu language, and in its final form it became far more elaborate and serviceable than its Mongolian prototype. Books had been printed in Manchu by 1647. The two emperors K'ang Hsi and Ch'ien Lung did most to establish and stereotype this somewhat artificial language by causing translations to be made of Chinese and Mongolian works and by the publication of numerous polyglot dictionaries. All officials had to pass an examination in Manchu. All imperial decrees and most official documents were issued in this language in addition to Chinese.

With the abdication of the young emperor P'u Yi and the proclamation of the republic in 1912, Manchu may be said to have disappeared from China proper. It is. however, still spoken in parts of northern China, Manchuria and elsewhere. Regarded as a dead language, Manchu has received a considerable amount of attention from European scholars because the literal translations made into that language from the Chinese classics have simplified the interpretation of the latter.

The vocalic harmony is not so strictly observed in Manchu as in Mongolian. and in the case of grammatical suffixes there are in some instances no alternative hard or soft forms. The suffixes are as follows: accusative *be;* genitive instrumental *i* or *ni;* dative locative *de;* ablative ti. The Manchu verb, like the Chinese, does not distinguish either person or number, the tenses are imperfectly expressed and general notions are conveyed by adverbial and participial forms. Manchu has no relative pronoun and expresses a relative preposition as any other subordinate clause by means of participles.

Manchu, like the other Altaic languages, adds suffixes to the verbal theme to form derived verbs or gerunds expressing some extended meaning; thus the syllable *bu* added to *ara* ("to write") gives *arabu* ("to cause to write") and the syllable *na* added to *wa* ("to kill") gives *wana* ("to go to kill"), etc. A peculiarity of Manchu is the indication of masculine and feminine, or strong and weak, by the alternation of the vowels *a/e:* thus, *ama* ("father") and *eme* ("mother"). Even foreign words undergo this change: the Turkish *arsalan* ("lion") is modified into *erselen* ("lioness") Sanskrit *garudai* ("male phoenix") becomes *gerzcdei* for the female phoenix; *ganggan* ("strong") becomes *genggen* ("weak") and *wasime* ("to descend") becomes *wesime* ("to climb").

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MANCHURIA, the western name for northwestern China (Tungpei). This term applies to the provinces of Liaoning (*q.v.*), Kirin, and Heilungkiang (*q.v.*) including the eastern section of Jehol (*q.v.*), which was abolished as a province in 1956 and parts of the reorganized Inner Mongolian Autonomous Region. In the 1960s this area had a population of more than 50,000,000, about 8% of the national total.

On the north and the east Manchuria borders on the Soviet Union (along the Amur and Ussuri rivers) and Korea (along the Tumen and Yalu rivers) ; on the south it ends in the Po Hai and the Yellow sea; on the southnest and the west it is bounded by Hopeh province and the Inner Mongolian Autonomous region.

Manchuria, with an area of more than 300,000 sq.mi., represents the most important single geographical region of China today and is the most advanced industrially, producing about half of the country's steel. It has rich potential in hydraulic power, forestry and mineral resources. Manchuria is also one of the ranking grain-surplus areas. It has been since the 19th century one of the key geopolitical areas in the world, essential to the safeguard of northern China where the capital Peking is located.

GEOGRAPHY

Geographical Regions. — The entire area of Manchuria may be divided into four subregions : the Manchurian plain, the southern Liaoning hills, the Ch'ang-pai mountains and the Khingan mountains.

Manchurian (Sungari-Liao) Plain. — This is a vast, flat basin formed mainly by erosion and alluvial deposit by the rivers. It is bounded by the east Manchurian uplands in the east, the Lesser Khingan range in the north. the Greater Khingan range (now largely in Inner Mongolia) in the west, and ends in the Liaotung peninsula in the south. Its average elevation ranges between 150 and 600 ft., with the Ch'ang-ch'un area in the central part higher than the rest (750 to 1,000 ft.). The eastern section of the plain is the meeting ground of the rivers Sungari, Ussuri and Hei-lung Chiang (see AMUR). The Sungari follows a northwesterly course to meet the Nonni river, then turns sharply to the northeast. After being joined by the Mutan Chiang, it flows northward to meet the Hei-lung Chiang. In the southern sector of the plain the Liao Ho flows east and then southward into the Gulf of Liaotung. This fertile plain region is a major granary of China.

Southern *Liaoning* Hills. — These may be divided into two general regions: the hills in the Liaotung peninsula, and those in southwest Liaoning province. Most of the Liaotung peninsula is characterized by eroded mountains which take the form of two hilly areas, 600 to 1,500 ft. above sea level. Along the seacoast and rivers are narrow stretches of plains. Dairen and Port Arthur (*qq.v.*) are located at the tip of the peninsula. Coal. iron, magnesium and oil shale are among the major mineral resources of this region.

Ch'ang-pai ("Long *White*") *Mountains.*—Also called the east Manchurian uplands, these mountains extend in a series of ranges north of the Liaotung peninsula and south of the Sungari plain. Elevations are generally between 1,500 and 3,000 ft. The culminating volcanic peak Pai-t'ou Shan ("white head") of the Ch'ang-pai Shan rises to 9,003 ft., the highest in the northeast. There, also, is the famous crater lake, T'ien Ch'ih ("heavenly pond"). Another lake, Ching-po Hu, was formed when the valley on the upper Mutan Chiang was blocked by lava. The spectacular waterfall Tiaoshuilou cascades from the Ching-po Hu. The Yalu and Tumen rivers border Korea and the Sungari. This area has vast timber reserves and hydroelectric potential. There are rich mineral deposits, notably of coal and oil shale at Fu-sung.

Khingan Mountains. — These mountains consist of three ranges : Greater Khingan, Lesser Khingan and Ilkhuri (I-li-hu-li Shan). The Greater Khingan are almost entirely within the Inner Mongolian Autonomous region. The Ilkhuri extend to the north and the Lesser Khingan to the east; they form the watershed between the Hei-lung Chiang and Sungari systems. See also KHINGAN MOUNTAINS.

Climate. — Climatically Manchuria, lying between lat. 40° and 50° N., reflects its northerly location on the eastern margins of the Eurasian continent with short, hot summers and long, cold winters. Average January temperature is 21° F.; in the Khingan mountains, −14° F. Such low winter temperatures are not found elsewhere in the world in these latitudes. Consequently, even in south Manchuria the rivers are frozen for about six months. Only the harbours at Dairen, Port Arthur and Hu-lu-tao remain ice-free. Summer months last about three months in the south and are practically nonexistent in the extreme north. As a result the growing period for plants is confined generally to five or six months a year, and the one annual crop is sown in late spring or early summer and harvested in autumn.

Precipitation. — Annual precipitation is very unevenly distributed, ranging from 40 in. in the southeast to 15 in. in the northwest. Precipitation is heaviest in the mountain areas; in the plains the rainfall is relatively light but most of it occurs during the growing seasons. Half of the annual rainfall occurs in the months of July and August. However, these natural handicaps to farmers have been partially counteracted by the extensive irrigation projects constructed by the Peking government.

Vegetation. — The natural vegetation cover of most of Manchuria is grassland or mixed grassland and forest, although variation in climate and terrain results in marked regional differences in soil and vegetation. In the Ch'ang-pai and Khingan mountain areas the soil is generally turfy and podsolic, conducive to forest growth. Brown forest soil prevails only in the southeastern district of the Ch'ang-pai mountains and in low slopes and gullies. The forests of Manchuria. mostly conifers, constitute about 30% of total timber reserves of China. Korean pine is the chief commercial tree and is found, together with spruce, larch, fir and other evergreens, at higher elevations. Hardwood forests of deciduous species — oak, elm. poplar and birch — occupy the lower elevations. Exploitation over a long period of time resulted in the decimation of the most accessible forests, leaving large stands of virgin timber only in remote areas. In the 1950s a huge afforestation project was initiated. The projected forest belt measures about 620 mi. from north to south — from the eastern foot of the Greater Khingan mountains to the southern part of Liaoning. Its widest point from east to west is 186 mi. In the northeast region of Manchuria marshes and ill-drained meadowlands follow the course of the lower Sungari. The southern section of the plain consists chiefly of dark brown soil, good for farming. In western Manchuria lies an open steppe which blends into the rolling steppes of Mongolia. Soils of the western plain range from dark chestnut-coloured to lighter saline varieties characteristic of semiarid and desert regions. Soils in the northern and higher eastern uplands are podsolic, formed under forest vegetation. (KN. C.)

POPULATION AND SETTLEMENT

Manchuria ceased long ago to be the land of the Manchus (*q.v.*). They were largely absorbed into the now overwhelmingly Chinese population who speak a Northern (Peking) Mandarin dialect. Ethnic compositions of other minorities represented are Korean, Japanese, Russian and Mongol (including Tungusic). Population in the early 1960s totaled more than 50,000,000.

There were Chinese in Manchuria from ancient times, possibly from as early as 1000 B.C., but until well into the 19th century their area of occupance was localized almost entirely in a triangular region in southern Manchuria, centring about the alluvial basin of the lower Liao Ho and the uplands of the Kwantung peninsula. Immigration apparently mas primarily by sea, and communication with China was by means of coastal shipping services with what later became Shantung and Hopeh provinces. This so-called Chinese Pale was bounded on three sides by a wall known as the

Willow Palisade. An extension of this frontier, the so-called Outer Willow Palisade, ran northeastward from a point north of Mukden to the Sungari river north of Ch'ang-ch'un. The southeastern portion of the Willow Palisade formed a frontier between Chinese and Koreans; the Outer Willow Palisade separated what was predominantly Manchu territory in the east from the Mongol-occupied steppe lands of west-central and western Manchuria. Within the Pale were duplicated as nearly as possible the patterns of occupance that characterized the north China plain; *i.e.,* a relatively dense agricultural population living in compact villages and oriented around rectangular walled cities.

Much of Manchuria was held until modern times by non-Chinese, Tungusic peoples. *(See* TUNGUSES.) On at least three occasions these peoples gained control of southern Manchuria and moved into north China as barbarian conquerors, recruiting manpower from their "reservoir" outside the Willow Palisade and from the Chinese whom they had conquered within the Pale. According to S. M. Shirokogoroff, Tunguses originally dwelt in northeastern China and retreated into Manchuria in the 2nd millennium B.C. before the Chinese advancing from the loesslands of northwestern China. The tide of Chinese colonization then swung south into the Yangtze valley and, while northern branches of the Tunguses spread into the northern forest, the southern remained in Manchuria. Tunguses of the forest retained their old hunting, nomadic life but those of the central and southern plains in time acquired the arts of cultivation from their Chinese neighbours and, according to Chinese annals, were already dependent by the 1st millennium A.D. on the "five kinds of cereal." Although excellent horsemen as befitted dwellers on the steppe, the Tunguses of the plain—as evidenced by the Manchus—were ignorant of the art of milking and were essentially not pastoral nomads. On the other hand, the Mongols were true steppe nomads. They came to occupy most of western Manchuria after the upsurge of Mongol power which culminated in the Yüan dynasty's rule over China; they continued well into the 19th century to control the grasslands of the central lowland eastward to Ch'ang-ch'un and nearly as far as Mukden itself.

Immigration of Chinese was long forbidden; but after 1776 this prohibition was relaxed in the case of Liaoning (Feng-t'ien), the southern province, and in the third quarter of the 19th century the Manchus had to recognize colonization in Kirin. The dense agricultural population of north China was beginning to spill over in considerable numbers into vacant lands whose settlements, always sparse, had been further depleted by recruitment for the Manchu garrisons in China. By the end of the 19th century the population of Manchuria, exclusive of Jehol, was estimated at 14,000,000, of which 80% were Chinese. In comparison with what was to follow, however, this movement was no more than an infiltration and consisted mainly of males who intermixed with the Manchus and in time absorbed them. Pure Manchu groups remain only in northern Manchuria, chiefly in the Ai-hun district. These are descendants of soldier-colonists planted by the early Manchu emperors in the Hei-lung Chiang valley. The rapid economic development of south Manchuria under Japanese auspices after 1905 set in motion a mass migration, coming mainly from Hopeh and Shantung, the most densely peopled provinces of north China. This for years involved from 300,000 to 400,000 annually, but of these more than half used to return to China after the Manchurian harvest. In the 1920s the seasonal migration of labourers was accompanied by a permanent migration of families. These Chinese peasant farmers penetrated inland along the railways and settled along the Chinese Eastern as well as the South Manchuria railways. In the 1960s they constituted about 90% of the total population. The Japanese restricted Chinese immigration but in peak year 1939 a net inflow of 595,000 was recorded. At that time the Japanese, exclusive of troops, numbered 850,000, almost entirely in cities despite Japanese attempts to encourage agricultural settlement. Only 68,347 Japanese agrarian colonists mere recorded in 1940. By 1944 these totals had changed to about 1,000,000 and 220.000 respectively. Almost all Japanese were repatriated by the end of 1946, however. Mongols numbered about 2,000,000, although Japanese statistics listed only 1,000,000. Koreans numbered an estimated 2,000,000, most of them concentrated in the Chien-tao region just northwest of the Tumen river, a region in which Korean settlement—long a fact—was encouraged officially by the Japanese after 1932. Many of these Koreans became supporters of the Chinese Communists and later formed the trained core of the North Korean armies.

Liaoning (58,301 sq.mi.) is the most densely settled province, with about 47% of the region's population; Kirin (72,201 sq.mi.) has 26%; and Heilungkiang (178,996 sq.mi.), 27%. Many expanding industrial centres, such as An-shan, Dairen, Fusin (Fouhsin), Fu-sung and Pen-ch'i, are located in Liaoning province; and Heilungkiang receives a steady stream of migrant farm labour.

Urban population in Manchuria rose sharply after 1949, when the Peking government undertook an accelerated program of industrialization. In the 1950s urban dwellers comprised 30% of the population, as compared with 70% rural. Over 50% of the former was concentrated in seven cities, each with 500,000 or more. Although the region has only 74% of China's total population, it has about 17% of the national urban total. Since urbanization and industrialization are related, this percentage reflects that Manchuria was more industrialized than other regions of the country.

Illiteracy among the Manchurian population was very high in the period of Japanese domination; and in the mid-1950s it was still estimated at 78%. However, by the 1960s it was claimed that over 90% of school-age children in the three northeastern provinces were receiving primary education and that illiteracy had been basically removed among adults, except the aged. Special attention was assigned to technical education.

See also CHINA: *Population;* MONGOLIA: *Population.*

HISTORY

Until 1900 Manchuria was not integrated with China proper. From earliest times Manchuria, except for the lower alluvial basin of the Liao Ho, had been sparsely populated, by non-Chinese Mongoloid peoples. To the Chinese it was. historically, the easternmost part of the vast territory beyond the Great Wall of China, peopled by nomadic barbarians who left their predominantly grassland "reservoir" region from time to time to invade China itself. Manchuria was an especially important part of the great reservoir. From it the Liao (Khitan or K'itan) dynasty extended its control over the northern China plain in the 10th century. In the 12th century the Nu-chen (Chin) also extended their advance to south of the Yangtze river from Manchuria. Later the Mongols spread over the region and descended upon China in the 13th century to found the Yuan dynasty. Finally the Manchus, a Tungusic tribal group originally from eastern Manchuria, crossed the Great Wall and established the Ch'ing dynasty (1644). Between these periods Chinese control extended over much of the outlands, but for centuries most of Manchuria remained a preserve of the Manchus and their Mongol tribal allies. It was not until the latter half of the 19th century, when Chinese immigration into Manchuria began to increase rapidly, that Manchuria became "Chinese."

In the closing decades of the 19th century foreign powers began to eye the region as a fruitful field for imperialist expansion. For Russia, Manchuria was to be an eastern outpost and terminus of the Trans-Siberian railway, intended to bind the tsarist empire together Japan, nith an overfloaing population and only limited resources, had a more vital interest than Russia in Manchuria; as a relatively undeveloped but potentially productive country, Manchuria promised an exportable surplus of foodstuffs and industrial raw materials, and a field for Japanese colonization.

Russo-Japanese Conflict.—-The conflict between Russia and Japan for control of Manchuria first raged over possession of the Liaotung peninsula, which not only represents the southern gateway into Manchuria but commands the seaward approaches to Peking. The first move aas made by Japan. As the prize of victory in the Chinese-Japanese War (*q.v.*) of 1894–95, Japan demanded the cession of the Liaotung peninsula from the mouth of the Yalu to the mouth of the Liao Ho. But Russia, backed by France and Germany. forced Japan to abandon this claim. Then, by means of intrigue and a show of force, Russia acquired (1898) the lease for 25 years of the territory of Kwantung (*q.v.*) at the tip of the peninsula—a territory containing the future naval base of Port Arthur (*q.v.*) and what later became the great commercial entrepbt of Dairen (*q.v.*). Japan returned to the attack and. by the treaty of Portsmouth (1905) which registered its victory over Russia in the Russo-Japanese War (*q.v.*) of 1904–05, obtained transfer of the Kwantung lease. Meanwhile Russia had been pushing forward its scheme of railway construction. It had already built the Chinese Eastern railway (C.E.R.) across northern Manchuria to Vladivostok, and completed construction of a branch through southern Manchuria to Port Arthur. Russia also had established an ethnically Russian centre of settlement Harbin (q v) on the Sungari river banks in northern Manchuria. By the treaty of Portsmouth Japan became heir not only to the lease of Kwantung but also to the Russian-built railway from Ch'ang-ch'un to Port Arthur. In 1906 the rights pertaining to it nere vested in the semigovernmental South Manchuria Railway company (S.M.R.). Russian interests were thus pushed back into Manchuria north of Ch'ang-ch'un and into the provinces of Kirin and Heilungkiang. The properties of the C.E.R. and S M.R. were held on leases of 99 years and 80 years respectively. China had the option of purchasing the latter after 36 years. Investment in the S.M.R. was limited to Chinese and Japanese subjects, in the C E.R to Chinese and Russian; in effect the paramount interests were Japanese and Russian.

1915–1930.—Through possession of the arterial railway through southern Manchuria and of its seaward terminus in the entrepbt of Dairen, Japan held the chief key to economic penetration of southern Manchuria. The famous Twenty-one demands presented to China in 191; affirmed "the predominant position of Japan in South Manchuria and Eastern (Inner) Mongolia." During the Chinese civil nar Japan continued to exercise a controlling influence in southern Manchuria with support of its Kwantung army, organized in 1919 and destined to become Japan's most powerful military force on the Asian continent. As a result there had come to exist an unstable condominium among Japanese. Russian and Chinese interests. Only tno possible changes could take place: either Manchuria could be divided among the three powers—an unlikely prospect at best because of the spread of Chinese colonists across the Manchurian lowland—or one or more of the powers would be eliminated from the scene.

For a few years it appeared that the first power to be eliminated would be Russia. The Russian Revolution of 1917 was followed by the breakdown of orderly Russian administration in the far east. The situation was complicated by dispatch of troops to invade eastern Siberia by Great Britain, France. Japan, the United States and China. Japanese troops outnumbered the others and for a time it appeared that Japan might supplant Russia in that region. Partly to prevent this development the C.E.R. was placed under control of an inter-Allied commission with an American at its head. In 1919 after the Communists had gained control in Russia they announced their renunciation of all special privileges acquired by the tsarist government in China. By an agreement signed May 31, 1924, after negotiations with China, Soviet Russia retained a share in the administration of the C E.R.. while surrendering extraterritoriality and former Russian concessions and agreeing in principle to eventual repurchase by China of the railroad. A somewhat similar agreement regarding the C.E.R. was signed between Russia and Chang Tso-lin (*q.v.*), the ruler of Manchuria, Sept. 20, 1924. Friction followed, accentuated by anti-communist and anti-Russian reaction in China after 1927. In 1929 under Chang Hsüeh-liang, youthful successor of Chang Tso-lin, the Chinese—impelled by the rising tide of nationalism—attempted to oust the Russians from their participation in the C.E.R. The Russians struck back, and in a sharp, brief, undeclared war the status quo was restored.

Japanese Domination.— Not Russia, but China was the first of the three powers to be eliminated from Manchuria as mounting Chinese nationalism clashed with Japanese militarism. The Chinese nere attempting to restrict the Japanese in various ways. Friction developed, too, between Koreans and Chinese in Manchuria, the former being Japanese subjects, On the night of Sept. 18–19, 1931, the Japanese military forces struck, giving as the reason an allegedly Chinese bomb explosion on the South Manchuria railway near Mukden. In the following few weeks they occupied a number of strategic centres. At the time Chang Hsüeh-liang had most of his forces south of the Great Wall, and his rule in Manchuria quickly collapsed before the Japanese army. China appealed to the League of Nations. That body appointed a commission, headed by Lord Lytton, which, after investigation, issued a report generally unfavourable to the Japanese in the autumn of 1932. The League proved unable to implement its decision but its action led to Japan's withdrawal from League membership.

Manchoukuo.—In the meantime the Japanese were erecting a puppet administration. Local and provincial provisional governments were set up, mostly by resident Chinese (and, in some areas, Mongols) with Japanese "advisers." Early in 1932 a Manchuria-wide government mas organized and on Feb. 18 of that year it declared the independence of the three eastern provinces under the name of Manchoukuo ("the state of Manchu"). To provide an air of legitimacy, P'u Yi—who, with the title of Hsüan T'ung, had been the emperor of the Manchu dynasty when it abdicated its control of China in 1912 and who had since been living in retirement in Peking and Tientsin—became "chief executive." A further step was taken when, on March 1, 1934, P'u Yi formally announced his ascent to the throne of newly-named Manchoutikuo ("the empire of Manchu") under the title of K'ang Te. His residence was established at Ch'ang-ch'un, renamed Hsin-ching, or Hsinking ("the new capital"). No attempt was made by the Japanese, however, to restore the Ch'ing dynasty for all of China by linking the new state with another puppet regime of Wang Ching-wei in northern China. Nevertheless, the government of Manchoutikuo throughout its life was Japanese-controlled. The most important agency in the government was the so-called general affairs board, a kind of executive secretariat with a Japanese director-general. Practical military control was exercised by the Kwantung army. Internationally, the new country was recognized only by Japan, Germany and Italy (its Axis partners) and El Salvador. Soviet official interests were practically eliminated by the sale of the C.E.R. to the Manchoutikuo government in 1935. However, Russia's continuing concern with the region was indicated by a series of border skirmishes between Soviet troops and military units (including Japanese) of the new government, in 1937, 1938 and 1939, the last at Nomonhan (No-men-k'an).

After World War 11.—On Aug. 9, 1945, after the Soviet Union's declaration of war against Japan, Soviet and Outer Mongolian troops invaded Manchuria from the southwest, the northwest: the northeast and the east. Fighting was sharp and short. The Japanese capitulated on Aug. 14, and within two weeks thereafter Soviet troops had occupied all the chief cities. Under the Yalta agreement the U.S.S.R. was granted use (with China) and practical control of the naval base at Port Arthur; Dairen was internationalized, although the harbour master was to be a Soviet national; and the C.E.R. and S.M.R. main lines, under the name of the Chinese Ch'ang-ch'un railway, were to be placed under joint Chinese-Soviet control for a period of 30 years. These conditions were confirmed in the treaty between China and the U.S.S.R. of Aug. 14, 1945. As a result the U.S.S.R. regained essentially the same rights and privileges, other than extraterritoriality, which tsarist Russia had held in 1904. By the end of April 1946 the Soviet Union had evacuated its troops from almost all of Manchuria, but not before a large-scale removal of Manchurian industrial equipment as war booty had taken place.

Meanwhile Chinese Communist troops had begun to enter Manchuria in large numbers as "civilians" under orders from Communist leader Chu Teh. with the tacit consent of the Russians. After the evacuation of the Soviet troops Chinese Communists—aided by anti-Japanese Chinese and Korean guerrillas and later by the Mongols of Manchuria—gained control and organized politically all of northern Manchuria and much of the countryside in the south. They armed themselves with captured Japanese military equipment. again with tacit Soviet consent. Nationalist troops landed at Ch'in-huang-tao in Nov. 1945, since Dairen was closed to them by the Russians and other ports were in Chinese Communist hands; they marched north along the Peking-Mukden railway and by May 1946 had gained control of Ch'ang-ch'un, the former capital. Nationalist and Communist armies fought over central Manchuria until Mukden fell to the Communists Oct. 30, 1948; the entire region passed shortly thereafter into their hands. Manchuria thus became the first major region of China to come wholly under Communist domination, and it was largely the Manchurian troops of Gen. Lin Piao who occupied Peking atter its surrender on Jan. 22, 1949. Manchuria became one of the seven major administrative regions of China and on Xug. 27, 1949, the Northeast People's government was established at Mukden under Kao Kang, it nas the first such government to be established among the seven administrative regions. On June 21, 1954, the major administrative regions were abolished in China because of tendencies toward regional independence from Peking; Kao Kang was purged and the powers of the Northeast People's government reverted to Peking, to the reconstituted truncated provinces of Heilungkiang, Kirin and Liaoning and to Inner Mongolian Autonomous region, respectively. Russian influence remained strong in the region, although on Dec. 31, 1952, the Soviet Union transferred its rights in the Chinese Ch'ang-ch'un railway to the Chinese. On Oct. 12, 1954, the U.S.S.R. agreed to withdraw from Port Arthur and transfer installations to China without compensation by May 31, 19jj. *See* also CHINA: *History;* JAPAN: *Hzstory;* RUSSIA: *History.* (N. S. G.; KN. C.)

ADMINISTRATION

After the reorganization of Jan. 1956, when all but 10,000 sq.mi. of Jehol was taken out of the administrative jurisdiction of the northeast, Manchuria consisted administratively of the three provinces of Liaoning, Kirin and Heilungkiang. This was almost a reversion to the old division at the beginning of the 20th century when the three provinces covered a larger area. The 1956 redivision transferred some parts of Manchuria into the Inner Mongolian Autonomous Region and a small part to Hopeh province.

When the Chinese Communist forces gained control of the northeast in 1948 the entire area consisted of nine provinces: Liaoning, Antung, Kirin, Sungkiang, Liaopeh, Hokiang, Nunkiang, Hsingan and Heilungkiang. In 1949 the number of provinces was reduced to six: Liaotung, Liaohsi. Jehol, Kirin, Sungkiang and Heilungkiang. The provinces of Hsingan and Liaopeh and a large part of Nunkiang were transferred to the Inner Mongolian Autonomous region, while some other provinces were consolidated. (See MONGOLIA.) In 1954 the number was further reduced to four (Liaoning, Kirin, Heilungkiang and Jehol) without any change in the total area. In 1956 the province of Jehol (created in 1928) was abolished, with about 34,000 sq.mi. going to the Inner Mongolian Autonomous region and Hopeh, while the remaining 10,000 sq.mi. were added to Liaoning province.

Between 1949 and 1953 Manchuria was under the semi-autonomous administration of an elaborately constructed regional government (the Northeast People's government). In 1954 the northeast regional government, together with five other Chinese regional governments, was abolished. The provinces came under direct control of the state council of the Central People's government. Some municipalities also lost their autonomous status and became subordinate administrative units under various provinces.

Each of the three provinces of Manchuria and the other provinces of China is governed by a provincial government which is elected by a provincial people's congress. Congressional delegates are elected by the county people's congress, which, in turn. is elected by the *hsiang* (or administrative village) people's congress. The members of the *hsiang* people's congress are chosen directly by the voters at the villages, now the people's communes.

Liaoning (1 chairman and 10 deputy chairmen) controls 10 municipalities with jurisdiction over 37 counties and 1 banner or *ch'i* (area populated by Mongols, comparable to *hsien* or district). Kirin (1 chairman and 8 deputy chairmen) controls 6 municipalities, 6 counties. 3 special districts and 1 autonomous *chou* (Yenpien Korean Autonomous district). Heilungkiang (1 chairman and 8 deputy chairmen) controls 7 municipalities. 8 counties. 1 autonomous county and 5 special districts which have 51 counties under their jurisdiction.

ECONOMY

After 1900 Manchuria made progress in many fields of economic activity — industry, agriculture, mining, trade, transportation and population expansion.

Transportation. — The framework for Manchuria's economic development was the railway system, virtually nonexistent in 1900. (See *Hzstory* above, for development) In the early 1960s the total length of railways in Manchuria mas more than 8,000 mi., or some 40% of the nation's total. From such trunk routes as Man-chou-li to Tung-ning (Suifenho), Harbin-Dairen, Mukden to Shan-hai-kuan, Mukden-Kirin, Ssu-p'ing to Tsitsihar and T'u-men to Chia-mu-ssu a netnork of railroads fans out in all directions. During the period of Japanese domination the Southern Manchurian Railway company not only controlled transportation but also participated in all the important economic activities. Roads are also extensive but unsurfaced, except for those connecting large cities. Inland navigation is generally restricted to the Sungari and its lower tributaries. The rivers of southern Manchuria are shallow and little used above their lowest courses, except by small native boats. There are a number of fine harbours in southern Manchuria. including Dairen, Port Arthur and Hu-lu-tao. Some ports need the help of icebreakers in winter but Antung and Ying-k'ou are frozen about four months a year.

Mining. — Although the northeast became the most important industrial region of China because of an intensive effort at industrialization, the mineral resources of Manchuria are not particularly superior to those of the rest of China. As development and prospecting increased elsenhere the relative weight of mineral resources of Manchuria decreased accordingly. In the 1930s it was estimated that Manchuria had about 8% of China's coal reserves (then estimated at 265,000,000,000 tons). By the 1960s the revised estimate of China s coal deposits came to 1,000,000,000,000 tons, with most of the reserves outside Manchuria. The chief deposits of coal in Manchuria are found in a belt along the line of demarcation between the eastern highlands and the plain, particularly at Fu-sung. Most of the Manchurian coals are non-coking and bituminous but good coking coals are found at Pen-ch'i, Pel-p iao, Hao-li and Tung-pien-tao. These deposits are associated uith vast beds of oil shale containing 3% to 7% petroleum. Little liquid petroleum has been found so far but there are favourable geological formations near Hu-lun Ch'ih (Lake Dalai Nor).

Iron ore represents a major resource of Manchuria. with an estimated half of China's ore reserves and a little less than half of the nation's iron output coming from the region The major mining centres are An-shan and Miao-erh-kou south of Pen-ch'i, and Talitze (Ta-li-tzu) in the Tung-pien-tao district on the Korean border. In the first two cases the ores are mostly low-grade mag-

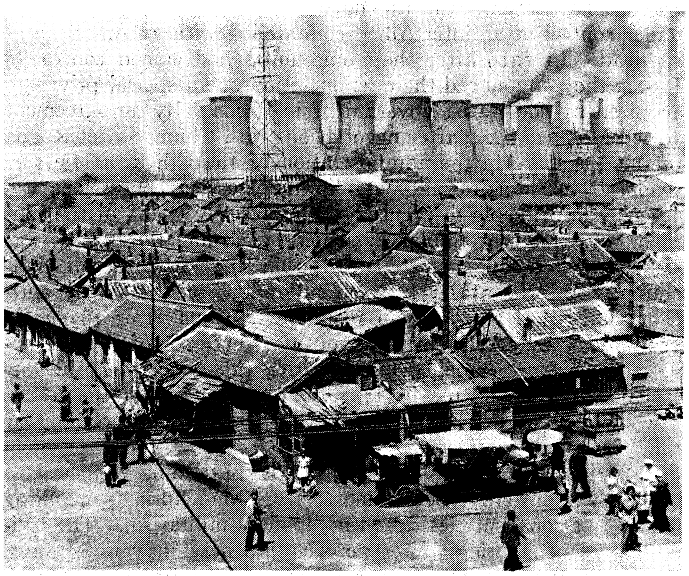

PHOTO BY WILLIAM KINMOND

POWER [illegible] FU-SUNG, MANCHURIA, LARGE [illegible] ERS' HOUSES ARE IN THE FOREGROUND netites and hematites with small deposits of higher-grade ores; in the last area the ores are hematites averaging 60% iron.

Gold is found both in placers and in lode deposits. The mining is done particularly in the eastern and northern highlands, along the Hei-lung Chiang and lower Sungari rivers. Lode deposits are mined near Hua-tien and \-en-chi bordering Korea.

Other important minerals mined in Manchuria include molybdenum, copper, zinc, lead, magnesite, alumina shales, limestone, talc, clays, mica, the last four being nonmetallic.

Industry. — For generations Manchuria has been known as the "Ruhr of China." About 90% of the steel produced on the Chinese mainland during the 1930s and early 1940s came from Manchuria. In the late 1950s, out of a total annual production of about 11,000,000 tons, 2,000,000 to 5,000,000 tons were produced in Manchuria, with An-shan accounting for some 80% of the steel manufactured in the northeast. More than 40,000,000 tons of coal (against the previous peak figure of 26,000,000 tons in 1943) were mined annually in the northeast. It was claimed that the capacity of electric power in Liaoning province alone had reached 10,000,000 kw.hr. in the early 1960s.

Although no detailed information is available, many major industrial projects scheduled to be completed during the first five-year plan are probably located in Manchuria. The first automobile plant at Ch'ang-ch'un was built with Soviet assistance. China's first precision instruments factory is now in production at Harbin. The shipyards at Dairen are reported to be building 20,000-ton ocean-going vessels and Mukden has become the nation's centre of machine-tool manufacturing. Primarily because of the development in Manchuria, China can manufacture about 80% of all the machine equipment she needs. According to official statistics the value of industrial production in the northeast increased by 144% during the first five-year plan period (1953–57) and 150 big industrial projects were completed.

Agriculture. — In agriculture Manchuria has always played an important role as supplier of both food grains and commercial crops, particularly soybeans. During the Japanese domination large quantities of food grains were shipped to Korea. which had to surrender most of her rice to feed Japan. Before World War II, 60% of the value of Manchuria's exports was derived from agricultural products, consisting largely of soybeans and soybean products. By the 1960s the picture had changed drastically, with industrial goods constituting the bulk of export values.

Under the Communists the rate of progress in Manchuria's agricultural development was not as rapid as industrial gronth. Not until 1952 did food-grain production reach its pre-1949 peak figure (20,800,000 tons, including soybeans, achieved in 1943). During the first five-year plan period there was no appreciable rate of increase in agricultural production. However, in the "big leap forward" of the entire nation in 1958 Manchuria also achieved impressive advances in food-grain production (kaoliang. millet. corn [maize], rice. wheat), claiming 30,000,000 tons, exclusive of the most important crop, soybeans, which was taken out of the category of food grains in 1956. Industrial crops include fibres (cotton, flax, hemp), sugar beets, tobacco and peanuts. Livestock raising (pigs, sheep, horses, cattle, goats) is important along the western margins of the Manchurian plain.

Programs to enhance agricultural production in hlanchuria, as those in other parts of Communist China, may be grouped into four general categories. (1) Those which contribute to the expansion of crop acreage — conservation, reclamation (especially in Heilungkiang) and encouragement of multiple-cropping practices. (2) Those which aid the increase of yield per acre—irrigation, afforestation, water and soil conservation, use of better seeds, application of more fertilizers. new farm implements and agrotechnical training; the promotion of higher-yielding crops, such as corn and potatoes. and the expansion of rice cultivation also help to increase the yield per unit of land. (3) Those which help reduce crop losses and waste. including control of plant or animal pests, better storage facilities and a host of other methods of practising greater economy in the use of agricultural produce. (4) Those organizational measures, such as establishment of co-operative and collective farming, which aim to raise labour efficiency and to achieve a more rational use of resources, as well as reform of marketing systems and improvement of other socio-economic institutional factors in rural areas.

In the propagation of various forms of organized farming, such as the mutual-aid teams, the co-operatives, the collective farms and the people's communes, the northeast played a major role in all except the last stage. As Manchuria was the first area to be consolidated under the Chinese Communists after World War II, major reforms and experiments in social engineering often were first tried out there. When mutual-aid teams were introduced in areas south of the Yangtze in 1950 they had already been extensively introduced in Manchuria. The region also led in co-operative farming. By the late 1950s all farms in the northeast were practically collectivized and about 10,000,000 peasant households in Manchuria participated in the communes.

Numerous advantages have been attributed to the commune system; among them, pooling of resources (land, labour, capital, farming skill), more rational utilization of such resources, release of village women from household chores by establishment of common dining halls, sewing services and nurseries; and the ability of communes to sponsor cultural-recreational programs for members.

Although several other regions, particularly in the northwest and the southwest, are currently developing their economies at a relatively quicker pace, Manchuria, with its solid foundation and rich resources, is likely to remain the major industrial base of China for some time to come.

Trade. — Manchuria's importance in domestic and foreign trade is obvious, given its position as the major geographical link between China and the G.S.S.R., which takes about 75% of China's exports. As the most industrially advanced base of China, Manchuria supplies a variety of capital goods to many areas in China proper, while receiving certain consumers' goods in return from light industrial centres such as Shanghai. Tientsin and Wuhan.

See Index references under "Manchuria" in the Index volume.

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MANCHUS. "Manchu" is the name given to a people who lived for many centuries in Manchuria and adjacent areas and who in the 17th century conquered China and ruled that country for more than 250 years. The term "Manchu" is comparatively modern, having been first used in the 16th century, but it is certain that the Manchus are the direct descendants of a people who under other names had lived in northeastern Manchuria from a time long prior to the Christian era. In the early Chinese records they are known as the Tung-i or Eastern Barbarians. In the 3rd century B.C. they were given the name of Sushen or Ilu. In the 10th century A.D. the Chinese historians speak of them as Nu-chi or Ju-chi, an attempt to transliterate the native word "Jurchen." The Jurchen managed to establish a kingdom of some extent and importance in Manchuria and in 1115 A.D. were able to secure control over northeastern China. In Chinese records the rulers of this kingdom were known as the Chin or Golden dynasty. This kingdom was annihilated by the Mongols in 1234 and the surviving Jurchen were driven back into northeastern Manchuria. In the 16th century the descendants of these Jurchen again came into prominence. but before long they dropped the name Jurchen and adopted the name Manchu. The Manchus rapidly rose to power under the leadership of a tribal leader named Nurhachi, who established military and political control over the whole of Manchuria. In 1616 he proclaimed himself emperor. Nurhachi fought several successful battles against the Chinese, but he died before he could carry out his life-long ambition of invading China. In 1644 the long-expected attack took place. Peking, the Chinese capital, soon fell, and by 1680 the Manchus had complete control over all sections of the Chinese empire. The Manchus managed to maintain a brilliant and powerful government until about 1800, after which they rapidly decayed in energy and ability. It was not, however, until 1912 that the Manchu dynasty was overthrown.

In order to understand the origin and cultural development of the Jurchen-Manchus it is important to bear in mind that Manchuria is divided into two sections: one, to the south and west, is an open, rolling and almost treeless plain, ideally suited for pasturage; the other. to the north and east, is essentially mountainous and is covered with natural forestation. In early times the south and west section was inhabited by the Tunghu tribes, the ancestors of the Mongols, who soon developed a nomadic horse culture. while the north and east section served as the breeding ground for the Ilu and their descendants, the Jurchens and Manchus. Because of the difference in terrain the Manchus never adopted the Mongol culture pattern. even after they secured control over the whole of Manchuria.

Modern research showed that Jurchen-Manchus are members of a widespread ethnic group known as the Tungus. At one time various Tungus tribes occupied most of Siberia between the Yenisei river and the Pacific ocean. Many of these tribes disappeared with the advance of Russian settlements, but others remained. Other Tungus tribes are to be found on Sakhalin Island. Basically the Manchus, like all the other Tungus peoples, are members of the Mongoloid race, but it is obvious that they have interbred widely with other peoples as there is wide variation in body type between different Manchu groups. It is almost certain that they have absorbed some of the Caucasoid races (Alpine and Proto-Nordic) which inhabited parts of Siberia in prehistoric times. From inscriptions in the two languages it is clear that the old Jurchen language and modern Manchu are practically identical. Manchu is also closely related to the other Tungus languages. There is some doubt as to the relationship of Tungus to other languages. but because of similarity of structure, most scholars place Tungus along with Mongolian, Turkish. Hungarian and Finnish in a language group known as Ural-Altaic. In any case it is certain that Tungus is in no way related to Chinese. In writing the Manchus never adopted the Chinese ideographs but employed a phonetic alphabet developed by the Jurchen on the basis of the Mongolian alphabet. The ultimate source of this alphabet is to be found in Syria.

From the Chinese records it is evident that the Ilu, the ancestors of the Manchus. were on a rather low cultural level. They, like many modern Tungus tribes in Siberia, were essentially hunters, fishers and food gatherers, though in later times they and their descendants the Jurchens and Manchus developed a rather primitive form of agriculture. Unlike the Mongols and Turks, the Jurchen-Manchus were noted breeders and eaters of swine. Swine also played an important role in their religious myths and rites. It is probable that the word "Tungus" is derived from an early Turkish word for pig. From very early times the Jurchen-Manchus were accustomed to braid their hair into a queue or "pigtail." When the Manchus conquered China they forced the Chinese to adopt this custom as a sign of loyalty to the new dynasty. Apart from this the Manchus made no attempt to impose their manners and customs upon the Chinese. They even permitted foot binding to go on among the Chinese women, though the Manchu women never adopted this custom.

After the conquest of China, the greater part of the Manchus migrated to the latter country, using their ancestral estates only as hunting lodges for occasional vacations. Eventually these estates were broken up and sold to or occupied by Chinese immigrant farmers. By 1900 even in Manchuria the Chinese enormously outnumbered the Manchus. Many Manchus in the years following 1644 settled in and around Peking, where they obtained official positions. No effort was made to destroy or even seriously to modify the traditional Chinese governmental structure. but in most cases the Manchus were given a good share of the higher administrative posts. Thus the grand council. the highest governmental organ, was usually half Chinese and half Manchu. A large number of Manchus were also incorporated in the mandarinate or administrative hierarchy scattered throughout the country. A great many Manchu males became hereditary soldiers, being incorporated in eight special "banners" or army divisions which were stationed at various strategic posts in order to maintain law and order and to prevent revolution.

Prior to their conquests of China the Manchus were distinctly backward as regards cultural development, but they were quick to learn once they had secured military and political power. Several of the early rulers of the Manchu or Ch'ing dynasty (especially the emperors K'ang Hsi and Ch'ien Lung. who between them ruled for 120 years) were not only men of high intelligence, they were also among the most able and munificent patrons of literature and art which China had ever known. Under their stimulus a Manchu literature was created. Many of these Manchu works were subsequently translated into Chinese. In like manner, many important Chinese works were translated into Manchu and published at imperial expense. The emperor K'ang Hsi gathered together from all parts of the empire the best scholars and set them to work on literary and historical research. As the result of these efforts there appeared the *K'ang Hsi* Dictionary, still the standard dictionary of the Chinese language, and the authoritative "(imperial edition" of the Chinese classics. A little later the Manchu court fostered the publication of a gigantic encyclopaedia comprising more than 1.joo volumes. The Manchu rulers were also noted patrons of ceramic art, and the types of porcelain known as K'ang Hsi and Ch'ien Lung ware are still prized museum pieces.

The Manchu emperors, in spite of their patronage of Chinese culture, made strenuous efforts to prevent the Manchus from being absorbed by the Chinese. The Manchus were urged to retain their own language and to give their children a Manchu education. Attempts were made to prevent the intermarriage of Manchus and Chinese, so as to keep the Manchu strain racially pure. Too much social intercourse between the two peoples was frowned upon. All these efforts proved fruitless. During the 19th century, as the dynasty decayed, the efforts to preserve cultural and racial segregation gradually broke down. The Manchus began to adopt Chinese customs, to speak the Chinese language and to interbreed with the Chinese. When the dynasty was overthrown, and it became politically inexpedient to be known as a Manchu, the Manchus quietly disappeared into the main mass of the Chinese populace. (W. M. McG.)

MANCINI, PASQUALE STANISLAO (1817–1888), Italian jurist and statesman, was born at Castel Baronia. Avellino province. March 17, 1817. In 1848 he helped to persuade Ferdinand II of Naples to participate in the war against Austria. Upon the triumph of the reactionary party he undertook the defense of the liberal political prisoners. Threatened with imprisonment in turn, he fled to Piedmont, where he obtained a professorship and became preceptor of the crown prince Humbert. After the fall of the Bourbons, he went to Naples as administrator of justice. in which capacity he suppressed the religious orders, revoked the concordat, proclaimed the right of the state to church property and unified civil and commercial jurisprudence. In 1862 he became minister of public instruction in the Rattazzi cabinet, and induced the chamber to abolish capital punishment. For the next 14 years he devoted himself chiefly to international law and arbitration. but in 1876, upon the advent of the left to power, became minister of justice in the Depretis cabinet. Mancini's liberalism found expression in the extension of press freedom, the repeal of imprisonment for debt and the abolition of ecclesiastical tithes. During the conclave of 1878 he succeeded, by negotiations with Cardinal Pecci (afterward Leo XIII), in inducing the Sacred College to remain in Rome, and, after the election of the new pope, arranged for his temporary absence from the Vatican for the purpose of settling private business. Resigning office in March 1878, he resumed the practice of law. and secured the annulment of Garibaldi's marriage. The fall of Cairoli led to Mancini's appointment (1881) to the ministry of foreign affairs. An indiscreet announcement of the limitations of the Triple Alliance contributed to his fall in June 1885; he was succeeded by Count di Robilant. He died in Rome, Dec. 26, 1888.

MANCUNIUM, the name often (though probably incorrectly) given as the Romano-British name of Manchester. Here, close to the Medlock, in the district still called Castlefield near Knott Mill, stood in Roman days a fort of 5 acres garrisoned by a cohort of Roman auxiliary soldiers. The site is now obscured by houses, railways and the Rochdale canal, but vestiges of Roman ramparts can still be seen, and other remains were found in 1907 and previous years. Traces of Romano-British inhabitation have been noted elsewhere in Manchester, especially near the cathedral. But there was no town here; we can trace nothing more than a fort guarding the roads running north through Lancashire and east into Yorkshire, and the dwellings of women-folk and traders which would naturally spring up outside such a fort. The ancient name is unknown. Our Roman authorities give both Mancunium and Mamucium, but it is not clear that either form is correct.

See numerous articles *by* J. J. Phelps, C. Roeder and F. A. Bruton throughout the *Transactions* of *the Lancashire and Cheshire Antiquarian Society.*

MANDAEANS, also known as Subba (Sabians), Naṣoraeans, or St. John's Christians, are an ancient sect akin to the Gnostic Christians of the 2nd and 3rd centuries, which still exists in lower Mesopotamia, in such places as Basra and Kut and Sūḳ-esh-Shuyūkh. They number now not more than about 2,000, and are said to be diminishing. Subba (sing. ṣubbi) is the modern Arabic name, referring to their frequent baptisms (in Mandaean mas*buta*); Naṣoraeans, like the Arabic *Naṣāra,* is ultimately connected with Ναζωραῖοι (*comp.* Acts 24, 5 and נוצרי), and is used by Mandaeans in the sense of "true believers"; St. John's Christians is the inappropriate name given to the Mandaeans by Christian missionaries from the 17th century onwards, who mistook their frequent immersions and the reverence paid by them to John the Baptist for signs that they were derived from the Baptist's disciples. This is not so, and their interest in the Baptist is grounded in their hostility to the Church as it was under the Sassanian empire, *i.e.,* the Nestorians. Mandaeans means γνωστικοί (מאנדאייא, from מאנדא, Syriac *mad'ā*): the Gnosis of which they profess themselves adherents is a personification, the aeon and mediator "knowledge of life" (Manda d'hayye).

The present condition and practices of the Mandaeans may be gathered from Siouffi's book, published in 1880. A later account, including a detailed description of a Mandaean baptism, is to be found in the Quest for Oct. 1924 and Jan. 1925. (See **Bibliog**raphy.) The sacred books of the Mandaeans are: (1) the Ginza ("Treasure"), known also as Sidra rabba ("the Great Book"); (2) the John-Book, a later collection; (3) Qolasta, a sort of hymnbook, cf. the Syriac *ḳullāsā* ("praise") and some minor works, partly astrological. The editions of the Ginza (1925) and the John-Book (1905–IS), both by Mark Lidzbarski, have now made the chief Mandaean writings generally accessible to scholars.

Mandaean mss. are written in a peculiar Aramaic. As in the Babylonian (cuneiform) documents the characteristic Semitic gutturals have disappeared; on the other hand the vowels are represented, a by *, e by ײ, while' is used both for *i* and y, ו for w and *u* and o. Initial *u* (or o) is represented by עו, initial *i* by עי. No ms. older than the 16th century seems to have survived, but the texts show few variations of importance.

The Ginza is the oldest document. It begins at both ends, like many ms. note-books. The longer part is called the Right-hand Ginza (GR), the shorter (about a quarter of the whole) is the Left-hand Ginza (GL). It is usually cited by the pages of Peterman's facsimile, given in the margin of Lidzbarski's edition. The last chapter of 'GR presents a kind of world-history, and as the dominion of the Arabs is placed at only 71 years it is evident that it must have been compiled very shortly before A.D. 700.

GR contains general cosmological, hortatory and doctrinal pieces. GL consists chiefly of hymns and doctrinal pieces about the fate of the soul after death. This part (GL) shows most clearly the essence of the Mandaean religion; this is the σῶμα-σῆμα ("the body, a tomb") philosophy, which Mandaism shares with almost all the religions which flourished in the early days of Christianity, except Judaism and Catholic Christianity itself. For the world in itself, both visible heavens and this earth, together with the bodies of all men, there is no redemption, and the final end of everything on the earth, except for the souls of the righteous, is to be swallowed by Leviathan and so annihilated (GR 393). Our world had been a kind of mistake from the beginning. There was a light-world, and a world of darkness in which the evil woman-demon lived, whom the Mandaeans call Ruha. That world seems to consist of the dark (or black) waters and things thereto allied, and in GR v. 134–172 we read the fantastic tale of how Hibil the Bright (Hibil-Ziwa, lit. "Abel-Splendouro": Hibil is the Mandaean form, *Hābēl* the Syriac form of Abel), son not of Adam but of Manda d'Hayye, traversed all these dark lower regions, despoiling the principalities and powers and enchaining them. But somehow—the account itself is not clear (GR 150ff.)—Ruha, as the result of this visit, bore a monstrous son called *Ur* (possibly a corruption of ὕλη), and from Ur and his mother Ruha came broods of Seven and of Twelve, which are the planets and the zodiacal constellations. Meanwhile a lower being of the light-world called Abathur had looked below into the dark waters and seen his image, which thereupon took independent shape and was called *Ptahil.* This Ptahil had in him therefore some of the substance or quality of the dark waters: he was told to form a solid world out of the dark waters, but failed to do so till he was helped by Hibil, who put some of his brightness into the mixture. Ruha also took some part, for she saw that this new world was partly formed out of her waters. This is our world, formed out of the dark substance, yet with a little of the light mingled with it.

Hibil set the sons of Ruha as sun and moon and planets in the sky. When man was made these constructed the body of Adam, while Hibil brought out a soul from the treasury of life and put it into Adam's body (GR 172).

No satisfactory derivation for the names Abatur and Ptahil has yet been found. (See Pallis: Mandaean Studies, pp. 111–114.) Abathur has become the judge and "weigher" of Mandaean souls (see esp. JB 70–72), but this does not seem to have been his original function.

Manda corresponds exactly to the Syriac mad'd, which Bardaisan used for the Divine element in man (Mitchell ii. 158), distinct from knowledge, and corresponding to something between "reason" and "revelation." The actual phrase *mad'ā d'ḥayyē* occurs in the Syriac Bible in Luke i. 77 (=γνῶσιν σωτηρίας).

The Mandaean hostility to Eshu *mshiha* (Syr. *Ishō' mshīḥā,* Jesus Christ) is hostility to the fully developed post-Niccne Church. In several places "Christ" is actually called "the Byzantine" (Rumaya), and we read that the disciples of this Christ become "Christians," and turn into monks and nuns who have no children and who keep fasts and never wear white clothes like the Mandaeans (GR 55). The Holy Spirit of Catholic theology is identified by the Mandaeans with the evil Ruha. The peculiar hfandaean terminology sometimes makes the ordinary use of familiar terms impossible and other words have to be substituted. Thus Ruha to the Mandaeans means exclusively the evil spirit, so that they never use it, as all other Aramaic dialects do, for "wind," but use zika (lit. "storm") instead. Similarly *Alaha* means to them "false god," so for "true God" they speak of "the Great Mana" or other titles. Now we have seen that "Jesus Christ" was to the Mandaeans only the Pseudo-messiah worshipped by the official Christians: the Mandaean name for the true Jesus was *Anush* (or *Enush*). In GR 29 and 53 we read that Anush-Utra comes into the world in the days of Piliaṭus (or Palṭus, *i.e.,* Pilate) the king of the world; he heals the sick, makes the blind to see, cleanses the lepers, etc. (*cf.* Luke vii. 22). (*Utra* [Syr. uthra, lit. "wealth," "treasure"] is the Mnndaean term for a good spirit, so that Anush-Utra might almost be rendered "St. Enosh.") With the power of the high King of Light he raises the dead. Those who believe in him among the Jews he teaches that there is truth and error, life and death, light and darkness and burning fire. At his word 360 (or 365) prophets go out of Jerusalem and preach: then Anush ascends to the Mandaean paradise (Mshune-Kushṭa, "the abode of Truth") and will not be seen again by mankind till the end comes. *Kushṭa,* lit. "truth," is much used by Mandaeans for "true religion" generally; "to give Kushṭa" means to shake hands (always the right hand), a ceremony which takes the place of the laying on of hands in Catholic ritual. (Note that this word is spelt by Mandaeans with k not k.) Before he ascended, however, he will have unmasked the Deceiver, the Byzantine Christ, who will confess that he is only Hermes-Mercury (Nbo), one of the deceiving Seven Planets; he will be seized by the Jews and crucified (GR 58).

What more or less orthodox Christians thought of the Mandaeans we learn from the Scholion of Theodore bar Ronai (?Kēwāni = Saturninus) who compiled a sort of catalogue of heretics in A.D. 792. He treats them as a comparatively recent sect, founded by one Ado, a beggar (*i.e.*, a wandering fakir) from Adiabene, and says that their doctrine is borrowed from the Marcionites, from the Manichees and from the Kantaeans (or Knathaeans). Of these last, who are only known from Theodore himself, the one significant fact handed down is that they professed to derive their teaching from Abel, as in part the Mandaeans do.

In polemic against Catholic Christianity some Mandaean writers must have studied the Bible. In all cases it is the Syriac Bible (the Peshiṭta) of which they show knowledge. Their general grasp of Bible history and geography is extremely slight and they do not clearly distinguish the Jews from the Church Christians. (See esp. Pallis: Mandaean Studies, p. 141.) The evidence which has from time to time been brought forward to show independent Mandaean knowledge of Jewish traditions or literature breaks down on closer investigation.

Especially is this the case with regard to Mandaean tales about John the Baptist. Mandaeans use for Baptism a different word from that used by Catholic Christians, so that their conception of baptism may be more or less independent of Catholic Christianity, but the fact that they call all running water in which baptism may be performed "Jordan" must ultimately be based on the biblical stories about John.

John plays very little part in the Ginza. Manda d'Hayye goes down to the place where he baptizes, but the Jordan draws back before him, and he takes John (*Yuhana*) away to heavenly regions. In the *John-Book,* on the other hand, a long section is devoted to John, in which he is also called Yahia. the Arabic form of the name John. The tale, at least in its present form, is therefore later than the Arab conquests. In this, and also in GR 57, we read of John's aged parents, the priest Zacharia and his wife Enishbai (*i.e.*, the Syriac name Elishba' corrupted): it is difficult to believe that this is not derived from Luke i. Presently *Eshu* meshiha goes down and asks baptism from John, who is at first unwilling but finally complies on hearing a voice from heaven. It was, of course, a trump card for the Mandaean controversialist to be able to point out that the Jesus of the Catholics had had to be baptized by John, while the Mandaean Anush-Utra had not needed baptism. (Note that in GR v. 189–196 we have what Lidzbarski calls "the baptism of Manda d'Hayye by John." But in this tale Manda d'Hayye is not baptized: Manda d'Hayye asks baptism from John, but at His approach Jordan is driven back, and when Manda d'Hayye at length "gives truth"; *i.e.*, holds John by the right hand, John's soul is drawn out of his body and goes to Paradise.) But from the point of view of the modern investigator of Christian origins, the Mandaean accounts of the Baptist are both too fantastic and too near in some details to the Christian tale preserved in Luke to be regarded as in any sense independent tradition.

Baptism is called by Mandaeans *maṣbuta,* the corresponding form of which in Syriac would be masbo'ithd. The common Syriac term for baptism is *ma'modīthā,* only used by Mandaeans in speaking of Catholic baptism, which they regard with contempt as being administered in "cut off," *i.e.,* not running water. It should be noted that the Christian Palestinian dialect uses the term *maṣbo'īthā.* The Jewish term is *ṭibbūlā.* But the main difference between the Mandaean and the Christian rite is that the Mandaean masbuta is continually being repeated; it is a purification. not an initiation Everything defiles. but running water makes all things clean: that is the Mandaean idea.

The Mandaeans have a clergy: the assistant or deacon (*shkanda*), the priest (*tarmida,* lit. "disciple") and the bishop (*ganzibra,* lit. "treasurer"). The priestly garment is called rasta. A sort of eucharist is given, consisting of a dough-cake (pehta,? Syr. *pitthā* "bit of bread") and a draught of water (Mambuha, lit. "fountain"): there is some reason to think that the original rite consisted of the *mambuha* alone. Their temples (*mashkana*) are small, being merely receptacles for objects used in the services, which are conducted in the courtyard outside. The congregations assemble on Sundays.

History. — No Arab accounts of "Ṣābians" or "Mughtasila" are detailed or accurate enough to be useful. Portuguese missionaries came to lower Babylonia as a result of the Portuguese occupation of Basra at the end of the 16th century, and found the Mandaeans there, a flourishing community estimated at over 14,000 souls. They were regarded as Christians of John the Baptist, and as such amenable to the Inquisition. The first account of them in Europe was in a letter from the Jesuit Pietro della Valle, dated June 1622, in which year the Portuguese lost their ascendancy in the Persian gulf. From about 1622–1651 the Jesuits were replaced by Carmelites under Ignatius a Jesu, who published in 1658 at Rome an account of the Mandaeans. A few years later some Mandaean mss. were bought for Robert Huntington, then in Aleppo, who left them to the Bodleian Library at Oxford. In 1854 the German orientalist, H. Petermann, spent three months at Suk esh-Shuyūkh and learnt the language from the local priest Yahya; in 1875 the grandson of this Yahya, having become a Christian, expounded the Mandaean religion to N. Siouffi, then French Consul at Baghdad, who published a full account of the modern Mandaeans at Paris in 1880.

Incantation Documents. — Quite distinct from the religious literature of the Mandaeans are two series of magical formulae described respectively by H. Pognon and M. Lidzbarski. (See Bibliography.) The former are written on earthenware saucers found at Khouabir, on the Euphrates between Baghdad and Kerbela. They are all formulae designed to protect so-and-so from hostile incantations.

Lidzbarski's documents consist of leaden tablets of similar content: in these the names of deities, etc., are of a more definitely Mandaean caste.

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MANDALAY, formerly capital of independent Burma, now headquarters of the Mandalay division and district, as well as the chief town in Upper Burma, stands on the Irrawaddy, in 21° 59' N. and 96° 8' E. Built in 1856–57 by King Mindōn, it is now a municipality.

The area inside the old walls of the palace and environs was called Fort Dufferin after the annexation, though no longer used as a fort. In the centre the palace, a group of wooden buildings, many of them highly carved and gilt, resting on a brick platform 900 ft. by 500 ft., and 6 ft. high, stood until its destruction during World War II. Pop. (1941) 163,537. The population is mixed, but Burmese Buddhists number over 77% of the whole. Mandalay is thus far more Burmese than Rangoon and is a great Buddhist religious centre and the abode of very large numbers of monks (*Hpongyis*). Besides Burmese there are Zerbadis (the offspring of a Mohammedan with a Burman wife), Mohammedans, Hindus, Jews, Chinese, Shans and Manipuris (called Kathe). Trains run from Mandalay to Rangoon, to Myit-kyina, and to Lashio, the beginning of the Burma road to Kunming. Steamers also ply in all directions. There are 20 bazaars.

The MANDALAY DISTRICT has an area of 2,115 sq.mi. and a pop. (1941) of 408.926. About 600 sq.mi. along the Irrawaddy are flat land, nearly all cultivated. In the north and east there are 1,500 sq.mi. of hills and tablelands, forming geographically a portion of the Shan tableland. This part of the district is well wooded and watered. The Maymyo subdivision has plateaux of 3,000 to 3.600 ft. The highest peaks are between 4.000 and 5,000 ft. The Irrawaddy, the Myit-ngè and the Madaya are the chief rivers. The last two come from the Shan states. and are navigable for between 20 and 30 mi. The Sagyin hills near Madaya are noted for their alabaster.

On the plains the climate is dry and healthful, the rainfall averaging about 30 in. Considerable areas are irrigated. The hilly eastern tracts have a heavier rainfall — about 60 in. — and are forested. The extremes of temperature on the plains are considerable, the thermometer in December going down to 55° and in July up to 110".

The DIVISION in 1941 included the districts of Mandalay, Kyaukse, Meiktila, Myingyan and Yamethin, with an area of 12,504 sq.mi. and a pop, of 1,907,703.

MANDAMUS, WRIT OF, originally a formal order of high prerogative issued by the crown commanding an official to perform a specific act within the duty of his office (Lat. *mandamus,* "we command"). It later became a judicial writ issuing from the court of king's bench in the name of the king at the request of individual suitors whose interests were alleged to be adversely affected by the failure of an official to act as his duty required.

It is not awarded as a matter of right but rather at the discretion of the court, and, although classified as a legal remedy, it is largely controlled by equitable principles. It is pot ordinarily granted where an alternative remedy is available and, it is said, never where the official to whom it mould be directed has legal discretion to perform the act demanded or to abstain from doing so.

In both England and the United States mandamus is used by courts of superior jurisdiction to compel the performance of a specific act refused by a lower court, such as the hearing of a case falling within the latter's authority. See PRACTICE AND PROCEDURE; APPEAL. (P. B. K.)

MANDAN. This Siouan tribe formed, with the Hidatsa and Arikara (*q.v.*), the so-called village Indians among the bison-hunting nomads of the plains in central United States. Their speech allies them rather with the Winnebago than with the Hidatsa, who in turn are close to the Crow. They lived in dome-shaped, earth-covered lodges clustered in stockaded villages; planted maize, beans, pumpkins and sunflowers; hunted buffalo seasonally; and made pottery. They had an origin myth of emergence from the lower world by a vine; treasured a sacred palladium in an ark; and performed ceremonies which, while containing Plains elements, were rather distinctive. The culture thus had eastern or southeastern affiliations; their drift in the historic period was upward along the Missouri river. Numbering 1,250 in 1804. they were reduced to a fraction a few decades later by disease, especially smallpox. The recent population has been variously given, owing to virtual loss of tribal identity among the Hidatsa. Theories deriving them from the mound builders of Ohio are unwarranted, and from the Welsh, fantastic. They were known as "tattooed people" in the sign language.

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MANDAN CHIEF OF SIOUAN STOCK

See G. Catlin, *North American Indians* (1841); *O-kee-pa* (1867); J. O. Dorsey, *Bur. Am. Ethn. Rep.* xi (1894), xv (1897); G. F. Will and H. J. Spinden, in *Pap. Peabody* Mus., vol. iii (1906). (A. L. K.)

MANDARIN, the common name for all public officials in imperial China, the Chinese name for whom is kuan. The word comes through the Portuguese from Malay mantri, a counselor or minister of state. With the passing of the old order in China the term, as applied to officials, went out of use.

The words "mandarin language" remained in use, though inappropriately so. Originally the term was used to describe the language as spoken in the capital city of Peking and, with local variations, in most parts of China away from the coast. The proper name is the national language, or *kuo-yü,* taught all over the country.

The mandarin duck (yuan-yang) is so described because of its bright, variegated plumage like the dress of the mandarins in imperial China.

The mandarin orange (*kan*) is so called because of its resemblance in colour, shape and size to the large button perched on the hat of those high officials, or very likely because of the similarity in colour to the brilliant yellow of their silk robes. (L. M. L.)

MANDASAUR or MANDSAUR, a municipal town, tehsil and district in Madhya Pradesh state, India. The town (pop., 1951, 34,541), formerly in the state of Gwalior, gave its name to the treaty with Holkar, which concluded the Mahratta-Pindari war in 1818. An inscription discovered near the town is of considerable archaeological interest. It indicates the erection of a temple of the sun in A.D. 437. The fort dates from the 14th and 15th centuries. Mandsaur tehsil (pop., 1951, 119,340) covers an area of 511 sq.mi. MANDSAUR DISTRICT (area 3.961 sq.mi.) had a population in 1951 of 606,601.

MANDATE refers generally to an authorization to act, but the connotation is different according as the term is used in a political, administrative or legal context. Politically, a mandate is an instruction from a constituency to its elected representative in a legislative body or to a policy enjoined upon the legislature as a whole by the results of an election (see REPRESENTATION; ELECTORAL SYSTEMS). Administratively, a mandate is an authoritative command or order, especially an order from a superior to an inferior court, a papal ordinance dealing with an individual case, or an order from the Roman emperor to a provincial officer. In private law and, by analogy, in international law the term refers to an authorization by a person to act for another. In Roman law it is a contract constituted by one person (the mandatarius) promising to do something gratuitously at the request of another (the mandator), who undertakes to indemnify him against loss. (See ROMAN LAW.) The essentials and the terminology of the contract are preserved in most modern systems; but in English law, mandate, under that name, can hardly be said to exist as a separate form of contract. To some extent the law of *mandatum* corresponds to the law of principal and agent. "Mandate" is retained to signify the contract more generally known as gratuitous bailment. It is restricted to personal property, and it implies the delivery of something to the bailee, both of which conditions are unknown in the *mandatum* of the civil law (see BAILMENT).

Mandate System of the League of Nations. — The treaty of Versailles set up various conditions for the administration of the former overseas possessions of Germany and Turkey, under which mandatory powers were selected by the supreme council of the Allies to administer the territories under mandate. This system was a novel experiment in the relations between a sovereign state and a country under its control, involving new departures in international law. It was created by art. 22 of the covenant of the League of Nations. which formed part of the treaty of Versailles, and thus gained the recognition of all states that were members of the League. Upon formation of the United Nations in 1945, the mandate system was superseded by the trusteeship system, and most of the mandated territories became trust territories. (See TRUSTEESHIP SYSTEM.)

In its origin the mandate system was in the nature of a compromise. After World War I the victorious Allies naturally wished to retain the German and Turkish colonies, in the conquest of which they had in most cases made great sacrifices. Pledges had been made to the native inhabitants, some of whom had taken part with the victors in the fighting. that they should not be handed over to the vengeance of their former masters; and finally, a misgiving existed lest. in case of rendition, Germany might use them as recruiting grounds for native armies. and their ports as bases for submarines in a future war. On the other hand, the Allies had declared (more particularly in the pre-Armistice statement of Nov. 5, 1918) that annexation of territory was not their aim in the war.

International control of some kind was the only alternative. Joint administration was believed to be impracticable and opposed to the interests of the people. Even as a condominium between two powers only, it had given rise to friction in Egypt. Samoa and the New Hebrides. The only other course lay in the appointment of an individual power in uhom could be vested responsibility for the administration of each separate territory as an agent or mandatory of the League. For this course there were analogies in the delegation of quasi-sovereign powers to British and Dutch chartered companies and in the control of the Ionian Isles on behalf of the powers by Great Britain in 1815, and of Morocco by France under the Algeciras treaty of 1906. Individuals also had been appointed as mandatories of the powers. as when King Leopold II of Belgium undertook control of the International Free State of the Congo, and when Prince George of Greece was made governor of Crete in 1898.

The main defect of these delegatioris of sovereignty was that they provided no machinery to ensure the due execution of the trust. and it mas the distinctive feature of the mandate system that it attempted to remedy this defect. The League of Nations afforded just such a supervisory authority as was needed, and its supervision was exercised through the medium of a standing committee knonn as the Permanent Mandates commission. The League did not assign the mandates or define their terms or the extent and boundaries of the territories. These were determined by the supreme council and confirmed by the League council. which had authority under the covenant to define "the degree of authority, control or administration to be exercised by the mandatory if not previously agreed on by the members of the League." The United States. not being a member of the League, was no party to this arrangement, but it insisted that as an associated power its consent was necessary. The mandates therefore nere submitted to the United States and approved on condition that "free and equal treatment in law and in fact was secured to the commerce of all nations." The United States negotiated separate treaties with most of the mandatories securing its interests.

Terms **of** the Mandates. — The mandates were framed to give expression in detail to the principles embodied in art. 22 of the covenant; and since that article prescribed that their character must vary with the varying conditions of each territory, they were divided into three classes to correspond with the three paragraphs of that article.

Class A included the former Turkish vilayets of Iraq, Palestine and Syria. whose independence was to be provisionally recognized until they were able to stand alone. The two former were assigned to Great Britain, the latter to France. These mandates came to an end through recognition of the independence of Iraq in 1932, of Syria and Lebanon in 1941, of Transjordan in 1946, and of Israel in 1948. The last two included the territory of the original mandate of Palestine.

Class B comprised the former German central African colonies —Togoland, Cameroons, Tanganyika and Ruanda-Urundi—in which the mandatory was responsible for the administration and undertook to promote the moral and material welfare of the people. Tanganyika and a small part of the Cameroons and Togo fell to Great Britain. the major portions of the latter tno being assigned to France, while Belgium became responsible for Ruanda-Urundi. These territories all became trusteeships under the United Nations, with the same administering powers. In 1956 British Togoland was, with approval of the United Nations following a plebiscite, joined to the Gold Coast, which soon became a member of the United Nations as the state of Ghana. France reorganized the independence of French Togoland in 1958.

Class C territories included those which could "best be administered under the lams of the mandatory as integral portions of its territories. subject to the safeguards in the interests of the indigenous population" which were laid donn for class B. The territories mere South-West Africa, Samoa. New Guinea, the islands north of the equator in the west Pacific and the tiny island of Nauru. For these. respectively. the Union of South Africa. New Zealand. Australia, Japan and the British empire accepted mandates.

In the case of Nauru, in July 1919 (before the issue of the mandate) Great Britain. Australia and New Zealand had by agreement jointly acquired control of the phosphate deposits, which constituted the sole value of the island, and they jointly undertook the execution of the mandate. Since. however, the British empire had no single code of laws, the administration was assigned by the tuo others to Australia.

These territories all became trusteeships under the United Nations except South-West Africa. The International Court of Justice held in 1950 that the latter continue under the mandate of South Africa, with supervisory authority vested in the United Nations general assembly. The United States became trustee of the former Japanese mandated islands. The others retained the same administering authorities.

The "safeguards in the interests of the indigenous population" were: (1) freedom of conscience and religion. subject only to the maintenance of public order and morals; (2) prohibition of abuses, such as the arms and liquor traffic and the slave trade; and (3) prevention of fortifications, naval and military bases and the military training of natives except for police and the defense of the territory.

After acceptance by each mandatory, the mandates were confirmed by the League council, which was charged with seeing that their terms were in accord with the covenant and whose consent was required for any alteration. The A class could not be issued until the treaty of Lausanne came into force (Aug. 1924). The mandate was to be a "sacred trust of civilization" assumed by nations who (inter *ulia)* "by reason of their resources can best undertake this responsibility and are milling to accept it." The altruistic nature of this pledge was confirmed in a reply to a German protest. "The Mandatory Powers." said the Allies. "in so far as they may be appointed trustees by the League of Nations. will derive no benefit from such trusteeship." A mandated territory differed from a protectorate in that the protecting power obtained rights over the population and against other powers, whereas a mandatory in its capacity as guardian assumed obligations both toward the population and the League.

League Supervision. — The system differed from such partial precedents as have been cited in that it set up machinery by which the proper execution of the mandate might be assured. This consisted in the unqualified right of supervision vested in the League, which imposed upon each mandatory the obligation to submit an annual report on its administration.

These reports were examined by a permanent mandates commission in the presence of an accredited representative of the mandatory concerned. The commission originally consisted of nine members of the following nationalities: Belgian, British, Dutch, French, Italian, Japanese. Portuguese. Spanish and Swedish. To these a Swiss and a German were later added, and a Norwegian superseded the Swede. The majority were nationals of nonmandatory states. The members were selected "for personal merit and competence" as private individuals, and not as representatives of their respective nations. They were nominated by their governments, but approved and appointed by the League council, and could not hold any office under their government. A representative of the International Labour office attended the sessions and took part in any discussions relative to labour. This international composition negatived any suspicion of bias and gave to the commission the aspect of an impartial tribunal of practical men, whose object it was to promote co-operation while fearlessly exposing any breach of the covenant. Its functions were purely advisory to the council.

In addition to the annual review of the reports of the mandatories. the commission received any petitions and memorials from inhabitants of the territories and others interested, and these, unless trivial or irrelevant, were forwarded to the mandatory concerned for comments before examination by the commission. The proceedings were conducted in French and English and were generally held in private to facilitate freedom of discussion. Full minutes were printed and given publicity. A permanent secretariat, under a director. collected and circulated all documents of interest concerning mandates and conducted the routine business. The conlmission met at least twice a year at Geneva; its procedure was governed by rules approved by the council.

The weak point in the system lay in the impossibility of independent verification of statements contained in the reports, which varied in completeness and accuracy. The League council refused to permit the permanent mandates commission to visit the mandated territories or to hear oral petitioners, but the International Court of Justice in 1956 authorized the general assembly committee on South-West Africa to hear petitioners from that territory. After Japan's withdrawal from the League in 1933, the reports on its mandate were inadequate. For information not contained in the report. the commission had to rely on those public bodies or individuals who interested themselves in the welfare of native races and on such memorials and petitions as were presented to it. In order to obtain more accurate information, the actual administrators generally appeared as the mandatory's representatives. The only practical means at the disposal of the League for compelling the proper execution of the mandate was the force of public opinion. although in theory the League could transfer a mandate if the mandatory grossly violated its obligations.

The French mandates in west Africa—unlike the British mandates for portions of the same territories (Cameroons and Togo)—contained a clause to the effect that "troops thus raised" (*i.e.*, for purposes of local defense and police) "may in the event of general war be utilized to repel an attack, or for defense of the territory outside that subject to the mandate." It was difficult to reconcile this clause with the words of the covenant. At the instance of the Mandates commission the British government was willing to go even further than the covenant prescribed, and agree to pledge itself not to enlist the natives of a mandated territory, even though they offered themselves for enlistment outside its frontiers, thus limiting its sovereign rights in adjacent territories not under mandate. The French government declared its willingness to accept the same restriction.

Prevention of Abuses.—The covenant enjoined the "prohibition of abuses such as the slave-trade, the arms traffic and the liquor traffic." Some urged that these words meant the enforcement of total prohibition alike for natives and nonnatives. The mandates, however, only prescribed a "strict *control* over the sale of spirituous liquors." The rights of the natives and the prevention of material advantages to the mandatory were major concerns of the League. To this end financial accounts were carefully scrutinized, as were administrative or customs unions of mandated territories with adjacent colonies of the mandatory.

In the matter of equal commercial opportunity for all nations, the covenant itself failed to fulfill the expectations raised by the pre-Armistice declarations of the Allies. No obligation in this regard was imposed in the C mandates, while in the B class it was restricted to states which were members of the League.

Boundaries.—Another cause of practical difficulty was presented by the fact that in some cases the boundaries of the territories assigned under mandate were not defined. In the case of Iraq this led to an acute dispute with Turkey in regard to the northern boundary. It was eventually settled by the council of the League. advised by a special commission sent to the area. The southern frontiers were the subject of an agreement with the sultan of Nejd, and an Anglo-French agreement determined the frontiers with Syria. The French in northern Syria had similar difficulties with Turkey. to whom they ceded Cilicia and later Alexandretta. In the Cameroons a joint commission was set up to determine the precise boundaries: while with regard to Ruanda, the mandatory (Belgium) complained that the agreed boundary involved the loss to King Musinga of a considerable part of his territory. The British at once agreed that this area should be restored to him, and the consequent changes in the mandates were approved by the council. In South-West Africa a neutral zone had long existed betneen the German and Portuguese colonies. This was replaced by a precise demarcation embodied in a treaty between the Union of South Africa and Portugal.

Sovereignty.—Wider issues were raised by such questions as the nature and extent of sovereignty exercised by a mandatory and the international status of the inhabitants of a mandated territory. The mandatory was authorized to make and enforce laws, to raise troops, to set up tribunals, to appoint officials and to raise and spend revenues. Sovereignty was not ceded by the treaty of Versailles to the League, but to the "principal allied and associated powers" who were obliged to place the territories under "mandatories on behalf of the League." The highest court in South Africa recorded the opinion that the territories were not ceded at all, but placed by Germany at the disposal of the Allies. to be administered under mandate—a status new to international law. (Rex v. *Christian,* S.Af. L.R. [1924], App. Div. 101.)

The mandatory's powers were exercised "in its capacity as such." Any action on the part of the mandatory which had for its object (or would ultimately involve) annexation—as for instance the acquisition of large monopolistic rights, or of essential public services—was held to be contrary to the covenant and the mandate.

Juristic opinion differed as to the location of sovereignty in the sense of capacity to change the status of the territories. Arguments were made for the mandatory, the principal allied and associated powers, the mandated communities, the League of Nations and various combinations of these. Opinion tended, however, to accept the theory of ultimate League sovereignty; and practice gave support to this theory, particularly if the United Nations was to be regarded as the successor of the League. Art. 80 of the UN charter recognized that mandated territories remained in *status quo* until changed by appropriate action in accord with that instrument.

Status of Natives.—The status of the indigenous inhabitants of a class B or C mandate territory was the subject of special definition. Since the country was not annexed, its inhabitants did not become the subjects of the mandatory. The formula was therefore adopted by the council that "they should be designated by some form of descriptive title which would identify them as such," viz., as "persons administered or protected under mandate." Art. 327 of the treaty of Versailles stipulated that they should be entitled to the diplomatic protection of the mandatory when outside the mandated territory; individuals could, if they so desired, become naturalized subjects of the mandatory.

The application to mandated territories of special conventions, entered into by a mandatory power, was the subject of investigation and recommendation by the Mandates commission, in older to ensure that 'persons protected under mandate" should not be in a less favourable position in regard to their persons and property and their economic interests than the inhabitants of a protectorate or colony. The terms of the covenant contemplated self-government as the natural fruition of the mandate and all of the A class territories achieved that status.

The mandate system for the first time in history accorded international sanction to the principles of "trusteeship," of "tutelage" and of "mandate" The annual report forined an effective means of inviting a popular verdict on the fulfillment of the trust and supervision by the League, constituted a fundamental distinction from annexation, whatever the degree of assimilation to other possessions of the mandatory.

The standards of the covenant came to be regarded as principles of general application and contributed both to the welfare and self-determination of dependent peoples. The mandate system was an acknonledgment of the international responsibility of powers that exercise control of "peoples not yet able to stand by themselves" and a contribution to the peaceful liquidation of "colonialism."

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MANDAYA, a tribe of Mindanao Island in the Philippines, which lives in tree dwellings, several families in one house; cultivates scanty plots of rice and other crops; practises slavery and ceremonial cannibalism, eating part of the liver of a slain enemy, but not genuine head-hunting (*q.v.*). As offensive weapons, spears, daos, daggers and poisoned arrows are used; as defensive, light wooden shields, cloth-protective armour and bamboo caltrops. The turtledove is regarded as sacred, and spirits are worshipped by mediums (ballyan), generally female, and are associated with wooden figures representing ancestors. Groups are governed by warrior leaders (bagani) whose rank is acquired by the killing of many enemies, as insignia for which a red costume is worn. Half a red costume (trousers only) is awarded for exploits not worthy of the whole. They do not tattoo, but file and blacken the teeth. They have been erroneously reported to be white in complexion.

See Cole, *Wild Tribes of Davao District* (1913).

MANDELIC ACID, discovered by F. L. Winckler (1832) in an emulsion of bitter almonds. (See Glycosides, Natural.) It is most conveniently obtained in colourless rhombic prisms, melting at 118° C., with sp.gr. 1.364, and soluble in water, alcohol or ether, from commercial benzaldehyde (*q.v.*) by adding concentrated aqueous sodium hydrogen sulphite to a mixture of benzaldehyde and aqueous sodium cyanide; oily mandelonitrile, $C_6H_5.CH(OH).CN$, separates and is hydrolyzed to mandelic acid (phenylglycollic acid, phenyl-α-hydroxyacetic acid), $C_6H_5.CH$-$(OH)\cdot CO_2H$, at the ordinary temperature with concentrated hydrochloric acid. The acid may be extracted with benzene or ether (see H. Gilman and others, Organic Syntheses, vol. vi., 1926). Mandelic acid contains an asymmetric carbon atom and is accordingly resolvable into two optically active isomerides (see Stereochemistry). This resolution has been accomplished, (1) through the agency of the alkaloid cinchonine, which furnishes a less soluble salt with dextro-mandelic acid, and (2) by means of living organisms. The yeast *Saccharomyces ellipsoideus* removes the d-modification and leaves the laevo-mandelic acid, whereas the mould, *Penicillium glaucum,* destroys the I-form in a solution of ammonium mandelate, leaving the *dextro*-mandelic acid. The two optically active forms, which melt at 132·8° C., are less fusible and more sparingly soluble in water than the inactive or racemoid variety, which has been termed paramandelic acid. A mixture of equal weights of the two active forms produces the inactive acid, which is also obtained on heating either active form at 160° C.

MANDER, KAREL VAN (1548–1606), Dutch painter, poet and biographer of painters, was born of a noble family at Meulebeke. He studied under Lucas de Heere, at Ghent, and in 1568–69 under Pieter Vlerick, at Courtrai and Tournai. The next five years he devoted to writing religious plays, for which he painted the scenery. From 1574–77 he studied in Rome, where he made the acquaintance of Bartholomaeus Spranger. On his return journey he passed through Vienna, where he collaborated with Spranger and the sculptor Hans Mont on the triumphal arch for the entry of the emperor Rudolf II. After much wandering he settled at Haarlem, where, with H. Goltzius and C. Cornelisz, he founded a successful academy of painting. His fame is principally based upon a biographical work on the painters of various epochs — a book that has become for the northern countries what G. Vasari's Lives of *the* Painters became for Italy. It was completed in 1603 and published in 1604, in which year Van Mander went to Amsterdam, where he died on Sept. 2, 1606. He translated Virgil's Bucolics and Georgics.

His *Het Schilderboeck* (1604) was translated into French by H. Hymans (1884) and into German by H. Floerke (1906). The poem in 14 chapters dealing with the technique of painting, which forms the introduction, was used as a source of information by Charles Eastlake in Materials for a History of Oil *Painting* (1847). (R. E. W. J.)

MANDEVILLE, BERNARD DE (1670?–1733), English philosopher and satirist, was born at Dordrecht, the Netherlands, where his father practised as a physician. On leaving the Erasmus school at Rotterdam he gave proof of his ability by an *Oratio scholastica* de medicina (1685), and at Leyden university in 1689 he maintained a thesis De brutorum operationibus, in which he advocated the Cartesian theory of automatism among animals. In 1691 he took his medical degree, pronouncing an "inaugural disputation," *De chylosi vitiata.* Afterward he came to England "to learn the language" and succeeded so remarkably that many refused to believe he was a foreigner. He died Jan. 21, 1733, at Hackney.

The work by which he is known is the Fable of the Bees or *Private* Vices made Public Benefits, published first in 1705 under the title of The Grumbling *Hive,* or *Knaves Turn'd* Honest (200 doggerel couplets) and often reprinted, with additions. The book was primarily written as a political satire on the state of England in 1705, when the Tories were accusing Marlborough and the ministry of advocating the French War for personal reasons. The edition of 1723 was presented as a nuisance by the grand jury of Middlesex, was denounced in the London Journal by "Theophilus Philo-Britannus," and attacked by many writers, notably by Archibald Campbell (1691–1756) in his Aretelogia (published as his own by Alexander Innes in 1728; afterward by Campbell, under his own name, in 1733, as Enquiry into the Original of Moral *Virtue*). George Berkeley attacked it in the second dialogue of the *Alciphron* (1732), and John Brown criticized him in his Essay *upon* Shaftesbury's Characteristics (1751).

Mandeville's main thesis is that the actions of men cannot be divided into lower and higher. The higher life of man is merely a fiction introduced by philosophers and rulers to simplify government and the relations of society. It is the vices (*i.e.,* the self-regarding actions of men) which alone, by means of inventions and the circulation of capital in connection with luxurious living, stimulate society into action and progress. Mandeville's ironical paradoxes are interesting mainly as a criticism of the "amiable" idealism of Shaftesbury, and in comparison with the serious egoistic systems of T. Hobbes and C. A. Helvetius. He may be said to have cleared the ground for the coming utilitarianism.

Works.—*Typhon: a Burlesque Poem* (1704); *Aesop Dress'd, or a Collection of Fables writ in Familiar Verse* (1704); *The Planter's Charity* (1704); *The Virgin Unmasked* (1709, 1724, 1731, 1742), a work in which the coarser side of his nature is prominent; *Treatise of the Hypochondriack and Hysterick Passions* (1711, 1715, 1730) admired by Johnson (Mandeville here protests against merely speculative therapeutics, and advances fanciful theories of his own about animal spirits in connection with "stomachic ferment": he shows a knowledge of Locke's methods, and an admiration for Sydenham); *Free Thoughts on Religion* (1720); *A Conference about Whoring* (1725); *An Enquiry into the Causes of the Frequent Executions at Tyburn* (1725); *The Origin of Honour and the Usefulness of Christianity in War* (1732); *A letter to Dion occasioned by his book called Alciphron* (1732). Other works attributed, probably wrongly, to him are *A Modest Defence of Public Stews* (1724); *The World Unmasked* (1736); and *Zoologia medicinalis hibernica* (1744).

See Hill's *Boswell,* iii, 291–293; L. Stephen's *English Thought in the Eighteenth Century;* A. Bain's *Moral Science* (593–598); Windelband's *History of Ethics* (Eng. tr. by Tufts); J. M. Robertson, *Pioneer Humanists* (1907); *P.* Sakmann, *Bernard de Mandeville und die Bienenfabel-Controverse* (Freiburg i/Br., 1897); and articles Ethics; Shaftesbury, Anthony Ashley Cooper; Hobbes, Thomas.

MANDEVILLE, GEOFFREY DE (d. 1144), earl of Essex, succeeded his father, William, as constable of the Tower of London in or shortly before 1130. Though a great Essex landowner, he played no conspicuous part in history till 1140, when Stephen created him earl of Essex in reward for his services against the empress Matilda. After the defeat and capture of Stephen at Lincoln (1141), the earl deserted to Matilda, but before the end of the year, learning that Stephen's release was imminent, returned to his original allegiance. In 1142 he was again intriguing with the empress; but before he could openly join her cause, he was detected and deprived of his castles by the king. In 1143–44 Geoffrey maintained himself as a rebel and a bandit in the fen country, using the Isle of Ely and Ramsey abbey as his headquarters. He was besieged by Stephen in the fens and met his death in Sept. 1144 in consequence of a wound received in a skirmish. His career is interesting for two reasons. The charters which he extorted from Stephen and Matilda illustrate the peculiar form taken by the ambitions of English feudatories. The most important concessions are grants of offices and jurisdictions which had the effect of making Mandeville a viceroy with full powers in Essex, Middlesex and London, and Hertfordshire. His career as an outlaw exemplifies the worst excesses of the anarchy which prevailed in some parts of England during the civil wars of 1140–47, and it is probable that Mandeville inspired the rhetorical description, in the Peterborough Chronicle of this period, when "men said openly that Christ and his saints were asleep."

See J. H. Round, *Geoffrey de Mandeville, a Study of the Anarchy* (1892). (H. W. C. D.)

MANDEVILLE, JEHAN DE ("Sir John Mandeville"), the name claimed by the compiler of a singular book of travels, written in French, and published between 1357 and 1371. By aid of translations into many other languages it acquired extraordinary popularity, while a few interpolated words in a particular edition of an English version gained for Mandeville in modern times the certainly spurious credit of being "the father of English prose."

In his preface the compiler calls himself a knight, and states that he was born and bred in England, of the town of St. Albans; had crossed the sea on Michaelmas Day 1322; had travelled by way of Turkey (Asia Minor), Armenia the little (Cilicia) and the great, Tartary, Persia, Syria, Arabia, Egypt upper and lower, Libya, great part of Ethiopia, Chaldaea, Amazonia, India the less, the greater and the middle, and many countries about India; had often been to Jerusalem, and had written in Romance as more generally understood than Latin. In the body of the work we hear that he had been at Paris and Constantinople; had served the sultan of Egypt a long time in his wars against the Bedawin, had been vainly offered by him a princely marriage and a great estate on condition of renouncing Christianity, and had left Egypt under sultan Melech Madabron, *i.e.,* Muzaffar or Mudhaffar[1] (who reigned in 1346–1347); had been at Mount Sinai, and had visited the Holy Land with letters under the great seal of the sultan, which gave him extraordinary facilities; had been in Russia, Livonia, Cracow, Lithuania, "en roialme daresten" (? of Daresten or Silistria), and many other parts near Tartary, but not in Tartary itself; had drunk of the well of youth at Polombe (Quilon on the Malabar coast), and still seemed to feel the better; had taken astronomical observations on the way to Lamory (Sumatra), as well as in Brabant, Germany, Bohemia and still farther north; had been at an isle called Pathen in the Indian Ocean; had been at Cansay (Hangchow-fu) in China, and had served the emperor of China fifteen months against the king of Manzi; had been among rocks of adamant in the Indian Ocean; had been through a haunted valley, which he places near "Milstorak" (*i.e.,* Malasgird in Armenia); had been driven home against his will in 1357 by arthritic gout; and had written his book as a consolation for his "wretched rest."

This personal history of Mandeville is mere invention. There is no reasonable doubt that the travels were in large part compiled by a Liége physician, known as Johains à la Barbe or Jehan à la Barbe, otherwise Jehan de Bourgogne, who drew his information not from his own travels, but from the works of Odoric, Carpini, Vincent de Beauvais, and others. Jehan à la Barbe is himself a man of mystery.

A modernized extract quoted by the Liége herald, Louis Abry (1643–1720), at third or fourth hand from the lost fourth book of the *Myreur des Hystors* of Johans des Preis, styled d'Outremeuse, states that "Jean de Bourgogne, dit à la Barbe," revealed himself on his deathbed to d'Outremeuse, whom he made his executor. and described himself in his will as "messire Jean de Mandeville, chevalier, comte de Montfort en Angleterre et seigneur de l'isle de Campdi et du château Pérouse." Having had the misfortune to kill an unnamed count in his own country, he engaged himself to travel through the three parts of the world, arrived at Liége in 1343, was a great naturalist, profound philosopher and astrologer, and had a remarkable knowledge of physic. In the now destroyed church of the Guillclmins was a tombstone of Mandeville, with a Latin inscription stating that he was otherwise named "ad Barbam," was a professor of medicine, and died at Liége on Nov. 17, 1372; this inscription is quoted as far back as 1462.

Whether after the appearance of the *Travels* either de Bourgogne or "Mangevilayn" visited England is very doubtful. St. Albans Abbey had a sapphire ring, and Canterbury a crystal orb, said to have been given by Mandeville; but these might have been sent from Liége, and it will appear later that the Liége physician possessed and wrote about precious stones. St. Albans also had a legend that a ruined marble tomb of Mandeville (represented cross-legged and in armour, with sword and shield) once stood in the abbey.

It is a little curious that the name preceding Mangevilayn in the list of persons pardoned is "Johan le Barber." But Dr. G. F. Warner has ingeniously suggested that de Bourgogne may be a certain Johan de Bourgogne, who was pardoned on Aug. 20, 1321. Did this suggest to de Bourgogne the *alias* "à le Barbe," or was that only a Liége nickname? Note also that the arms on Mandeville's tomb were borne by the Tyrrells of Hertfordshire (the county in which St. Albans lies); for of course the crescent on the lion's breast is only the "difference" indicating a second son.

The Sources.—Leaving aside the stories which have grown up around the Liége physician, there remains the question whether the book contains any facts and knowledge acquired by actual travels and residence in the East. Possibly it may, but only in a small portion of the section which treats of the Holy Land and the ways of getting thither, of Egypt, and in general of the Levant. Even this section seems to be based on the travels of William of Boldensele (1336). The prologue, indeed, points almost exclusively to the Holy Land as the subject of the work. The mention of more distant regions comes in only towards the end of this prologue, and (in a manner) as an afterthought.

By far the greater part of these more distant travels, extending in fact from Trebizond to Hormuz, India, the Malay Archipelago, and China, and back again to western Asia, has been appropriated from the narrative of Friar Odoric (written in 1330). These passages, as served up by Mandeville, are almost always, indeed, swollen with interpolated particulars, usually of an extravagant kind, whilst in some cases the writer has failed to understand the passages which he adopts from Odoric and professes to give as his own experiences. Thus where Odoric has given a most curious and veracious account of the Chinese custom of employing tame cormorants to catch fish, the cormorants are converted by Mandeville into "little beasts called *loyres* (*layre,* B), which are taught to go into the water" (the word *loyre* being apparently used here for "otter," *lutra,* for which the Provençal is *luria* or *loiria*). Much, again, of Mandeville's matter, particularly in Asiatic geography and history, is taken from the *Historiae Orientis* of Hetoum, an Armenian of princely family, who became a monk of the Praemonstrant order, and in 1307 dictated this work on the East, in the French tongue at Poitiers. A good deal about the manners and customs'of the Tatars is demonstrably derived from the famous work of the Franciscan Joannes de Plano Carpini (*q.v.*), but Dr. Warner considers that much was taken at second hand and that Mandeville's immediate source was the *Speculum historiale* of Vincent de Beauvais.

The account of Prester John (*q.v.*) is taken from the famous *Epistle,* which was so widely diffused in the 13th century, and created that renown which made it incumbent on every traveller in Asia to find some new tale to tell of him. Many fabulous stories, again, of monsters, such as Pliny has collected, are introduced here and there, derived no doubt from him, Solinus, the bestiaries, or the *Speculum naturale.* And interspersed. especially in the chapters about the Levant, are the stories and legends that were retailed to every pilgrim, such as the legend of Seth and the grains of paradise from which grew the wood of the cross, that of the shooting of old Cain by Lamech, that of the castle of the sparrow-hawk (which appears in the tale of Melusina), those of the origin of the balsam plants at Maṭarīya, of the dragon of Cos, of the river Sabbation, etc.

[1]The *on* in Madabron apparently represents the Arabic form, though, as a matter of fact, its use in such a case is very odd.

While recording Mandeville's borrowings it is only fair to recognize his imaginative powers; a notorious passage, filched, with additions, from Boldensele, seems likely to have inspired the Valley of the Shadow of Death in *Pilgrim's Progress*. Nor does it follow that the whole work is borrowed or fictitious. In such works as those of Jan van Hees and Arnold von Harff we have examples of pilgrims to the Holy Land whose narratives begin apparently in sober truth, and gradually pass into flourishes of fiction and extravagance.

So in Mandeville also we find particulars not yet traced to other writers, and which may therefore be provisionally assigned either to the writer's own experience or to knowledge acquired by colloquial intercourse in the east.

BIBLIOGRAPHY.—The oldest known manuscript of the original—once Barrois's, afterward the earl of Ashburnham's, now Nouv. Acq. Franç. 4515 in the Bibliothèque Nationale, Paris—is dated 1371, but is nevertheless very inaccurate in proper names. The first English translation direct from the French was made (at least as early as the beginning of the 15th century) from a manuscript of which many pages were lost.

For Mandeville's sources *see* A. Bovenschen, *Die Quellen für die Reisebeschreibung des Johann von Mandeville, Inaugural-Dissertation . . . Leipzig* (Berlin, 1888), revised and enlarged as "Untersuchungen über Johann von Mandeville und die Quellen seiner Reisebeschreibung," in the *Zeitschrift der Gesellschaft für Erdkunde zu Berlin,* Bd. 23, Heft 3 u. 4 (no. 135, 136), and G. F. Warner, in the edition prepared for the Roxburghe club.

All English printed texts before 1725, and Ashton's 1887 edition, follow these defective copies.

The Egerton text (Brit. Mus. manuscript Egerton 1982) edited by G. F. Warner, has been printed by the Roxburghe club, while the Cotton text (Brit. Mus. manuscript Cotton Titus c xvi), first printed in 1725 and 1727, is in modern reprints the current English version.

That none of the forms of the English version can be from the same hand which wrote the original is made patent by their glaring errors of translation, but the Cotton text asserts in the preface that it was made by Mandeville himself. Mätzner (*Altenglische Sprachproben,* I, ii, 154–155) seems to have been the first to show that the current English text cannot possibly have been made by Mandeville himself. Other works bearing the name of Mandeville or de Bourgogne are a short French life of St. Alban of *Germany,* the author of which calls himself Johan Mandivill[e], knight, formerly of the town of St. Alban, contained in manuscript Add. C. 280 of the Bodleian; a *Lapidaire* printed in L. Pannier, *Les Lapidaires français;* and there are medical and alchemical receipts in the Ashmolean manuscripts in the Bodleian by John de Villa Magna. Finally, de Bourgogne wrote under his own name a treatise on the plague, *see* David Murray, *The Black Book of Paisley,* etc. (1885), and *John de Burdeus,* etc. (1891), extant in Latin, French and English texts, and in Latin and English abridgments. Herein he describes himself as Johannes de Burgundia, otherwise called *cum Barba,* citizen of Liège and professor of the art of medicine; says that he had practised 40 years and had been in Liège in the plague of 1365; and adds that he had previously written a treatise on the cause of the plague, according to the indications of astrology (beginning *Deus deorum*), and another on distinguishing pestilential diseases (beginning *Cum nimium propter instans tempus epidimiale*). "Burgundia" is sometimes corrupted into "Burdegalia," and in English translations of the abridgment almost always appears as "Burdews" (Bordeaux) or the like. Manuscript Rawlinson D. 251 (15th century) in the Bodleian also contains a large number of English medical receipts, headed "Practica phisicalia Magistri Johannis de Burgundia."

See further G. F. Warner's article in the *Dictionary of National Biography* for a comprehensive account, and for bibliographical references; Ulysse Chevalier's *Répertoire des sources historiques du moyen âge* for references generally; and the *Zeitschr. f. celt. Philologie* II, i, 126, for an edition and translation, by Whitley Stokes, of Fingin O'Mahony's Irish version of the *Travels*. (E. W. B. N.; H. Y.)

MANDHATA, a famous place of Hindu pilgrimage in the Nimar district of Madhya Pradesh, India, partly on the south bank of the Nerbudda river and partly on an island in the river. One of the temples is famous for containing one of the 12 great lingas of Siva.

Mandhata's annual fair was formerly the scene of the self-immolation of devotees who threw themselves from the high cliffs into the river. The last sacrifice, which was witnessed by a British officer, occurred in 1824.

MANDI, town and district of Himachal Pradesh, India. The town is 2,991 ft. above sea level on the Beas, a mountain torrent crossed by a fine iron bridge, and is a centre for transfrontier trade with Tibet and Yarkand. Pop. (1951) 8,909. It is linked by road to Simla.

The DISTRICT OF MANDI, area 1,527 sq.mi. (before 1948 a princely state), is intersected by two great parallel ranges, with an average height of 5,000 to 7,000 ft. above sea level.

The valleys are fertile and produce all ordinary grains, besides more valuable crops of rice, maize, sugar cane and tobacco. Rock salt is found (annual production about 4,000 tons). Pop. (1951) 310,626. (S. GL.)

MANDINGO (MANDINGA, MANDINKA, MANDE), one of the most important groups of tribes in western Africa, covering much of the western Sudan and the Guinea coast. Although primarily a linguistic classification, the Mandingo group still exhibits some degree of cultural unity (*e.g.,* in leatherwork). In the late middle ages the principal Mandingo-speaking peoples were politically much more closely knit than in recent times, and maintained one of the major empires of the western Sudan. The western group of Mandingo-speaking tribes includes the Mandingo of the Gambia valley and, on the middle Senegal, the Khassonke, Soninke and Marka; the eastern group includes the Bambara (Banmana), the Malinke, the Diula, the Bozo and the Sorko, mostly near the upper reaches of the Niger, and it is to this group rather than to the Mandingo-speakers as a whole that the term "Mandingue" is commonly applied in French ethnological literature. The southern group includes the Dan and Guro of the Ivory Coast, the Mende and Kono of Sierra Leone and the Kissi (who, however, have adopted a language of the Senegal-Guinea group), Kpelle, Susu, Toma and Vai of French Guinea and Liberia. These tribes are still predominantly pagan, though some groups are partly Islamized; all are mainly agriculturalists, and the men are normally organized by age groups in secret societies (such as the Poro among the Dan and Mende, and the N'tomo among the Bambara), one of whose main functions is to promote increase and well-being by ritual dances (though the political function of the societies is uppermost in some tribes). With these societies (notably among the Bambara, Dan, Guro, Toma and Mende) are often associated some of the finest African sculpture in the form of wooden figures and dance masks or dance headdresses, often of highly abstract design. An elaborate system of symbolism is said to play an important part in the life of some tribes, especially the Bambara, and certain symbols are found to be shared with the Dogon of the Niger bend on the one hand and the Ashanti of the southern Gold Coast.

See H. Labouret, "Westsudan und Guineaküste" in *Afrika,* ed. by H. A. Bernatzik, vol. 1 (Innsbruck, 1947), and *Les Manding et leur Langue* (Paris, 1934); D. Zahan, "Pictographic Writing in the Western Sudan," *Man,* vol. 50, no. 219 (London, 1950). (W. B. FG.)

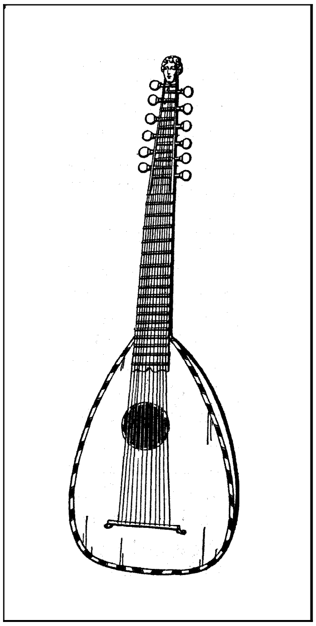
MANDLA, a town and district of Madhya Pradesh, India, on the Nerbudda river, notable for the manufacture of bell-metal vessels. A large part of the town was submerged by the flood of 1926. Pop. (1951), 14,243.

The DISTRICT OF MANDLA (area 5,122 sq.mi.) is in the Satpura hills. It is a wild highland region broken up by the valleys of numerous rivers and streams. The Nerbudda flows through the centre of the district, receiving several tributaries which take their rise in the Maikal hills, a range thickly clothed with sal forests and forming part of the great watershed between eastern and western India.

Except for one small fertile area producing wheat, it is a district of jungle, rice and millets, with a large aboriginal population. The forest area is large, including some sal forests and fine grazing areas on the plateau lands. The forests abound with big game and tigers are numerous. A few main roads opened up the district to some extent and the Eastern railway (Satpura section) touches the district at Mandla town. The population of the district in 1951 was 547,620 (60% aboriginal tribes, principally Gonds).

There is some export of food grains and oilseeds, and a larger export of timber and forest produce. It is a favourite shooting district, but very malarious.

MANDOLINE, the treble member of the lute (*q.v.*) family, and therefore a stringed instrument of great antiquity. There are two varieties and both Italian: (1) the *Neapolitan,* 2 ft. long, the best known, which has for strings four courses of pairs of unisons, tuned like the violin in fifths; (2) the *Milanese,* which is slightly larger and has five or six courses of pairs of unisons. The strings, of wire-spun gut, steel and brass, are twanged by means of a plectrum or pick. The Neapolitan mandoline was scored for by Mozart as an accompaniment to the celebrated serenade in *Don Giovanni.* Beethoven wrote for it a "Sonatina per il mandolino" and an Adagio for mandoline and harpsichord. Grétry and Paisiello also introduced it into their operas as an accompaniment to serenades.


BY COURTESY OF THE METROPOLITAN MUSEUM OF ART

THE MANDOLINE, THE DESCENDANT AND ONLY SURVIVOR OF THE LUTE

MANDRAKE (*Mandragora officinarum*), a plant of the potato family, Solanaceae, and a native of the Mediterranean region. It has a short stem bearing a tuft of ovate flowers. with a thick fleshy and often forked root. The flowers are solitary, with a purple bell-shaped corolla; the fruit is a fleshy orange-coloured berry. The mandrake has been long known for its poisonous properties and supposed virtues. It acts as an emetic, purgative and narcotic. and mas much esteemed in old times; but. except in Africa and the East, where it is used as a narcotic and antispasmodic, it has fallen into disrepute. In ancient times it was used as a narcotic to diminish sensibility under surgical operations. Shakespeare more than once alludes to this plant, as in *Antony and Cleopatva:* "Give me to drink mandragora." The notion that the plant shrieked when touched is alluded to in *Romeo and Juliet:* "And shrieks like mandrakes torn out of the earth, that living mortals, hearing them. run mad." The mandrake was supposed to have other virtues. and was much used for love philtres. while the fruit was supposed, and in the East is still supposed, to facilitate pregnancy. The North American May apple (*q.v.*) is known also as mandrake.

MANDRILL, the most hideous and most brilliantly coloured of the baboons (*Papio*). The mandrill (*P. sphinx*) inhabits West Africa and is characterized by the shortness of its tail, heavy body, prominent brow ridges, small, deeply sunk eyes placed close together, and by the vivid colouring of the bare skin on the face and buttocks. In the latter region it is crimson, shading into blue at the sides and varying in intensity according to the condition of the animals. The cheek prominences are intense blue. while the central line and termination of the nose are scarlet. The fur is light olive above and silvery-gray beneath, with a small pointed yellow beard. The female is much smaller and less brightly coloured. Young males have black faces. Mandrills feed on fruit, roots, reptiles, insects, scorpions, etc., and inhabit rocky country in large troops. The old males are very ferocious, but, when young. the animals can be easily tamed.

MANDU (Mandogarh), a ruined city in Dhar district, Madhya Pradesh. India. the ancient capital of the Mohammedan kingdom of Malwa. The city is 38 mi. S.W. of Indore city, at an elevation of 2,079 ft., and extends for 8 mi. along the crest of the Vindhyan mountains. It reached its greatest splendour in the 15th century under Hoshang Shah (1405–34). The circuit of the battlemented wall is nearly 23 mi., enclosing a large number of palaces, mosques and other buildings. The oldest mosque dates from 1405; the finest is the Jama Masjid or Great mosque, a notable example of Pathan architecture. founded by Hoshang Shah. The marble-domed tomb of this ruler is also magnificent.

MANES, the inhabitants of the underworld, especially the ghosts of the dead. (Lat. "good people," an obvious euphemism.) In pure Roman cult we hear nothing of the worship of individual dead persons. and fear of ghosts does not seem to have been prevalent. But the collectivity of the inhabitants of the underworld was regarded as divine (*di manes*). Properly, the ancestral ghosts of a family are called *di parentes* or *parentum*, the *di manes* being the same as the *di inferi;* but this distinction tends to disappear about the beginning of our era, hence the common formula on tombstones, *dis manibus* followed by a name in the genitive or dative. *i.e.,* "to the glorified spirit of so-and-so" or "to so-and-so, a glorified spirit." The formula is clumsy at best.

Of public cult of the *manes* we hear little. They are mentioned in a few prayers (*see* Ancestor Worship); such things as burial grounds are sacred to them; certain persons guilty of very serious offenses were devoted (*sacri*) to them (*see* Consecration). It was supposed, at least in later times. that they came forth when the *mundus,* or ritual pit dug at the foundation of a city and opened three times a year (Aug. 24, Oct. 5, Nov. 8) was uncovered. Their dwelling place was the bowels of the earth, to which any deep chasm might lead (*see* Livy, vii.. 6, 4).

In private cult, they, or properly the *di parentes,* were propitiated with offerings of food. wine, garlands, etc., left on potsherds in the middle of the road, during the *dies parentales,* Feb. 13–21. On Feb. 22 followed a family reunion, the Caristia. At the Lemuria (May 9, 11, 13) each householder rose in the night, dropped beans from his mouth, saying "with these beans I ransom me and mine," and then bade the *manes paterni, i.e.,* the *di parenturn,* be gone (Ovid, *Fasti,* ii., 531, *et seq.;* v. 419 *et seq.*). Hence, perhaps, is derived the name *lemures* for ghosts. The *larvae* were malignant phantoms, supposed to possess and madden people (Plautus, *Capt.,* 598, *Menaech.,* 890); they had no part in cult.

See G. Wissowa, *Religion u. Kultus* (2nd ed.) p. 232, *et seq.,* and in Pauly-Wissowa, *Realencyklopädie, s.v.* Lemuria; W. Warde Fowler, *Roman Essays,* p. 24 *et seq.*

MANET, ÉDOUARD (1832–1883), one of the greatest French painters and engravers, and precursor of the Impressionists, was born in Paris. the son of a magistrate, on Jan. 23, 1832. He studied at the Collège Rollin (1844–48), where he met his future biographer, A. Proust. He is alleged to have already preferred to make drawings from nature than from casts and to have subscribed to the realist doctrine, *il faut être de son temps* ("one must be of one's own day and age"). After seeking entrance to the naval college, he joined the training ship "Guadeloupe," bound for Rio de Janeiro, returning to Le Havre in June 1849. From 1850 to 1856 Manet was a pupil in the studio of T. Couture, where he seems to have been only an intermittent visitor since he made several visits, during these years, to Fontainebleau in France, and to Italy, Austria, Germany, Belgium and Holland. It was in 1859 that he made his first submission to the Salon, a painting. "Buveur d'absinthe" (Absinthe drinker), in which. according to Proust, concessions had been made to the formulae of Couture. It was rejected but in 1861 his entries ("Portrait of the artist's parents," related to the style of Gustave Courbet, and "Guitarrero") mere accepted, earned an honourable mention and were well received by the critics. In 1862 Manet became a member of the Société des Aquafortistes and in the same year was praised by Charles Baudelaire. In 1863 Manet exhibited at the Galerie Martinet 14 pictures including his latest and most personal work "La Musique aux Tuileries" (Music in the Tuileries), (1862); in the same year the Salon des Refusés was opened to all artists who had been rejected at the official Salon, and included three pictures by him, chief among them being "Le déjeuner sur l'herbe" (Picnic on the grass). Both of these exhibitions aroused considerable hostile criticism, but also succeeded in making of Manet a rallying point for the younger painters who were to form the nucleus of the Impressionists. Despite the obvious allusions to traditional themes in the latter painting, it was the realism (the painting of the events and appearances of contemporary life!, together with the rejection of customary relationships of colour and tone, that inspired both the hostile criticism and the enthusiasm of the younger painters.

In 1865 Manet exhibited at the Salon "Christ mocked by soldiers" and "Olympia," painted in 1863, the latter evoking another storm of abuse. This key work in his development is one in which.

having assimilated the lessons to be gleaned from Japanese woodcuts, his preoccupation with the formal qualities of painting is perhaps for the first time clearly evident. In August of the same year he visited Spain primarily to study Velazquez, and one of the earliest pictures executed on his return, "Le Fifre" (The Fife-Player, rejected at the Salon 1866), represents a combination of the renewed influence of Velazquez (the open atmospheric background), and the lessons of Japanese art (the simplification and intensification of colour and tone and the ornamental character of the silhouette).

On the occasion of the international exhibition in 1867, Manet organized his own exhibition, showing some 50 paintings, but these were hardly received any more favourably than before. During the later 1860s his work was varied in character, but in general it seems to represent a greater concern with close relations of tone, with complexities of illumination and atmosphere, and sometimes exhibits a freedom of handling comparable with that in "La Musique aux Tuileries." "The Execution of Maximilian," of 1867, and "The Folkestone boat," of 1869, are representative of his work at this time.

During the Franco-German War of 1870 Manet served in the national guard under J. Meissonier, witnessing the siege of Paris and the Commune. In 1872, on a visit to Holland, he was impressed by the work of Frans Hals, and was much influenced by this artist when painting his "Bon Bock," which achieved considerable success when exhibited at the Salon of 1873.

At this time Manet was in intimate contact with all the members of the Impressionist group and during the course of 1874 spent some time at Argenteuil (near Paris) in the company of Monet and Renoir painting directly from the motif, a practice which he seems to have begun a few years earlier. An example of his work done at this time is "The Monet family in their garden at Argenteuil." Despite his intimacy with the Impressionists, and their influence upon his work at this time, he refused to participate in their independent exhibitions and continued to send to the Salon. "The Railway" (Salon, 1874) and one Argenteuil picture (Salon, 1875) were both badly received while two were rejected in 1876. At this time critics readily underlined the connection between Manet and the Impressionists even though the character of the works shown did not really justify it. Manet continued to submit to the Salon with very little success until 1880 when his portrait of Proust was fairly well received, but it was not until the following year that he obtained a second-class medal and became thereby free to exhibit as he liked. In 1882 the important "Bar at the Folies-Bergère" was exhibited with some success and in the same year, partly through the machinations of Proust, Manet was nominated *chevalier* of the Legion of Honour. By this time, however, he was seriously ill and he died at Paris on April 30, 1883. In 1884 a large retrospective exhibition was organized at the École des Beaux Arts and it was after this memorial show and after the Manet sale of the same year that the price of his pictures began to rise.

Manet's importance is due first to his insistence upon drawing his subjects from the events and appearances of his own time and upon representing them in attitudes, shapes and relationships of tone and colour which he had seen and considered to be "natural." and secondly, to the importance given to the appearance of the picture as an arrangement of paint areas on a canvas over and above its function as representation.

See also PAINTING: *France: 19th Century*.

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MANETHO (Μανέθων in an inscription of Carthage; Μανεθὼς in a papyrus), Egyptian priest and annalist, was a native of Sebennytus in the Delta. The evidence of Plutarch and other indications connect him with the reigns of Ptolemy I. and II. His most important work was an Egyptian history in Greek, for which he translated the native records. It is now only known by some fragments of narrative in Josephus's treatise *Against Apion*, and by tables of dynasties and kings with lengths of reigns, divided into three books, in the works of Christian chronographers. The earliest and best of the latter is Julius Africanus, besides whom Eusebius and some falsifying apologists offer the same materials; the chief text is that preserved in the *Chronographia* of Georgius Syncellus. Notwithstanding all their defects, the fragments of Manetho have been of great service to scholars ever since Champollion's first decipherments.

MANFRED (*c.* 1232–1266), king of Sicily, was a natural son of the emperor Frederick II by Bianca Lancia, or Lanzia. Frederick appears to have regarded Manfred as legitimate and by his will named him as prince of Tarentum and representative in Italy of his half brother, the German king Conrad IV. Manfred acted loyally and with vigour in the execution of his trust. and when Conrad appeared in southern Italy in 1252, his authority was quickly and generally acknowledged. When Conrad died (1254), Manfred, after refusing to surrender Sicily to Pope Innocent IV, accepted the regency on behalf of the infant Conradin.

On a rumour (1258) that Conradin was dead, Manfred was crowned king of Sicily at Palermo on Aug. 10 in that year. The report was false, but the new king declined to abdicate and pointed out the necessity for a strong native ruler. The pope declared Manfred's coronation void and pronounced sentence of excommunication. In conjunction with the Ghibellines, Manfred's forces defeated the Guelphs at Monte Aperto on Sept. 4, 1260. He was eventually defeated and killed near Benevento, Feb. 26, 1266.

MANFREDONIA, town and archiepiscopal see (with Vieste), Puglia, Italy, province of Foggia. $22\frac{1}{2}$ mi. X.E. of Foggia by rail, on the coast, 13 ft. above sea level, to the south of Monte Gargano, and giving its name to the gulf to the east of it. Pop. (1951) 27.634. Founded by Manfred (1263), the Turks destroyed it in 1620, but the castle of the Angevins and parts of the walls are preserved. In the church of S. Domenico. the chapel of the Maddalena contains 14th-century paintings. Two miles southwest is the cathedral of Sta. Maria Maggiore di Siponto, built in 1117 in the Romanesque style, with a dome and crypt. This marks the site of the ancient Sipontum, the harbour of Arpi, which became a Roman colony in 194 B.C. and was not deserted in favour of Manfredonia until the 13th century, having become unhealthy owing to the stagnant lagoons.

MANGABEY, a name applied to slender west African monkeys of the genus *Cercocebus*, characterized by their bare, whitish upper eyelids, large cheek pouches and the uniformly coloured hairs of the fur. *See* PRIMATES.

MANGALORE, a seaport and administrative headquarters of the South Kanara district, Mysore state, India. It is the terminus of the west coast line of the Southern railway. Pop. (1951) 117,083. The harbour is formed by the backwater of two small rivers, and large vessels lie 3 mi. offshore. The chief exports are coffee, pepper, sandalwood, fish and fish manure. There is a small shipbuilding industry, and fishing, coffee curing and manure making are carried on. The town has a large Roman Catholic population, with a European bishop, several churches and a convent, and is an industrial and educational centre. It is the headquarters of the Basel Lutheran mission, which successfully introduced the industries of printing, carpentry and the manufacture of tiles. There are three colleges, all affiliated to the University of Madras: the Government college, St. Agnes' college and St. Aloysius' college.

Mangalore was gallantly defended by Col. John Campbell in 1784, with a garrison of 1,850 men, of whom 412 were English, against Tipu sahib's whole army.

MANGAN. JAMES CLARENCE (1803–1849), Irish poet, was born'in Dublin on May 1, 1803. His baptismal name was James, the "Clarence" being his own addition. His father, a grocer, who boasted of the terror with which he inspired his children, had ruined himself by imprudent speculation and extravagant hospitality. The burden of supporting the family fell on James, who entered a scrivener's office at the age of 15 and drudged as a copying clerk for ten years. He was employed for some time in the library of Trinity college, and in 1833 he found a place in the Irish ordnance survey. He suffered a disappointment in love, and continued ill heaith drove him to the use of opium. He mas habitually the victim of hallucinations, which at times threatened his reason. For Charles Maturin, the eccentric author of *Melmoth,* he cherished a deep admiration, the results of which are evident in his prose stories. He belonged to the Comet club, a group of youthful enthusiasts who carried on war in their paper, the *Comet,* against the levying of tithes on behalf of the Protestant clergy. Contributions to the *Dublin Penny Journal* followed, and to the *Dublin University Magazine* he sent translations from the German poets. The mystical tendency of German poetry had a special appeal for him. He also wrote versions of old Irish poems, though his knowledge of the language, at any rate at the beginning of his career, was but slight. Some of his best-knoun Irish poems. however, *O'Hussey's Ode to the Maguire,* for instance, follow the originals very closely. Besides these were "translations" from Arabic, Turkish and Persian. How much of these languages he knew is uncertain, but he had read widely in oriental subjects, and some of the poems are exquisite though the original authors whom he cites are frequently mythical. He took a mischievous pleasure in mystifying his readers and in practising extraordinary metres. For the *Nation* he wrote from the beginning (1842) of its career, and much of his best work appeared in it. He afterward contributed to the *United Irishman.* On June 20, 1849, he died at Meath hospital, Dublin, of cholera. It is not true that starvation was the real cause, but there is no doubt that his wretched poverty made him ill able to withstand disease.

Mangan's fame was deferred by the inequality and mass of his work, much of which lay buried in inaccessible newspaper files under his many pseudonyms, "Vacuus," "Terrae Filius," "Clarence," e t ~ .Of his genius, morbid though it sometimes is, as in his tragic autobiographical ballad *The Nameless One,* there can he no question. He expressed with rare sincerity the tragedy of Irish hopes and aspirations, and he furnished abundant proof of his versatility in his excellent nonsense verses, which are in strange contrast with the general trend of his work.

The Poems of *James Clarence Mangan* (1903) and the *Prose Writings* (1904) mere both edited by D. J. O'Donoghue, who wrote in 1897 a complete account of the life and writings of the poet.

MANGANESE, symbol Mn, a hard, brittle metal melting at 1,245° C. (2,273° F.), was first recognized as an element by the great Swedish chemist C. W. Scheele in 1774 while working with pyrolusite, the manganese dioxide ore, and was isolated by his associate, J. G. Gahn, in the same year. Frequently found in conjunction with iron ores, the element was named for the magnetic properties exhibited by pyrolusite from the Latin, *magnes,* or magnet.

The addition of manganese in the Bessemer steelmaking process, initiated in 18j6 by Robert Mushet, made that process a practical success *(see* MANGANESE STEEL). In 1882 Robert Hadfield discovered the high-manganese steels which bear his name. The use of manganese is essential in steel manufacture for deoxidation and the control of sulfur content, and this application accounts for over 90% of the manganese consumed in all forms in the United States. Somewhat less than 13 Ib. of manganese, chiefly in the form of ferromanganese, is used for each ton of steel produced, and no substitute exists for it.

Manganese is vital to plant and animal life and is essential to reproduction in animals. While it has been known and commonly used in both alloy and compound form for a long time, it was only introduced to industry in pure form with the development of the electrolytic process for its recovery in the late 1930s. Relatively impure metal, made by aluminothermic *(see* THERMIT) or silicothermic reduction of the oxides, had previously been available, but only with the advent of the very pure electrolytic product was precise and extensive work on the potentialities of manganese made possible.

OCCURRENCE

Manganese is widely distributed in the combined state, ranking 12th in abundance among the elements in the earth's crust. It is commonly found associated with iron ores in concentrations too low in most cases, however, to make its commercial recovery attractive.

The United States is a have-not nation insofar as deposits of high-grade manganese ore are concerned. The known manganese deposits in this country have been estimated to total 3,500,000,000 long tons (2,240 Ib.) of ore and 75,000,000 tons of contained manganese. More than 98% of this manganese is contained in 12 large low-grade deposits, of which the most important are those of Chamberlain, S.D.; the Cuyuna range, Minnesota; Aroostook county, Maine; and Artillery peak, Arizona.

The Aroostook ore averages 6.5% to 9% manganese content. The Artillery mountains (Mohave county, Arizona) deposits are comprised of 200,000,000 tons of 3% to 4% manganese. 20,000,000 tons of 5% or more, 2,000,000 to 3,000,000 tons of 10% or more, and 500,000 tons of 15% or more. The South Dakota ore is estimated to comprise 2,000,000,000 tons, of which about 78,000,000 tons average 15% manganese.

The U.S. reserves of high-grade ore (48% or more manganese) amount to less than 200,000 tons. About 20,000,000 tons of ore average over 15% manganese, and when the grade is decreased to include ores containing 10% or more manganese, the reserves amount to about 100,000,000 tons.

Over 90% of the country's consumption of manganese ore is imported. and most of the domestic ore is derived from the Butte, Mont., district as the carbonate mineral rhodochrosite *(q.v.).* After 1950 annual manganese imports amounted to over 2,000,000 tons of ore containing under 50% manganese, the domestic consumption was almost the same and domestic production was about 300,000 tons of ore. India and Brazil supplied the largest amounts of imports, followed by Ghana, Union of South Africa, Cuba, Mexico and Brazil. Ghana provides the bulk of the battery and chemical grade ore. Before the deterioration of trade between the two countries. Russia was a major supplier of manganese to the United States, and its production is about one-third of the world production. *(See* also NATURAL RESOURCES: *Minerals: Iron and the Ferroalloys.)*

A large portion of the steel industry's manganese requirement could be obtained on a current basis from the basic open-hearth slag that contains from 10% to 15% manganese. This concentration is equal to or better than much of the low-grade ore available and is located at the steel mills. Further, millions of tons of previously produced slag might be treated to supply all needs for a period of many years.

The strategic import of the lack of this vital raw material has been long recognized and has impelled the development of feasible methods of utilizing the low-grade deposits and basic open-hearth slag for the production of manganese oxides suitable for ferromanganese manufacture. These programs have been conducted by the U.S. bureau of mines, the American Iron and Steel institute and many private companies. While the processes developed cannot compete economically with prices of foreign ores, they assure a supply of manganese should imports be cut off.

The most common minerals of manganese are pyrolusite and psilomelane *(qq.v.)*; characteristics of these and other manganese minerals are:

Pyrolusite, MnO_2, black, 60%–63% Mn
Psilomelane, $BaMnMn_8O_{16}(OH)_4$, black, 45%–60% Mn
Hausmannite, Mn_3O_4, brown, black, 72% Mn
Rhodochrosite, $MnCO_3$, light rose, 47% Mn, most common carbonate mineral, constituent of the Butte deposits
Rhodonite, $MnSiO_3$, reddish brown, 42% Mn
Braunite, $3Mn_2O_3.MnSiO_3$, black, 63% Mn

USES

Ferroalloys.—Over 95% of the manganese consumed is used in the form of ferroalloys by the metal industries, chiefly for steel manufacture. The predominant type, ferromanganese (74%–82% manganese, 12%–16% iron, 6%–8% carbon, 1% silicon), is made in blast furnaces and, to a lesser extent, in electric furnaces, by reduction of high-grade ores (48% or more manganese) with carbon. About 1,000,000 tons are produced annually. Low-carbon grades containing 0.07%–0.75% carbon are made by reduction of ores with ferrosilicon. Other types include spiegelcisen (16%–28% manganese, 6.5% carbon, 1%–3% silicon, balance iron) and siiicomanganese (65%–70% manganese, 17%–20% silicon, 1.5% carbon, balance iron). These are used in steelmaking to a lesser extent than standard ferromanganese. In addition to their use in deoxidizing and desulfurizing steel, the ferroalloys are used in the preparation of manganese-containing alloy steels.

Pure Manganese. — The only source of pure manganese is the electrolytic process, and while the tonnage of metal produced is small compared with that used in the form of ferromanganese, it has grown steadily. Following the pioneering work done by S. M. Shelton and co-workers at the U.S. bureau of mines, production on a commercial scale was begun in the United States in 1941 by the Electro Manganese Corp. in Knoxville, Tenn. Electrolytic manganese contains 99.9% manganese, and the greater portion, 60%–75%, goes into steel production as an alloying element and purifying agent, where it competes in cost with low-carbon ferromanganese. The balance is consumed in the preparation of nonferrous alloys of copper, aluminum, magnesium and the nickel-base alloys and of chemicals of high purity.

While methods in various plants differ in details, the electrolytic process uses a two-compartment diaphragm cell whose anolyte contains manganous sulfate, ammonium sulfate and sulfuric acid to give a pH of about 1, and whose catholyte is maintained at a pH of 7.2 to 7.6 in the presence of sulfur dioxide. The raw material is high-grade ore or high-manganese slag whose manganese content has been converted to manganous oxide, MnO, by roasting. This material is then leached with the anolyte from the cell, and the solution carefully purified to remove such impurities as iron, arsenic, antimony, tin, lead, nickel, cobalt, molybdenum, silica, aluminum, calcium and magnesium. The leach solution is returned to the cells as catholyte.

The compartmented cell operates with lead-base alloy anodes and stainless steel or Hastelloy C (trade name of Haynes Stellite Co. for alloy containing 14%–19% molybdenum, 4%–8% iron, 12%–16% chromium, 3%–5.5% tungsten, balance nickel', cathodes in the form of thin sheets. Manganese cathode deposits are removed periodically from these sheets by flexing and hammering and are recovered in the form of chips from & to $\frac{1}{8}$ in. thick. An impure form of manganese metal, containing 95%–98% of the element, is made by the reduction of manganese oxide with aluminum or ferrosilicon.

Alloys. — Several alloys containing manganese are of commercial importance. One of the ferrous alloys is the iron-chromium-manganese stainless type, where manganese is substituted for nickel (*see* STAINLESS STEEL: *Austenitic Stainless Steels*). These contain 17%–19% chromium, 8%–10% manganese and about 0.1% carbon and have good structural strength and corrosion resistance. Practically all commercial alloys of aluminum and magnesium contain manganese to improve corrosion resistance and mechanical properties. The presence of manganese in titanium improves the strength and workability of this light metal. An extremely high ability to damp vibrations is possessed by binary copper-manganese alloys. The development of alloys of manganese has expanded with the increasing availability of electrolytic manganese (*see* also ALLOYS).

Chemical Applications. — About 50,000 tons per year of high-grade natural manganese dioxide are used in the preparation of dry cells, or primary batteries, where the MnO_2 acts as a depolarizer to react with the hydrogen liberated by the cell reaction. A special crystal structure in addition to chemical purity is required for this purpose. A satisfactory grade is made by electrolysis of manganous sulfate in a sulfuric acid solution. This battery use is the most important nonmetallurgical application of manganese

Manganese compounds are used in glassmaking to counteract the green colour from iron and for pink and black colouring. Organic compounds, such as the naphthenate, as well as oxides and salts of manganese, are used in paints and varnishes as driers to promote the absorption of oxygen, which causes paints to set. Manganous sulfate, $MnSO_4$, is used alone and admixed with fertilizers to supply trace quantities of this element in agriculture, especially for citrus crops, to stimulate growth and to combat chlorosis in crops grown in certain calcareous and highly organic soils. Manganous chloride, $MnCl_2$, is added in some cases directly to the electrolytic cells producing magnesium in order to add the desired quantity of manganese for the alloying of the magnesium. The powerful oxidizing properties of potassium permanganate are utilized for disinfecting, deodorizing and decolorizing, and this compound is an important analytical reagent.

CHEMICAL AND PHYSICAL PROPERTIES

Chemical Properties. — Manganese, whose atomic number is 25 and atomic weight 54.93, is located in group VIIa of the periodic table, horizontally between chromium and iron. Although somewhat similar to iron in general chemical activity, it can exist in its compounds in the valence states of 1, 2, 3, 4, 6 and 7, the most stable salts being those of the divalent form, and the most stable oxide, the dioxide MnO_2. The lower oxides, MnO and Mn_2O_3, are basic; the higher oxides, acidic. The most stable compounds are those of valence 2, 6 and 7, exemplified, respectively, by the manganous salts, such as $MnCl_2$, $MnSO_4$ and $MnNO_3$; the manganates, such as K_2MnO_4; and the permanganates, such as $KMnO_4$. Divalent manganese is a reducing agent, tetravalent manganese is a good oxidizing agent and heptavalent manganese is a powerful oxidizing agent. The trivalent and hexavalent forms undergo auto-oxidation and reduction in acid solutions:

$$2Mn^{+3} + 2H_2O \longrightarrow MnO_2 + Mn^{+2} + 4H+$$
$$3MnO_4^{-2} + 4H^+ \longrightarrow MnO_2 + 2MnO_4^- + 2H_2O$$

These factors make manganese compounds useful for analytical procedures and for a variety of industrial applications.

Manganese metal oxidizes superficially in air and rusts in moist air. It burns in air or oxygen at elevated temperatures, like iron; decomposes water slowly when cold and rapidly on heating, forming manganous hydroxide, $Mn(OH)_2$, with hydrogen evolution; and dissolves readily in dilute mineral acids, with hydrogen evolution and the formation of the corresponding divalent salts.

Fluorine, chlorine and bromine react with manganese when heated. At 1200° C. or over, nitrogen attacks the metal to form the nitride Mn_5N_2, and when heated with ammonia, manganese forms the nitride Mn_3N_2. Manganese reacts with sulfur.

Fused manganese dissolves carbon, as does iron, ultimately forming a carbide, and it reacts with carbon monoxide at temperatures above 330° C. and with carbon dioxide when strongly heated.

Because of its position in the electromotive series, the metal will displace arsenic, antimony, bismuth, tin, lead, copper, iron, nickel, cobalt, cadmium and zinc from solutions of salts of these elements. This property can be used to substitute manganese for zinc as a sacrificial electrode for cathodic protection and corrosion pre-

Physical Properties of Manganese

Atomic number	2j
Atomic weight	54.93
Stable isotope	55

	Alpha	Beta	Gamma	Delta
Density				
Solid, g./cc. at 20° C.	7.44	7.29	7.18	
Liquid, g /cc.		6.54		
Atomic volume, cc./gram-atom		7.4		
Melting point, ° C.		1,245 ± 3		
Boiling point, ° C.		2,097		
Specific heat				
Cal./g. at 25° C. or B.T.U./lb. at 77" F.	0.114	0.154	0.148	0.191
Linear coefficient'of thermal expansion				
Per ° C. (0°–100° C.)	22×10^{-6}		14×10^{-6}	
Per ° F. (32°–212° F.)	12.2×10^{-6}		7.8×10^{-6}	
Electrical resistivity at 20° C., microhm-cm.	185	91	45.1	

Latent heat of fusion, cal./g.	61.7
Latent heat of vaporization, cal./g.	977.6
Magnetic susceptibility, 18° C (cg. units)	9.9
Hardness, Mohs' scale	5.0
Heat of transformation, cal./gram-atom	
Alpha to beta. 727° C.	535
Beta to gamma, 1,100° C.	545
Gamma to delta, 1,138° C.	430
Standard electrode potential, Mn = Mn^{+2} + 2e + 1.1 volts	

Allotropic transition points

From	To	Temperature, ° C.	Condition
Alpha	Beta	727 ± 3	Heating
Beta	Alpha	692–665	Cooling
Beta	Gamma	1,100 ± 3	Heating & Cooling
Gamma	Delta	1,138 ± 3	Heating & Cooling
Delta	Liauid	1,245 ± 3	Heating & Cooling

vention in steel equipment. Roiling, concentrated solutions of potassium or sodium hydroxide have no action on manganese.

Physical Properties.— Manganese exists in three: and possibiy four, allotropic modifications, the alpha being the one stable at ordinary temperatures. Alpha and beta manganese are hard, brittle metals that will scratch glass. Tine pure metal cannot be fabricated. Gamma manganese, which changes to alpha at ordinary temperatures, is reported to be flexible and soft and can be bent and easily cut. The alpha form can be transformed to a ductile alloy by the addition of 2% copper and 1% nickel. The physical properties of manganese are listed in the accompanying table.

See Index references under "Manganese" in the Index volume.

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MANGANESE STEEL. In the middle of the 19th century. when Sir Henry Bessemer (*q.v.*) was developing his pneumatic process for converting pig iron into steel, his experiments almost failed. He found that when he used Swedish pig iron, made from high-purity ore and reduced with charcoal, he could produce a usable steel; however, when he tried English pig irons, with higher contents of sulfur and phosphorus, the steel he produced could not be hot-rolled or forged without breaking up. It was hot-short. Fortunately, contemporary experiments by Robert Mushet showed that manganese, added to steel containing sulfur, would prevent this hot-shortness, and steelmaking on a large scale thus became successful. Since that time, manganese has been the one most essential additive to steels (iron-carbon alloys). In the absence of manganese, the iron sulfide in the steel melts at about 985° C., or 1,805° F., forming an intergranular liquid at hot-rolling temperatures. Manganese converts the sulfur to manganese sulfide, which has a much higher melting point and which remains a plastic solid during hot-rolling or forging and thus cures hot-shortness. When not added for alloying effects the normal manganese content of steel is 0.3% to 0.7%. In resulfurized steels, where sulfur is added to improve machinability, manganese may be increased to 1.5% with a sulfur content of 0.35%.

The term manganese steel often connotes Hadfield's austenitic manganese steel, which contains about 1.25% carbon and from 12% to 14% manganese. The carbon and manganese contents are high enough to cause the transformation from the high-temperature form of iron, austenite, to the low-temperature form, ferrite, to be very sluggish. As a consequence, when this steel is water quenched from a temperature of 1,000° C. (1,800° F.), it remains wholly austenitic at room temperature and is soft and ductile. The austenite is metastable, however, and when the steel is plastically deformed, as by cold working, it transforms rapidly to very hard martensite. (See STEELS, ALLOY.) Thus, for very rugged service, as in the rock crushers or railway frogs, it presents a hard, wear-resistant and self-renewing surface over a tough unbreakable core.

Manganese is fully the equivalent of nickel, chromium and molybdenum in promoting hardenability in steel, and it is cheaper. In low-alloy steels that are to be used in the normalized or hot-rolled condition. an increase in carbon will raise the strength, with a sacrifice in ductility, but an increase of manganese strengthens the steel, with no loss of ductility. Popular compositions contain 0.20% to 0.30% carbon and 1.25% to 1.75% manganese. Manganese is seldom used alone, however, because such steels tend to be coarse grained and notch sensitive. If not to be hardened, the grain size is usually refined with small additions of vanadium, titanium or aluminum. Whey they are to be hardened by water quenching, they often contain 0.2% molybdenum.

The so-called silicomanganese spring steel, containing 0.45% to 0.60% carbon, 1.8% to 2.2% silicon and 0.6% to 0.9% manganese, is really a silicon steel. Nondeforming steels for gauges, master tools, dies, etc., contain 0.80% to 0.90% carbon and 1.5% to 3% manganese and are characterized by their ability to maintain their shape and dimensions through a heat-treating cycle.

The high price and great scarcity of nickel and the production of carbon-free electrolytic manganese spurred the substitution of manganese for part of the nickel in austenitic stainless steels of the 18% chromium, 8% nickel type. Successful steels range from 16% chromium, 16% manganese, 1% nickel with 0.15% nitrogen to 18% chromium, 10% manganese, 4% nickel and 0.15% nitrogen, the latter being almost identical in properties with the 18% chromium, 8% nickel.

See also MANGANESE: Uses; IRON AND STEEL INDUSTRY: Some Ferro-Alloys. (C. E. Ss.)

MANGANITE, a basic manganese oxide mineral, MnO(OH), is an ore of manganese. ranking after pyrolusite and psilomelane (*qq* v.), to which it readily alters. The colour of manganite is dark steel gray to iron black. and the lustre brilliant and submetallic. The streak is dark reddish-brown. the hardness 4, and the specific gravity 4.33. It is a low-temperature hydrothermal vein mineral, and is chemically similar to lepidocrocite FeO(OH) and boehmite AlO(OH), but has a different structure. Manganite crystallizes in the monoclinic system, but nith an angle β of 90°, and hence appears as orthorhombic. The crystals are prismatic and deeply striated parallel to their length; they are often grouped in bundles and in columnar or fibrous masses. There is a perfect cleavage parallel to the side pinacoid. Manganite contains So 6% MnO; it dissolves in hydrochloric acid with evolution of chlorine Fine crystals are found at Ilfeld, Harz mountains. Ger., with calcite and barite. It also occurs in England, in Nova Scotia and in the United States, in the Lake Superior iron district. (L S. RL.)

MANGBETU (*Monbuttu*), a Negroid, Sudanic-speaking people of central Africa living to the south of the Azande in the Welle district of the Belgian Congo, where they cultivate chiefly bananas and manioc. The name Mangbetu refers strictly only to the aristocracy. which in the 19th century established a number of powerful kingdoms, though in looser usage it denotes the whole amalgam of peoples whom they rule. They impressed early travelers with their political institutions and their arts, especially with their remarkable skill as builders. potters and sculptors. They became renowned also for their cannibalism and for their practice of deforming the heads of babies by binding them tightly so that they retained through life a curiously elongated form. (E. E. E.-P.)

MANGEL, mangel-wurzel or mangold is a large type of beet belonging to the species Beta *vulgaris* which also includes vegetable and sugar beets arid Swiss chard. These types interbreed freely. The species probably originated from the wild beet Beta *maritima* and had its principal developmental centre in the eastern Mediterranean region. Mangold, the original name, is German and it has been somewhat modified in use. In France mangels are known as disettes. The mangel root is a store of food-stuffs in the forms of sugar and other carbohydrates. The sugar percentage is approximately 7%-8%, being about half that of sugar beets. The principal use of the crop is to provide a high tonnage of a succulent. nutritious feed for use in livestock, including poultry feeding. As feed for cattle and sheep. mangel roots are highly regarded and being very palatable they are often utilized as a relish for stimulating milk production. They are also considered valuable in conditioning animals for show purposes. Pound for pound the dry matter of mangels is equivalent in feed value to grain. The crop is usually grown in regions too cool or seasons too short for corn and where other conditions, such as soil fertility. soil type and moisture supply: are particularly favourable. Corn as compared with mangels will produce nearly double the yields of dry matter in the regions of its adaptation. Mangels are grown chiefly in northern and coastal western Europe and on the Pacific coast of the United States and Canada.

The plant is a biennial. During the first year of growth the stem of the mangel remains short and a rosette of large, crisp. prominent-veined leaves arises from it. The upper portion of the primary root becomes large during midsummer and autumn, attaining a diameter of from 4–10 in. and a length of from 6–30 in. The shape of the root is a varietal characteristic. If it remains in place and survives the winter, or if it is properly stored, and transplanted the following spring, tall, angular, branching stems grow to heights of three feet or more and produce inconspicuous flowers and seeds. The flowers are perfect and arranged in dense, sessile clusters, each subtended by a small bract, along an axis. The seeds are embedded in the flower parts and usually several flowers clustered together give rise to the seed ball, from which several seedlings may develop. Five groups of varieties are recognized based upon root shape and colour and leaf colour. Shapes recognized are globular, flattened, cylindrical and fusiform while colours may be white, yellow, orange or red. Zonal colouration may also occur within the root.

Culture. — Like other root plants the mangel is a row crop. The seed is drilled about $1\frac{1}{2}$ in. deep in rows 24–36 in. apart at a rate of 10–15 lb. per acre. After emergence of the seedlings cultivation is begun and continued until late summer. When the plants reach the iour-leaved stage they are spaced about 10–14 in. apart in the rows by thinning. Hand hoeing is then begun and the crop is weeded as required. Harvesting is done by mechanically liiting the roots previous to heavy frosts in the fall and removing the tops by cutting. The roots may be stored in large heaps or in covered pits or root cellars. Successful storage is dependent upon careful handling to avoid severe bruising, and also upon good ventilation. The roots may be pulled and ied directly as needed without topping.

Best soils for mangels are those rich, well drained and in good tilth. On more shallow land varieties with shorter roots may he grown. The crop responds markedly to heavy applications of barnyard manure and to potash, phosphate and nitrogen fertilizers. Although mangels are sometimes grown for several years on the same land they more commonly occupy a place in rotation with grain and forage crops. Requiring careful cultivation and weed control, they leave the soil in excellent condition for succeeding crops.

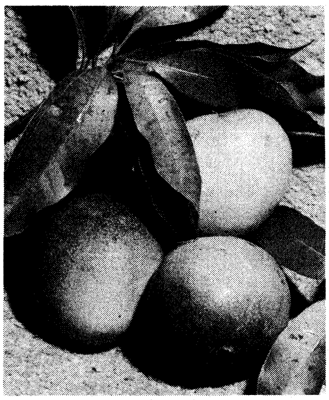
The principal values of the mangel are its productiveness, yields usually being 20–45 tons per acre, and its succulence. Very few crops will produce as much succulent feed per area. Mangels require much hand labour in thinning, cultivating, harvesting and storage. In corn regions cost of producing corn ensilage for succulent feed is much less than with mangels or other root crops. Mangels are more drought and heat-tolerant but more sensitive to frost than turnips or rutabagas, often grown for similar uses. Also, they are less affected by root maggots and aphis than the latter crops. Important objectives sought in better varieties are high yield of sugar and dry matter, freedom from disease and premature seed-stalk formation (bolting) and smooth, well-shaped roots of good keeping quality. (D. C. SH.)

MANGO, one of the most important and widely cultivated fruits of the tropical world. Its origin is lost in antiquity: according to some authorities, horticultural forms are derived from *Mangifera indica* (family Anacardiaceae), considered indigenous to the region of the eastern Indian subcontinent. Burma and Assam; but other species. such as *M. laurina* may have entered into the composition of some, particularly those of the Malayan region.

History.—Few fruits are so inextricably connected with the folklore and religious ceremonies of India as the mango. Buddha himself was presented with a mango grove, that he might find repose in its grateful shade. The economic importance of the mango in ancient times is attested by one of the Sanskrit names, ***am***, which has an alternative meaning of provisions or victuals. The Chinese traveler Hwen T'sang, who visited Hindustan between A.D. 632 and 645, was the first person, so far as known. to bring the mango to the attention of the outside world. Friar Jordanus wrote of it in 1328. and John de Marignolli in 1349. Akbar. the Mogul emperor who reigned at Delhi from 1jj6 to 1605, planted near Darbhanga the Lakh Bagh. an orchard of 100,000 mango trees. Nothing better attests the esteem in which the fruit has long been held than this immense planting. made at a time when large orchards of fruit trees were almost unknown.

The name mango, by which the fruit is known in English- and Spanish-speaking countries, is derived from the Tamil *man-kay* or *man-gay,* which the Portuguese adopted as *manga* when they settled in western India. Probably because of the difficulty in transporting seeds (they retain their viability a short time only). introduction of the tree into the western hemisphere did not take place until about 1700, when it was planted in Brazil; thence it reached the West Indies about 1740. It has taken on the appearance of a wild species in many parts of tropical America, trees springing up everywhere from seeds scattered by the roadside. During the ripening season, mangos are a major foodstuff wherever grown.

Description. — The tree is evergreen, often reaching large size (50–60 ft.) and attaining great age. It is one of the favourite shade trees of the tropics. The leaves are lanceolate, up to 12 in. long; the flowers, which are small. pinkish and fragrant, are borne in large terminal panicles. They are polygamous, *i.e.,* some have both stamens and pistil, others stamens only. The fruit varies greatly in size and character, as would be expected of a species (or combination of species) which has been in cultivation for a long time. The smallest mangos are no larger than plums. while others may weigh four or even five pounds. The form is oval, round, heart-shaped. kidney-shaped or long and slender. Some varieties are beautifully coloured with shades of red and yellow, while others are dull green. The single large seed is flattened. the flesh which surrounds it yellow to orange in colour, juicy and of delicious spicy flavour. Fryer, writing of mangos in 1673. said "for Taste, the Nectarine. Peach and Apricot fall short." Hamilton. who wrote in 1727, went even further. "The Goa mango," he declared. "is reckoned the largest and most delicious to the taste of any in the world. and I may add, the wholesomest and best tasted of any Fruit in the World." There are ample grounds for considering the mango—as has been done by many writers—the "king of tropical fruits."



BY COURTESY OF FLORIDA STATE NEWS BUREAU

FLORIDA MANGOS

Most of the seedlings so abundant throughout the tropics do not represent this fruit at its best. While of good flavour, they are commonly characterized by coarse fibres throughout the flesh which makes eating an annoying process. In contrast, the fine grafted varieties which have originated in India and a few other regions, as well as seedlings of the race cultivated in the Philippines and other countries (known as Mangos de Manila in Mexico and Filipinos in Cuba), are almost devoid of fibre and are of excellent quality.

Distribution and Cultivation. — In 1889 the U.S. department of agriculture introduced into Florida the first of the grafted Indian varieties known in the United States — the variety Mulgoba, of superb quality but not highly productive. In subsequent years, mainly through the efforts of Reasoner brothers and David Fairchild (*q.v.*), more than jo other choice varieties mere taken to the Gnited States, whence the cultivation of several gradually spread to many parts of the American tropics. The British and French also introduced a number into the West Indies. Some of the best imported varieties are Pairi (known in Jamaica as Bombay). Borsha and Amini. In addition to these such varieties as Carabao from the Philippines and Saigon from Cambodia should be mentioned. as well as Julie which first received horticultural attention in the French West Indies and later became popular in Jamaica.

Because of the failure of many varieties to produce regular and heavy crops of fruit, they have been replaced in commercial orchards by Haden (a seedling of Mulgoba which originated in Florida) and others which have been developed in that state.

Mango trees are injured by a few degrees of frost. They are grown commercially in southern Florida. but were not wholly successful in California. though numerous trees have fruited in that state. The mango is not particular as to soil, but the finer varieties only yield good crops where there is a well-marked dry season to stimulate fruit production rather than vegetative growth. There is another serious problem in rainy areas: a fungous disease known as anthracnose (*Colletotrichum*) which destroys the flowers and young fruits and is expensive to control.

Propagation is by means of grafting or budding. Inarching is widely practised in tropical Asia. but is tedious and relatively expensive. In Florida better methods have been developed and are used commercially. Chief among these are veneer grafting and chip budding. However. seedling trees of the Philippine race usually produce fruit like that of the parent and for this reason are extensively grown in Mexico. This race is polyembryonic. which means that trees usually do not develop from fertilized ovules, but from what are known as nucellar buds arising from the vegetative tissues surrounding the egg cell, hence they are in most respects similar to grafted plants. On the other hand, most of the Indian varieties are monoembryonic, which means that young plants develop only from fertilized ovules and thzrefore are subject to the variation which is characteristic of cultivated fruit trees in general.

Except with occasional dwarf varieties such as Julie, mangos in commercial plantings are spaced 35 to 45 ft. apart. The tree has a number of enemies, chief among which are the anthracnose disease mentioned above and certain scale insects (family Coccidae). In numerous tropical regions the fruits may be infested by the larvae of fruit flies, which render them unfit for human consumption and are difficult to combat. (W. Po.)

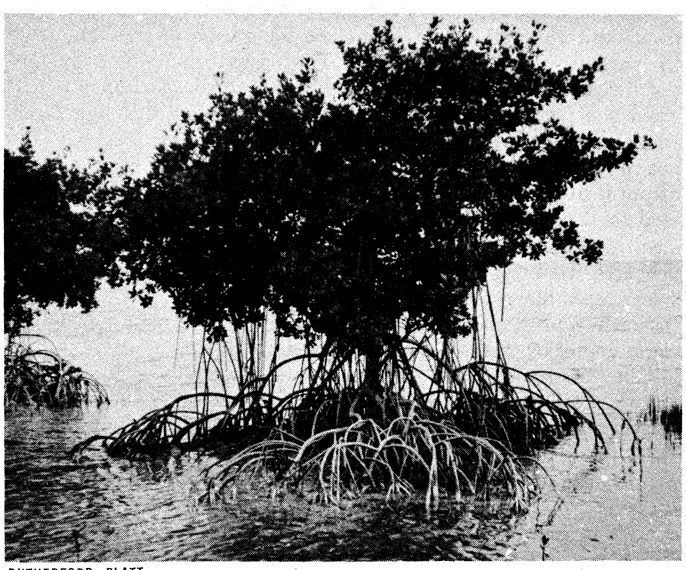
MANGOLD: *see* MANGEL.

MANGOSTEEN. A beautiful, delicious fruit of tropical southeast Asia. produced by a handsome tree *(Garcinia mangostana)* of the family Guttiferae which under favourable conditions reaches a height of about 35 ft. It has thick, dark-green, glossy leaves six to ten inches long; the flowers are large, polygamous; the fruits are about three inches in diameter, round to oblate in form, and dark purple in colour. They have thick hard rinds surrounding a large cavity in which lie several segments of snow-white flesh, resembling a mandarin orange; it is juicy, delicate in texture, and of delightful acidulous flavour.

In spite of the fact that the mangosteen is so highly valued, and that its cultivation in such regions as Java, Sumatra, Indochina and the southern Philippines dates from very early times, the tree has nowhere been planted on an extensive scale, for mangosteens are difficult to ship very long distances. It was introduced into the western hemisphere in the 19th century, where it became established in several of the West Indian islands; it was later established on the mainland; *e.g.,* in Guatemala, Honduras, Panama and Ecuador. It did not prove well adapted to the climates of California and Florida. but has been grown successfully in Hawaii.

For best results the mangosteen needs a rich deep soil and a moist tropical climate, but it will grow under less ideal conditions. though not where temperatures often go below about 40° F. Propagation is by seeds, which do not long retain their viability. Grafting has been unsuccessful and not required, since the embryos develop from tissues surrounding the ovary; hence, being of vegetative origin they produce trees which are as much alike as grafted ones. Occasional trees may yield as many as 500 to 600 fruits; there is a tendency to produce good crops only in alternate years. (W. Po.)

MANGROVE. The mangrove forests along tidal estuaries, in salt marshes, and on muddy coasts in the tropics of both old and new worlds, are composed of trees and shrubs belonging mainly to the genus *Rhizophora* of the family Rhizophoraceae, but including. especially in the eastern mangrove formations of further India and the Malay archipelago, members of other families, such as Lythraceae (*Sonneratia*), Verbenaceae (*Avicennia*), and the acaulescent Nipa-palm. Their trunks and branches constantly produce adventitious roots. which, descending in arched fashion, strike at some distance from the parent stem, and send up new trunks, the forest thus spreading like a banyan (*q.v.*) grove. An advantage in dispersal, very characteristic of the order, is afforded by the seeds, which have a striking peculiarity of germination While the fruit is still attached to the parent branch the long radicle emerges from the seed and grows rapidly downward. When the seed falls the young root is in the right position to be driven into the mud; the plant being thus rooted the plumule makes its appearance. The young root may grow to such a length that it becomes fixed in the mud before the fruit separates from the parent tree. An interesting feature of the mangrove is the air roots, erect or kneed branches of the roots, which project above the mud, and are provided with minute openings (lenticels), into which the air diffuses and then passes by means of passages in the soft spongy tissue to the roots which spread beneath the mud. The wood of some species is hard and durable; the astringent bark is used in tanning, yielding cutch. The fruit of the common mangrove. *Rhizophora mangle,* is sweet and wholesome.



RUTHERFORD PLATT

COMMON MANGROVE (RHIZOPHORA MANGLE) SHOWING THE TANGLED ROOT FORMATION

MANHATTAN, a city of northeastern Kansas, U.S., the seat of Riley county, is located on the north fringe of the rolling Flint Hills, at the confluence of the Big Blue and Kansas (Kaw) rivers, 55 mi. W. of Topeka, and 10 mi. E. of Fort Riley, one of the state's beauty spots. The village was founded in 1854 when the settlements of Poleska and Canton were consolidated as Boston. It was renamed Manhattan in 1855 by mutual agreement between the Boston association and a party of colonists from Cincinnati. The city was incorporated in 1857 and adopted the commission-manager form of government in 1951. Manhattan, chiefly an educational centre, is the home of Kansas State University of Agriculture and Applied Science (formerly Bluemont Central college, chartered 1858), one of the first land-grant colleges in the U.S. The city supports a municipal airport, a zoo, several large parks and a recreational program. It is 5 mi. from Tuttle Creek dam. Commercial and industrial activities include insurance, wholesaling, food processing, farm machinery, cut stone and truck farming. For comparative population figures see table in KANSAS: *Population.* (A. B. SR.)

MANHATTAN, an island 14 mi. long and 2.3 mi. wide lying between the Hudson and East rivers in the southernmost part of New York state, U.S., is one of the five boroughs comprising New York city and also forms New York county. The borough of Manhattan includes, in addition to the island, a small area on the mainland known as Marble Hill and a number of small islands in the East river — Welfare, Governors, Randalis and Wards. Manhattan is the centre of much of the city's activities and is often mistaken as being synonymous with New York city.

The Dutch West India company founded Manhattan as a trading post and from the beginning finance was among its chief interests. In 1626 Peter Minuit, the first director-general of New Netherland province, is said to have purchased the island from the Brooklyn Indians (Canarsees) with trinkets and cloth valued at 60 guilders (then about $24). The island became the possession of the English in 1664, having already been incorporated as the city of New Amsterdam in 1653. Renamed New York city, it played a prominent role in the early history of the republic, both militarily and politically. It served as the meeting place for congress from 1785 to 1790 and George Washington was inaugurated there in 1789 as the country's first president. In the 19th century, particularly following the opening' of the Erie canal in 1825, Manhattan developed rapidly and became the heart of a prosperous and expanding metropolis. In 1898 greater New York was formed when Manhattan was joined with the newly created boroughs of Brooklyn, Queens, Richmond and the Bronx (*qq.v.*).

Manhattan is renowned for its many attractions and points of interest. Among these are Broadway, one of the best-known streets in the world; Wall street, focal point of the financial district; the skyscrapers, such as the Empire State building; Greenwich Village; Central park, extending from 59th to 110th street; the United Nations Headquarters building; and cultural and educational institutions, including the Metropolitan Museum of Art; Metropolitan Opera house; American Museum of Natural History; Hayden planetarium; Columbia university, including Barnard college; Hunter college and City College, both operated by the College of the City of New York; and New York university. See also NEW YORK (CITY). (D. L. D.)

MANI (MANES or MANICHAEUS) (215/6–274?), the Iranian founder of the Manichaean religion, was born in 215/6 in southern Babylonia, where his father, Patek, a native of Hamadan, had joined a religious community practising baptism and abstinence. Through his mother Mani was related to the Parthian royal family (overthrown in 224). Information about his life appears to derive from his own writings and the traditions of his church. He grew up at his birthplace, speaking a form of eastern Aramaic. Twice, as a boy and young man, he saw in vision an angel, the "Twin," who, the second time, called him to preach a new religion. He traveled to India (probably Sind and Turan) and made converts. Favourably received on his return by the newly crowned Persian king, Shapur I, he was permitted to preach his religion in the Persian empire during that long reign. There is little information about Mani's life in those years. He probably traveled widely in the western parts of the empire, but later traditions that he visited the northeast seem unsound. Under the reign of Bahram I he was attacked by Zoroastrian priests and imprisoned by the king at Gundeshapur (Belapet), where he died after 26 days in captivity in 274 or 277. See also MANICHAEISM.

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MANICHAEISM, the religion of Mani (*q.v.*), which spread from Babylonia and during the 4th century was widely influential in the empire.

Manichaean System.—The Manichaean system is one of consistent, uncompromising dualism, in the form of a fantastic philosophy of nature. The distinction between the physical and the ethical, the natural and the spiritual, did not exist for Mani. When he co-ordinates good with light, and evil with darkness, this is no mere figure of speech, but light is actually good and darkness evil. Religious knowledge involves the knowledge of nature and her elements, and redemption consists in freeing light from darkness. Thus ethics becomes a doctrine of abstinence in regard to all elements originating within the sphere of darkness.

The self-contradictory character of the present world forms the point of departure for Mani's speculations. From the contradictory character of the world he concludes the existence of two beings, originally quite separate from each other—light and darkness. Each is to be thought of according to the analogy of a kingdom. Light presents itself to us as the good primal spirit (God, radiant with the virtues of love, faith, fidelity, high-mindedness, wisdom, meekness, knowledge, understanding, mystery and insight), and then further as the heavens of light and the earth of light, with their guardians the glorious aeons or angels. Darkness is likewise a spiritual kingdom (more correctly, it also is conceived of as a spiritual and feminine personification), but it has no "God" at its head. It embraces an "earth of darkness." As the earth of light has five tokens (the mild zephyr, cooling wind, bright light, quickening fire and clear water), so has the earth of darkness also five (mist, heat, the sirocco, darkness and vapour). Satan with his demons was born from the kingdom of darkness. These two kingdoms stood opposed to each other from all eternity, touching each other on one side, but remaining unmingled. Then Satan made an incursion into the kingdom of light, into the earth of light. The God of light, with his syzygy, "the spirit of his right hand," now begot the primal man, and sent him, equipped with the five pure elements, to fight against Satan. But the latter proved himself the stronger, and the primal man was for a moment vanquished. And although the God of light himself now took to the field and with the help of new aeons (the spirit of life, etc.) inflicted total defeat upon Satan and set the primal man free, the latter had already been robbed of part of his light by the darkness, and the five dark elements had mingled themselves with the generations of light.

Creation of Man.—It is significant of the pessimistic character of the system that, while the formation of the world is considered as a work of the good spirits, the creation of man is referred to the princes of darkness. The first man, Adam, was engendered by Satan in conjunction with "sin," "cupidity," "desire." But the spirit of darkness drove into him all the portions of light he had stolen, in order to be able to dominate them the more securely. Thus Adam is a discordant being, created in the image of Satan. but carrying within him the stronger spark of light. Eve is given him by Satan as his companion. She is seductive sensuousness, though also having in her a small spark of light. But if the first human beings thus stood entirely under the dominion of the devil, the glorious spirits took them under their care from the very outset, sending aeons down to them (including Jesus), who instructed them regarding their nature, and in particular warned Adam against sensuality. But this first man fell under the temptation of sexual desire. Cain and Abel indeed are not sons of Adam, but of Satan and Eve; Seth, however, who is full of light, is the offspring of Adam by Eve. Thus did mankind come into existence, its various members possessing very different shares of light, but the men having uniformly a larger measure of it than the women. In the course of history the demons sought to bind men to themselves by means of sensuality, error and false religions (among which is to be reckoned above all the religion of Moses and the prophets), while the spirits of light carried on their process of distillation with the view of gaining the pure light which exists in the world. But these good spirits can save men only by imparting to them the true gnosis concerning nature and her forces and by calling them away from the service of darkness and sensuality. To this end prophets, preachers of true knowledge, have been sent into the world. Mani, following the example of the gnostic Jewish Christians, appears to have held Adam, Noah, Abraham (perhaps Zoroaster and Buddha) to be such prophets. Probably Jesus was also accounted a prophet—not, however, the historical Jesus, but a contemporaneous phantom Jesus, who neither suffered nor died (Jesus *impatibilis*). According to the teaching of some Manichaeans, it was the primal man who disseminated the true gnosis in the character of Christ.

Mani, the "Ambassador of Light."—But at all events Mani himself, on his own claim, is to be reckoned the last and greatest prophet, who took up the work of Jesus impatibilis and first brought full knowledge. It is only through his agency and that of his imitators, "the elect," that the separation of the light from the darkness can be completed. The system contains very fantastic descriptions of the processes by which the portions of light when once set free finally ascend even to the God of light. He who during his lifetime did not become one of the elect, who did not completely redeem himself, has to go through a severe process of purification on the other side of the grave, till he too is gathered to the blessedness of the light. When the imprisoned elements of light have at last been completely, or as far as possible, delivered from the world, the end of all things comes. All glorious spirits assemble, the God of light himself appears, accompanied by the aeons and the perfected just ones. The angels supporting the world withdraw themselves from their burden, and everything falls in ruins. A tremendous conflagration consumes the world; the perfect separation of the two powers takes place once more.

Ethics of the **Manichaeans.**—On the basis of such a cosmical philosophy, ethics can have only a dualistic ascetic character, Manichaean ethics is not merely negative, however, since it is necessary to cherish, strengthen and purify the elements of light, as well as free oneself from the elements of darkness. The aim is not self-destruction, but self-preservation; and yet the ethics of Manichaeism appears in point of fact as ascetic, to an extent that could be practised only by few; hence the religion must have abandoned all attempts at an extensive propaganda had it not conceded the principle of a twofold morality. A distinction was made in the community between the electi (*perfecti*), the perfect Manichaeans, and the *catechumeni* (auditores), the secular Manichaeans. Only the former submitted themselves to all the demands made by their religion; for the latter the stringency of the precepts was relaxed. They had to avoid idolatry, sorcery, avarice. falsehood, fornication, etc.; above all, they were not allowed to kill any living being (the ten commandments of Mani). They had also to free themselves as much as possible from the world: but in truth they lived very much as their non-Manichaean fellow citizens. We have here essentially the same condition of things as in the Catholic Church, where a twofold morality is also in force. that of the religious orders and that of secular Christians—only that the position of the electi was more distinguished than that of the monks. For, after all, the Christian monks never quite forgot that salvation is given by God through Christ, whereas the Manichaean electi mere themselves redeemers.

It is evident that the religion of Mani borrowed various elements from older oriental faiths especially from Babylonian and Zoroastrian sources. It arose "in a country where several religions were competing with one another. and where, in consequence of this, various hybrid sects had been formed" The relations of Manichaeism to other religions have been investigated in detail; but mention must be made of its relation to Christianity.

Manichaeism and Christianity.— It is very difficult to determine the extent of Mani's knowledge of Christianity. how much he himself borrowed from it, and through what channels it reached him. It is certain that Manichaeism, in those districts nhere it was brought much into contact with Christianity, became influenced by it. The western Manichaeans of the 4th and 5th centuries are much more like Christians than their eastern brethren As regards Mani himself. it is safest to assume that he held both Judaism and Catholic Christianity to be false religions.

Finally, the Manichaean doctrines exhibit points of similarity to those of the Christian Elkessites. The historical relation of Mani to Christianity is then as follows From Catholicism. of which he very probably had no detailed knonledge he borrowed nothing. On the other hand, he looked upon what he considered to be Christianity proper—that is, Christianity as it had been developed among the sects of Basilidians, Marcionites and perhaps Bardesanites—as a comparatively valuable and sound religion. He took from it the moral teaching of the Sermon on the Mount and a criticism of the Old Testament and of Judaism so far as he required it Indications of the influence of Marcionitism are found in the high estimation in which Mani held the apostle Paul and in the fact that he explicitly rejects the Book of Acts.

The Secret of **Manichaeism.**—What gave Manichaeism strength was that it united an ancient mythology and a thoroughgoing materialistic dualism uith an exceedingly simple spiritual uorship and a strict morality. On comparing it with the Semitic religions of nature we perceive that it was free from their sensuous cultus substituting instead a spiritual uorship as well as a strict morality. Manichaeism nas thus able to satisfy the new wants of an old world. It offered revelation. redemption moral virtue and immortality, spiritual benefits on the , of the religion of nature. A further source of strength lay in the simple yet firm social organization which was given by Mani to his new institution. The wise man and the ignorant, the enthusiast and the man of the world could all find acceptance here, and there was laid on no one more than he was able and willing to bear.

Originally furnished from fragments of various religions, Manichaeism could increase or diminish this possession nithout rupturing its own elastic framework. And. after all, great adaptability is just as necessary for a universal religion as a divine founder. Manichaeism indeed, though it applies the title "redeemer" to Mani, has really no knowledge of a redeemer, but only of a physical and gnostic process of redempticn; on the other hand, it possesses in Mani the supreme prophet of God. If we consider in conclusion that Manichaeism gave a simple, apparently profound, and yet convenient solution of the problem of good and evil, a problem that had become peculiarly oppressive to the human race in the 2nd and 3rd centuries, we shall have named the main factors which account for the rapid spread of the system.

History of **Manichaeism.**—Manichaeism first gained a firm footing in the east, *i.e.,* in Persia, Mesopotamia and Transoxiana. The persecutions it had to endure did not hinder its extension. Even after the conquests of Islam the Manichaean Church continued to maintain itself, indeed it seems to have become still more nidely diffused by the victorious campaigns of the Moslems, and frequently it gained secret adherents among the latter themselves Its doctrine and discipline underwent little change in the east; in particular. it drew no nearer to the Christian religion. It first penetrated the Greek-Roman empire about the year 280, in the time of the emperor Probus (see the Chronicon of Eusebius).

It was only subsequent to about 330 that Manichaeism spread rapidly in the Roman empire. Its adherents were recruited on the one hand from the old gnostic sects (especially from the Marcionites—Manichaeism exerted besides this a strong influence on the development of the Marcionite churches of the 4th century) on the other hand from the large number of the "cultured," who were striving after a "rational" and yet in some manner Christian religion. Its polemics and its criticism of the Catholic Church now became the strong side of Manichaeism, especially in the west. It admitted the stumbling blocks which the Old Testament offers to every intelligent reader and gave itself out as a Christianity nithout the Old Testament. Instead of the subtle Catholic theories it offered an exceedingly simple conception of sin and goodness.

The farther Manichaeism advanced into the west the more Christian and philosophic did it become. In Syria it maintained itself in comparative purity. In north Africa it found its most numerous adherents, gaining secret support even among the clergy.

Opposition of Roman **Emperors.**—The Christian Byzantine and Roman emperors, from Valens onwards. enacted strict laws against the Manichaeans. But at first these bore little fruit. The *auditores* were difficult to trace out, and besides they really gave little occasion for persecution. In Rome itself between 370 and 440 Manichaeism gained a large amount of support. especially among the scholars and public teachers. It also made its way into the life of the people by means of a popular literature in which the apostles were made to play a prominent part (Apocryphal Acts of the Apostles). In Rome Leo the Great was the first who took energetic measures, along with the state authorities, against the system. Valentinian III decreed banishment against its adherents. Justinian the punishment of death. In north Africa hlanichaeism appears to have been extinguished by the persecution of the Vandals. But it still continued to exist elsewhere, both in the Byzantine empire and in the west, and in the earlier part of the middle ages it gave an impulse to the formation of new sects, which remained related to it. It is at least undoubted that the Paulicians and Bogomils, as well as the Catharists and the Albigenses, are to be traced back to Manichaeism (and Marcionitism). Thus the system. not indeed of Mani the Persian, but of Manichaeism as modified by Christian influences, accompanied Catholicism until the 13th century.

Sources.—(a) Oriental. Among the sources for a history of Manichaeism the most important are the Oriental. Of these the Moslem sources, though of comparatively late date, are distinguished by the excellent manner in which they have been transmitted to us, as well as by their impartiality. They must be named first, because ancient Manichaean writings have been used in their construction. At the head of all stands En-Nedim, author of the *Fihrist* or "Catalogue" (c. 980) containing an account of hlanichaeism which has been published separately with translstion and notes by G. Flügel, Mani, seine *Lehre* u. seine *Schriften* (1862).

Of the Christian Orientals those that afford most information are Ephraem Syrus (d. 373), in various writings; the Armenian Esnik (German translation by J. M. Schmid. 1900 see also *Zeitsch. f. hist.* Theol., 1840, ii.; Langlois, Collection, ii. 375 seq.), who wrote in the 5th century against Marcion and Mani; and the Alexandrian patriarch Eutychius (d. 916), Annales, ed. Pococke (1628). There are, besides, scattered pieces of information in Aphraates (4th cent.), Bar-Hebraeus (13th cent.) and others. The newly found Syriac *Book of Scholia* of Theodor bar Khouni (*see* Pognon, *Les Coupes de Kouabir*, Paris, 1898) gives many details about Mani's teaching (also ed. without translation by Dr. M. Lewin, Berlin, 1905).

(b) Greek and Latin. The earliest mention of the Manichaeans in the Graeco-Roman Empire is to be found in an edict of Diocletian (*see* Hanel, *Cod. Gregor.*, tit. xv.), which is held by some to be spurious, while others assign it to one or other of the years 287, *290*, *296*, 308 (so Mason, *The Persec. of Diocl.*, pp. 275 *seq.*). Eusebius gives a short account of the sect (H. E., vii. 31). It was the *Acta Archelai*, however, that became the principal source on the subject of Manichaeism for Greek and Roman writers. In the form in which we now possess them, they are a compilation after the pattern of the *Clementine Homilies*, and have been subjected to manifold redactions, and give an account of Manichaeism which is largely legendary. These *Acta* were used by Cyril of Jerusalem (*Catech.* 6), Epiphanius (*Haer.* 66), and a great number of other writers. Important matter is to be found in the resolutions of the councils from the 4th century onwards (*see* Mansi, *Acta concil.*, and Hefele, *Conciliengeschichte*, vols. i.–iii.), and also in the controversial writings of Titus of Bostra (6th century), Πρὸς Μανιχαίους (ed. Lagarde, 1859), and of Alexander of Lycopolis Λόγος πρὸς τὰς Μανιχαίου δόξας (ed. Combefis; transl. in *Ante-Nic. Lib.*, vol. xiv.). Of the Byzantines, the most worthy of mention are John of Damascus (De *haeres.* and *Dialog.*) and Photius (*cod.* 179 *Biblioth.*).

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MANICURING is the art of treating the nails of the hands to protect and improve their health and to beautify them according to the current standards of fashion. In the days of Salome and Cleopatra, women stained their nails with henna, and this vogue persists among some primitive peoples to-day. Under the social régime of the Chinese Empire, finger nails worn several inches long, and covered with gold cases, were a symbol of the aristocracy who did not have to work with their hands. The present mode is to shape the nails like the finger-ends and pink them to emphasize or suggest their healthy colour.

These rules, almost the same as those for a professional manicure, should be followed in the home manicure:

The nails should be thoroughly cleaned with a nail brush and warm soap suds. They should then be filed and shaped. Extreme points or blunt nails are not natural or in good taste. The tip of the nail should conform to the curved shape of the cuticle at the base of the nail, when this is normal.

When the filing is completed, immerse the fingers in soapy water for about three minutes to soften the cuticle. Then use a cuticle solvent with an orangewood stick (the end of which has been wrapped in a bit of cotton) around the base of the nail, under the edge of the cuticle surrounding the base of the nail, and under the free edge of the nail at the tip of the finger. Gently remove the accumulated loosened cuticle with a blunt pointed cuticle knife, holding the blade of the knife flat against the cuticle at the side of the nail, and wipe off with the end of a small towel.

A little bleach may be applied under the nails to whiten them. Then rub in a little nail cream around the cuticle to nourish the nail and keep the cuticle from becoming dry and cracking or forming hang-nails. Remove any loose bits of cuticle with a nipper or manicure scissors.

If a powder polish is used, first apply a bit of nail burnish cream to the nails and then the powder. Polish each nail with a chamois-covered buffer, using long strokes from left to right until the desired gloss is secured. (D. Co.)

MANIFEST, in commercial law, a document delivered to the officer of customs by the captain of a ship before leaving port, giving a description of the shipped goods of every kind, and setting forth the marks, numbers and descriptions of the packages and the names of the consignors thereof. In England, by the Revenue Act 1884, s. 3, where goods are exported for which no bond is required, a manifest must be delivered to the officer of Customs by the master or owner of the ship within six days after the final clearance, or a declaration in lieu thereof, the penalty in default being a sum not exceeding five pounds.

The U.S. Rev. Stat., § 2807, specifically sets forth the requirements of a manifest. It should list, among other items, the ports of lading and destination, names of consignees, passengers and owners of the vessel.

MANIFOLDS. Two geometrical figures are said to be *homeomorphic* if it is possible to set them into point for point continuous correspondence with one another. To illustrate: a closed curve (of the simple sort which passes through no point more than once) is homeomorphic with the circumference of a circle; the surface of a sphere is homeomorphic with the surface of an ellipsoid or of a cube, but not with a ring shaped surface such as a torus (fig. 1). The *topological* properties of a figure F are those which are shared by all figures homeomorphic with F. For instance, one of the topological properties of a line segment is its separability into two pieces by the removal of just one of its points; a non-topological property of the segment is its length. *Analysis Situs* (*q.v.*), or *Topology*, is the theory of the topological properties of figures. Theorems of analysis situs are very general in character and often synthesize results originally obtained in widely separated fields of mathematics.

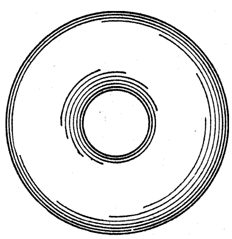

FIG. 1

n-Dimensional Manifolds.—The theory of functions of several variables leads directly to the study of a special class of figures called n-dimensional manifolds. These figures are hard to define with precision in non technical terms. We may say that a *one-dimensional manifold* is *a* simple, closed curve, a *two-dimensional manifold* a closed surface without singularities and, broadly speaking, an *n-dimensional manifold* the generalization to n dimensions of a closed curve or surface without singularities. One of the important outstanding problems of analysis situs is to classify higher dimensional manifolds into *types* such that two manifolds are of the same type if, and only if, they are homeomorphic. Up to the present, a complete classification has been carried out only for manifolds of dimensions one and two. The case $n=1$ is trivial: all one-dimensional manifolds are of the same type since every simple, closed curve is homeomorphic with the circumference of **a** circle. We shall outline below the results of the classification for the case $n=2$.

Mobius Strip.—First, it will be necessary to call attention to a rather curiously shaped surface known as a *Möbius* strip. This surface may be obtained by taking a plane rectangular region $ABCD$, where A and C denote diagonally opposite points, and deforming the region in three dimensional space so as to bring the point A into contact with the point C and the edge AB into contact with the edge CD. The resulting strip will be a belt-shaped surface with a twist in it (fig. 2). It obviously differs in type from an ordinary belt-shaped surface without the twist, since its boundary consists of a single curve, whereas the boundary of the untwisted surface consists of a pair of curves.

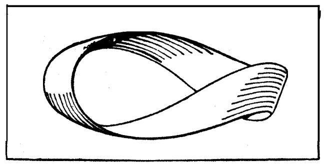

FIG. 2

A two dimensional manifold is said to be *orientable* if no **por-**

tion of it is homeomorphic with a Mobius strip; otherwise, it is said to be non orientable. The manifold is said to have the *connectivity* k if the maximum number of simple, closed curves that may be traced upon it without separating it into two or more pieces is k—1. The type of a two dimensional manifold is completely fixed when we know the connectivity of the manifold and whether or not the manifold is orientable.

A model of the most general orientable, two dimensional manifold M may be obtained by making a target out of a spherical block and shooting a suitable number of bullet holes completely through the block. The surface of the pierced block will then be homeomorphic with the manifold M. The connectivity of the manifold M is $k=2p+1$, where p is the number of bullet holes in the target; consequently. the connectivity of M is always odd in this case. The number p is called the genus of the manifold M. The sphere is of genus zero, the torus of genus one.

Genus of a Manifold.—The notion of the genus of a manifold plays an important rôle in the theory of algebraic equations of the form

$$F(x, y) = 0 \tag{1}$$

The solutions (x,y) of an irreducible algebraic equation (1) may always be represented by the points of an orientable two dimensional manifold of suitable genus p, where p is a function of the expression $F(x,y)$. Many of the properties of equation (1) depend upon the value of the number p. In Riemann's classical theory of the integrals of rational functions,

$$\int\Phi(x, y)dx, \tag{2}$$

where x and y are connected by a relation of the form (1) the genus of the manifold determined by (1) again comes into evidence. When p is zero the integral (2) is elementary, in the sense that it may be expressed in terms of rational functions and logarithms; when p is unity, the evaluation of (2) leads to the theory of elliptic functions, and so on.

A non orientable two dimensional manifold M cannot be immersed in a Euclidean space of less than four dimensions. It may, however, be represented schematically by a plane region R bounded by a suitable finite number q of non intersecting circles, where pairs of opposite points on the various bounding circles are each to be thought of as representing a single point of the manifold In four dimensional space it would be possible to reconstruct a model of the manifold M by deforming the region R in such a manner as to bring into coincidence opposite points on the bounding circles. The connectivity of the manifold M is $k=q+1$, so that, in this case, k may be any integer greater than unity. The plane of real, projective geometry (with a line of points at infinity) is a non orientable manifold of the simplest type, with k equal to two.

Combinatorial Method.—A very effective way of studying manifolds is the so-called *combinatorial* one. Consider a convex polyhedral surface in ordinary space. Regarded as a set of points, the surface is an ordinary manifold of genus zero of the same type as the sphere. But the surface may also be regarded as a collection of vertices, edges and faces. Let the number of these vertices, edges and faces be α_0, α_1, and α_2 respectively. We then find that a relation of the form

$$\alpha_0-\alpha_1+\alpha_2 = 2 \tag{3}$$

is always satisfied, irrespective of the polyhedron chosen. Now, in reality, relation (3) has an underlying topological significance. Let us use the terms *o-cell*, *1-cell* and *2-cell* to denote figures homeomorphic with the vertices, edges and faces respectively of a convex polyhedron. Then if we take any two dimensional manifold and subdivide it in a perfectly arbitrary manner into a finite number of cells we always obtain the relation

$$\alpha_0-\alpha_1+\alpha_2 = 3-k \tag{4}$$

where, this time, α_0, α_1 and α_2 denote the number of 0-, 1- and 2-cells of the subdivision respectively. Relation (3) is a special case of relation (4); where we have $k=1$, and where the cells are all straight. The number $\alpha_0-\alpha_1+\alpha_2$ is called the *Euler number* of the manifold M. In view of relation (4), a knowledge of the Euler number of a manifold is equivalent to a knowledge of the connectivity number k.

Manifolds of more than two dimensions were considered by Riemann and Betti, but Poincaré was the real founder of the higher dimensional theory. Poincaré extended to n dimensions the combinatorial method of cellular subdivision described above and discovered a number of new topological invariants. Of these last, the most important ones are his "Betti numbers" $P_1, P_2, \ldots, P_{n-1}$ which are generalizations of the connectivity number k. The Betti numbers satisfy a duality relation

$$P_i = P_{n-i}, \quad (i = 1, 2, \ldots, n-1)$$

and a generalized Euler

$$\sum_{i=0}^{n}(-1)^i\alpha_i = 1+\sum_{i=1}^{n-1}(-1)^iP_i+(-1)^n$$

which reduces to (4) in the two dimensional case. Alexander has shown that the invariants of Poincaré are insufficient to fix the type of a higher dimensional manifold, and has found further invariants which appear, also, to be insufficient. Heegaard has studied the theory of three dimensional manifolds by a somewhat different method which would, no doubt, bear further exploitation.

An important class of problems has to do with the possible types of continuous transformations of a manifold into itself. and with the existence of points left invariant by these transformations. Brouwer has studied the transformations of a sphere of n dimensions and has shown, in particular, that a one-to-one sense preserving transformation of a two dimensional sphere always leaves at least one point invariant. Lefschetz has obtained a very general theorem about the fixed points of an arbitrary transformation of an arbitrary n-dimensional manifold. Morse, Nielsen and others have made noteworthy contributions to the theory. Numerous applications are to be found for this branch of analysis situs. For example, to take a very simple case, the so-called fundamental theorem of algebra to the effect that every algebraic equation

$$F(x) = 0$$

has a root obviously reduces to the theorem that the transformation

$$y = x+F(x)$$

has a fixed point. Birkhoff and Kellogg have proved that extremely general systems of differential and integral equations admit solutions by studying the transformations of a sphere of infinitely many dimensions. (*See* also KNOTS; TOPOLOGY.)

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(J. W. A.)

MANIHIKI (MANAHIKI), a scattered part of the Cook islands in the central Pacific ocean, between 4° and 11° S., and 150° and 162° W. It includes Caroline island, Vostok and Flint to the east; Suvorov, Manihiki or Humphrey. and Tongareva or Penrhyn to the west; and Starbuck and Malden to the north. Nearly all are coral atolls of small land area. There are pearl and pearl-shell fisheries at Tongareva and Suvorov; other products are copra and guano. The inhabitants are Polynesians The islands were mostly discovered early in the 19th century and were annexed by Great Britain mainly in 1888–89. They are administered by New Zealand.

MANIHOT: *see* CASSAVA.

MANILA, the premier city of the Philippines in almost all respects. It is the chief port, the major trade centre. the leading manufacturing area and the focus of political and intellectual activity of the islands. Its northeastern suburb, Quezon City, is the official national capital but Manila handles many functions of government.

Manila has grown rapidly to a 1960 population of 1,145,723 (1948 census 983,906). About 80,000 Chinese, 4,000 U.S. citizens, 2,000 Spanish and a few hundred nationals from each of several other countries give the city an international aspect.

Geography and Topography. — Manila is about 1,500 mi. from Singapore and 1,400 mi. from Nagasaki. The city lies on the eastern shore of Manila bay (*q.v.*). To the north Mt. Arayat, a sacred mountain to the early Malays, is visible from the bay; to the west are the Mariveles mountains, and to the east the terrain rises to Laguna de Bay, a large lake from which the Pasig river issues to bisect the city. Various tidewater creeks find their way through Manila, connecting with the river or directly with the bav.

The modern Manila metropolitan area includes the chartered cities of Manila, Pasay City, Quezon City and 13 separate municipalities. Urban subdivisions reach out into Rizal province, overlapping a number of rural towns, villages and barrios in which truck gardening, poultry raising and a few rice fields still are found. Northeast of Manila is the suburb and national capital of Quezon City (*q.v.*) to which the University of the Philippines was moved. On the south is the smaller area of Pasay City.

Each of the 13 municipalities that serve as administrative centres for the political districts around Manila forms an older core of urban settlement around which new subdivisions in modern style were built. On the north, along the bay, lie Navotas and Malabon, with Caloocan inland. On the northeast, just beyond Quezon City. is San Mateo. To the east, south of Quezon City, are Marikina, San Juan del Monte and Mandaluyong. On the southeast lie San Pedro Makati, Pasig, Pateros and Tagig, and on the south, beyond Pasay City, are Paranaque and Las Pinas. Outward from the city core run main highways to the north, east and south; and thousands of persons who work daily in the urban area commute distances up to 20 mi.

Local names are applied to districts that are not formal political units, such as Diliman district, where the University of the Philippines is located, Wack Wack, where a country club was established, and Santa Mesa. Grace Park, Rosario Heights and Balintawak, chiefly residential subdivisions.

As there are three Romes so there are three Manilas. There is the native Malay element indicated by pile-built houses of nipa palm thatch and bamboo thickly packed together along narrow streets and tidal creeks. There are the bits and pieces of Spanish medieval, reduced to remnants during World War II. Finally there is the Americanized modern element in the city (sometimes clearly of U.S. origin and sometimes a subtle blend of American, Malay and Spanish) indicated by public buildings, docks and warehouses, bridges, wide streets crammed with automobiles, the newer hotels, apartment houses, private houses built in contemporary U.S. styles, the country clubs and the airports.

The city of Manila proper is divided into 14 districts of unequal size, population and appearance. The most populous district is Tondo; north of the Pasig river and fronting the bay, it is still largely a native Malay zone. San Nicolas, Binondo, Santa Cruz, San Miguel and Quiapo, just north of the Pasig, are the heart of old Manila and of the business district, with Chinese stores, embroidery shops, banks, shipping offices, theatres and the Escolta— the famous business street — plus a tightly jammed residential zone.

Just out of the retail district, along the Pasig in San Miguel, is the Malacaiian palace, formerly the residence of Spanish and U.S. governors and later the home of the Philippine president. To the east Sampaloc, the largest district and formerly a native residential area, gradually became largely a business section.

Four bridges cross the Pasig river within the main part of the city, offering access to the seven southern districts'. On the bay front is the Port Area, a result of U.S. dredging of the harbour and construction of docks and warehouses. Although it was later dwarfed by a larger port district north of the Pasig, between San Nicolas, Tondo and the bay, most of the companies and government offices dealing in shipping services remained in the Port Area.

Just inland from this is the old walled city of Spanish times, the Intramuros, with its 20-ft. walls stretching for two and one-half miles. About 1905 the old moat was filled and much of the space outside the wall was converted into gardens, playgrounds and a golf course. By the end of World War II only the church of St. Augustine was left intact within the Intramuros. South of the Port Area and the Intramuros lie Burnham Green, the Luneta and Wallace field, Manila's "common." Southward along the bay, Dewey boulevard and Taft avenue lead through the older residential zones, where many government bureaus, the general hospital and other institutions were established.

Ermita and Malate, the two districts involved, remained choice residential area;, and large houses and apartment houses were rebuilt there after World War II. Inland lie the chiefly middle-class

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SAINT AUGUSTINE CHURCH. BUILT IN THE **16TH** CENTURY. WAS THE ONLY CHURCH INSIDE **INTRAMUROS** NOT DESTROYED DURING WORLD WAR II

residential areas of Paco, Pandacan and Santa Ana.

Climate. — The climate of Manila is similar to that of lowlands along the Philippine west coasts, having two pronounced seasons in rainfall but only mild seasonality in temperature. Weather is normally dry during January through April and rainy the rest of the year, particularly from June through October. July, normally the rainiest month, has high humidity and frequent thundershowers —24 rainy days as opposed to 3 rainy days in February. The annual total of 159 rainy days produces an average of 81.52 in., but annual variation is marked, ranging from 35.69 in. in 1885 to 154.35 in. in 1919. In temperature March through June is the warmest period, with May having a monthly mean of 83.4"; November through February is the cooler period, January having a monthly mean of 76.8°.

History. — The first European settlement at Manila was established by Miguel López de Legazpi in 1571. At that time a Mohammedan rajah (Lakandola) reigned in Tondo. Manila became the capital and Lagazpi the first governor of the Philippines. The islands were placed under the viceroy of New Spain in Mexico City, and official communication between the two widely separated areas was maintained by a galleon which plied annually between Acapulco and Manila. Trade of considerable proportions was developed.

Accompanying Legazpi to the islands was an Augustinian friar, Urdaneta, with others of that order, some of whom went on to Manila. In 1577 arrived Franciscans, who were followed by Dominicans, Jesuits and Augustinian Recollectos. These orders founded convents, churches and schools and became very powerful in the government. In 1580 the first and only Roman Catholic bishop of Manila arrived in the person of Domingo de Salazar, a Dominican; but in 1595 the diocese was raised to a metropolitan see. and Ignacio Santibañez became the first of a long line of Spanish archbishops which ended with Nozaleda about 1900. In 1583 an *audiencia* (supreme court) was established. Abolished later, it was re-established in 1558 and continued as a Spanish institution for three centuries. The Spanish law was applied in those portions of the archipelago actually ruled by Spain; but the Spanish civil code came into force there only in 1889.

In the 17th century Spain warred with the Dutch and Moros, and Manila was menaced repeatedly. In 1762. the city was captured by British forces under Gen. William Draper and Adm. Samuel Cornish, who held it until 1764, the treaty of Paris (1763) having restored it to Spain. The 19th century was marked by some signs of progress. In 1825 Russell and Sturgis of Boston opened a branch of their Canton mercantile house—the first U.S. enterprise in the Philippines—and in 1837 the city was opened generally to foreign trade.

On the completion of the Suez canal a generation later, direct means of communication with Europe were provided and commerce accordingly was stimulated. The first Masonic lodge was founded at Cavite, near Manila, in 1856, and the Katipunan, a revolutionary society, borrowing some of its features from Masonry but never sanctioned by the Filipino nationalist leader José Rizal y Mercado, acquired a large following. The execution of Rizal on Dec. 30, 1896, was the signal for the outbreak of revolution, and the Spanish-American War brought Commodore George Dewey and his U.S. fleet, which destroyed the Spanish fleet at Cavite on May 1, 1898. Manila surrendered to the United States forces on Aug. 13, and for nearly 44 years the U.S. flag floated continuously over the city. The Japanese invasion on Dec. 8, 1941 (Philippine time), and Japanese occupation of the city on Jan. 2, 1942, was its fourth capture by a foreign power.

Liberation of greater Manila from Japanese control was accomplished by the end of Feb. 1945, and reconstruction began throughout the city, which had suffered greatly from war devastation. A significant change in the appearance of the city was brought about by its rapid industrialization; from 1950 to 1956 industrial capacity of the area increased 50%. In order to accommodate the expanding population many private houses and older two-story constructions were replaced with apartment buildings. The historic Intramuros area was cleared of debris and a reconstruction scheme was proposed in the early 1960s. The rehabilitation program in Manila, as throughout the Philippines, was assisted by war damage payments by the U.S.; see PHILIPPINES, REPUBLIC OF THE.

(C. S. L.; J. E. SR.; R. E. HE.)

Educational and Religious Institutions.— Most of the early schools and churches in the islands were founded in Manila by religious orders. The Dominican order founded the University of Santo Tomas in 1619 and the Collegio de San Juan de Letran in 1640. As early as 1601 the Jesuit order founded the Collegio de San José, and in 1859, after the order returned to the islands, it established the Escuela Municipal, which later became the Ateneo de Manila. The Augustinians (the original order and the Augustinian Recollectos) also have churches and convents.

The Protestant churches generally supported the public schools; a union theological school—Ellinwood seminary—was established for the training of Protestant ministers. The imposing Episcopal cathedral of St. Mary and St. John is located in Ermita, as is the Union (formerly Presbyterian) church.

There are a number of private technical schools, colleges and universities in greater Manila. Of these, the Far Eastern university was the largest in the second half of the 20th century. At the apex of the public school system are three national institutions, the Philippine Normal college, the Philippine College of Commerce and the University of the Philippines, in the Diliman district of Quezon City.

Administration.— Under Spain the city formed part of a province of the same name, which was abolished by the U S. government after about three years of military rule. On July 31, 1901, by an act of the Philippine commission, Manila became the first of the Philippine chartered cities; other municipalities of the old province became part of the new province of Rizal. The so-called administrative code of 1917, amended in 1921, provided for a mayor appointed by the governor general (later by the commonwealth president) and confirmed by the senate, and a municipal board of ten members elected at large and serving for three years. Administrative departments were: engineering and public works, police, law, fire, finance. assessment, health and welfare.

On gaining independence in 1946, the Philippine government made the officeof mayor in all chartered cities and municipalities elective, though the Philippine president exercised executive authority thereafter with regard to various of the chartered cities. There also are elective councils for each of the chartered cities. Because the national government's seat is in Manila and Quezon City, none of the cities and municipalities in greater Manila operates with complete autonomy; all are peculiarly subject to controls and influence from congress and the executive department.

Trade and Industry.— Greater Manila is by far the most important manufacturing center in the islands, having about one-half of the assets, one-quarter of the value of production and one-third of the persons engaged in manufacturing in the country. Growth in and around Manila continued to be rapid after World War II. The circumferential highway around the city was a particular focus of development during the late 1950s. Manufacturing in the city includes textiles and clothing, food and beverage processing, fish canning, vegetable oil pressing, lumber veneer and plywood manufacture, production of chemicals and drugs, leather tanning and manufacturing, light metal fabrication and shipbuilding. Manila is the heart of most service facilities in the islands, the nerve centre of financial and political activity, and the centre of educational and medical facilities. About one-half of all professional persons in the country live in greater Manila. See also Index references under "Manila" in the Index volume. (J. E SR.; R. E. HE.)

MANILA BAY, an almost completely landlocked bay extending into the Philippine island of Luzon from the South China sea. Its widest diameter from northwest to southeast measures 36 mi. and from Corregidor Island to the piers in Manila harbour is 30 mi. The bay has two entrances, one on either side of Corregidor (*q.v.*); the seldom used South channel is 6 mi. wide while the busy and safer North channel between Corregidor and Bataan peninsula is only 2 mi. wide. The north and northeast shore of Manila bay adjoins the central plain of Luzon. In this section the bay is shallow and lined by mud flats and mangrove; here are located the most extensive commercial fish ponds in the Philippines. The major part of the bay is between 30 and 120 ft. in depth; it has only a moderate tidal range and provides good to excellent anchorage. Manila harbour at the easternmost part of the bay is divided into two sections, North harbour for interisland ships and South harbour for international shipping; both have excellent docking facilities. Sangley Point, a U.S. naval reservation near Cavite city on the southeast shore, provides servicing for naval vessels. Bolanga on the western shore is home base for a small fishing fleet. In 1574 the Chinese pirate Lim-Ah-Hong sailed into Manila bay but was repulsed by Spanish forces. The bay was the western terminus of the Manila-Acapulco "galleon trade" between 1593 and 1815. The Spanish fleet was destroyed in the bay by a U.S. squadron under the command of Commodore George Dewey on May 1, 1898. During World War II many Philippine, American and Japanese ships were sunk at Manila, Cavite, Corregidor and several other locations by aerial bombardment. *See* WORLD WAR II: *The War in the Pacific.* (R. E. HE.)

MANILA HEMP: *see* ABACÁ FIBRE.

MANILIUS, MARCUS (fl. early 1st century A D.), Roman didactic poet, was the author of *Astronomica,* an unfinished poem on astronomy and astrology, of which five books remain. The poem consists of over 4.000 hexameters and was composed in the reigns of Augustus and Tiberius. To the reader unversed in astrological calculations the interest chiefly resides in the attractive prefaces to each book and the mythological or moralizing digressions Manilius, writing as a Stoic, stresses the providential government of the world and the operation of divine reason. His style shows indebtedness to Lucretius, Virgil and Ovid. He abuses his unparalleled facility for versifying astronomical computations and habitually substitutes the complex for the simple. Rarely read *in tòto* even by Latinists, he has been given unexpected publicity by the five brilliant volumes of A E. Housman.

BIBLIOGRAPHY —For text with an introduction, apparatus criticus, review of Manilian scholarship, full discussion of textual and palaeographical problems, elucidation of difficulties, etc , *see A.* E. Housman, *M Manilii Astronomicon, j* vol, 2nd ed. (1937) *See* also G *P* Goold, "De fonte codicum Manilianorum," *Rheinisches Museum,* vol xcvii (1954). (H. H HY.)

MANIN, DANIELE (1804–57), Venetian patriot and statesman, was born in Venice, on May 13, 1804. He was the son of a converted Jew, who took the name of Manin because that patrician family stood sponsors to him, as the custom then was. He studied law at Padua, and then practised at the bar of his native city. A man of great learning and a profound jurist, he was inspired from an early age with a deep hatred for Austria. The heroic but foolhardy attempt of the brothers Bandiera. Venetians who had served in the Austrian navy against the Neapolitan Bourbons in 1844, was the first event to cause an awakening of Venetian patriotism, and in 1847 Manin presented a petition to the Venetian congregation, a shadowy consultative assembly tolerated by Austria but without any power, informing the emperor of the wants of the nation. He was arrested on a charge of high treason (Jan. 18, 1848), but this only served to increase the agitation of the Venetians, who were beginning to know and love Manin. Two months later, when all Italy and half the rest of Europe were in the throes of revolution, the people forced Count Palffy, the Austrian governor, to release him (March 17). The Austrians soon lost all control of the city, and under the direction of Manin a civic guard and a provisional government were instituted.

The Austrians evacuated Venice on March 26, and Manin became president of the Venetian republic. He was already in favour of Italian unity, and though not anxious for annexation to Piedmont (he would have preferred to invoke French aid) he gave way to the majority, and resigned his powers to the Piedmontese commissioners on Aug. 7. But after the Piedrnontese defeats in Lombardy, and the armistice by which King Charles Albert abandoned Lombardy and Venetia to Austria, the Venetians attempted to lynch the royal commissioners, whose lives Manin saved with difficulty; an assembly was summoned, and a triumvirate formed with Manin at its head. Toward the end of 1848 the Austrians, having been heavily reinforced, reoccupied all the Venetian mainland. Early in 1349 Manin was again chosen president of the republic and conducted the defense of the city.

After the defeat of Charles Albert's forlorn hope at Novara in March the Venetian assembly voted "Resistance at all costs!" and granted Manin unlimited powers. Meanwhile the Austrian forces closed round the city; but Manin, assisted by G. Pepe, showed an astonishing power of organization. On May 26, however, the Venetians were forced to abandon Ft. Malghera, halfway between the city and the mainland; food was becoming scarce, on June 19 the powder magazine blew up and in July cholera broke out. Then the Austrian batteries began to bombard Venice itself, and when the Sardinian fleet withdrew from the Adriatic the city was also attacked by sea, while certain demagogues caused internal trouble. At last, on Aug. 24, 1849, Manin, who had courted death in vain, negotiated an honourable capitulation, on terms of amnesty to all save Manin himself, Pepe and some others, who were to go into exile.

On the 27th Manin left Venice forever on board a French ship. His wife died at Marseilles, and he himself reached Paris broken in health and almost destitute, having spent all his fortune for Venice. In Paris he became a leader among the Italian exiles. There he became a convert to monarchism, being convinced that only under the auspices of King Victor Emmanuel could Italy be freed, and together with Giorgio Pallavicini and Giuseppe La Farina he founded the *Società Nazionale Italiana* with the object of propagating the idea of unity under the Piedrnontese monarchy.

His last years were embittered by the terrible sufferings of his daughter, who died in 1854; and he himself died on Sept. 22, 1857, and was buried in Ary Scheffer's family tomb. In 1868, two years after the Austrians finally departed from Venice, his remains were brought to his native city and honoured with a public funeral.

Manin was a man of the greatest honesty and possessed genuinely statesmanlike qualities. He believed in Italian unity when most men, even Cavour, regarded it as a vain thing, and his work of propaganda by means of the National society greatly contributed to the success of the cause.

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MANING, FREDERICK EDWARD (1812–1883), New Zealand judge and author, son of Frederick Maning, of Johnville, county Dublin, was born July 5, 1812. His father emigrated to Tasmania in the ship "Ardent" in 1824 and took up a grant of land there. Young Maning served in the fatuous expedition which attempted to drive in the Tasmanian blacks by sueeping with an unbroken line of armed men across the island. Soon afterward he decided to try the life of a trader among the wild tribes of New Zealand and, landing in the inlet of Hokianga in 1833, took up his abode among the Ngapuhi. With them the tall Irish lad—he stood *6* ft. 3 in.—full of daring and good humour and as fond of fun as of fighting, quickly became a prime favourite, was adopted into the tribe, married a chief's daughter and became a "Pakeha-Maori" (foreigner turned Maori). With the profits of his trading he bought a farm of 200 ac. on the Hokianga, for which, unlike most white adventurers of the time, he paid full value. When New Zealand was peacefully annexed in 1840, Maning's advice to the Maori was against the arrangement, but from the moment of annexation he became a loyal friend to the government, and in the wars of 1845–46 his influence was exerted with effect in the settlers' favour. Again, in 1860, he persuaded the Ngapuhi to volunteer to put down the insurrection in Taranaki. From 1865 to 1881 he was a judge of the native lands court, where his unequalled knowledge of the Maori language, customs, traditions and prejudices was of solid value. He died in London on July 25, 1883. At his wish, his body was taken back to New Zealand and buried there. Maning wrote *Old New Zealand* and *History of the War in the North of New Zealand against the Chief Heké,* reprinted in London in 1876 and 1884.

MANIPLE, a liturgical vestment of the Catholic Church, proper to all orders from the subdeacon upward. It is a narrow strip of material, silk or half-silk, about a yard long, worn on the left fore-arm in such a way that the ends hang down to an equal length on either side. In order to secure it, it is sometimes tied on with strings attached underneath, sometimes provided with a hole in the lining through which the arm is passed. It is ornamented with three crosses, one in the centre and one at each end, that in the centre being obligatory, and is often elaborately embroidered. It is the special ensign of the office of subdeacon and at the ordination is placed on the arm of the new subdeacon by the bishop with the words: "Take the maniple, the symbol of the fruit of good works." It is strictly a "mass vestment," being worn, with certain exceptions (*e.g.,* by a deacon singing the Gospel at the service of blessing the palms), only at mass, by the celebrant and the ministers assisting.

The earliest extant specimen of the bandlike maniple is that found in the grave of St. Cuthbert (early 10th century); by the 11th century (except in the case of subdeacons, whose maniples would seem to have continued for a while to be cloths in practical use) the maniple had universally assumed its present general form and purely ceremonial character.

The maniple mas originally carried in the left hand. In pictures of the 9th, 10th and 11th centuries it is represented either as so carried or as hung over the left fore-arm. By the 12th century the rule according to which it is worn over the left arm had been universally accepted. According to present usage the maniple is put on by priests after the alb and girdle; by deacons and subdeacons after the dalmatic or tunicle; by bishops at the altar after the *Confiteor*, except at masses for the dead, when it is assumed before the stole.

In the east the maniple in its western form is known only to the Armenians, where it is peculiar to subdeacons. This vestment is not derived from the Roman rite but is properly a stole, which the subdeacons used to carry in the left hand. It is now laid over the subdeacon's left arm at ordination. The true equivalent of the maniple (in the Greek and Armenian rites only) is not. as has been assumed, the *epimanikion,* a sort of loose, embroidered cuff *(see* VESTMENTS), but the *epigonation.*

See J. Braun, S. J., *Die liturgische Gewandung* (1907), pp. 515–561, and the bibliography to VESTMENTS.

MANIPUR, a territory of the Republic of India, against that country's frontier with Upper Burma. Area 8,629 sq.mi. Pop. (1951) 577,635. Its western districts project into Assam state and are bounded on the north by the Naea country and the hills overlooking the Assam valley, on the west by Cachar district and on the south by the Lushai hills. The capital is Imphal (pop., 1951, 2,862). The state consists of the wide valley of the Manipur river. a tributary of the Chindwin, with an area of about 650 sq mi.. and a large surrounding tract of mountainous country. The hill ranges generally run north and south. with occasional connecting spurs and ridges of lower elevation between. Their greatest altitude is in the north. where they reach to more than 8,000 ft. above sea level. The principal geographical feature in the valley is the Loktak lake. over 25 sq.mi. in area, but said to be gradually growing smaller. The state is watered by numerous other rivers, the Barak in the west being the most important. The hills are densely covered with tree jungle and large forest timber. Rice and forest produce are the principal exports. The road from Imphal northward to the North-Eastern railway at Dimapur, Assam. and southeast to Tamu on the Burmese border, is the principal trade route.

Although their general facial characteristics are Mongolian, there is a great diversity of feature among the Manipuris, some of them showing a regularity approaching the Aryan type. In the valley the people are chiefly Hindus, that religion being of recent introduction. Their own name for themselves is Meithei, and their language is a branch of the Kuki-Chin family. One of their peculiarities is the high position enjoyed by women, who conduct most of the trade of the valley. The aboriginal hillmen belong to one of the two great divisions of Nagas and Kukis, and are subdivided into innumerable clans and sections. The state is noted for the excellence of its breed of ponies.

The first relations of the British with Manipur date from 1762, when the rajah solicited British aid to repel a Burmese invasion and a treaty was concluded. Little further communication took place until 1824, on the outbreak of the first Burmese War. British assistance was again invoked by the rajah, and the Burmese were finally expelled from both the Assam and the Manipur valleys. Disputed successions became a continuous cause of trouble. In 1890 a brother of the rajah. the *senapati* or commander in chief, dethroned the rajah and installed the *jubraj* or heir apparent as rajah. In 1891 the chief commissioner of Assam (James Wallace Quinton) marched to Manipur with 400 Gurkhas, in order to recognize the new ruler and remove the *senapati.* An attempt was made to arrest the *senapati,* but after some sharp fighting he escaped. The Nanipuris then attacked the British residency with an overwhelming force. An armistice having been declared, Quinton with the political resident (Frank St. Clair Grimwood) and three other officers went to the fort, under promise of safe conduct, to negotiate. They were all treacherously murdered. The attack on the residency was resumed and the defenders, thinking it untenable, retreated to Cachar, taking Mrs. Grimwood and the wounded with them. A month later a military expedition occupied Manipur. The *senapati* was captured, tried and hanged and the new rajah transported for life. It was decided to preserve the existence of the state, and a five year old child of the ruling family, named Chura Chand, was nominated rajah.

During his minority the administration was conducted under British supervision. The opportunity was seized to abolish slavery and unpaid forced labour, to open up the state by roads and to introduce other reforms. In 1907 the government of the state was handed over to the rajah and durbar, or council, with a member of the Indian civil service as vice-president. Subsequently the administration of the state was transferred to the rajah from the durbar, of which the vice-president became president.

During World War I a corps of 2,000 labourers was raised in Manipur and sent to France. When an attempt was made to raise a second corps in 1917, the Kukis broke out in rebellion, which was not suppressed until the cold weather of 1918–19 by a large force of Assam Rifles and Burma military police.

A new system of administration was adopted after this, three subdivisions being established, each under an officer lent by the Assam government. After the accession of the state to India (Aug. 15, 1947) the political agency exercised by Assam was abolished; on Oct. 1j, 1949, the administration was taken over by the Indian government and effected through a chief commissioner.

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MANISA (anc. *Magnesia* **ad** *Sipylum*), the chief town of the Manisa *vilayet* (province) in Turkey, situated in the valley of the Gediz Chai (Hermus). at the foot of Mt. Sipylus, and connected by railway with Smyrna and Afium Kara-Hissar. Population (1955) 45,484. Manisa is an important commercial centre, and contains interesting buildings dating from the times of the Seljuk and early Osmanli sultans, including mosques built by Murad II and III and a Mevlevi *Tekke* second only to that at Konia.

In 1204 Manisa mas occupied by John Ducas, who when he became emperor made it the Byzantine seat of government. In 1305, Roger de Flor besieged it unsuccessfully. In 1313 the town was taken by Saru Khan and became the capital of the Turcoman emirate of that name. In 1398 it submitted to the Osmanli sultan Bayezid I, and in 1402 was made a treasure city by Timur. In 1419 it was the scene of the insurrection of Bedr ed-Din, which was crushed by Prince Murad, residing in the town as Murad II. In the 17th century Manisa became the residence of the greatest of the Dere Bey families, Kara Osman Oglu, Turcoman in origin, and possibly connected with the former emirs of Sarukhan, which seems to have risen to power by farming the taxes of a province which princes of the house of Othman had often governed and regarded with especial affection. The *liva* of Sarukhan was one of the 22 in the Ottoman empire leased on a life tenure up to the time of Mahmud II.

In the 18th century the family of Kara Osman Oglu (or Karasman) ruled *de facto* all west central Anatolia, one member being lord of Bergama and another of Aidin, while the head of the house held Manisa with all the Hermus valley and had greater power in Smyrna than the representative of the capitan pasha in whose province that city nominally lay. Outside their own fiefs the family had so much property that it was commonly said they could sleep in a house of their own at any stage from Smyrna to Baghdad. The last of its great beys was Haji Hussein Zade, who was frequently called in to Smyrna on the petition of his friends, the European merchants, to assure tranquillity in the troublous times consequent on Napoleon's invasion of Egypt and the British and Russian attacks on the Porte early in the 19th century. He always acquitted himself well; but, since he refused to bring his contingent to the grand vizier when on the march to Egypt in 1798 and awakened the jealousy of the capitan pasha, he was in continual danger. Exiled in 1812, he was subsequently restored to Manisa. and died there in 1821. His son succeeded after sanguinary tumults; but Mahmud II. who had long marked the family for destruction, was so hostile toward it, after he had disposed of the janissaries, that it had lost al! but the shadow of power by 1830. Descendants survived in Manisa who retained a special right of granting title deeds within the district, independent of the local administration.

MANISTIQUE, city and seat of Schoolcraft county in the Upper Peninsula of Michigan, U.S., lies at the mouth of the Manistique river on the north shore of Lake Michigan about 40 mi. N.E. of Escanaba. It was incorporated as a village in 1885, chartered as a city in 1901, and adopted a city-manager form of local government in 1926. Manistique originated as a lumbering centre, and much of its pine went to help build many midnestern cities, including Chicago. Its natural harbour. kept relatively ice free by the swift current of the Manistique river, makes it an important commercial fishing port Wood and paper products are among its principal manufactures. The area is rich in Indian folk-lore, and sites include the allegedly haunted Big Spring or Kitchitikipi in the woods adjoining Indian lake (5 mi. W.), said to have been worshipped by the Chippewa tribe. (B. L. F.)

MANITO (MANITOU or MANITU), a term for supernatural power used by the Algonkian-speaking Indians of eastern North America. Generally it was attributed to various deities and nature spirits, who might become protectors or guardians as well as causing ill-fortune. In some tribes the manito was personified as the supreme deity, perhaps as a result of Christian teachings. (F. R. E.)

MANITOBA, a province of Canada, situated midway across the North American continent. Area 251,000 sq.mi., of which 39,225 sq.mi. are fresh water. Although known as one of the three "prairie" provinces (with Saskatchewan and Alberta), Manitoba possesses great diversity and only a small portion is treeless prairie. The remainder consists of parkland, forest interspersed with lakes, and subarctic tundra, and the province has 400 mi. of coast on Hudson bay. It is bounded by the U.S. on the south, Saskatchewan on the west, Mackenzie District on the north, and Ontario on the east. The whole of the province falls within the central time zone, which is six hours behind Greenwich time.

Geology and Physiography. — The Pre-Cambrian shield (see map), covering three-fifths of the province, is made up of ancient rocks (gneisses, granites, etc.); it forms hilly broken ice-worn country with numerous lakes, and is drained noriheast to Hudson bay by the Seal, Churchill and Nelson rivers. The Hudson bay lowland, the land sloping down from the shield to the sea, is built of horizontal Palaeozoic limestones. The Manitoba lowland, southwest of the shield, is a basin that once held the great glacial lake known as Lake Agassiz. The several large lakes found in this lowland today are its remains and include some of the largest lakes in Canada: Lake Winnipeg (9,094 sq.mi.), Lake Winnipegosis (2,086 sq.mi.), Lake Manitoba (*qq.v.*) (1,817 sq.mi.), Cedar lake (537 sq.mi.) and Moose lake (525 sq.mi.). The Red river valley forms the southern part of the lowland and its fertile soils derive from the lacustrine clays deposited there by Lake Agassiz. The Manitoba escarpment (or cuesta) terminates the lowland on its southwest side; this feature has been broken up by rivers (of which the Assiniboine is the chief) into hilly areas known as the Porcupine, Duck and Riding mountains. The Saskatchewan plain, composed of Cretaceous shales with a covering of glacial boulder clays and lacustrine clays, extends westward from the escarpment into Saskatchewan.

Climate. — The climate is extreme or continental, with very cold winters and warm summers. In winter the temperature may fall to $-40°$ F. and below in all parts of the province. The average minimum January temperature is $-13°$ at Winnipeg and $-27°$ at Churchill. The average maximum January temperature is $7°$ at Winnipeg and $-11°$ at Churchill. Sudden changes of temperature of up to $40°$ may occur within 24 hours in winter. Spring is a brief season in which temperatures rise rapidly in May after the April thaw. June, on the average, is about $25°$ warmer than April.

Summer temperatures often exceed $90°$ F. and occasionally reach $100°$ in the south, but nights are relatively cool. The average minimum July temperature at Winnipeg is $55°$, at Churchill $43°$; the average maximum July temperature is $79°$ at Winnipeg and $64°$ at Churchill. Violent electrical storms accompanied by heavy rain and often hail occur in summer. Autumn often has prolonged periods of dry sunny weather with mild days and frosty nights. Annual precipitation, occurring mostly in the suinmer months, ranges from 15 in. in the north and west to 20 in. in the south and east. Most of the province receives over 2,000 hours of sunshine a year.

Vegetation and Animal Life. — Except for a belt cf barren tundra along the Hudson bay shore and a small area of prairie along the U.S. border in the south, the natural vegetation of Manitoba is forest. North of the prairie comes an open parkland with such trees as the aspen, Manitoba maple, elm and bur oak. This gives way to a mixed forest, where coniferous species are found along with deciduous trees. Next, beginning at the southern edge of the Canadian shield, comes the full development of northern coniferous forest with spruce, larch, pine and fir. This degenerates northward into subarctic forest where the trees become smaller and fewer until open tundra is reached.

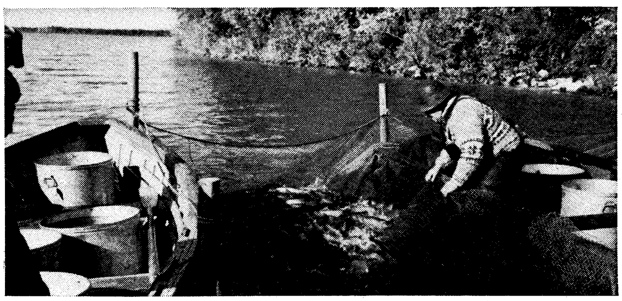
The bison, antelope and elk, which flourished on the prairie before the white man came, have vanished. The principal prairie animals are gophers, badgers, coyotes and jack rabbits, and among the birds are prairie chicken, grouse, gull, and mallard and black duck. In the forests, the black bear, moose, timber wolf, fox, otter, skunk, marten, mink and weasel may be found. along with such rodents as the squirrel and beaver. A variety of fish inhabit the lakes (see ***Fishing,*** below).

History. — Southern Manitoba was inhabited by Blackfoot. Sarcee, Assiniboine and Ojibwa (Chippewa) Indians, with Eskimos farther north along the shores of Hudson bay. The first white man to enter the territory was probably Sir Thomas Button, who entered the Nelson river in 1612; seven years later two Danish ships wintered at the mouth of the Churchill. After its foundation in 1670, the Hudson's Bay company began to build forts in the area, the chief of which was York Factory at the mouth of the Nelson. From here, in 1691–92 Henry Kelsey explored parts of the province in the direction of the Saskatchewan river. In 1717 a wooden fort, Fort Prince of Wales, was built at the mouth of the Churchill; this was rebuilt in stone (1731–76).

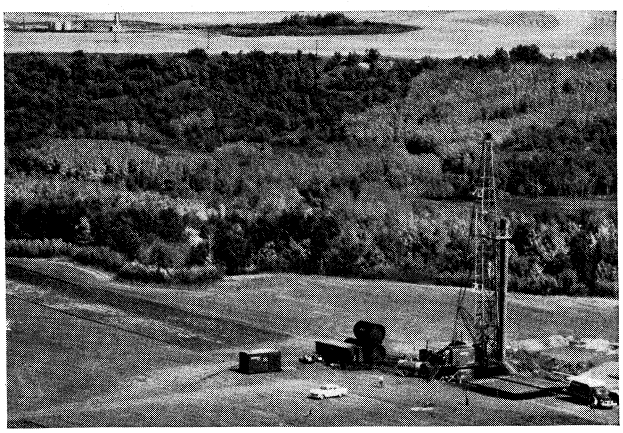
Throughout the 18th century the area was affected by the Anglo-French feud. The Hudson bay region was recognized as British by the treaty of Utrecht in 1713, but the French entered Manitoba' from the east. In 1731 La Vérendrye crossed southern Manitoba and in 1738 the French built Fort Rouge at the future site of Winnipeg. After the British conquest of Canada this rivalry was continued by the Hudson's Bay company, operating southward from York Factory, and the Northwest company of Montreal, the successor of the French fur traders. The routes from the north and the east met at "the Forks" or junction of the Red and Assiniboine rivers (Winnipeg). There the Northwest company built Fort Gibraltar (1804). It was in this disputed area that Lord Selkirk, in 1812, began the first agricultural settlement on the Red river (see RED RIVER SETTLEMENT). A struggle ensued in which the Northwest company destroyed the colony and the Hudson's Bay company destroyed Fort Gibraltar. Yet colonists still arrived, despite the harsh journey by way of Hudson bay. Numerous half-breeds (métis) swarmed around the colony and trading post. In 1821 the rival companies amalgamated and a new fort, Fort Garry, was built, first of wood, but later, in 1836–39, of stone. The whole territory was then under the jurisdiction of the Hudson's Bay company.

In 1867 the Red river colonies became linked by steam navigation with the westward development of settlement and railways in the United States. and settlers began to pour into the region from the south; they came from eastern Canada, the British Isles and continental Europe. In 1869 the newly formed Dominion of Canada acquired the territory from the Hudson's Bay company, and in the unsuccessful Riel rebellion of that year the métis took up arms against the new order. In 1870 the province of Manitoba was

Harvesting wheat near Portage la Prairie. Grown chiefly in the southern part of the province, wheat is Manitoba's most important field crop



Commercial fishermen netting a catch from one of Manitoba's many lakes. Only Alberta outranks Manitoba in the development and value of its inland fisheries



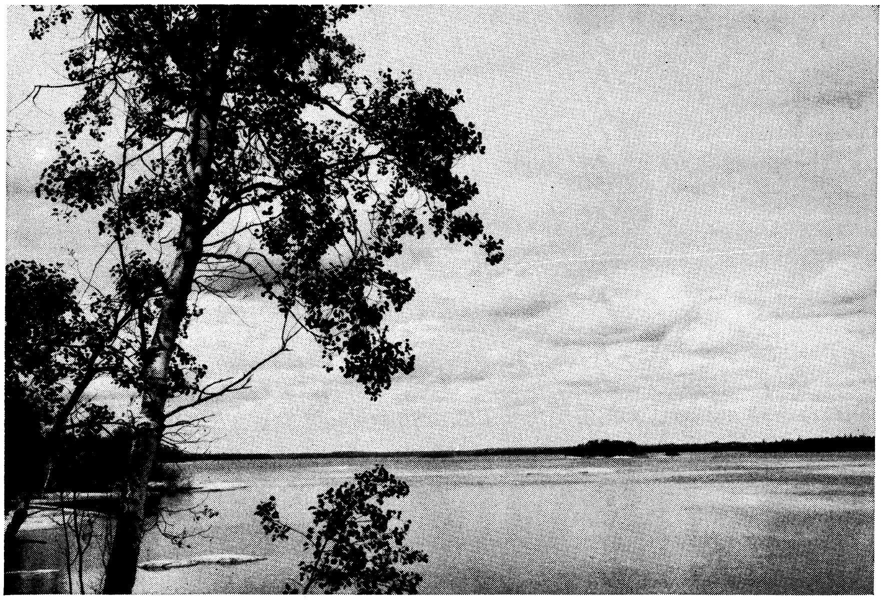
Oil derrick in the plains region of southwestern Manitoba. Although not commercially produced until after World War II, petroleum became the most valuable mineral industry of the province

View of the business district of Winnipeg, capital of Manitoba and fourth largest city of Canada. In foreground is the Red river

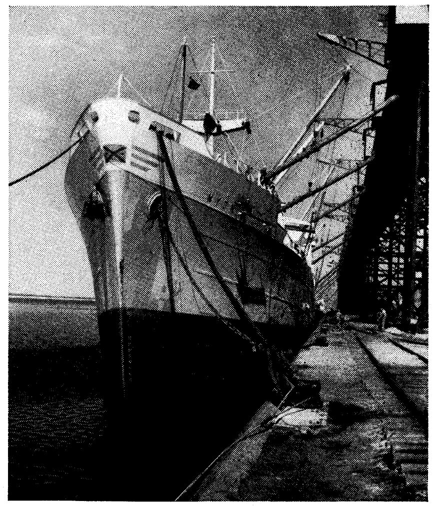
SCENES IN MANITOBA

BY COURTESY OF (CENTRE LEFT, BOTTOM LEFT, BOTTOM RIGHT) PROVINCE OF MANITOBA. DEPARTMENT OF INDUSTRY AND COMMERCE; PHOTOGRAPH, (TOP) HUNTING SURVEY CORP., LTD.

MANITOBA



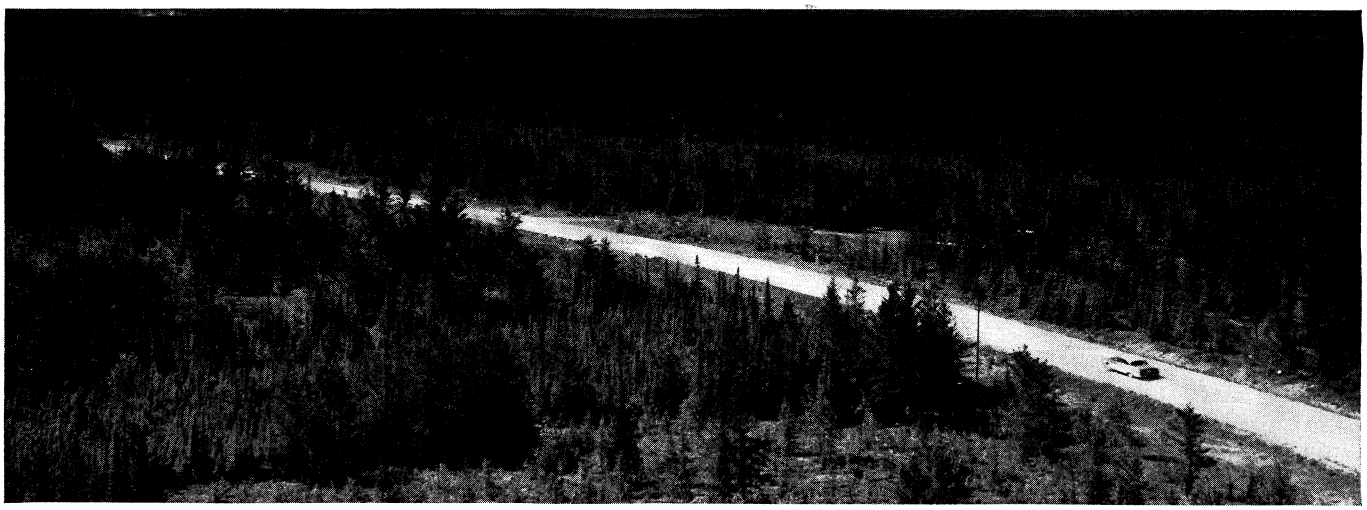
View along the Winnipeg river in the Whiteshell forest and game reserve near the Ontario border. Once a route used by explorers and trappers, the river now supplies most of the hydroelectric power of Manitoba



Ocean-going freighter tied up at Churchill, chief seaport of Manitoba, on Hudson bay. Wheat is the major item of export

Freight yards at Winnipeg, among the largest in the world. Its central location made Winnipeg the principal rail and air centre of western Canada

Miners preparing to drill into ore face in one of the pits at Flin Flon, the chief mining and smelting centre of Manitoba



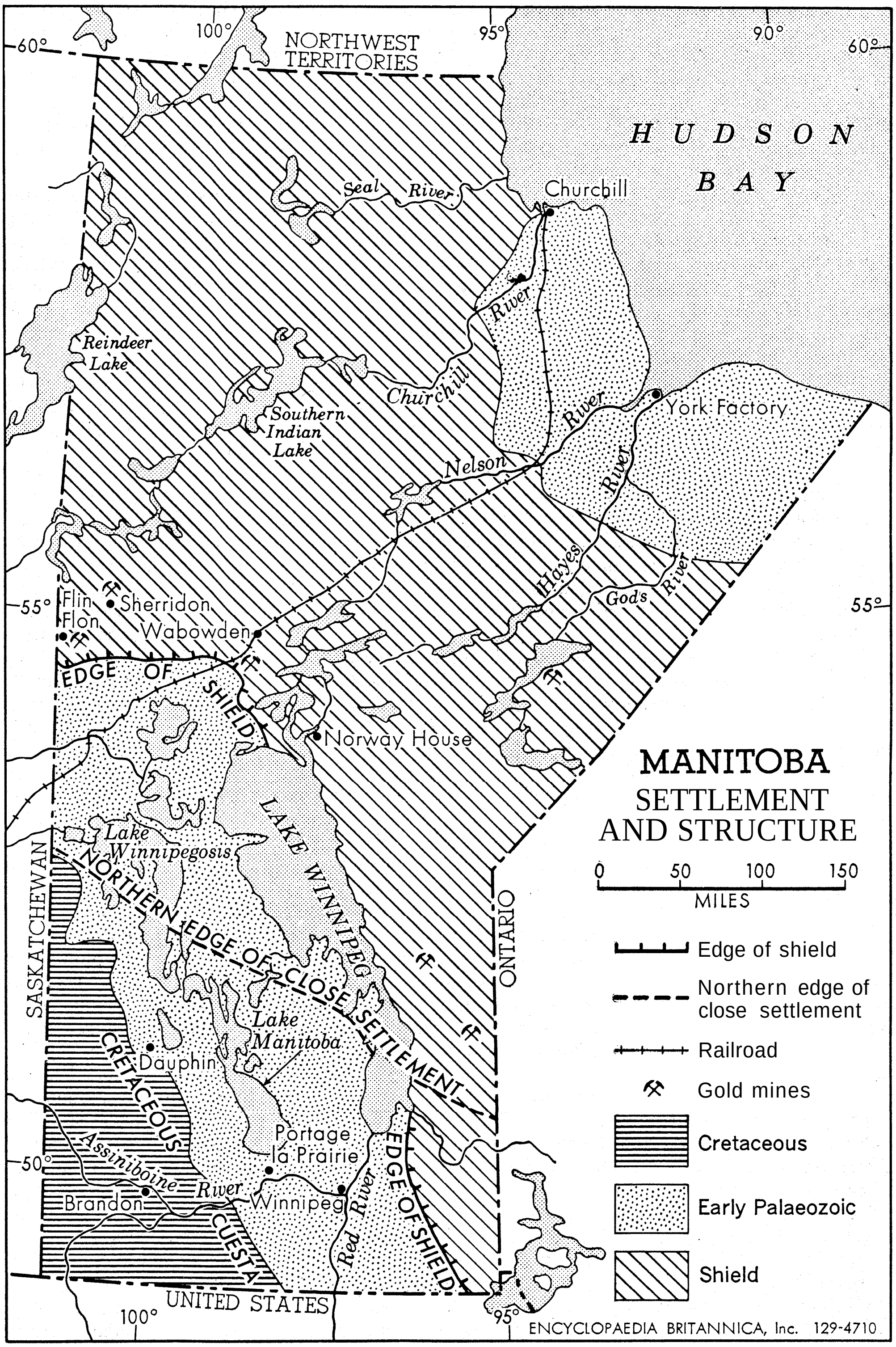
Highway through the forest region of northern Manitoba. Only small sections in the east have been cut over for paper and pulp. The remainder is virgin timber, and the area is largely unpopulated

TRANSPORTATION AND INDUSTRY

BY COURTESY OF (TOP LEFT) MANITOBA TRAVEL AND PUBLICITY BUREAU, (TOP RIGHT, BOTTOM) PROVINCE OF MANITOBA, DEPARTMENT OF INDUSTRY AND COMMERCE, (CENTRE RIGHT) CANADIAN CONSULATE GENERAL, CHICAGO: PHOTOGRAPH, (CENTRE LEFT) KARSH OF OTTAWA FROM PUBLIX set up and entered the federation. The town of Winnipeg grew rapidly around Fort Garry after 1870 and was linked by rail with the U.S. in 1878 and with eastern Canada in 1881. Immigrants came in still larger numbers by rail to Winnipeg and spread over the province to the west, breaking up the virgin land; wheat flowed eastward in increasing quantities. To provide an additional outlet for this growing agricultural production, a railway to Hudson bay was begun in 1910, but work had to be abandoned with the outbreak of World War I; it was resumed again in 1926 and completed to the port of Churchill in 1929. The population of Manitoba, which was 25.000 in 1871, had passed 250,000 by 1901 and reached 700.000 in 1931. The boundaries of the province were extended in 1881 and again in 1912.

The 1930s were years of depression and drought. After World War II there was a greater diversification of agriculture, increased industrial expansion and mining activity.

Population.—With a population of 850,040 in 1956, and 921,-686 in 1961, Manitoba was sixth among the Canadian provinces. The rate of growth was very slow during the economically difficult period from 1931 to 1946, when immigration almost ceased and there was much migration from the province. After 1946 the increase was marked; it amounted to 123.117 in the intercensal period 1946–56, compared with 26.784 in the preceding 15 years. Urban population increased rapidly while rural inhabitants became less numerous; between 1941 and 1951 the urban population increased from 49% to 56%, and in 1961 almost one-half the population lived in greater Winnipeg. The chief towns of the province with their populations (1961 census) are: Winnipeg (*q.v.*) 260,391; St. Boniface (*q.v.*) 37,247; St. James 33,644; Brandon (*q.v.*) 27,787; East Kildonan 27,174; Portage la Prairie 12,223; Transcona 14,171; Flin Flon 10,992. All except Brandon and Portage form part of greater Winnipeg (469.055).



SETTLEMENT IS CONCENTRATED IN THE SOUTHERN PART AWAY FROM THE INFERTILE SHIELD. THE CHURCHILL RAILWAY TO CHURCHILL ON HUDSON BAY IS SHOWN

An excess of males over females has always been a feature of Manitoba's population, but this excess steadily declined and by 1961 had almost disappeared. The population is mixed by national origin; in 1951 less than 50% were of British origin. There are large minorities of French. Ukrainian. German. Dutch, Polish, Scandinavian and Jewish origin: many other nationalities are represented by smaller groups. Several European languages are spoken in different parts of the province. The United Church of Canada is the largest religious denomination (1951 census. 224,554 adherents), followed by the Roman Catholic (156,283) and Anglican (120,690) Churches: there are also considerable numbers of Lutherans. Mennonites. Presbyterians. Greek Orthodox and Jews.

Government and **Public Finance.**- he constitution of the province is derived from the British North America acts of the imperial parliament (1867 and 1871) ; the hlanitoba act of the Canadian parliament (1870); such laws and institutions of the Northwest Territory as have not been abolished or amended; and British common law and constitutional conventions. Power is divided between the federal government at Ottawa and the provincial government seated in Winnipeg, the capital. The crown is represented in the province by the lieutenant governor. The provincial premier and his ministers are normally selected from the largest party in the single-chamber legislature, which consists of 57 members and is elected for a maximum period of five years. Local government is under provincial control, and in 1958 there were 6 incorporated cities, 35 incorporated towns, 37 incorporated villages and 112 rural municipalities which vary greatly in size and which are divided into land units called townships (each 6 miles square). There are 14 unincorporated local government districts in newly developed areas which before 1945 had no organization. There are no counties but 16 census divisions. Manitoba is represented in the federal parliament at Ottawa by 6 senators and 14 members of the house of commons. Revenue for 1958–59 was estimated at $81,000,000, derived from taxes (44%), gasoline tax (17%), liquor control (13%), licences (8%) and mining (5%). Expenditure was estimated at $105,000,000, mostly for highways (34%), education (22%), health and public welfare (18%).

Education. — Public-school education (primary, secondary and technical) is administered by locally elected school boards under the general supervision of the provincial department of education, and financed by government grants and local rates. Many rural schools are one-room schools. There are two stages of secondary education: the junior high school offers a general program with options for special interests; the senior high school has five courses: general, agricultural, industrial. commercial and home economics. Teachers are trained at the University of Manitoba, the Manitoba Teachers' college. and at Brandon college. The University of Manitoba, situated at Fort Garry near Winnipeg, has over 6,000 students.

Production. — Agriculture. — Although Manitoba is traditionally thought of as an agricultural province, the relative importance of farm produce declined steadily after 1937, and in 1957 the value of manufacturing was almost three times as great. Agriculture became more diversrfied with less dependence on grain crops. Out of a total production valued at $251,000,000 in 1957, field crops contributed a little over one-half while most of the remainder was made up of livestock and derived products. Among the field crops, the importance of wheat declined while that of oats, barley, pasture land, canning crops and grass and fodder crops increased. Wheat still led in value of production (45,000,000 bu. from 2,114,-000 ac., valued at $50,000,000), but more oats were grown (58,-000,000 bu. from 1,800,000 ac., valued at $27,000,000); barley was third in importance (33,000,000 bu. from 1,704,000 ac., valued at $25,000,000), followed by flaxseed, potatoes, mixed grains and rye. Sunflowers, grown for their oil seeds. occupied 25,000 ac. in the Red river valley. The production of sugar beets, though small and limited to lands close to the Winnipeg refinery, increased from 80,000 tons in 1948 to 219,000 tons in 1957.

The principal variety of wheat grown was Selkirk (94% in 1957); the protein content was about 13%. Wheat seeding normally takes place in May and the harvest in August. Frost in the ground stops plowing in November. The province has over 700 grain elevators with a total storage capacity of 60,000,000 bu.

The principal animal livestock is cattle (885,000 in 1957), followed by swine (316,000) and sheep (71,000); there is a large demand from the U.S. for Manitoba cattle. Because of mechanization there are very few horses left. There are also over 6,000,000 chickens and hens, 780,000 turkeys, 40,000 ducks and 4,000 geese. More than 30,000,000 eggs are produced annually. Beekeeping and honey production (5,000,000 lb.) are noteworthy.

Agricultural land is concentrated in the southern part of the province, where about 7,000,000 ac. are cultivated (4,000,000 tilled, 3,000,000 summer fallow). Another estimated 2,500,000 ac. could be developed elsewhere in the province and in the second half of the 20th century land reclamation projects were under way in northern Manitoba. The federal government has worked an experimental farm at Brandon since 1888, with substations at Melita (soil reclamation), Portage la Prairie (special crops) and Waborden (crop testing in the northern clay belt). There is a horticultural experimental farm at Morden. In 1956 the province had 49,201 farms; their average size was about 300 ac., which is relatively small for the prairie. About 43,000 farms, or 83%, were served with electricity.

Forestry. — Forest production in the form of pulpwood (70%) and lumber was valued at over $26,000,000 in 1957. A survey made in 1956 showed that about 120,000 sq.mi. or about one-half the total area of the province was forested and that timber reserves amounted to 27,400,000 cords. The forested lands are almost all crown land and administered by the provincial forest service. Fire is a great hazard; there are annually nearly 300 fires burning over 200,000 ac.

Fishing. — The fresh-water fishery of Manitoba is one of the most valuable in the world and produces about 30,000,000 lb. of fish a year valued at over $5,000,000. Lake Winnipeg provides about half the catch. The principal fish caught in order of poundage are pickerel, whitefish, pike. sauger, tullibee, suckers, perch, bass, trout and carp. More than 5,000 commercial fishermen take part, using motorboats in summer and fishing through the ice from snow-tractors in winter. Aircraft and refrigerated boats, trucks and rail cars are used to transport the fish, 90% of which is sold in the U.S. Sports fishing is a major tourist attraction, with about 82,000 licensed anglers taking part in the summer season and about 3,000 in the winter season.

Mining. — The value of mineral production rose sharply after 1945; in 1957 it was more than $61,000,000. A little more than half of this total was made up of metals, principally nickel (20,-000,000 lb. valued at more than $14,000,000), copper (37,000,000 lb.. more than $10,000,000), gold (120,000 fine oz., $4,000,000) and zinc (27,000,000 lb., more than $3,000,000). Petroleum was the most important single mineral; more than 6,000,000 bbl., valued at $15,000,000, were produced from 846 wells. Industrial minerals accounted for $14,000,000.

The Hudson Bay Mining and Smelting company produces copper, zinc, gold, silver, cadmium, selenium and tellurium at Flin Flon, which has been the principal mining and smelting centre in the province since 1930. Sherritt Gordon Mines have been producing copper and nickel at Lynn Lake since 1951, and San Antonio Gold Mines operate at Bissett. The Britannia Mining and Smelting Company has been mining gold around Herb and Snow lakes since 1946. In Dec. 1956, the International Nickel Company decided to begin mining nickel in the Mystery-Moak lake area. The company and the province are investing $180,000,000 in the construction of mines, concentrator, smelter, refinery, railways, a hydroelectric power station and a townsite (Thompson).

Petroleum is produced in the southwestern part of the province near Virden. where commercial production began in 1951. The oil is of good quality, though sometimes affected by excess sulfur.

Electricity. — A remarkably rapid growth in the supply and consumption of hydroelectricity between 1947 and 1958 made Manitoba the most completely electrified province in western Canada. In 1958 there were nine power stations. Six were on the Winnipeg river 70 mi. northeast of Winnipeg and supplied the towns and rural areas of southern Manitoba; the others were in northern Manitoba on the Laurie river and on Island lake. The total output from all stations in 1957 was 3,374,000,000 k.w.h. Average annual consumption in 1958 was 7,600 k.w.h. per consumer in the Winnipeg area and 4,704 k.w.h. in rural areas. An estimated 5,000,000 h.p. remained to be developed in the province.

Manufacturing. — In 1957 the gross value of manufactured goods was $705,000,000, or more than double the combined value of agricultural, mining, forest and 'fishery output. This represented an increase of 84% since 1947. The growth was based upon increased population, advantageous position with respect to communications, greater diversification of agriculture, and expanding mineral, forest and water-power exploitation. The industries of the province, which are mostly located in the Winnipeg area, serve a regional market extending from the Rockies to the Great Lakes and containing about 20% of Canada's population and national income.

Over 50,000 workers were employed in industry in 1957 and the payroll reached almost $140,000,000. The food and beverages industry. with output valued at $2 50,000,000 and employing 10.000 workers, was most important; its major subdivisions were meat packing and slaughtering. Iron and steel products (value $100,-000,000, 5,250 employed) came next, followed by petroleum and coal products (value $60,000,000, 926 employed); this industry rose from 12th to 3rd place in ten years. Fourth in value of output ($50,000,000), but second in numbers employed (6.600) was the transportation equipment industry, producing railway rolling stock, buses, automotive and aircraft parts. The clothing industry, including fur processing, employed 5,605 workers, mostly female, and produced goods valued at $48.000.000. Chemicals, electrical goods, textile and leather products were also important.

Communications. — Southern Manitoba enjoys unusually good transport facilities because the approach of the northern wilderness toward the U.S. frontier compels east-west traffic to concentrate in the Winnipeg area. Westward from Winnipeg, rail, road and air routes fan out over the prairies.

Canadian National railways and Canadian Pacific railways operate nearly 5.000 mi. of railway in the province; these are centred on Winnipeg, the major rail town of western Canada, possessing some of the largest freight yards in the world. A 510-mi, railway, opened in 1929, connects The Pas with the northern port of Churchill on Hudson bay. Churchill is only about 450 mi. farther from Liverpool, Eng., than Halifax on the Atlantic coast, but this advantage is offset by the short navigable season (July–October) and the distance from Winnipeg. Nevertheless. nearly 17,000,000 bu. of grain were exported from Churchill in 1957. The nearby military base greatly increased the use and importance of the port. It possesses a modern 5,000,000 bu. elevator.

In 1958 there were 92,000 mi. of road but only a small proportion of these were surfaced. The most important main roads are the Trans-Canada highway running from east to west, and two highways into the U.S. Roads also serve the beach resorts on the lakes north of Winnipeg. About 180,000 passenger cars were licensed in the province in 1957. There are bus services from Winnipeg, Brandon and other towns to most of the inhabited parts of the province. Winnipeg is a stopping place on all Canadian transcontinental air services, some of which also serve Brandon. The northern resort, mining and fur-trapping centres are accessible by regular or chartered aircraft.

The telephone system is owned and operated by the province; it has nearly 250,000 subscribers, over half of whom are in Winnipeg. The principal radio station is CBW with transmitter at Carman (50,000 watts, 990 kc.); it serves the whole province. There are several local privately owned stations. CKSB at St. Boniface is a French-language station. In 1958 there were two television stations, CBWT in Winnipeg and CKX-TV at Brandon.

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MANITOBA, LAKE, a narrow, irregularly shaped lake in the Red river lowlands of Manitoba, Can. Discovered by Pierre de la Vérendrye in 1738, the lake is 124 mi. long and lies 813 ft. above sea level. Its southern end is 80 mi. N.W. of Winnipeg and 25 mi. N. of Portage la Prairie. Separated from Lake Winnipegosis by a narrow isthmus, it is a remnant of Lake Agassiz which covered the area in glacial times. It has a valuable commercial fishery and there are small settlements and summer resorts located around its low and often swampy shores. Many of the settlers are Icelandic in origin. (W. H. PR.)

MANITOWOC, seat of Manitowoc county, Wis., U.S., is an industrial city and port on Lake Michigan at the mouth of the Manitowoc river, 83 mi. N. of Milwaukee. A French Canadian established a post there in 1795 and permanent settlement by Americans began in 1836. The city was incorporated in 1870. Manitowoc was early renowned for its shipbuilding; hence its nickname of "Clipper city." It built a sailing ship of 62 tons in 1847 and a steamboat of 434 tons in 1861. The harbour, which is kept open throughout the year, handles more than 2,400,000 tons of freight annually. Railway car and auto ferries connecting nith Michigan ports account for about 60% of this total. The city has a diversified industry with a labour force of more than 6,000. One-third of that number is engaged in shipbuilding and maintenance, and as many more in aluminum work. Other important industries are food packing, lumber, wood products and furniture, paper, metal products including toys, and electrical and other machinery. The name Manitomoc means "spirit land." For comparative population figures *see* table in WISCONSIN: *Population.* (W. F. RY.)

MANIU, IULIU (1873–1953), Rumanian statesman who was the first after the country's unification to win a free election, was born a Roman Catholic on Jan. 8, 1873, at Simleul-Silvaniei, Transylvania. Elected deputy in 1906, he sat in the Budapest parliament until 1910. When the Habsburg monarchy collapsed he was elected head of the regional government at Alba Iulia. In 1926 the National party of Transylvania and the Peasant party of old Rumania merged under Maniu's leadership. On Nov. 10, 1928, he formed the government and the National Peasant party won 349 seats out of 387. In June 1930 Maniu aided Carol II's return from exile but was forced to resign in October. He returned to power in Oct. 1932 to resign again in Jan. 1933. Maniu opposed Carol's dictatorship and from 1940 that of Gen. Ion Antonescu. As a democrat Maniu opposed the Communist dictatorship. Arrested on July 14. 1947, he was sentenced on Nov. 11 to hard labour for life. He died in the Sighet prison in 1953.

MANIZALES, a city of Colombia on the western flank of the volcanic Central Cordillera, 75 mi. S. of Medellín. Pop. (1951) 88,893. It is situated on a commanding ridge-top (elevation 6,988 ft.) its huge, gray cathedral visible for miles in all directions. Manizales was founded in 1848 by colonists from Antioquia. In 1905 it was made capital of the newly created department of Caldas. The airport is located 20 mi. away, near the Cauca river. An unusual means of transportation, an aerial cableway across the crest of the Central Cordillera. connects Manizales with Mariquita and the Magdalena river. Manizales is the halfway point on the principal highway between Bogotá and Medellín and is also connected by highway and railroad with the Quindio region and Cali. It is the centre of Colombia's most important coffee-growing district; nearby, at Chinchiná, is an important coffee experiment station. (Js. J. P.)

MANKATO, a city in south central Minnesota, U.S, the seat of Blue Earth county, about 85 mi. S W. of Minneapolis. The site was settled at the head of navigation on the Minnesota river in the early 1850s by Henry Jackson, Parsons K. Johnson and Daniel Williams of St. Paul. It was incorporated as a village in 1865, was chartered as a city in 1868, and adopted the city-manager form of municipal government in 1953. Mankato is the Sioux name for the blue earth of the region, once thought to be copper-bearing. In its early years as a frontier settlement it was menaced by hostile Indians. The Sioux uprising of 1862 culminated there in the multiple hanging of 38 Indians out of more than 400 who were tried for massacring white settlers. It is the centre of a prosperous farming region, and has an important hog market and many agricultural processing plants, two of which process a large part of Minnesota's soybean crop. Other industries include the manufacturing of cans, electrical equipment, brake assemblies, insulation and cement and the quarrying of limestone. The city is a large wholesale and retail trade centre.

Mankato State college (1868) and Bethany Lutheran college (1911), a junior college, are located there. For comparative population figures *see* table in MINNESOTA: *Population.* (H. T. H.)

MAN LANGUAGES. The term "Man" (in Chinese, "southern barbarian) is applied to languages also known as "Yao" which together nith the Miao languages constitute a group (Miao-Yao) spoken by hill peoples in southern China. North Vietnam, Laos and northern Burma. The Miao-Yao languages are Imperfectly knonn but appear to be an independent group remotely related to the Mon-Khmer languages (Mon and Cambodian). They have no writing system of their onn and no published literature.

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MANLEY, MARY DE LA RIVIÈRE (c. 1663–1724), English writer, daughter of Sir Roger Manley, governor of the Channel Islands. was born on April 7. 1663, in Jersey. She wrote her own biography under the title of *The* Adventures of *Rivella,* *or the History of the Author of the Atalantis* by "Sir Charles Lovemore" (1714). In 1709 she achieved her principal triumph as a writer by her *Secret Memoirs . . . of Several Persons of Quality,* a scandalous chronicle "from the New Atalantis, an island in the Mediterranean." She was arrested in the autumn of 1709 as the author of a libellous publication, but was discharged by the court of queen's bench on Feb. 13, 1710. Mrs. Manley sought in this scandalous narrative to expose the private vices of the ministers whom Jonathan Swift, Lord Bolingbroke and Robert Harley, earl of Oxford, combined to drive from office. Later were published her tragedy *Lucius* (1717), *The Power of Love, in Seven Novels* (1720) and *A Stage Coach Journey to Exeter* (1725).

MANLIUS, the name of a Roman gens, chiefly patrician, but containing plebeian families also.

1. MARCUS MANLIUS CAPITOLINUS, a patrician, consul (392 B.C.). According to tradition, when in 390 B.C. the besieging Gauls were attempting to scale the Capitol, he was roused by the cackling of the sacred geese, rushed to the spot and threw down the foremost assailants (Livy v, 47; Plutarch, *Camillus*, 27). Several years after, seeing a centurion led to prison for debt, he freed him with his own money, and sold his estate to relieve other debtors. He was charged with aspiring to kingly power, and condemned by the comitia when the assembly had adjourned to a place whence they could no longer see the Capitol which he had saved. His house on the Capitol (the origin of his surname) was razed, and the Manlii resolved that henceforth no patrician Manlius should bear the name of Marcus.

See Livy vi, 14–20; Plutarch, *Camillus,* 36, and Cicero, *De Domo,* 38.

2. TITUS MANLIUS IMPERIOSUS TORQUATUS, twice dictator (353, 349 B.C.) and three times consul (347, 344, 340). When his father was brought to trial by the tribune M. Pomponius for abusing his office of dictator, he forced Pomponius to drop the accusation by threatening his life (Livy vii, 3–5). In 360, during a war with the Gauls, he slew one of the enemy, a man of gigantic stature, in single combat, and took from him a *torques* (neck ornament), whence his surname. When the Latins demanded an equal share in the government of the confederacy, Manlius vowed to kill with his own hand the first Latin he saw in the senate house. The Latins and Campanians revolted, and Manlius, consul for the third time, gained two great victories in Campania. In this campaign Manlius executed his own son, who had killed an enemy in single combat, and thus disobeyed the express command of the consuls.

See Livy vii. 4, 10, 27, and viii, 3; Cicero, *De Officiis,* iii, 31.

MANN, HEINRICH (1871–1950), German novelist, elder brother of Thomas Mann (*q.v.*), was born at Lubeck on March 27, 1871. Educated in Liibeck and Berlin, he travelled in Italy and Germany and produced a series of novels which displayed a deep feeling for beauty and much satiric power. *Im Schlaraffenland* (1900) was a mordant account of high finance in Berlin. *Dte Göttinnen* (3 vol., 1903) was a romantic and often very beautiful, but fantastic, account of a Dalmatian duchess with political, artistic and erotic aspirations. Later works described and satirized German society. They include *Die Jagd nach der Liebe, Professor Unrat* (1905), *Die kleine Stadt* and the trilogy, *Das Kaiserreich* (1914–2j). After leaving Germany in 1933, he wrote two historical novels about Henry of Navarre, and the autobiography *Ein zeitalter wird besichtigt* (1945–46).

Mann died March 12,1950.

MANN, HORACE (1796–1859), U.S. educator, "the father of American public education." was born in Franklin, Mass., on May 4. 1796 He grew up in an environment governed by poverty, hardship and self-denial. His early schooling came in brief and erratic periods of eight to ten weeks a year, and from comparatively poor teachers. But he managed to educate himself in the Franklin tonn library, and with the help of some tutoring by an itinerant schoolmaster he gained admission at the age of 20 to the sophomore class at Brown university. He did brilliant work at Brown, manifesting great interest in problems of politics, education and social reform; his valedictory address, on the progressive character of the human race, was a model of humanitarian optimism: portraying the way in which education, philanthropy and republicanism can combine to allay the wants and shortcomings that have traditionally beset mankind.

Cpon graduation in 1819 Mann chose law as a career. There was a brief period of reading law with a Wrentham, Mass., lawyer, followed by an interlude of teaching at Brown. Then came a time of more concentrated study at Litchfield (Conn.) Law school, and finally admission to the bar in 1823. Meanwhile, he had decided to settle in Dedham, and there his legal acumen and oratorical skill soon won him a seat in the state legislature. From 1827 to 1833 he served in the Massachusetts house of representatives, where he led in the establishment of a state hospital for the in. sane at Worcester, the first of its kind in the United States. In 1833 he moved to Boston and was elected to the Massachusetts senate. where he served four years, the last two as president of that body.

Of the many causes Mann espoused, none was dearer to him than the education of the people. Nineteenth-century Massachusetts could boast a public school system going back to 1647. Yet during Mann's own lifetime, the quality of education had steadily deteriorated as school control had gradually slipped into the hands of economy-minded local districts. A vigorous reform movement arose, committed to halting this decline by reasserting the state's influence over the schools. The result was the establishment in 1837 of a state board of education, charged with collecting and publicizing school information throughout the state. Much against the advice of friends. who thought he was tossing aside a promising political career, Mann accepted the first secretaryship of this board.

Endowed with little direct power, the new office demanded moral leadership of the highest order and this Mann supplied for 12 years. He started a biweekly *Common School Journal* for teachers, and lectured widely to interested groups of citizens. His 12 annual reports to the board ranged far and wide through the field of pedagogy, stating the case for the public school and discussing its problems. Essentially his message centred in six fundamental propositions: (1) that a republic cannot long remain ignorant and free, hence the necessity of universal popular education; (2) that such education must be paid for, controlled and sustained by an interested public; (3) that such education is best provided in schools embracing children of all religious, social and ethnic backgrounds; (4) that such education, while profoundly moral in character, must be free of sectarian religious influence; (5) that such education must be permeated throughout by the spirit, methods and discipline of a free society, hence harsh pedagogy in the classroom is undesirable; and (6) that such education can be provided only by well-trained, professional teachers who have mastered their subject matter and the pedagogical arts as well. Mann encountered strong resistance to these ideas—from clergymen who deplored nonsectarian schools, from educators who condemned his pedagogy as subversive of classroom authority and from politicians who opposed the board as an improper trespass on local educational authority—but in the end his views prevailed.

Mann resigned the secretaryship in 1848 to take the seat of former Pres. John Quincy Adams in the United States congress. There followed a stormy period during which he took an uncompromising stand against slavery. In 1853, having run unsuccessfully for the Massachusetts governorship a year before: he assumed the presidency of Antioch college in Ohio, a new institution committed to coeducation, nonsectarianism and equal opportunity for Negroes. There, amidst the usual crises attendant upon the running of an infant college, Mann finished out his years. He died on Aug. 2, 1859. Two months before, he had given his own valedictory in a final address to the graduating class: "I beseech you to treasure up in your hearts these my parting words: Be ashamed to die until you have won some victory for humanity."

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MANN, THOMAS (1875–1955), German novelist and recipient of the 1929 Nobel prize for literature. He was born at Lubeck on June 6, 1875, the son of a merchant and senator. At 19 he moved to Munich, where, while working in an insurance office. he devoted himself to literature. Later he studied at the university, lived in Italy and worked on the satirical journal *Simplicissimus.* In 1897 he began Buddenbrooks (pub. 1900), his first important work, a chronicle of a Lubeck family, nhich introduced his favourite themes of a civilization in decay and the conflict between art and life. It was followed by *Tristan* (1903), a collection including the powerful "Tonio Kroger"; Konigliche Hoheit (1909; Royal Highness); and Der Tod in *Venedig* (1912; Death in Venice).

In 1912 Mann began Der Zauberberg (1924; The Magic Mountain), a study in microcosm of the forces which disrupted European society. In it and Betrachtungen *eines Unpolitischen* (1918) he sought to clarify his ideas about Germany's national ideal. His growing liberalism led to his leaving Germany in 1933; in 1936 he was deprived of his citizenship and in 1944 became a U S. citizen. In 1954 he settled in Zurich, where he died on Aug. 12, 1955.

The novels of Mann's exile—ever more diffuse and idiosyncratic in style—included the biblical tetralogy. Joseph und seine *Brüder* (1933–43); *Lotte* in *Weimar* (1939); Dr. *Faustus* (1947); Die Betrogene (1953); and Bekenntnisse des *Hochstaplers* Felix *Krull,* (1954), a comic novel expanded from an early short story.

MANNA. Although the word manna is familiar and widely quoted, it has no exact meaning; it may refer to plants or even birds However it popularly connotes a miraculously supplied food—"the bread of heaven." Not all the references to manna (in at least ten books of the Bible) signify the same species of plant; that falling from heaven. in the wilderness (Ex. xvi) was presumably wind-borne lichens, while the "honeydew" manna of many later references signifies gummy exudations or resins from several desert trees and shrubs. Exodus xvi:13–15 states ". . . Behold it will rain bread from Heaven . . . the children of Israel saw it, they said one to another, it is manna: . . . taste of wafers made with honey . . . and the children of Israel did eat manna forty years . . . ."

Lichens.—The Biblical manna is believed to be the lichen *Lecanora* esculenta—perhaps also L. *affinis, L. fruticulosa* and L. tartarea. Lecanora is a relative of reindeer moss (Cladonia *rangiferina*), famed in the arctic tundra as sustenance for sizable herds.

A lichen (*q.v.*) is a "synthetic" plant, consisting of a partnership (see SYMBIOSIS) of a green alga and a fungus The alga manufactures food for the combination and the fungus provides the protective housing.

Bedouin herdsmen collect lichen manna and consume it mixed with one-third meal. In many parts of the near east, lichen breads are baked and a manna jelly is prepared.

Lecanora manna ranges from southern U.S.S.R. to Syria and Iran; it is absent from the Sinai desert and eastern north Africa, but is found in Algeria and the Atlas mountains During drought, it curls into lightweight flakes or balls. which break loose easily. Strong winds carry it great distances and windrows often accumulate in the desert, wafted from the mountains. In 1854 a manna shower fell upon Persia during drought and famine. In 1891 an abundant fall was reported in Turkey. It is supposed that manna was, in this way, provided Moses while en route to the Promised Land, or that a migration of quail may have coincided with the blowing in of lichen, providing additional food.

Resins.—*Alhagi maurorum* (camel's thorn) is a spiny-branched shrub up to 3 ft. tall. with simple leaves. It occurs in the uastes of Syria. Lebanon. Palestine and Arabia. Heat or insect activity causes it to exude a resin. which hardens and may be collected by shaking the bushes over a cloth, spread on the ground.

A tamarisk. Tamarix *gallica,* a shrub up to 15 ft. in height. with scalelike leaves and clusters of tiny pink flowers, occurs in the deserts of the same area as the *Alhagi* and is common in the Sinai. A scale insect either punctures the stem, triggering the exudation which hardens in drops; or secretes the manna itself. Bedouins collect this honeylike material, considering it a great delicacy.

The flowering ash, Fraxinus ornus, is a tree, up to 50 ft. in height, with pinnate leaves. It ranges from southern Europe into Syria and Lebanon and is cultivated on some Mediterranean islands. In summer the branches are slashed and the juices exude and harden as manna (the source of commercial manna).

Ash manna is a saeetish exudate, finding limited commerce as flakes (flake manna) or fragments (common manna) or viscid droplets (fat manna). Chemically it consists of mannin, which is a laxative, demulcent and expectorant.

One of these purchasable "sweet mannas" was likely referred to in the book of Baruch i:10, ". . . and prepare ye manna, and offer upon the altar of the Lord. . . ." Authorities have also suggested a dozen other arid land species which might be the source of gum-resin mannas, including legumes, willows, oaks, pears, cedars and members of the genus Eucalyptus and the composite family.

(R W. SY.)

MANNERHEIM, CARL GUSTAF EMIL, BARON (1867–1951), Russian and later Finnish army officer, called the George Washington of modern Finland, was born at Villnäs, near Turku, Fin., on June 4, 1867. He began his military career as a lieutenant of cavalry in the Russian army in 1889, and served in the Russo-Japanese War and in World War I. By 1917 he was a corps commander with the rank of lieutenant general. In Dec. 1917, following the Russian Revolution, he returned to his native Finland, which had declared its independence. In Jan. 1918 he assumed command of the "White" forces opposing the Bolsheviks. leading them to victory in four months. He became regent of Finland in Dec. 1918, holding this position for seven months until a republic was declared.

In 1931 Mannerheim returned from retirement to become chairman of the defense council. During his eight years in this post there was built a line of fortifications across the Karelian isthmus, popularly called the Mannerheim line in his honour. At the age of 72, Mannerheim served as commander in chief in the defensive "winter war" against the Soviet Union (Nov. 1939 to March 1940). The brilliance and remarkable skill of this campaign against a great power led to a relatively favourable peace settlement. Following a new Soviet attack in June 1941, Mannerheim continued to serve as commander in chief until peace was negotiated in Aug. 1944. He was named the only marshal of Finland in June 1942. Mannerheim became president of the republic in 1944, retiring because of ill health in 1946.

He died at Lausanne, Switz., on Jan. 27, 1951. He wrote Across Asia From West to East in *1906–1908* (1940); the Memoirs of Marshal Mannerheim was published in English in New York in 1954.

(R. L. GF.)

MANNERISM is the name now given to the style which prevailed in the arts in Italy from about 1520 until about 1590. The word derives from the phrase di maniera, meaning "by rote," frequently used by G. Vasari and others to describe the creation of a work of art without reference to nature but by dependence on an inner idea, formed originally in the artist's mind from nature, but modified by aesthetic considerations and by the study of other works of art.

Early in the 20th century it was realized that the art of the period between the death of Raphael and the rise of the Carracci and Caravaggio (*qq.v.*) is not simply a decadent version of the high Renaissance but a fundamentally different style. The reasons for this change are manifold, although a school of Marxist historians in the 1920s sought to explain the phenomenon in terms of the economic and social crises precipitated by the rise of Lutheranism and, still more, by the catastrophe of the sack of Rome in 1527. The sack of Rome came as a numbing shock to contemporaries; and it led to the complete collapse of the serene and apparently stable world of humanist values which had given birth to the Renaissance and to a marked increase in religious emotion in the arts, but the external causes do not explain Mannerism as an artistic phenomenon: it is also necessary to refer to artistic reasons. A desire for a new style, expressed in what would now be called Mannerist terms, can be traced well before 1527 and even in Raphael's own last works, most notably in the "Transfiguration" (Vatican gallery) begun in 1517. This uas the result of two main factors: the general feeling that the Stanze (in the Vatican palace) of Raphael, or the architecture of D. Bramante, represented a norm of classical perfection and that no further progress was possible on that road; and the opening of new vistas in the use of the nude as a means of emotional expression by Michelangelo's "Battle of Cascina" and Sistine chapel ceiling, whereby many artists fell into the trap of regarding "clever" poses, much foreshortening and anatomical knowledge as ends in themselves. Others, perhaps more sensitive to approaching disaster, began to impart a tension into their works directly at variance with the serenity of the Renaissance style. In architecture the deliberate flouting of Bramante's ideas in favour of a new style, both exciting and deliberately allusive, can best be seen in the Palazzo del Tè at Mantua, begun in 1525 by Raphael's pupil Giulio Romano (*q.v.*).

The neurosis implicit in much early Mannerist art was partly caused by its exponents, for Rosso. Jacopo da Pontormo and Parmigianino uere all somewhat unbalanced; but they created a religious art of direct and personal expressiveness which was later continued outside central Italy by Tintoretto and El Greco, who, with the aged Michelangelo, were the greatest artists of the style.

Mannerism is a negative style based on rejections and unresolved conflicts. The imitation of nature is modified in favour of the "idea" in the artist's mind (see G. P. Lomazzo, Trattato dell Arte . . . , 1584), compositions are deliberately asymmetrical and too little picture space is allotted to the figures, thus crowding them together and emphasizing the twisted and elaborate poses imitated from Michelangelo. Figures are much elongated to gain in grace and also for the sophisticated pleasure of breaking the classical rules of proportion. It is essentially a learned art, for the spectator is supposed to be both shocked and thrilled by this rule-breaking, as where Michelangelo, in his Laurenziana library in Florence, recessed columns into the wall thus contradicting their strengthening function.

In the second half of the century Mannerism itself became codified into a set of elaborate rules, but many fine portraits of cold elegance were painted (by Bronzino in Florence and N. Hilliard in England, for example), and much of what began as an Italian movement was copied, though rarely understood, by the Romanists in the Low Countries, France and elsewhere. According to some critics, Mannerist influences are discernible in certain trends of modern art and literature, such as Surrealism (see G. R. Hocke, Die *Welt Als* Labyrinth, 1957).

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MANNERS, CHARLES (1857–193j), English musician, whose real name was Southcote Mansergh, was born in London, son of Col. John Mansergh, an Irishman. He had a fine bass voice, and studied at the Royal Academy of Music in London. He began singing in opera in 1881, and in 1882 had great success as the sentry in *Iolanthe* at the Savoy, following this with numerous engagements in opera both in England and America. He married the singer Fanny Moody. already a leading soprano on the operatic stage, in 1890; and in 1897 they formed the bloody-Manners opera company, which had a great success in the provinces and undertook seasons in London in 1902, 1903 and 1904.

Manners died at Dundrum, Ire., May 3, 1935.

MANNERS-SUTTON, CHARLES (1755–1828), archbishop of Canterbury, was educated at Charterhouse and Cambridge, where he graduated in 1777. He became dean of Peterborough (1791), bishop of Norwich (1792), dean of Windsor (1794), and archbishop of Canterbury (1805).

During his primacy the old archiepiscopal palace at Croydon was sold, and the country palace of Addington bought with the proceeds.

For his son Charles see CANTERBURY, CHARLES MANNERS-SUTTON.

MANNHEIM, a town in the Land of Baden-Württemberg, Germany, lies at the confluence of the Neckar with the Rhine and is joined by a railway and road bridge with Ludwigshafen on the left bank of the Rhine. The old tonn, which is surrounded by the Ring, is built like a chessboard in 136 rectangular blocks of houses, known as the Quadraten. Pop. (1950) 245,634.

First mentioned in 766 as a village, Mannheim was fortified in 1606 and received its privileges and municipal law in 1607. It was destroyed in 1622 during the Thirty Years' War and again in 1689 in the struggle for succession which led to the War of the Grand Alliance. In 1720, however, when Charles Philip of the Palatinate moved his residence from Heidelberg to Mannheim, it was rebuilt. The castle, the Jesuit church, the old town hall in the market place with the Unteren Pfarrkirche, the Kaufhaus and the Zeughaus or arsenal are among the baroque buildings of this period. Learning and the arts were cultivated and the Mannheim school of conductors, violinists and composers, the art gallery and the academy of sciences had a European reputation. In 1778 the court moved to Munich. In the same year the National theatre was opened and in 1782 it gave the first performance of Schiller's Die *Räuber*. In 179j Mannheim was destroyed for the third time, during the French mars, and in 1802 it was transferred to Baden. In 1848–49 it was at the centre of the revolutionary movement.

Mannheim's economic rise in the 19th century was due to its position at the highest navigable point on the Rhine for large ships. By the end of the century it had developed from a commercial into an industrial city. In World War II more than half the town was destroyed in air raids but the castle, the Jesuit church, the old town hall and the arsenal were later rebuilt.

Mannheim's chief manufactures are chemicals, cellulose, soap, machinery, steel, electrical and railway equipment, foodstuffs and tobacco. Of special importance is the import trade and trade in coal and iron. With more than 1,000 yd. of quays, numerous docks and a dock railway, Mannheim has the second largest inland harbour in Europe. Mannheim has remained a cultural centre with the National theatre (rebuilt 1954–57, with two stages), colleges for music and drama, engineering and industry, and art collections in the Reiss museum and the Kunsthalle. (G. JB.)

MANNING, HENRY EDWARD (1808–1892), English Roman Catholic cardinal, was born at Totteridge, Hertfordshire, on July 1j, 1808[1], being the third and youngest son of William Manning, a West India merchant, who was a director of the Bank of England and governor, 1812–1813, and who sat in parliament for some 30 years. Manning's boyhood was mainly spent at Coombe Bank, Sundridge, Kent, where he had for companions Charles and Christopher U'ordsworth, afterward bishops of St. Andrews and of Lincoln. He was educated at Harrow, and at Balliol college, Oxford. He made his mark in the Union, where Gladstone succeeded him as president in 1830. He graduated with first-class honours in 1830, and obtained, in 1831, through Viscount Goderich, a post as supernumerary clerk in the colonial office. But he returned to Oxford in 1832, was elected a fellow of Merton college, and was ordained; and in 1833 he was presented to the rectory of Lavington-with-Graffham in Sussex by Mrs. Sargent, whose granddaughter Caroline he married on Nov. 7, 1833. Manning's married life was of brief duration. His young wife died childless (July 24, 1837). This bereavement tended to facilitate his acceptance of the austere teaching of the Oxford Tracts; and though he was never an acknowledged disciple of Newman, it was due to the latter's influence that from this date his theology assumed an increasingly High Church character, and his printed sermon on the "Rule of Faith" was taken as a public profession of his alliance aith the Tractarians.

In 1838 Manning took a leading part in the Church education movement, by which diocesan boards were established throughout the country; and he wrote an open letter to his bishop in criticism of the recent appointment of the ecclesiastical commission. In December of that year he paid his first visit to Rome, and called on Dr. Wiseman in company with W. E. Gladstone. In Jan. 1841 Shuttleworth, bishop of Chichester, appointed him archdeacon. In 1842 he published a treatise on The Unity of *the* Church, arid in that year he was appointed select

[1]Purcell's assertion that the year of his birth was 1807 rests on no trustworthy evidence.

preacher by his university. Four volumes of his sermons appeared between the years 1842 and 1850, and these had reached the 7th, 4th, 3rd and 2nd editions respectively in 1850, but were not afterwards reprinted.

Newman's secession from the Church of England in 1845 placed Manning in a position of greater responsibility, as one of the High Church leaders, along with Pusey and Keble and Marriott; but it was with Gladstone and James Hope (afterwards Hope-Scott) that he was at this time most closely associated. In the spring of 1847 he was seriously ill, and that autumn and the following winter he spent abroad, chiefly in Rome, where he saw Newman "wearing the Oratorian habit and dead to the world." He had public and private audiences with the pope on April g and May 11, 1848, but recorded next to nothing in his diary concerning them, though numerous other entries show an eager interest in everything connected with the Roman Catholic Church, and private papers also indicate that he recognized at this time grave defects in the Church of England and an attraction in Roman Catholicism. Returning to England, he protested, but with moderation, against the appointment of Hampden as bishop of Hereford, and continued to take an active part in the religious education controversy. Through the influence of Samuel Wilberforce he was offered the post of sub-almoner to Queen Victoria, always recognized as a stepping-stone to the episcopal bench, and his refusal of it was honourably consonant with all else in his career as an Anglican dignitary, in which he united pastoral diligence with an asceticism that was then quite exceptional.

In 1850 the decision of the privy council, that the bishop of Exeter was bound to institute the Rev. G. C. Gorham to the benefice of Brampford Speke in spite of the latter's acknowledged disbelief in the doctrine of baptismal regeneration, brought to a crisis the position within the Church of England of those who believed in that Church as a legitimate part of the infallible *Ecclesia docens.* Manning made it clear that he regarded the matter as vital, though he did not act on this conviction until no hope remained of the decision being set aside or practically annulled by joint action of the bishops. In July he addressed to his bishop an open letter on "The Appellate Jurisdiction of the Crown in Matters Spiritual," and he also took part in a meeting in London which protested against the decision. In the autumn of this year (1850) was the great popular outcry against the "Papal aggression" *(see* WISEMAN, NICHOLAS PATRICK STEPHEN), and Manning, feeling himself unable to take part in this protest, resigned, early in December his benefice and his archdeaconry; and writing to Hope-Scott, who a little later became a Roman Catholic with him. stated his conviction that the alternative was "either Rome or licence of thought and will."

He was received into the Roman Catholic Church by Father Brownbill, S.J., at the church in Farm Street, on Passion Sunday, April 6, 1851. On the following Sunday he was confirmed and received to communion by Cardinal Wiseman, who also, within ten weeks of his reception, ordained him priest. Manning thereupon proceeded to Rome to pursue his theological studies, residing at the college known as the ('Academy for Noble Ecclesiastics," and attending lectures by Perrone and Passaglia among others. The pope frequently received him in private audience, and in 1854 conferred on him the degree of D.D. In 1857 the pope, *proprio motu,* appointed him provost (or head of the chapter) of Westminster, and the same year he took up his residence in Bayswater as superior of a community known as the "Oblates of St. Charles," an association of secular priests on the same lines as the institute of the Oratory, but with this difference, that they are by their constitution at the beck and call of the bishop in whose diocese they live.

The community was thus of the greatest service to Cardinal Wiseman, whose right-hand man Manning thenceforward became. During the eight years of his life at Bayswater he was most active in all the duties of the priesthood, preaching, hearing confessions, and receiving converts; and he was notably zealous to promote in England all that was specially Roman and papal, thus giving offence to old-fashioned Catholics, both clerical and lay, many of whom were largely influenced by Gallican ideas, and had with difficulty accepted the restoration of the hierarchy in 1850. In 1860 he delivered a course of lectures on the pope's temporal power, at that date seriously threatened, and shortly afterwards he was appointed a papal domestic prelate.

He was now generally recognized as the able and effective leader of the Ultramontane party among English Roman Catholics, acting always, however, in subordination to Cardinal Wiseman; and on the latter's death (Feb. 15, 1865) it was felt that, if Manning should succeed to the vacant archbishopric, the triumph of Ultramontanism would be secured. Such a consummation not being desired by the Westminster chapter, they submitted to the pope three names, and Manning's was not one of them. Pius IX. ignored the nominations, and appointed Manning to the archi-episcopal see. Consecrated at the pro-cathedral at Moorfields (since destroyed) by Dr. Ullathorne, bishop of Birmingham (June 8, 1865), and enthroned there (Nov. 6), after receiving the *pallium* in Rome, Manning began his work as archbishop by devoting himself especially to the religious education of the poor and to the establishment of Catholic industrial and reformatory schools. He steadily opposed whatever might encourage the admission of Catholics to the national universities, and so put his foot down on Newman's project to open a branch house of the Oratory at Oxford with himself as superior. He made an unsuccessful and costly effort to establish a Catholic university at Kensington, and he also made provision for a diocesan seminary of strictly ecclesiastical type. He procured a further condemnation at Rome of the "Association for the Promotion of the Unity of Christendom," which advocated prayers for the accomplishment of a kind of federal union between the Roman, Greek and Anglican Churches, and in a pastoral letter he insisted on the heretical assumption implied in such an undertaking. He also worked for the due recognition of the dignity of the secular or pastoral clergy, whose position seemed to be threatened by the growing ascendancy of the regulars, and especially of the Jesuits, whom, as a practically distinct organization within the Church, he steadily opposed.

In addition to his diocesan synods, he presided in 1873 over the fourth provincial synod of Westminster, which legislated on "acatholic" universities, church music, mixed marriages, and the order of a priest's household, having previously taken part, as theologian, in the provincial synods of 1853 and 1855. with a hand in the preparation of their decrees. But it was chiefly through his strenuous advocacy of the policy of defining papal infallibility at the Vatican council (1869–1870) that Manning's name obtained world-wide renown. In this he was instant in season and out of season. He brought to Rome a petition in its favour from his chapter at Westminster. and during the progress of the council he laboured incessantly to overcome the opposition of the "inopportunists." And he never ceased to regard it as one of the chief privileges of his life that he had been able to take an active part in securing the definition, and in having heard with his own ears that doctrine proclaimed as a part of divine revelation In 187j he published a reply to Gladstone's attack on the Vatican decrees; and on March 1; in that year he was created cardinal, with the title of SS. Andrew and Gregory on the Coelian. He was present at the death of Pius IX. (Feb. 7, 1878): and in the subsequent conclave, while some Italian cardinals were prepared to vote for his election to fill the vacant chair, he himself supported Cardinal Pecci, afterwards known as Leo XIII.

With Leo XIII. Manning found less sympathy than with his predecessor, though Manning's advocacy of the claims of labour attracted Leo's attention, and influenced the encyclical which he issued on the subject. After the Vatican council, and more especially after the death of Pius IX., Manning devoted his attention mainly to social questions, and with these his name was popularly associated during the last fifteen years of his life. From 1872 onwards he was a strict teetotaller, not touching alcohol even as a medicine. His example and his zeal profoundly influenced for good the Irish poor forming the majority of his flock; and the "League of the Cross" which he founded, and which held annual demonstrations at the Crystal Palace, numbered nearly

30,000 members in London alone in 1874. He sat on two royal commissions, the one on the housing of the working classes (1884), and the other on primary education (1886); and in each case the report showed evident marks of his influence, which his fellow-commissioners recognized as that of a wise and competent social reformer. In the cause of labour he was active for many years, and in 1872 he set an example to the clergy of all the churches by taking a prominent part in a meeting held in Exeter Hall on behalf of the newly established Agricultural Labourers' Union, Joseph Arch and Charles Bradlaugh being among those who sat with him on the platform.

In later years Manning's strenuous advocacy of the claims of the working classes, and his declaration that "every man has a right to work or to bread" led to his being denounced as a Socialist. That he was such he denied more than once (Lemire, *Le Cardinal Manning et son action sociale,* Paris, 1893, p. 210), nor was he ever a Socialist in principle; but he favoured some of the methods of Socialism, because they alone seemed to him practically to meet the case of that pressing poverty which appealed to his heart. He took a leading part in the settlement of the dockers' strike in the autumn of 1889, and his patient and effectual action on this and on similar occasions secured for him the esteem and affection of great numbers of working men, so that his death on Jan. 14, 1892, and his funeral a week later, were the occasion for a remarkable demonstration. The Cathedral at Westminster is his joint memorial with his predecessor, Cardinal Wiseman.

Preeminently Manning was a devout ecclesiastic, a "great priest"; and his sermons, both Anglican and Catholic, are marked by fervour and dignity, by a conviction of his own authoritative mission as preacher, and by an eloquent insistence on considerations such as warm the heart and bend the will rather than on such as force the intellect to assent. But many of his instincts were those of a statesman, a diplomatist, a man of the world, even of a business man; and herein lay, at least in part, the secret of his influence and success. In the later years of his life especially he showed that he loved righteousness and hated iniquity, and that he realized as clearly as any one that the service of God was incomplete without the service of man.

The publication in 1896 of Manning's *Life,* by Edward Purcell, with its very frank revelation of character was the occasion for some controversy on the ethics of biography. Edward Purcell was a Roman Catholic journalist, to whom Manning, late in life, had entrusted, rather by way of charitable bequest, his private diaries and other confidential papers. It thus came to pass that in Purcell's voluminous biography much that was obviously never intended for the public eye was, perhaps inadvertently, printed, together with a good deal of ungenerous comment. The facts disclosed which mainly attracted attention were: (1) that Manning, while yet formally an Anglican, and while publicly and privately dissuading others from joining the Roman Catholic Church, was yet within a little convinced that it was his own duty and destiny to take that step himself; (2) that he was continually intriguing at the back-stairs of the Vatican for the furtherance of his own views as to what was desirable in matters ecclesiastical; (3) that his relations with Newman were very unfriendly; and (4) that, while for the most part he exhibited towards his own clergy a frigid and masterful demeanour, he held privately very cordial relations with men of diverse religions or of no theological beliefs at all. And certainly Manning does betray in these autobiographical fragments an unheroic sensitiveness to the verdict of posterity on his career. But independent critics (among whom may specially be named François de Pressensé) held that Manning came well through the ordeal, and that Purcell's *Life* had great value as an unintentionally frank revelation of character. *See* also sketches by J. E. C. Bodley, *Cardinal Manning* (and other essays) (1912); Lytton Strachey's *Eminent Victorians* (1918); Shane Leslie's *Henry Edward Manning, His Life and Labours* (1921), in which Purcell is supplemented by correspondence not before used, and the Cardinal's letters are sympathetically interpreted.

(A. W. Hu.; X.)

MANNING, WILLIAM THOMAS (1866–1949), U.S. Protestant Episcopal divine, was born in Northampton, England, on May 12, 1866. He entered the ministry from the diocese of California, being ordained deacon 1889 and priest 1891. He became rector of Trinity church, Redlands, Calif., 1892, and in 1893 was appointed professor of theology in the University of the South, Sewanee, Tenn., where in the same year he received the degree of bachelor of divinity. He became successively rector of St. John's, Lansdowne, Pa., 1896; rector of Christ church, Nashville, Tenn., 1898; Vicar of St. Agnes's chapel, Trinity parish, New York city 1903. In 1904 he was appointed assistant rector of Trinity church, New York city, becoming rector in 1908. He was consecrated bishop of New York, May 11, 1921. In 1925 he inaugurated the public movement for the completion of the cathedral of St. John the Divine, New York city. He resigned as bishop 25 years later, in 1946, and on Nov. 18, 1949, he died in New York city.

MANNY, SIR WALTER DE MANNY, Baron de (d. 1372), soldier of fortune and founder of the Charterhouse (*q.v.*), was a native of Hainaut, from whose counts he claimed descent. He was a patron and friend of Froissart. He appears to have come to England as an esquire of Queen Philippa in 1327, and he took a distinguished part in the Scottish wars of Edward III. In 1337 he was placed in command of an English fleet, and in the following years proved himself an able military commander. He was summoned to parliament as a baron by writ from Nov. 1347 to Jan. 1371. In 1359 he was made a knight of the Garter, and at various times received extensive lands both in England and in France. He was frequently employed by King Edward in the conduct of diplomatic negotiations as well as in military commands. He was one of those charged with the safe custody of the French king John when a prisoner at Calais in 1360; in 1369 he was second in command under John of Gaunt.

Manny is remembered for his share in the foundation of the Charterhouse in London. In 1349 he bought some land near Smithfield and built a chapel, afterwards sold to the bishop of London, Michael de Northburgh, who died in 1361 and bequeathed a large sum of money to found there a Carthusian convent. It is not clear whether this direction was carried out; for in 1371 Manny obtained letters patent from Edward III. permitting him to found, apparently on the same site, a Carthusian monastery called "La Salutation Mère Dieu," where the monks were to pray for the soul of Northburgh as well as for the soul of Manny himself. The bishop's bequest may have contributed to the building and endowment of the house; or possibly, as seems to be implied by a bull granted by Urban VI., in 1378, there were originally two kindred establishments owing their foundation to Northburgh and Manny respectively. At all events, Manny who died early in 1372 left instructions that he was to be buried in the church of the Carthusian monastery founded by himself. About 1335 he married Margaret, daughter and heiress of Thomas Plantagenet, earl of Norfolk, son of King Edward I.

See *Oeuvres de Froissart, I. Chroniques,* ed. by Baron Kervyn de Lettenhove (Brussels, 1867–77), and the Globe edition of *Froissart's Chronicles* (Eng. trans., 1895); G. F. Beltz, *Memorials of the Most Noble Order of the Garter* (1841); *Chronicon Angliae 1323–1388,* ed. by E. Maunde Thompson (Rolls series 64, 1874); P. Bearcroft, *An Historical Account of Thomas Sutton and of his Foundation in Charterhouse* (1737).

MANNYNG (of Brunne), **ROBERT** (*fl.* 1283–1338), early English poet and author of *Handlyng Synne,* a poem of popular morality, and of the chronicle *Story of England.* He is probably to be identified with a Sir Robert de Brunne, chaplain, named as executor in a Lincoln will of 1327; apart from this mention his biography can only be reconstructed from his writings. He was born at Brunne (Bourne), Lincolnshire, in 1283 or somewhat earlier, and in *c.* 1300 was at the University of Cambridge, where he met Alexander, brother of the future King Robert the Bruce of Scotland. For 15 years (*c.* 1302–*c.* 1317) Mannyng was a Gilbertine canon at Sempringham priory, Lincolnshire, the original foundation of the order. There in 1303 he began *Handlyng Synne* and was still working at it after 1307. For many years before 1338 he was engaged on the *Story of England,* which he wrote at the request of the prior of the Gilbertine house at Sixhills near Market Rasen, Lincolnshire. The *Story of England,* the author relates, was finished between three and four o'clock, on Friday, May 15, 1338.

Handlyng Synne is an adaptation in about 13,000 lines, in short couplets poorly versified, of the *Manuel des Péchés,* which is usually ascribed to William of Waddington (or Widdington), an Englishman, probably a Yorkshireman, writing in Anglo-Norman between 1250 and 1270. The text of the *Manuel* remains amorphous; there are more than a score of manuscripts, which present the work in many degrees of completeness and expansion—evidently it was highly popular and influential. Like Waddington, Mannyng aimed to provide a handbook which should serve to stimulate careful self-examination as preparation for auricular confession. *Handlyng Synne* is thus an exact title, and the English work and its source represent extensions into the terms of popular thought and into vernacular languages of the copious clerical literature on confession which had developed in western Europe from the end of the 12th century.

Mannyng follows his original closely. He sometimes omits, but more often amplifies to elucidate doctrine, does not hesitate to soften the rigour of injunctions and in general shows a superior power in organization. He deals in turn with the Ten Commandments. the Seven Deadly Sins and the sin of sacrilege, the Seven Sacraments, the 12 requisites of confession and the 12 graces of confession. There is much direct instruction, exhortation and didactic comment, but each of the topics is illustrated by one or more tales. These *exempla* have sometimes been considered to provide the particular interest of the work. Most of them are drawn from the *Manuel*, but Mannyng sometimes provides a local setting and sometimes goes back to Waddington's sources for further detail He also adds 13 fresh stories, some from the Bible and several of local provenance. The whole work is designed for oral delivery. Mannyng's merit as a storyteller lies in his apt management of material and in his lucid, direct narration. Otherwise the literary merits of *Handlyng Synne* are negligible, although its documentary value for social history is great. It illustrates clearly the attitudes and values of the English minor clergy and peasantry in the early 14th century; throughout there is much comment on the social, domestic, parochial and commercial scene. The poem was popular in the 14th and 15th centuries; passages from it were worked into other compositions. Its modern appeal will be found in its moralized realism.

Of similar literary quality is Mannyng's later work, the *Story of England;* but, as Mannyng's editor, F. J. Furnivall, observes, whereas the matter of *Handlyng Synne* is fact, the basis of the *Story of England* is fiction. As history it is almost worthless, The work falls into two parts. The first, in something less than 9,000 lines written in short couplets, tells the story from Noah to the death of Cædwalla in 689. In form and substance Mannyng follows *Le Roman de Brut* by the Anglo-Norman poet Wace, but he draws also on Bede, on Geoffrey of Monmouth (Wace's source) directly and on the Anglo-Norman *Chronicle* of Peter Langtoft (*q.v.*). In the 9,000 lines of the second part, taking the story to the death of Edward I (1307), Mannyng relies primarily on Langtoft's *Chronicle* and again adopts the metrical form of his original, in this case the alexandrine couplet, which he manages clumsily.

He continues to incorporate material from other sources—from Bede again! from lives of English saints and from later historians —and he adds scraps of his own. Of particular interest is his use of popular romance. into his account of Aethelstan he inserts the story of Guy of Warwick's encounter with the giant Colbrand, he affects surprise that no reputable historian has dealt with Arthur or with Havelock and he draws heavily on the extravagant 14th-century romance of Richard the Lion-Hearted. Following Langtoft, but with some variations from Langtoft's text, he works into his narrative several topical songs, mainly on the Scottish wars of Edward I's time.

Handlyng Synne and the *Story* are preserved independentiy in several manuscripts, none contemporary with Mannyng and none of certain provenance; but insofar as the original east midland dialect of composition can be discerned, Mannyng's language is of importance in tracing the development of the spoken and literary standard of English. *Meditations of the Supper of Our Lord,* a verse rendering of part of the *Meditationes vitae Christi* of St. Bonaventure, has been ascribed to Mannyng on no better ground than that in two manuscripts it is transcribed immediately after *Handlyng Synne.*

BIBLIOGRAPHY.—Mannyng's *Handlyng Synne* was ed. by F. J. Furnivall, with text of the *Manuel* in parallel, for the Roxburghe club (1862) and with extracts from the *Manuel* for the Early English Text society, original series 119, 123, 2 vol. (1901–03); there is no satisfactory edition of the *Manuel des Péchés*. The 1st pt. of *The Story of England* was ed by F. J. Furnivall, "Rolls Series," 2 vol. (1887); for the 2nd pt. see *Peter Langtoft's Chronicle, T.* Hearne (ed.), 2 vol. (1725). *See* also Ruth Crosby, "R. M. of B.: *A* New Biography," *Publications of the Modern Languagr Association of America,* vol. lvii (1942); E. J. F. Arnould, *Le Manuel des Péchés, Étude de littérature religieuse anglo-normande* (1940); and, for full bibliography, J E. Wells, *A Manual of the Writings in Middle English, 1050–1400* (1916) and *Supplements* (1919–51). (G. SD.)

MANOAH, or MANUE (Douay version), in biblical history the father of Samson (*q.v.*).

The story, according to chapter 13 of the Book of Judges, is that a messenger appeared first before Manoah's wife, who had been childless, and announced that she was to bear a son, who would begin to deliver Israel from the Philistines. He admonished her to abstain from drinking wine or strong drink and from eating "any unclean thing"

After learning of this visit, Manoah prayed to have the messenger return to give him more instructions concerning the child. When he appeared before Manoah, the angel answered his questions by repeating his instructions to the woman. When Manoah made a burnt offering of a kid, the angel ascended with the flames toward heaven.

The child which was later born to them was named Samson. Samson was buried, according to chapter 16 of the same book. in his father's burying place between Zorah and Eshtaol (Saraa and Esthaol in Douay version).

MANOEL II, former king of Portugal (1889–1932), was born at Lisbon on Nov. 15, 1889, the younger son of Carlos I by his wife Marie Amélie of Orleans. On the assassination of King Carlos and of the crown prince, Luis, duke of Braganza, on Feb. 1, 1908, Dom Manoel succeeded to the throne of Portugal, but he retained it for only a short time, since the revolution of Oct. 3, 1910, forced him to flee the country (*see* PORTUGAL). He took refuge with his mother in England, and finally settled at Fulwell Park, Twickenham. He became a familiar and popular figure in English society. On Sept. 4, 1913, he married, at Sigmaringen, Princess Augusta Victoria of Hohenzollern, daughter of Prince Wilhelm of Hohenzollern. Dom Manoel died July 2, 1932.

MANOEUVRE, in military and naval tactics, a planned or regulated strategic movement, evolution or change of position of troops, vessels, etc. Used in the plural, the term usually refers to a series of extended field tactical movements or exercises carried out in imitation of war conditions by troops, ships, coastal defenses, etc.

In 1758 the term was discussed in *The Annual Register: "Coup de main*, and *Manoeuvre*, might be excusable in Marshal Saxe, as he was in the service of France . . . ; but we cannot see what apology can be made for our officers lugging them in . . . , as a sudden stroke might have done for one, and a proper motion for the other." The following use of the term is attributed to Manasseh Cutler in 1778 in *Life, Journal,* and *Correspondence, by his Grandchildren* (1881): "The army was ordered . . . to embark and re-embark in the boats, that they might the better understand such a maneuvre."

In general, the term means skilful or artful operation or management. It is used figuratively to mean an adroit move, expedient or proceeding in politics, finance, etc. According to John Adams's *Familiar Letters* (1876), Adams in 1774 said, "These A: ts of Parliament and ministerial manoeuvres will injure me." In Adams's *Works* (1854), he is quoted in 1790: "If the time should ever come when corruption shall be added to intrigue and manoeuvre in elections . . . chance will be better than choice."

MANOLY, LUDWIG EMANUEL (1855–1932), Hungarian double-bass player and teacher, was born in Teresia-Opel, Hungary, on Feb. 18, 1855. Manoly attended the Vienna conservatory and studied under Anton Bruckner. In 1876 he went to the United States, where he played with the Theodore Thomas orchestra and later played with the Mendelssohn Quintet in Boston, Mass. He was a member of the New York Symphony orchestra and later of the New York Philharmonic orchestra for many years. In 1927 he retired.

Manoly was a teacher at the New York Institute of Musical Art.

He died in New York on March 16, 1932.

MANOMETER: *see* VACUUM.

MANOR. Any definition of a manor, in land tenure, must take note of two elements — economic and political. The manor has an estate for its basis, although it need not coincide with an estate, but may be wider. It is also a political unit, a district formed for purposes of government, although the political functions made over to it may greatly vary. As a lordship based on land tenure, the manor necessarily comprises a ruler and a population dependent on him, and the characteristic trait of such dependence consists in various forms and degrees of subjection, chiefly regulated by custom. In the sense mentioned the manor is by no means a peculiarly English institution; it occurs in every country where feudalism got a hold. Under other names we find it not only in France, Germany, Italy, Spain, but also, to a certain extent, in the Byzantine empire, Russia, Japan, etc. It is especially representative of an aristocratic stage in the development of European nations. When tribal notions and arrangements ceased to be sufficient for upholding their commonwealths, when social and political life had to be built up on the basis of land-tenure, the type of manorial organization came forward in natural course.

Origin and Development.—One problem common to the entire European world has to be considered from the very beginning. Does the manor date from the Roman empire, or not? Can its chief features be traced in Roman institutions? There can be no doubt that at the end of the Roman period certain traits are noticeable which might, under favourable conditions, develop into a manorial combination. Great estates with political functions, populations subjected to the political lordship of landowners, appear in the closing centuries of the empire, and have to be reckoned with as precursors of mediaeval manorial life. During the last centuries of its existence the Western empire became more and more a conglomerate of barbaric and half-civilized populations. The central power, after claiming an absolute sway over its subjects, is obliged more and more to lean on private forces in order to maintain itself. One of its favourite resources in the 4th and 5th centuries consists in making great landowners responsible for the good behaviour of their tenants and even of their less important neighbours. The *saltus,* the great domain, is occasionally recognized as a separate district exempt from the ordinary administration of the city, subordinated to its owner in respect of taxes and police. Even in ordinary estates (*fundi*) there is a tendency to make the landowner responsible for military conscription, for the presentation of criminals to justice. On the other hand the incumbents of ecclesiastical offices are nominated in accordance with the wishes of patrons among the landowners; in the administration of justice the influence of this same class makes itself felt more and more. Nor are signs of a convergent evolution wanting on the economic side. Slaves are used more and more as small householders provided with rural tenements and burdened with rents and services. Free peasant farmers holding by free agreement get more and more reduced to a status of half-free settlers occupying their tenancies on the strength of custom and traditional ascription to the glebe. Eventually this status is recognized as a distinct class by imperial legislation. Yet there could be no talk of a manorial system as long as the empire and the commercial intercourse protected by it continued to exist.

The fall of the empire hastened the course of evolution. It brought into prominence barbaric tribes who were unable to uphold either the political power or the economic system of the Romans. The Germans had from of old certain manorial features in the constitution of their government and husbandry. The owner of a house had always been possessed of a certain political power within its precincts, as well as within the fenced area surrounding it: the peace of the dwelling and the peace of the hedged-in yard were recognized by the legal customs of all the German tribes. The aristocratic superiority of warriors over all classes engaged in base peaceful work was also deeply engraved in the minds of the fighting and conquering tribes. On the other hand the downfall of complicated forms of civilization and civil intercourse rendered necessary a kind of subjection in which tributary labourers were left to a certain extent to manage their own affairs. The Germanic conqueror was unable to move slaves about like draughts: he had no scope for a complicated administration of capital and work. The natural outcome was to have recourse to serfdom with its convenient system of tribute and services.

But, as in the case of the Roman empire, the formation of regular manors was held back for a time in the early Germanic monarchies by the lingering influence of tribal organization. In the second period of mediaeval development in continental Europe, in the Carolingian epoch, the features of the estate as a political unit are more sharply marked. Notwithstanding the immense efforts of Charles Martel, Pippin and Charlemagne to strengthen the tottering edifice of the Frankish empire, public authority had to compromise with aristocratic forces in order to ensure regular government. As regards military organization this is expressed in the recognition of the power of *seniores,* called upon to lead their vassals in the host; as regards jurisdiction, in the increase of the numbers of commended freemen who seek to interpose the powerful patronage of lay and secular magnates between themselves and the Crown. Great estates arose not only on the lands belonging to the king, but on that of churches and of lay potentates, and the constitution of these estates reminds us forcibly of that of later feudal estates.

The struggle against Northmen, Magyars and Slavs gave a crowning touch to the process of localization of political life and of the aristocratic constitution of society.

France. — In order to describe the full-grown continental manor of the 11th century it is better to take French examples than German, Italian or Spanish. Feudalism in France attained the greatest extension and utmost regularity, while in other European countries it was hampered and intermixed with other institutional features. The expression best corresponding to the English "manor," in the sense of an organized district, was *seigneurie. Manoir* is in use but meant strictly "mansion" or chief homestead in France.

The *seigneurie* may be considered from three points of view—as a unit of administration, as an economic unit, and as a union of social classes.

(*a*) In principle the disruption of political life brought about by feudalism ought to have resulted in the complete administrative independence of the manor. *Chaque baron est souverain dans sa baronie* is a proverb meant to express this radical view of manorial separatism. As a matter of fact this separatism was never completely realized, and even at the time of the greatest prevalence of feudalism the little sovereigns of France were combined into a loose federation of independent fiefs. The institutional expression of this aspect of feudalism in the life of the *seigneurie* was the jurisdiction combined with the latter. The principal origin of this jurisdiction was the dismemberment of royal justice, the acquisition by certain landowners of the right of holding royal pleas. The assumption of authority over public tribunals of any kind was naturally considered as equivalent to such a transmission of royal right. But other sources may be noticed also. It was assumed by French feudal law that in all cases when land was granted by a *seigneur* in subinfeudation the recipients would be bound to appear as members of a court of tenants for the settlement of conflicts in regard to land. A third source may be traced in the extension of the patrimonial justice of a person over his serfs and personal dependents to the classes of free and half-free population connected with the *seigneurie* in one way or another. There arose in consequence of these assumptions of jurisdiction a most bewildering confusion of tribunals and judicial rights. A certain order was brought into this feudal chaos by the classification of judiciary functions according to the four categories of high, middle, low and tenurial justice. The scope of the first three subdivisions is sufficiently explained by their names; the fourth concerned cases arising from subinfeudation. As a rule the baron or *seigneur* sat in justice with a court of assessors or peers, but the constitution of such courts varied a great deal.

(*b*) The economic fabric of the French *seigneurie* varied greatly, according to localities. In the north of France it was not unlike that of the English manor. The capital messuage, or castle, and the home-farm of the lord, were surrounded by dependent holdings, *censives,* paying rent, and villein tenements burdened with services. Between these tenancies there were various ties of neighbourhood and economic solidarity recalling the open-field cultivation in England and Germany. When the harvest was removed from the open strips they returned to a state of undivided pasture in which the householders of the village exercised rights of common with their cattle. Wild pasture and woods were used more or less in the same fashion as in England *(droit de pacage de vaine pâture).* The inhabitants often formed courts and held meetings in order to settle the by-laws, and to adjudicate as to trespasses and encroachments *(courts colongdres).*

(c) The social relations between the manorial lord and his subjects are marked by various forms of the exploitation of the latter by the former. Apart from jurisdictional profits, rents and agricultural services, dues of all kinds are exacted from the rural population. Some of these dues have to be traced to servile origins, although they were evidently gradually extended to groups of people who were not descended from downright serfs but had lapsed into a state of considerable subjection. The *main morte* of rustic tenants meant that they had no goods of their own, but held movable property on sufferance without the right of passing it on to their successors, although after payment of a heavy fine, succession might be permitted. The *formariage* corresponded to the English *merchetum,* and was exacted from rustics on the marriage of their daughters; this payment was considered a badge of serfdom. *Chevage (capitagium)* might be exacted as a poll-tax from all the unfree inhabitants of a *seigneurie,* or, more especially, from those who left it to look for sustenance abroad. The power of the lord as a landowner was more particularly expressed in his right of pre-emption *(retrait seigneurial),* and in taxes on alienation *(lods et ventes).* As a person wielding political authority, a kind of sovereignty, the lord enjoyed divers rights which are commonly attributed to the State—the right of coining money, of levying direct taxes and toll *(tallagium, tolneta)* and of instituting monopolies, such as the use of the lord's mill *(moulin banal),* or of his oven *(four banal)* or of his bull *(taureazc banal).*

See Fustel de Coulanges, *Histoire des institutions de la France* (1874–92), especially the volumes "L'Alleu et le domaine rural" and "L'Invasion germanique;" Beaudouin, "Les Grands domaines dans l'empire romain" *(Nouvelle revue de droit français et ttranger, 1898)*; J. Flach, *Les Origines de l'ancienne France,* I., II., III. *(1886)*; P. Viollet, *Histoire des institutions de la France,* I., II. *(1890, 1898)*; A. Luchaire, *Manuel des institutions françaises (1892)*; G. Waitz, *Deutsche Verfassungsgeschichte,* I.–VIII. (1865–83); K. T. von Inama-Sternegg, *Deutsche Wirtschaftsgeschichte,* I., II. (1879–91); K. Lamprecht, *Deutsches Wirthsckaftsleben,* I.–IV. *(1885)*; A. Meitzen, *Ansiedelungen, Wanderungen und Agrarwesen der Völker Europas,* I.–IV. *(1895 seq.)*; W. Wittich, *Die Grundherrschaft in Nordwestdeutschland (1896)*; G. F. von Maurer, *Geschichte der Mark-, Dorf- und Hofverfassung in Deutschland;* F. Seebohm, *The English Village Community (1883)*; P. Vinogradoff, *Historical Jurisprudence* (2 vols., 1920, 1922).
(P. Vi.)

THE MANOR IN ENGLAND

The typical English Manor, if there be a recognized or definite type, is known to us through the records of the 13th century. There is much valuable material in the somewhat cryptic descriptions in the Domesday survey; there are admirable pictures of the custom and working of a manor in the 12th century extents, surveys, custumals and cartularies, but in the 13th century we find in addition to these, systematic information as to the economic progress of the manor, in the Ministers' accounts, and as to the judicial proceedings of the manorial courts, in the court rolls. By the 14th century we are confronted with a picture of change and decay, emancipation and development.

Topography.—Topographically, a manor is a complex estate, consisting of *(a)* the lord's demesne, scattered in strips in the open fields, or in consolidated blocks of fields; *(b)* the land of the free tenants, who owe the lord small rents in money or in kind, and certain fixed labour-services; *(c)* the land of the villeins, lying for the most part in the open fields, and owing more onerous and uncertain services, as well as rents in money and in kind. The land of the manor is partly arable, partly meadow (very highly valued), partly rough pasture, waste or wood. In central and southern England the arable land was divided into three great fields, arranged for a three year rotation of crops and fallow; the fields were divided into acre or ½-acre strips, grouped in "shots" or furlongs. The lord, the free tenants and the villeins all held more or less defined rights to a share in the meadow and the waste. Much of the communal administrative action of the manorial courts is connected with these rights. In the north and west, and again in Kent and East Anglia the three-field division is hardly to be found, and the whole agrarian system varies sharply from the "normal"; this fact is important in local investigations.

Inhabitants of the Manor.—The inhabitants of the manor have all their separate rights, asserted and defended by the manorial court. The lord at the head of the society, in his hall or manor-house, enjoys his own demesne, holds a certain "superiority" over the lands of the villeins (which, the later lawyers describe as ownership of the freehold of all villein or copyhold land) and possesses rights over the waste paramount to those enjoyed by the other inhabitants. These rights were to some extent limited by the Statute of Merton (1236) and the second Statute of Westminster (1285). The lord's rights of jurisdiction will be better treated in connection with the courts. The free tenant is not yet a modern free-holder; economically he is often hardly distinguishable from a villein, but his status is clearly marked by his power to appeal to the royal courts of justice, even against his lord. Below the free-tenants came the villeins *(nativi, rustici,* bondmen, virgaters, customers, etc.)—customary tenants holding a house, a virgate or half-virgate in acre strips, and a share in the meadows and waste. A virgate was normally about 30 acres—the fourth part of a hide; but it might vary from 10–15 acres up to 60 or 80, while the acre itself varies in different districts. The villein was in certain respects unfree; in the eye of the law he had no rights against his lord, who "was protected from all suits by the *exceptio villenagii";* he might not leave the manor without permission. and he could be reclaimed if he did, by the writ *"de nativo habendo";* he could not, in theory, own any property, and he was subject to certain "base" incidents, such as the payment of *merchet,* and the need to ask permission to put his son to school or to allow him to seek ordination. But in practice the villein bought and sold like other men, after payment of a small fee; he leased, exchanged or sold his land, through the very efficient machinery of the manorial cburt; he made wills, and at times appears even to have disposed of his villein lands by will—proved in the lord's court. He could, no doubt, be ejected by the lord, but such ejection was very rare, and seemed to require a complete cessation of services, by physical or mental incapacity, before it could be accomplished "according to the custom of the manor." The villein was never exposed to the arbitrary will of the lord, but was always protected by the court, which interpreted the "custom" by the spoken witness of the *villata* (or the *curia,* the *homagizcm,* the *jurati*) or the written testimony of court roll or custumal. The inevitable confusion which arose between unfree status, and unfree tenure usually reacted to the advantage of the villein by blood, but on some estates (notably monastic lands) there was a determined attempt to impose the whole burden of unfree status upon free men holding villein tenements. Individual villeins, with their *sequela,* or villein brood, were sometimes bought and sold, but they could not be separated from their tenements, and all that is implied by sale is transfer from one lord to another as regards services and jurisdiction. The hardship or prosperity of a villein's lot depended mainly upon his economic position, which would seem to have steadily improved in the 14th century. His rents in money, in kind, and in services were for the most part fixed. The rents of assize (probably a commutation of earlier rents in kind rather than of services) varied considerably on different manors, but as they remained fixed for centuries, the advantage of any fall in the value of money remained with the villein. The dues in kind were gradually almost all commuted, or dropped.

Labour Services.—Although it happened that the villein paid small rents in moneys and in kind, labour dues were the most serious part of a villein's obligations. Two or three days week-work throughout the year might be combined with two or three extra days per week in harvest to make an apparently insupportable burden It should be noted, however, that a day's work sometimes means, by definition, half a day's work, or a fixed measure of reaping or mowing. Moreover, the labour was due from the virgate, and not from each man; hence a father might send his son to fulfill his obligation. Generally the harvest works (boon-days) survived longest as they were available for emergencies.

One of the most important problems in connection with the manor is the local distribution of labour services, and the varying reasons for their commutation. The history of the manor in the 14th century is the story of the change from typical mediaeval methods to an elementary form of the modern farm worked by hired labour. By the end of the 14th century the class of villeins included men of varied economic status; cottiers or bordars holding a plot of 4 or 5 acres and a cottage at one end of the scale were legally in the same position as men who had laid field to field, virgates and enclosures, until they might hold 100 to 200 acres of land, and require the services of wage-paid men, even while they themselves owed "base" services.

Administration of the Manor.—A very important factor in the development of the manor was the administrative system, the history of which has as yet been imperfectly explored. This aspect of manorial history is, however, useful in correcting over-sweeping generalizations. The lord of a manor might be the king, the duke of Lancaster, a wealthy bishop or monastic house, or, on the other hand the humblest of knights or freemen. Upon his status and the number of his manors depended the character of the administration. The minimum staff would be the lord's bailiff, working with the provost or reeve, who was usually elected by the "homage," and who had under him certain regular servants of the manor—a hay-ward, a reap-reeve, a shepherd, swineherd, bee-keeper, etc. Whenever it happened that the lord held a number of manors, he required a seneschal, or steward, whose office is variously described as agricultural supervision, or as judicial and legal (cf. Walter of Henley, etc.). The seneschal was usually assisted by a group of clerks and auditors, and other officials, who were responsible for the final presentation of the manorial accounts. The seneschal and his subordinates were admitted to office by an oath, closely parallel to that of a royal councillor; the whole group of officials tended to develop into a private council, which often contained professional lawyers, described as *utrius jurisperiti.* Rudimentary forms of these private councils may be found in the 12th century, and they were evidently well established by the end of the 13th century (*e.g.,* for the abbey of St. Albans, or the bishoprics of Durham, Worcester and Ely, and the archbishopric of Canterbury).

Manor Court.—The manor court is a complicated structure, though the division court leet, court baron and court customary does not belong to its early history. It originally exercised its criminal, civil, or manorial jurisdiction as one court; its names may differ, the parties before it may be free or unfree, but the court is the same. Its president was the lord's steward; the bailiff was the lord's representative and the public prosecutor; and the tenants of the manor, both free and unfree, attended at the court and gave judgment in the cases brought before it To modern ears the constitution sounds unfamiliar. The president of the court settled the procedure of the court, carried it out, and gave the final sentence, but over the law of the court he had no power. All that is comprised in the word "judgment" was settled by the body of tenants present at the court. The business of the court may be divided into criminal, manorial and civil. The powers under the first head depended on the franchises enjoyed by the lord in the particular manor; for the most part only petty offences were triable, such as small thefts, breaches of the assize of bread and ale, assaults, and the like; except under special conditions, the justice of great offenses remaining in the king. But offences against the custom of the manor, such as bad ploughing, improper taking of wood from the lord's woods, and the like, were of course the staple business of the court. Under the bead of manorial business the court dealt with the choice of manorial officers, and had some power of making regulations for the management of the manor; but its chief function was the recording of the surrenders and admittances of the villein tenants.

It is in this function that we find the origin of copyhold tenure. The manorial court acted as a registry of an active land market, and, provided the fees on transfer were paid, lords evidently made no effort to maintain static conditions. On some estates we find an almost complete replica of the system of royal writs for possessory and even proprietary actions. Litigation became so common that the written record takes the place of the testimony of the old men or of the court. Court rolls were constantly produced in court, as evidence, and from the first half of the 14th century, we find tenants in possession of a copy of court roll. By 1400 the possession of a copy is often enforced, and the existence of the copyholder is thus acknowledged. Besides land questions, the manorial court dealt with any other civil suits that might arise, such as questions of debt, detinue, damages, or contract. In semi-urban manorial courts, which might have to deal with fairs or with industry, these civil cases became of considerable importance. Occasionally, the manor court would appear to encroach upon the province of the courts christian—*e.g.,* in dealing with wills of villeins and copyholders, and in proceedings against usurers.

During the 15th century, the villein slowly developed into a copyholder, and the importance of the manorial court was correspondingly diminished. After ten well-known decisions of Danby, C.J., and Bryan, C.J., in 7 Ed. IV. and 21 Ed. IV., it was established that the courts of law could entertain an action of trespass brought against his lord by a customary tenant. From this time onward, the courts, both of law and of equity, began to intervene, and the records of the courts of Chancery, Star Chamber, and Requests show that in the Tudor period equitable suits brought by tenants against their lords were not infrequent The few remaining "bondsmen" of the 16th century were constrained to pay heavily for their manumission. Gradually the manor ceased to have any social or economic importance, and its few remaining privileges and peculiarities of tenure were swept away by the Law of Property Acts 1922.

It is clear that the manor court as here described consisted of conflicting elements of very different origin and history. Founded partly on express grants of franchises, partly on the inherent right of a feudal lord to hold a court for his free tenants, partly on the obscure community traceable among the unfree inhabitants of the manor, it is incapable of strict legal definition. All these elements, moreover, contain in themselves reasons for the decay which gradually came over the system In some cases of urban development, the manorial court was strengthened. But for the most part only a shadow of its former powers survived to control the few remaining copyholders, until the passing of the Law of Property Acts 1922.

Later Legal Theory.—A few words must be given to the legal theories of the 17th century on the manor court. It would seem to have become the law that to the existence of the manor two courts were necessary—a court customary for customary tenants, and a court baron for free tenants. If the freeholders in the manor diminish to less than two, the court baron cannot be held, and the manor perishes. This distinction seems to be without historical justification, as the court of the 13th century was not differentiated in this way; the terms were also very loosely applied, and it is not unusual in the 16th century to find a so-called court baron exercising all the functions of a customary court.

Apart from the change in the court of the manor, the most important thread in its later history is the process, mentioned above, which converted the villein into the copyholder. Although it seems hardly accurate to describe the villein of the 13th century as holding at the will of the lord, yet he could claim no protection from the king's courts. If, however, the villein were a tenant on the king's Ancient Demesne, his condition was distinctly more secure. He was protected by the writs of *monstraverunt* and the little writ of right close from the improper exactions of services and from ejection by the lord. But in ordinary manors there was no such immunity. That ejection was legally possible has already been shown, and it was not until the well-known decision of

Danby. C. J. and Bryan, C. J. in 7 Edw. IV, and 21 Edw. IV, that the courts of law would entertain an action of trespass brought against his lord by a customary tenant. There was nothing. however. to prevent a customary tenant from proceeding by way of petition to the king, and there are cases of such petitions as early as the end of the 14th century.

Moreover, in 1381 royal justice had come to the aid of the lords against their villeins, and it was not unknown that a lord should call in the private aid of a distinguished justice or counsel. In time the process is reversed: and the royal courts begin to help the villein or copyholder against his lord. From the decision of Bryan and Danby onwards, the courts, both of law and of equity, begin to intervene and the records of the courts of Chancery, Star Chamber. and Requests show that in the Tudor period equitable suits brought by tenants against their lords are not infrequent. The 16th century also saw the manumission of the few remaining "bondsmen." who were constrained to pay heavily' for their personal freedom. From that period onwards the manor ceased to have any social importance, and survived merely as the nucleus of a peculiar form of land tenure.

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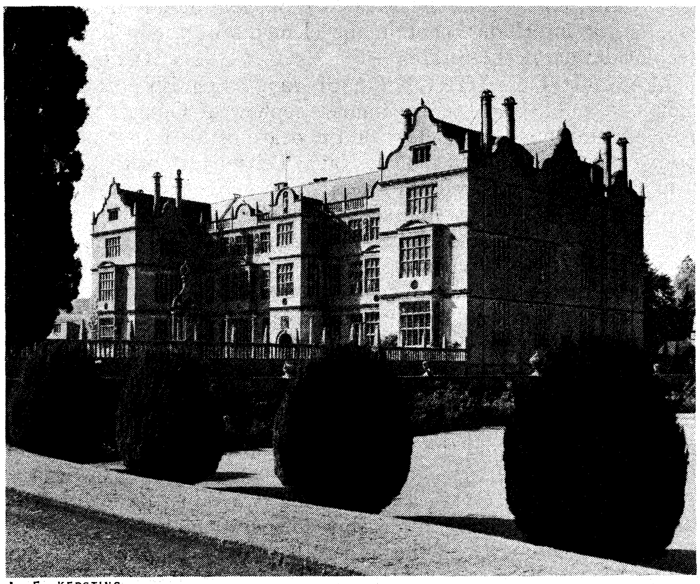
MANOR **MOUSE,** the dwelling of the lord of the manor or his residential bailiff, and the administrative centre of the feudal estate. Development in the middle ages is related to that of the castle (*q.v.*), which is however distinguished by Its primarily defensive character and greater political significance as a military strong point. Early manors were generally fortified, licence to crenelate being required from the king. and the evolution of domestic planning at the expense of more military considerations is in proportion to the degree of peaceful settlement of any country or region. With the church, the medieval manor house was the centre of village life. its hall the scene of the manorial court and the place of assembly of the tenantry. Usually the work of local craftsmen. the house mas more subject than the castle to local influences. physical and political. giving rise to distinctive regional forms of building. The particular character of the manor house is most clearly represented in England and France. but under different names the dwellings of feudal overlords are to be found in all countries wherein the manorial system developed. fulfilling similar functions within the national expression of style and period.

In England in the 11th century, the early manor house was an informal group of related buildings in timber or stone comprising the hall. chapel, kitchen and farm buildings contained within a defensive wall and ditch. The manor house of Boothby Pagnell, Lincolnshire, is of late 12th-century date and comprises a hall and private chamber placed defensively at first-floor level over a storage undercroft, and contained n-ithin a moated enclosure. In large houses at this time the hall (*q.v.*), which throughout the medieval period was the major element of domestic architecture, was more conveniently planned at ground level, as in Oakham castle. Rutland. n-ithin a more strongly deiended enclosure. and subsequently this hall arrangement was generally adopted. Stokesay castle, Shropshire. is the finest surviving example of a fortified manor house of the 13th century, the ground-floor hall being flanked by toners and further defended by a moated enclosure. By the 14th century the manor house plan was clearly defined, with private living apartments and service rooms planned at opposite ends of the great hall. the parts being more closely integrated, in many major instances enclosing an irregular courtyard, while battlements, gatehouse and moat continued to be provided as at Ightam Mote. Kent. Cothay manor, Somerset, is a characteristic house of the 15th century showing little advance in planning but having more domestic character than earlier instances, while Ockwells manor. Berkshire. also built in the 1 jth century, is the regional timber framed expression of the same hall plan, without defensive pretensions.

Comparable development in France was delayed by internal conflict. and until the ending of the Hundred Years War. in 1453, considerations of defense dominated manorial building. Such early manor houses as that at Saint Medard en Jalle. near Bordeaux, built in the 13th century, and the 14th-century Manoir de Camarsac (Gironde) comprise a rectangular fortified tower in which the principal rooms are at first-floor level above cellars, standing nith subsidiary buildings in a walled and moated enclosure. In Normandy, the Manoir d'Ango, near Dieppe. reveals some advance in domestic planning in the 1 jth century, the house standing at one end of a courtyard, flanked by farm buildings and defended by a gatehouse.



A. F. KERSTING

MONTACUTE HOUSE. SOMERSET. EARLY ENGLISH RENAISSANCE STYLE, 1580–1601

With the decline of manorial significance coinciding with increased prosperity and the call for more commodious dwellings, development of the manor house in the 16th century emerges into that of the Renaissance country house. In England. increased formality combined nith the new use of bricks and terra cotta produced more elaborate buildings, frequently of regular quadrangular plan, the hall declining in size and importance. Sutton place, Surrey (c. 1525), illustrates this phase. which leads to the more complex block plans of the Renaissance as at Ramsbury manor. Wiltshire (c. 1680). where the hall is reduced to the status of an entrance. The defended tower-house tradition persists in France throughout the 16th century in such instances as the Manoir des Tourelles, at Rumilly, near Troyes. generally retaining corner turrets and other defensive archaisms. while revealing classical influence in the symmetry of the *appartement* plan, which was later to become a feature of the Renaissance château. In later years the title of manor house in England lost particular significance. being adopted by large country mansions which had no manorial foundation.

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MANRESA, a rown of Spain, in the province of Barcelona, on the Cardoner river and the Barcelona-Lérida railway. Pop. (1950) 40,021 (mun.). It is probably the *Munorisa* of the Romans, the capital of the Jacetani or Jaccetani. A large part of the town was burned by the French in 1811. Manresa is the chief town of the highlands watered by the Cardoner and upper Llobregat, which meet below the town, and are also connected by a canal 18 mi. long. The principal buildings are the collegiate church of Santa Maria de la Seo, the Dominican monastery, and the church of San Ignacio, built over the cavern where Ignatius de Loyola spent most of the year *1522* in penitentiary exercises and the composition of his *Exercitia spiritualia.* Manresa has iron-foundries and manufactures of woolen, cotton and linen goods, ribbons, hats, paper, soap, chemicals, spirits and flour. Building stone is quarried nearby.

MANRIQUE, GÓMEZ (1415?–1490?), Spanish poet, chiefly remembered as the earliest Spanish dramatist whose name is known, was born at Amusco, Tierra de Campos, and probably died at Toledo. He took a prominent part in the rebellions of the reigns of John II and Henry IV, as soldier, politician and diplomat and won fame as an orator during his governorship of Toledo. His *Cancionero* contains 108 poems, written in the manner of the time. His nativity play, *Representacidn del nacimiento de Nuestro Señor,* his *Lamentaciones fechas para Semana Santa,* and his two *momos,* or interludes, contain the elements of the religious and secular drama of the future. (C. C. SH.)

MANRIQUE, JORGE (1440?–1479), Spanish poet and soldier, of a noble and literary family, nephew of Gómez Manrique (*q.v.*), is famous for his elegy on the death of his father. He was born probably at Paredes de la Nava, Palencia, *c.* 1440, and died near Garci-Muñoz on March 27, 1479. His love songs, satires and acrostic verses are little more than ingenious compositions in the manner of his age; he owes his imperishable renown to the *Coplas por la muerte de su padre* (1476), an elegy in the haunting *pie quebrado* metre, in which each 12-line stanza has 4 triplets, the triplets having lines of 8, 8 and 4 syllables. Although this is based in part on a similar lament by his uncle, and contains numerous echoes of the Bible and Boethius, its derived thoughts and commonplaces on death are transformed by grief into something intensely personal and (for the 15th century) unusually lyrical. The perfect technique and the sublimity of expression help to explain the poem's lasting fame. (C. C. SH.)

MANSARD ROOF, a roof having two slopes on every side, the lower slope being considerably steeper than the upper. Although used as early as the mid-16th century by Pierre Lescot at the Louvre, it was named after François Mansart (*q.v.*), who employed it for Paris *hôtels* and the châteaux of Balleroy. Blois and Maisons. It was probably first used because its predominantly horizontal profile was more in harmony with the classical orders than high-pitched roofs. The mansard, when pierced with dormers, also provides a more spacious and economical attic story. During the mid-19th century it was particularly popular, especially in France and the United States. *See* also **ROOF.** (Js. S. P.)

MANSART (MANSARD), **(NICHOLAS) FRANÇOIS** (1598–1666), French architect, who expressed more than any contemporary architect the classical spirit of the 17th century in France, was born in Paris on Jan. 23, 1598. He was the son of a Parisian master carpenter, probably worked under Salomon de Brosse and was certainly strongly influenced by him. By 1635 he was undertaking important commissions for the crown, but the masterpiece of his early period is the château of Balleroy (begun *c.* 1626) for Choisy. chancellor to Gaston d'Orleans, in which he combines the classicism of de Brosse with the Henri IV brick-and-stone style of building. Soon afterward Mansart reconstructed Blois for Louis XIV's brother. This work, although never completed, shows Mansart's classicism at its most subtle; it was there that he first used the high-pitched type of roof which bears his name (mansard), though. in fact, de Brosse had already used it at Rennes. In 1645 Mansart was commissioned by Anne of Austria to build the church of the Val-de-Grbce in Paris. Though he was replaced by J. Lemercier in 1646, the plan and much of the construction of the walls is Mansart's work. The design derives from Palladio's church of the Redentore at Venice, one of the purest examples of High Renaissance classicism, and a scheme adopted again by Mansart for the chapel at Fresnes. Between 1635 and 1655 he built a number of important private houses in Paris in which his subtle and ingenious mind is revealed in skillful planning on sites often awkwardly shaped. The château de Maisons (now Maisons-Laffitte) is the most complete work by the architect to survive. It was completed save for the severely rich decoration by 1646.

Mansart's work is marked by extraordinary clarity and restraint. He was able to combine a flexible use of the classical with great richness of decoration.

See A. F. Blunt, *François Mansart* (1941) and *Art and Architecture in France 1500 to 1700* (1953). (F. J. B. W.)

MANSART (MANSARD), **JULES HARDOUIN** (1646?–1708), French architect, who designed Versailles under Louis XIV, was born in Paris probably on April 16, 1646, son of the painter Raphael Hardouin. He was a grandnephew by marriage of the architect François Mansart, whose surname he adopted in 1668. In 1674 Mansart was commissioned by Louis XIV to build a château for Madame de Montespan. He was by this time launched upon a brilliant career under the king's patronage. Among his earlier additions to St. Germain were a number of private houses, including the Hôtel de Lorges (later Hôtel de Conti), his own residence. As official architect to the king he was entrusted with the redesigning and additions to the palace of Versailles and its environs; there he built the new Galerie des Glaces and Orangerie, the Trianon and the north and south wings in a harmonious, classical style. In addition to this enormous project. which occupied much of his life, Mansart built many other public buildings, churches and sumptuous houses. After making additions to the Palais Royal and building part of Orleans cathedral, he completed the famous chapel of St. Louis des Invalides (Dôme des Invalides), Paris, in a blend of Greek classical and baroque styles. He was responsible for the Place Vendôme, the Place des Victoires and the Maison de St. Cyr, all in Paris. His country mansions included the Château de Luneville and the Chbteau de Sagonne. The royal residence at Marly was his creation. One of the most successful architects of his day, Mansart had his own atelier where he worked with collaborators and trained his protégés. He was working on the chapel at Versailles when he died on May 11, 1708.

MANSEL, HENRY LONGUEVILLE (1820–1871), English philosopher and churchman, born at Cosgrove, Northamptonshire on Oct. 6. 1820, was educated at Merchant Taylor's school and St. John's college, Oxford. He was elected Waynflete professor of moral and metaphysical philosophy at Oxford in 1859 and regius professor of ecclesiastical history in 1867, in which year he also became canon of Christ Church. He was appointed dean of St. Paul's in 1868. Mansel died at Cosgrove on July 30, 1871.

In philosophy, Mansel was a follower of Sir William Hamilton (*q.v.*), developing Hamilton's ideas in an article on metaphysics written for the eighth edition of the *Encyclopœdia Britannica* (1857) and defending them, in *The Philosophy of the Conditioned* (1866), against the attacks of John Stuart Mill. In his Bampton lectures, *The Limits of Religious Thought* (1858), Mansel developed Hamilton's doctrine that human knowledge was strictly limited to the finite and "conditioned." The resulting contention that the human mind could not attain to any positive conception of the nature of God provoked much controversy in which Mansel was accused of agnosticism, though he had meant to attack deism, not theism. Mansel's other published works include *Prolegomena logica: an Inquiry Into the Psychological Character of Logical Processes* (1851) and *The Gnostic Heresies of the First and Second Centuries* (ed. by J. B. Lightfoot, 1875). He edited Henry Aldrich's *Artis logicae rudimenta* (1849) and, with J. Veitch, Sir W. Hamilton's *Lectures on Metaphysics and Logic,* 4 vol. (1859–60).

See J W. Burgon, *Lives of Twelve Good Men* (1888).

MANSFELD, a German family which took its name from Mansfeld in Saxony, where it was seated from the 11th to the 18th century. One of its earliest members was Hoyer von Mansfeld (d. 1115), a partisan of the emperor Henry V during his struggles with the Saxons; he fought for Henry at Warnstadt and was killed in his service at Welfesholz. Albert, count of Mansfeld (1480–1560), nas an intimate friend of Luther and one of the earliest and staunchest supporters of the Reformation

With Albert was associated his brother Gebhard, and another member of the family was Johann Gebhard, elector of Cologne from 1558 to 1562. A scion of another branch of the Mansfelds was Peter Ernst, Fürst von Mansfeld (1517–1604), governor of Luxemburg, nho was loyal to Charles V. He went with the emperor to Tunis and fought for him in France He served Philip II at St. Quentin and in the Netherlands, and led a body of troops against the Huguenots. In this capacity he was present in 1569 at the battle of Moncontour, nhere Count Wolrad of Mansfeld (d 1578) was among the Huguenot leaders.

MANSFELD, ERNST, GRAF VON (*c* 1580–1626), German soldier, was an illegitimate son of Peter Ernst, Fürst von Mansfeld. He allied himself with the Protestant princes, and was dispatched by Charles Emmanuel duke of Savoy, at the head of about 2 000 men to aid the revolting Bohemians at the outbreak of the Thirty Years' War in 1618. He took Pilsen, but in the summer of 1619 he was defeated at Zablat. After this he remained inactive while the titular king of Bohemia, Frederick V elector palatine of the Rhine, was driven from Prague. Mansfeld was appointed by Frederick to command his army in Bohemia, and in 1621 he established himself in the Upper Palatinate, successfully resisting the efforts made by Tilly to dislodge him. From the Upper he passed into the Rhenish Palatinate. There he relieved Frankenthal and took Hagenau; then, joined by his master, the elector Frederick, he defeated Tilly at Wiesloch in April 1622 and plundered Alsace and Hesse. Mansfeld's ravages were so ruinous to the districts he was commissioned to defend that Frederick was obliged to dismiss Mansfeld's troops from his service Joining Christian of Brunswick, the count then led his army through Lorraine, devastating the country, and in Aug. 1622 defeating the Spaniards at Fleurus. He next entered the service of the Gnited Provinces About 1624 he paid three visits to London, where he was hailed as a hero. James I furnished him with men and money for the recovery of the Palatinate, and in Jan. 1625 Mansfeld and his army sailed from Dover to the Netherlands. On the renewal of operations in Germany in the autumn Mansfeld was again engaged. Defeated by Wallenstein at Dessau (1626), he raised another army, and pursued by Wallenstein, he pressed toward Hungary, where he hoped for aid from Bethlen Gabor, prince of Transylvania. But Gabor made peace with the emperor, and Mansfeld was compelled to disband his troops. He died at Rakowitza Nov. 20, 1626.

MANSFIELD, KATHERINE (1888–1923), British writer, was born at Wellington, N.Z. She published *In a German Pension* (1911), and in 1918 married John Middleton Murry, the critic, with whom she had been associated in the publication of a literary review, *Rhythm*. Her brilliant talent for the short story form was displayed in a collection issued as *Bliss* (1920), and her acute critical powers in frequent contributions to *The Athenaeum*, then edited by her husband. This was followed by *The Garden Party* (1922), but a career of great promise was cut short by death on Jan. 9, 1923. Further stories, *The Doves' Nest*, appeared later in that year, also a volume of *Poems*. In 1924 was published *Something Childish*, tales and fragments of minor interest, and in 1927 the *Journal of Katherine Mansfield* (1914-22). Her *Letters* in two volumes were published in 1928.

MANSFIELD, RICHARD (1854 or 1857–1907), U.S. actor, intense, somewhat eccentric, but unquestionably brilliant and one of the last of the great romantic stars, was born on May 24 in Berlin, where his mother Erminia Rudersdorff was engaged in a concert tour. His father Maurice Mansfield died when Richard was two, and Madame Rudersdorff and Richard spent the subsequent years in concert tours of England and the continent. In 1872 they arrived for the first time in New York city, where young Richard alternately turned to singing, painting and acting. Dissatisfied with his lack of accomplishment, he returned to England in 18;7 and during the next six years achieved moderate success as a singer of light opera, principally of Gilbert and Sullivan. In the United States again in 1882, he turned to the spoken drama, attracting considerable attention as Baron Chevrial in *A Parisian Romance*. Through the next 20 years he continued to build his reputation in both England and the United States as an exciting, though frequently unpredictable, star. His chief roles were Jekyll and Hyde (1887), Richard III (1889), Beau Brummell (1890), Shylock (1893) and Cyrano (1898). In 1894 Mansfield produced *Arms and the Man* in New York, the first production of Shaw in America. In 1906 his *Peer Gynt* was a success in its Chicago opening, but, after moving it to New York and playing Peer and Baron Chevrial on the same day, Mansfield collapsed, physically and nervously exhausted. After a year's struggle to regain his health, he died in New London, Conn., Aug. 30, 1907.

See Paul Wilstach, *Richard Mansfield, the Man and the Actor* (1908); William Winter, *Life and Art of Richard Mansfield*, 2 vol. (1910).

(S. W. H.)

MANSFIELD, WILLIAM MURRAY, 1ST EARL OF (1705–1793), English judge, for 34 years chief justice of the king's bench, was born at Scone, in Perthshire, Scot., on March 2, 1705, the son of the 5th viscount Stormont. Only Sir Edward Coke and Sir Matthew Hale rivaled him as chief justice, parts of his work being published and becoming authoritative almost before he was off the bench. Subsequently, he three times procured position as a member of the cabinet, simultaneously getting the Great Seal (the chancellor's office) entrusted to a committee. Thus he retained the chief justiceship regardless of changes in administration but still exerted political power, a practice which later happily became unconstitutional. Educated at Perth grammar school, Westminster school and Christ Church college, Oxford, Mansfield was called to the bar at Lincoln's Inn in 1730. In Scotland he became famous by his appearance for the city of Edinburgh when it was threatened with disfranchisement for the affair of the Porteous mob, but his English practice remained scanty until in 1737 a single speech in one jury trial placed him at the head of the bar. In 1742 he was appointed solicitor general. In 1754 he became attorney general and acted as leader of the house of commons under the duke of Newcastle. In 1756 he claimed the chief justiceship of the king's bench and was made Baron Mansfield. In 1776 he was created earl of Mansfield. In 1783, during the coalition ministry, he declined cabinet office, but served as speaker of the house of lords. He resigned as chief justice in 1788 and died on March 20, 1793.

As must be the case with any court in central position, politics followed Mansfield to the bench. Three matters particularly reveal the man. After the burning of his house and precious library in 1780 in those "No Popery" riots, which involved mobs of 50,000 and invasion of parliament itself, Mansfield so fairly conducted the treason trial of the leader Lord George Gordon, that an acquittal resulted. In the Wilkes case (1768) he rose above both popular clamour and royal pressure by careful technical work on the precedents. This work developed legal flaws in the crown's case unknown to the defendant himself. Thus the Tory judge discharged an agitator because the Tory's own type of due process so required. The nidespread viem that Mansfield abolished slavery with one judicial decision, while it took a civil war in the United States, is, however, superstition. Mansfield sought, with all of his high tactical powers, to avoid any slavery issue: he was a property-minded man of commerce. Even the famous judgment in Somersett's case (1772) decided only that an escaping slave could not be forcibly removed from England to vengeance in a colony. This, as Benjamin Franklin rightly protested, meant no abolition of "a detestable commerce" or of slavery in the colonies—both encouraged by the British laws until statutory changes in 1807 and 1833. Indeed, no vital emotional issue can be settled—though it may be helped toward solution—by judicial decision. The Dred Scott case and the segregation cases make this clear.

Mansfield's permanent stamp upon Anglo-American law lies in commercial law. When he mounted the bench, two years before the start of that Seven Years War that riveted Britain's grasp upon America, India and international trade, the English law was land-centred and landbound in outlook and intrenched professional tradition. Reform was imperative. Mansfield's vision and ambition reached beyond following the continental model of a special body of rules for commerce and banking. He sought to make the international law of commerce not a separate branch but an integral part of the general law of England, both common law and equity, using the leverage thus gained to pry loose from feudalism whole blocks of other rules which had few or no direct commercial bearing. An important part of this brilliant venture succeeded.

In the area of bills of exchange (drafts), promissory notes and the then novel check. Mansfield, modeling on standard international practice. shaped the law in sweeping judgments, each typically canvassing the whole relevant situation and its reasons. *Heylyn* v. *Adamson* (1758) 2 Burrow 669 is an example. No judge has ever surpassed him here. A second area involved fresh creation. Marine insurance. then a new industry. was centred in London and was a weapon of competition and cold war. Mansfield did not build here on models; he created the entire discipline.

He was not always so successful. In *Pillans* v. *Van Mierop* (1765) 3 Burrow 1663. he made enforceable without consideration, *i.e.*, roughly. without any bargained-for return, a merchant's (banker's) "confirmed credit" or promise to accept drafts drawn from abroad. This decision was viewed, though without good ground, as a flat attack on the whole doctrine of consideration. and that doctrine was reaffirmed in its entirety by the house of lords in *Rann* v. *Hughes* (1778) 7 T.R. 350, n. A second defeat was in his effort to make a document transferring land receive an interpretation according to plain intention, rather than have such intention frustrated by some technical rule giving unmeant effect to words. His decision on this, in *Perrin* v. *Blake*, was reversed in 1772 (one of six reversals during 32 years of active service). But he triumphed in his expansion of the idea that a man should turn back or turn over any value received by mistake or wrongdoing or otherwise under circumstances making it inequitable for him to retain it. The remedy was by a fictitious "promise" to pay over ("quasi-contract"; modernly, the fiction being discontinued: "restitution"). This decision involved not only a wide new range for remedy but, as in the case when the sum received on resale of another's goods was substituted for their arguable value, an important simplification and easing of the plaintiff's proof.

Despite his long tenure, the "father of commercial law" had almost no cases on the heart of modern commercial law: mercantile contracts for the sale of wares. But he had chosen to make commercial law and general law a single whole. When commercial sales cases did arise, they came, ironically, before judges who thought in terms of haystacks and of horses, and the central area of commercial law was for more than a century given a flavour of land and manure rather than of commerce.

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(K. N. L.)

MANSFIELD, a municipal borough in the Mansfield parliamentary division of Nottinghamshire, Eng., on the river Maun, 14 mi. N.N.W. of Nottingham. Pop. (1951) 51,352. It lies on the western outskirts of Sherwood forest and the dukeries. Mansfield was occasionally the residence of Mercian kings and afterward the resort of Norman sovereigns. During the reign of Edward the Confessor it was a royal manor and was finally held by the duke of Portland. A market charter was granted in 1227, a fair charter in 1377. In 1891 it was incorporated. Rock houses (hewn out of the solid rock) are a reminder of the town's antiquity. The parish church of SS. Peter and Paul is early Norman and Perpendicular. The Old Meeting house was built in 1701. The Moot hall was built in 1752. The Bentinck memorial, in the market place, was erected in 1849. Newstead abbey, ancestral home of the poet Lord Byron, lies 4 mi. S.

Mansfield is situated in the heart of the north Nottinghamshire coal field. Manufactures include boots and shoes, hosiery, artificial silk. woolens, plastics, radio and aircraft components, leather and bricks.

MANSFIELD, a city in north-central Ohio, U.S., the seat of Richland county., is almost equidistant between Cleveland and Columbus, about 75 mi. from each city. Situated on rolling land at the very edge of the Allegheny plateau, it was first surveyed by Gen. James Hedges in 1808, three years after Indian titles were removed by the treaty of Fort Industry. Named after Jared Mansfield. surveyor general of the United States, the town grew slowly until the advent of the Mansfield and Sandusky railroad (later part of the Baltimore and Ohio system) in 1846; the Pittsburgh, Fort Wayne and Chicago railway (ultimately part of the Pennsylvania system) in 1849; and the Atlantic and Great Western railway (later included in the Erie system) in 1863. Thereafter its growth was more rapid; the city became an important manufacturing centre in the post-Civil War period. By the 1960s Mansfield's diversified industry embraced electric and gas appliances, tires and inner tubes, auto bodies, sheet steel, electric distribution equipment, plumbing fixtures, vitreous china and thermostats.

Distinctive features of the community include the Kingwood Center; a 47-ac. horticultural and botanical garden; a War of 1812 log blockhouse; and a monument to John Chapman (Johnny Appleseed), who for nearly 20 years considered Richland county his home.

The Malabar farm, established by novelist Louis Bromfield, is not far from the city. For comparative population figures ***see*** table in OHIO: *Population*. (P. R. S.)

MANSHIP, PAUL (1885–), U.S. sculptor, creator of the large bronze figure of Prometheus overlooking the Rockefeller Center plaza, in New York city, was born in St. Paul, Minn., on Dec. 25. 1885. After studying in St. Paul, Philadelphia and New York city, he won a scholarship in 1909 to the American academy in Rome. After three years abroad he settled in New York. Starting in 1913 with a prize from the National Academy of Design, his works continued to win awards. In their subjects and generalized style his statues are inspired by classical art. To a lesser degree he was influenced by the east, especially India. Renowned for excellent craftsmanship, he developed a distinctive style remarkable for its simplified modeling and rhythmical patterns. Among his large decorative works, mostly in bronze, are: "Dancer and Gazelles" (1916), of which there are versions in several museums; the Prometheus fountain (1934) in Rockefeller plaza; "Celestial Sphere" (1939); and Woodrow Wilson memorial at the Palais des Nations, Geneva.

Manship executed many portraits in marble; most striking are: "Pauline Frances — Three Weeks Old" (1914), Metropolitan Museum of Art, New York city and "John D. Rockefeller" (1918), collection of John D. Rockefeller, Jr. His bronze "The Young Lincoln'! is in Fort Wayne, Ind. Manship's delightful depictions of animals are much admired; particularly famous is the Paul J. Rainey memorial gateway at the Bronx zoo, New York city (1934).

See E. Murtha, *Paul Manship* (1957). (M. I. B.)

MANSLAUGHTER, in Anglo-American criminal law, the unlawful killing of another human being, without malice, either express or implied. In the U.S., several states define by statute two kinds of manslaughter: voluntary, in which there is intent to produce the injury; and involuntary, in which there is no such intent. Other states recognize several distinct degrees of the crime. All these distinctions are purely statutory and do not enter into the common law definition. For the distinction between manslaughter, murder and other forms of homicide, see HOMICIDE. (A. DM.)

MANSON, SIR PATRICK (1844–1922), British parasitologist, the first outstanding modern practitioner, teacher and research worker in the field of tropical medicine, was born in Scotland on Oct. 3, 1844 He practised medicine in Takao, Amoy and Hong Kong (1866–89), and thereafter in London until his death. He was elected fellow of the Royal society in 1900, knighted in 1903, created Knight Grand Cross of St. Michael and St. George in 1912, became first president of the Society of Tropical Medicine and Hygiene (1907–08) and was recipient of many medals and honorary degrees. He published several hundred scientific papers. He died on April 9. 1922.

Manson was first to discover (1877–79) that an insect (mosquito) can be host to a developing parasite (the worm *Filaria bancrofti)* of a human disease (filariasis). In 1894 he published his mosquito-malaria hypothesis, which led to the discovery by Ronald Ross (*q.v.*) that malaria, like filariasis, is a mosquito-transmitted disease.

In 1898 Manson published a textbook on tropical diseases that, frequently revised, has been a standard ever since. In 1899 he organized the London School of Tropical Medicine.

See P. H. Manson-Bahr and A. Alcock, *The Life and Work of Sir Patrick Manson (1927).* (P. F. R.)

MANSUR, AL-, throne name or honorific title assumed by several Muslim rulers, meaning "aided," or "rendered victorious [by God]." It is also used as an ordinary name. The best-known are discussed below.

ABU JA'FAR ABDULLAH AL-MANSUR (714–775), second Abbasid caliph (see CALIPHATE). who reigned from 754 to 775. Born in Xug. 714, the son of a Berber slave girl. he followed his brother Abu'l-Abbas al-Saffah on the throne. His main task mas to secure the rule of the dynasty, which had come to power only in 750. So successful mas he in this that he must be regarded as the real founder of the dynasty. First. with the help of Abu Muslim. he defeated his uncle Abdullah, governor of Syria. who disputed his succession. Then he had Xbu Muslim treacherously murdered, since his power in Khurasan seemed to threaten the caliph's. Later, in 762–763. a Shi'ite rising in Mecca and Medina was ruthlessly crushed. Khurasan was pacified by the appointment in 759 of al-Mansur's son. known as al-Mahdi, as governor. The completion of the new capital at Baghdad in 766 was an outward mark of al-Mansur's success in pacifying the caliphate (apart from Spain) and firmly establishing Xbbasid rule. The new capital also shows the shift of power eastward, since the Abbasids depended on the armies of Iraq and Khurasan. At the same time Persian traditions of government mere followed more closely. and Persian Muslims had a greater share in the state. The Persian office of vizier was introduced. with a number of separate offices or ministries (diwans) subordinate to it, Al-Mansur died in Bir Maimun in Oct. 775 while on a pilgrimage to Mecca.

ABU TAHIR ISMA'IL IBN AL-QA'IM, third Fatimid caliph in north Africa who reigned from 946 to 953.

ABU YUSUF YAQUB AL-MANSUR. often called Jacob Almanzor, nho ruled from 1184 to 1189 as prince of the Moorish dynasty of the Xlmohads (*q.v.*) in north Africa and Spain. He was the son of a Christian slave girl. The Giralda at Seville is a notable architectural monument of his reign. His defeat of Alfonso VIII of Castile at Xlarcos (1196) is the culminating event of Almohad rule in Spain. Subsequently it rapidly declined.

IBN ABI-'AMIR AL-MANSUR. known to European writers as Almanzor, chief minister and virtual ruler of the Omayyad caliphate of Córdoba from 978 to his death in 1002. (See CÓRDOBA, CALIPHATE OF.) Descended from an Arab nho took part in the conquest of Spain, he rose by his own skill. tact and efficiency. He had the support of Subh, the Basque mother of the young caliph Hisham II, and she nas said to be his mistress. With his father-in-law. the general Ghalib, he overthrew the previous chief minister in 978. A rupture with Ghalib led to the latter's defeat and death in battle in 981. By giving the African territories local independence under Omayyad suzerainty. he stopped a drain on his resources. This and the replacement of the Slavs in the army by Berber and Christian mercenaries enabled him to conduct a series of successful campaigns against the Christian states of northern Spain. including one against Santiago in 997. From 981, when he assumed the honorific name of *al-Mansur bi'llah* ("the one made victorious by God"), he had supreme power and gradually adopted various outward marks of it. Though in 994 he took the title of "Noble King" (*al-Malik al-Karim*). the caliph continued as nominal head of state. He died at Medinaceli on Aug. 10, 1002. on the way back from a campaign. His rise to power is comparable to that of the Buyids and Seljuks in the east. A son succeeded him. but the family. known as the Amirids. retained poner for only a few years. (W. M. WT)

MANSURAH, AL (MANSURA), a tonn of lower Egypt on the eastern side of the Damietta branch of the Nile. It is the capital of Ad Daqahliyah governorate and is 90 mi. N. of Cairo and 34 mi. S.W. of Damietta. Pop. (1957) 136 057. It has rail connections with Az Zaqaziq (Zagazig) and Cairo and is an important market centre for the cotton, flax and rice of the northeast delta. Its principal industries include cotton ginning. cottonseed oil extraction. rice milling and textile manufactures.

Al Mansurah was founded in A.D. 1221. The only event of importance in its history is the battle of the same name, when King Louis IX, who was leading a crusade to attack Islamic power in Egypt. was outmaneuvered and his forces decimated on Feb. 8, 1250. It was this battle that largely contributed to the ultimate defeat of the French expedition (*see* CRUSADES).

The fort, called St. Louis after the French king, is still standing. (A. B. M.; M. V. S.-W.)

MANTEGNA, ANDREA (1431–1506), greatest north Italian fresco painter of the 15th century. was born at Isola di Cartura near Piazzola. Italy, in 1431 and was apprenticed by his father, a carpenter. to the Paduan painter Francesco Squarcione. In 1441 he is mentioned as Squarcione's adopted son. He seems to have remained in this painter's studio for six years. moving mith Squarcione to Venice in 1446. By 1448. when at the age of 17 he signed a lost altarpiece for Sta. Sofia in Padua, he was an independent artist. Padua was the seat of the most prominent university in north Italy, and from a very early date Mantegna must have been indoctrinated with the humanist culture that formed the mainstay of his art. In addition. he would have become familiar with the work of the Florentine artists nho had been employed in the church of S. Antonio, notably Fra Filippo Lippi and Donatello. The latter was resident in Padua after 1443 and exercised a profound influence on Mantegna's work. In Venice the frescoes of Andrea del Castagno in S Zaccaria. the mosaics of Paolo Uccello and the personality of Jacopo Bellini must also have left their impression on his mind. These experiences are summed up in Mantegna's first major work, the frescoes in the Ovetari chapel of the church of the Eremitani in Padua.

Before this chapel was destroyed by bombing in 1944, it contained a cycle of frescoes covering the lateral walls and vault, the altar wall and the upper part of the apse behind. The commission owed its origin to the will of Antonio Ovetari and seems to have been allotted in the first instance to Squarcione, by whom the work was subcontracted to Antonio Vivarini and Giovanni d'Allemagna, on the one hand, and to Mantegna and Niccolo Pizzolo, on the other Of the sections executed by Mantegna, the "Martyrdom and Removal of the Body of St. Christopher" (begun by Pizzolo) and an Assumption of the Virgin survive in part. The poles of Mantegna's development in the Ovetari chapel are the still tentative full-length saints painted in the apse and the masterly scenes on the base of the left wall, which belong to the last phase of work in the chapel, and were probably painted in 1456. Viewed solely from the standpoint of space projection. Mantegna's frescoes are the most progressive paintings of their time. Throughout the scenes the architecture is authentically classical and incorporates the rich archaeological detail that is a feature of Mantegna's mature work.

In Aug. 1453 Mantegna received the commission for a polyptych for the chapel of St. Luke in Sta. Giustina at Padua. This altarpiece, now in the Brera gallery in Milan, was completed in November of the following year and corresponds in style with the intermediate frescoes in the Ovetari chapel. The style of the latest of the frescoes is translated to the field of panel painting in an altarpiece commissioned for S. Zeno at Verona by Gregorio Correr. probably in 1456 (completed 1459). Inspired by Donatello's high altar in the Santo at Padua, the main panels represent, between four massive wooden columns, the Virgin and Child enthroned with four saints in an open hall. One of the richest and most brilliant of all north Italian altarpieces, the S. Zeno triptych now lacks its predella which is distributed between the Louvre ("Crucifixion") and the museum at Tours ("Agony in the Garden" and "Resurrection").

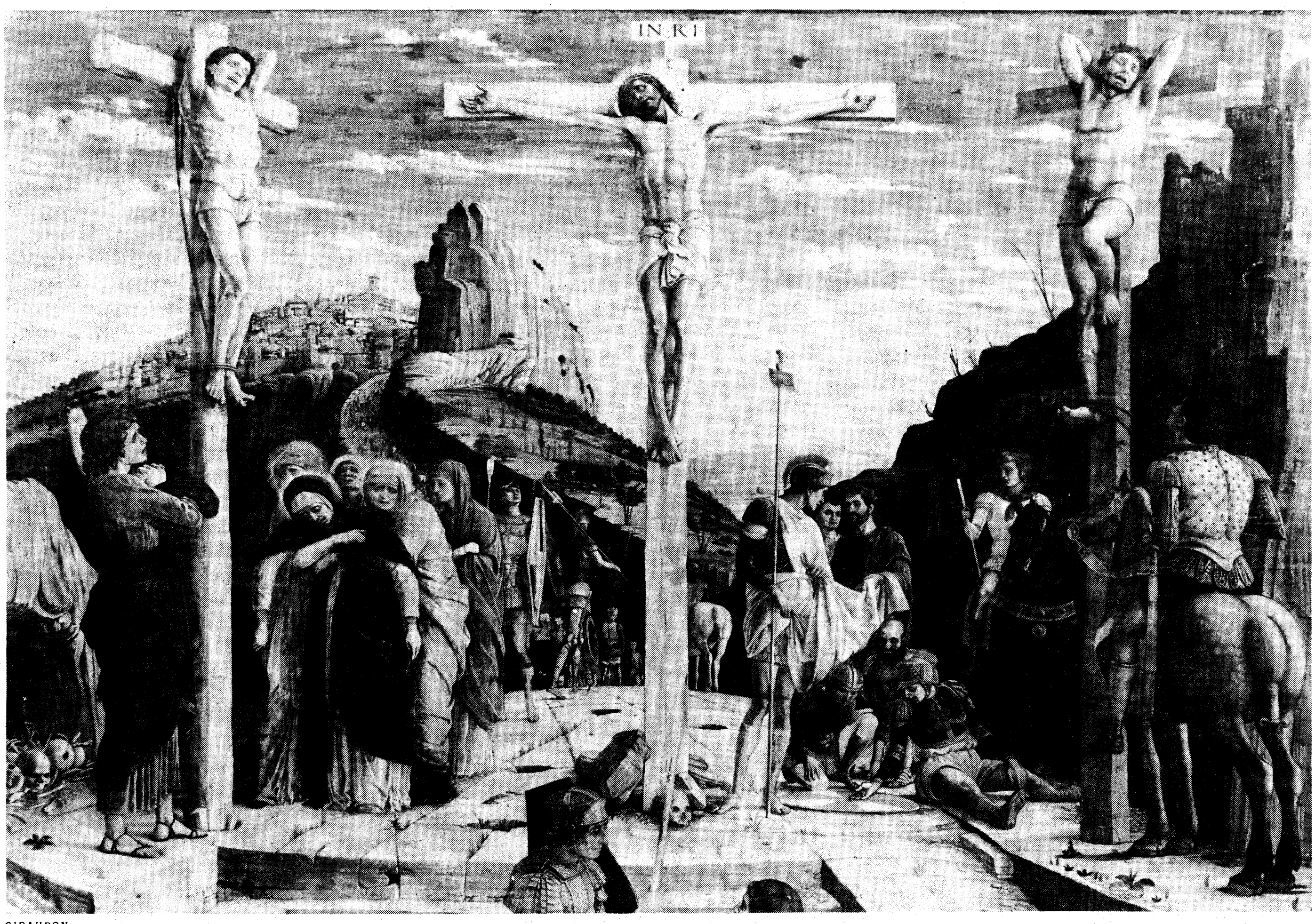
Before 1453 Mantegna married Nicolosia, daughter of Iacopo and sister of Giovanni Bellini. Mantegna's influence on Bellini is evident in a painting of the "Transfiguration" in the Museo Correr in Venice and certain other early works. A point of comparison betneen the tno artists is afforded by two paintings of the "Agony in the Garden" in the National gallery. London. both of which derive from a drawing by Iacopo Bellini. Mantegna's classicizing figures are set in the same arid landscape as the Ovetari "Martyrdom of St. James," whereas in Bellini's panel this academic classicism is replaced by a warm romantic apprehension of nature and natural forms.

On Jan 30, 1459, Mantegna was appointed court painter to Lodovico Gonzaga, marquess of Mantua, and he moved to Mantua later in the year. No dated work by him survives between this year and the completion of the frescoes in the Camera degli Sposi of the ducal palace at Mantua in 1474, though it is known that he executed paintings (lost) in the chapel of the ducal palace (still unfinished in 1464), in the castle of Goito and at Cavriana. In 1466–67 he visited Pisa and Florence. The commission for the Camera degli Sposi has been credibly assigned to the year 1472. The ceiling of the room is decorated with fictive reliefs of emperor heads and nith triangular grisaille paintings of mythological scenes, also in imitation of the antique. In the centre is a circular aperture in which a number of figures are represented looking down over a balustrade. This detail forms a landmark in the history of illusionistic painting and was of fundamental importance for the illusionistic frescoes of Correggio. On the wall above the fireplace is a much damaged scene representing the court of Lodovico Gonzaga. There, too, the wall surface is treated illusionistically with consummate constructional resource. On the second of the two painted walls is a fresco of Lodovico Gonzaga and his son Cardinal Francesco (possibly in commemoration of the latter's visit to Mantua in 1472), a fragmentary fresco of two huntsmen and hounds and. above the doorway between them. a number of putti supporting a tablet recording the date of completion of the work. The frescoes reveal Mantegna as a portrait painter of the first rank. Other examples of this aspect of his work are portraits of Cardinal Mezzarota (Raiser Friedrich museum, Berlin). Cardinal Carlo de' Medici (Uffizi, Florence) and an unidentified man (National Gallery of Art, Washington, D.C.).

At this time Mantegna enjoyed a high reputation not only as an artist but as a connoisseur of the antique. His archaeological and epigraphic studies provide a context for the second of his great Mantuan commissions. that for nine canvases of the "Triumph of Caesar" (Hampton court, Middlesex). These were in course of execution in 1486 and were still unfinished in 1492. Gravely damaged as they are, they form one of the most significant monuments of 15th-century humanist art.

In 1488 Mantegna visited Rome to decorate a small chapel in the Vatican (destroyed) on the commission of Pope Innocent VIII and to execute *trompe-l'oeil* (illusionistic) paintings in the adjacent sacristy. Work in the Vatican interrupted the progress of the "Triumph of Caesar." In 1495, after the completion of the latter work. Mantegna began work on the "Madonna of the Victory" (Louvre, Paris), which was commissioned by Giovanni Francesco Gonzaga to commemorate his victory over the French at Fornovo and was installed in the Cappella della Vittoria (also designed by Mantegna) in 1496. The course of Mantegna's development in the last years of his life may be judged from two paintings of St. Sebastian, one in the Louvre (probably 1481) and the other in the Ca d'Oro in Venice (before 1506). His last important commission was for three allegorical paintings for the studio of Isabella d'Este in the ducal palace. Two of these are now in the Louvre. A third painting (later completed by Lorenzo Costa) was unfinished when Mantegna died on Sept. 13, 1506. He was buried in the church of S. Andrea, Mantua, in a funerary chapel of his own design.

In addition to these major works Mantegna was responsible for executing many smaller paintings. Among these is a notable series



GIRAUDON

"THE CRUCIFIXION," CENTRE PREDELLA PANEL OF S. ZENO ALTARPIECE, BY ANDREA MANTEGNA. IN THE LOUVRE, PARIS of Madonnas (Kaiser Friedrich museum, Berlin; Accademia Carrara, Bergamo; Museo Poldi-Pezzoli, Milan; Brera gallery, Milan), the form of which was clearly influenced by the Madonna reliefs of Donatello. Other paintings are a well-known panel of "St. George" in the Accademia in Venice, a triptych of the "Adoration of the Magi." "Presentation in the Temple" and "Ascension" in the Uffizi gallery, Florence, and a strongly foreshortened figure, the "Dead Christ," in the Brera gallery, Milan. After 1491 (and perhaps as early as 1475) Mantegna was active as an engraver. Seven engravings (four of them of classical subjects) are usually accepted as his work. Though Mantegna's work is less immediately appealing, because colder and more detached, than that of his contemporary and brother-in-law Giovanni Bellini, we are conscious in his paintings of the working of a powerful intelligence and of the presence of an inventive faculty richer than that of any other north Italian artist of his time. His late work, like Bellini's, bridges the transition to the 16th century and opens the way to a world of experience which was explored, in the decades following his death, by his disciple Correggio.

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(J. W. P.-H.)

MANTELL, GIDEON ALGERNON (1790–1852), pioneer English geologist and paleontologist, noted as a discoverer and collector, was born at Lewes, Sussex. Educated for the medical profession, he practised at Lewes, Brighton and Clapham. He studied the paleontology of the Secondary rocks, particularly in Sussex—a region which he made classical in the history of discovery. His most remarkable discoveries were made in the Wealden formations. He demonstrated the fresh-water origin of the strata, and from them he brought to light and described the remarkable Dinosaurian reptiles known as Iguanodon, Hylaeosaurus, *Pelorosaurus* and Regnosaurus. He also described the Triassic reptile Telerpeton elginense.

Mantell was elected a fellow of the Royal society in 1825 and died in London on Nov. 10, 1852.

MANTEUFFEL, EDWIN, FREIHERR VON (1809–1885), Prussian general field marshal, was born at Dresden on Feb. 24, 1809, and entered the guard cavalry at Berlin in 1827.

In 1848 Manteuffel became aide-de-camp to Frederick William IV, whose confidence he had gained during the revolutionary movement in Berlin. Promoted to lieutenant colonel in 1852, and colonel to command the jth Uhlans in 1853, he was sent on important diplomatic missions to Vienna and St. Petersburg. In 1857 he became major general and chief of the military cabinet. He supported the prince regent's plans for the reorganization of the army. He served in the Danish war of 1864, and at its conclusion was appointed civil and military governor of Schleswig. In the Austrian War of 1866 he occupied Holstein and afterward commanded a division under Vogel von Falkenstein in the Hanoverian campaign, and succeeded him, in July. in command of the army of the Main (see SEVEN WEEKS' WAR). His successful operations ended with the occupation of Wurzburg, and he received the order *pour le mérite*. He then went on a diplomatic mission to St. Petersburg, where he was persona grata, and succeeded in gaining Russia's assent to the new position in north Germany. In the war of 1870–71 he led the I corps under Steinmetz, distinguishing himself in the battle of Colombey-Neuilly, and in the repulse of Bazaine at Noisseville (see FRANCO-GERMAN WAR; and METZ). He succeeded Steinmetz in October in the command of the I army, won the battle of Amiens against General Farre, and occupied Rouen, but was less fortunate against Faidherbe at Pont Noyelles and Bapaume. In Jan. 1871 he commanded the newly formed army of the South, which he led, in spite of hard frost. through the Côte d'Or and over the plateau of Langres, cut off Bourbaki's army of the east (80,000 men), and. after the action of Pontarlier, compelled it to cross the Swiss frontier. where it was disarmed. When the southern army was disbanded Manteuffel commanded first the II army, and. from June 1871 until 1873. the army of occupation left in France, showing great tact in a difficult position. He nas rewarded by promotion to the rank of general field marshal and a large grant in money. He was employed on several diplomatic missions, was for a time governor of Berlin, and in 1879 was appointed governor general of Alsace-Lorraine; and this office he filled until his death at Carlsbad, Bohemia, on June 17, 1885.

MANTINEA (MANTINEIA), an ancient city of Arcadia, in Greece, about 8 mi. N. of modern Tripolis in a long narrow marshy plain bounded on the west by Mt. Mainalon, on the east by Mt. Artemision, and without opening to the coast, the water percolating through underground passages (*katavothra*) to the sea. The supremacy of the district was disputed with Tegea (*q.v.*).

Mantinea is mentioned in the catalogue of ships in Homer's *Iliad*, but in early Greek times it was only a cluster of villages, insignificant compared with Tegea and submissive to Sparta. But soon after the Persian wars its five constituent villages, at the suggestion of Argos, were merged into one city, whose policy was henceforth guided by three main considerations: its democratic constitution of small freeholders; its ambition to control the watershed of the Alpheus (Alfios) river and Arcadian roads to the Isthmus of Corinth; and its chronic disputes with Tegea. In 468 B.C. the Mantineans alone of Arcadian townships refused to join the combination of Tegea and Argos against Sparta, and they assisted Sparta during the revolt of the Messenian helots of 464. Though formally on the same side in the Peloponnesian War. they employed the truce of 423 in fierce but indecisive war with Tegea. After the peace of Nicias (421) Mantinea allied mith Elis, Argos and Athens, but this alliance was defeated by the Spartans at the battle of Mantinea (418) and dissolved. During the 4th century and Hellenistic period Mantinea was of less importance, and in the later Roman empire the city dwindled into a mere village (which from the 6th century bore the Slavonic name Goritza) and as a result of malaria and Turkish rule has disappeared. The site was excavated by the French school at Athens, in 1888. The agora and adjacent buildings and the walls have been investigated. When the city was rebuilt in 370 B.C., the Ophis river, which formerly ran through the town, was divided so as to encircle the malls.

Battles of Mantinea.—Battles were fought in the years 418, 362 and 207 B.C. at Mantinea.

1. The first battle, in the Peloponnesian War (*q.v.*), is of some interest in the evolution of tactics. On the one side were the Spartans under the Spartan king Agis, while the other was composed of Argives. Mantineans and a small Athenian force. As the Spartan line advanced, a drift to the right occurred—a common occurrence in ancient battles, due to the natural instinct of each man to hug closely to his neighbour's shield as a protection to his own unguarded (*i.e.*, nonshield-bearing) side. Agis. seeing that this drift would cause his left flank to be overlapped by the enemy. sought to prolong his left. This stretching caused a gap in the centre, and the Spartan left wing was broken up by their adversaries who poured into the gap. This, however, was offset by the success of the Spartan right.

2. The second and more justly famous battle took place in 362 B.C. Epaminondas had followed up the sensational Theban victory at Leuctra (*q.v.*) by invading the Peloponnese in 370 and 369. A surprise attack on Sparta had narrowly failed. but strong opposition against it had been built up. Messenia had been re-established as an independent state with a new capital, Messene. on Mt. Ithome, and a new federal capital had been designed at Megalopolis for the Arcadian league. The position of Epaminondas, however, was not secure and Theban policy lacked consistency. A serious division also broke out in the Arcadian league reviving the old hostility between Tegea and Mantinea.

In 362 Thebes was driven to choose between reasserting its authority and sacrificing its prestige. Its move against Arcadia caused Greece to divide afresh into two hostile coalitions. Once more Epaminondas made a surprise spring at Sparta. but he was deprived of the fruits of his night march through a deserter, who warned the Spartan main army in time for it to hurry back and safeguard the capital. Epaminondas then stood on guard at Tegea while the enemy forces concentrated at Mantinea. The valley in which these places lay is shaped like an hourglass by the surrounding mountain ranges, and at the mile-wide waist the Spartans and their allies took up a strong position. Epaminondas determined to seek a decision by battle, and as in his strategy so in his grand tactics showed his art by an indirect approach.

At first he marched directly toward the Spartan camp, causing the enemy to form up in battle order facing his line of approach. But when still several miles distant. he suddenly changed direction to the left, turning in beneath a projecting spur. This surprise maneuver threatened to take in enfilade the Spartan right. and to dislocate still further the Spartans' battle dispositions he halted his troops and made them ground arms as if to encamp. The deception succeeded; the enemy were induced to relax their battle order, allowing men to fall out and the horses to be unbridled. Meanwhile Epaminondas was actually completing his battle dispositions behind a screen of light troops.

Then, on a signal, the Theban army took up its arms and swept forward. Caught by surprise the enemy made haste to reform, but their cavalry were driven back by the Theban cavalry covering the left flank of the massed column, and this striking the Spartan line pierced it in two. But in the moment of decision Epaminondas himself was mortally wounded, and with his fall the advance came to a stop and failed to complete the victory.

3. The third battle for which Mantinea is notable mas that of 207 B.C., in which Philopoemen, the commander of the forces of the Achaean league, routed Machanidas, tyrant of Sparta.

Bibliography.— City: Strabo, viii, *337;* Pausanias, viii, *7–12;* Thucydides, v; Xenophon, *Hellenica,* iv–vii; Diodorus, xv, *83–87* ; Polybius, ii, 57 ff., vi, *43;* D. Worenka, *Mantineia (1905)*; *B.* V. Head, *Historia numorum,* 2nd ed., p. *449 (1911)*; *G.* Fougères, *Bulletin de correspondance hellénique* (1890), *Mantinée et l'Arcadie orientale (1898). First Battle (418 B.C.):* Thucydides, v; W. J. Woodhouse. *King Agis of Sparta and His Campaign in Arkadia in 418 B C. (1933). Second Battle (362 B.C.):* Xenophon. *Hellenica,* vii, 5. *Third Battle (207 B.C.)*: Polybius, xi, *8–18:* Plutarch. *Philopoemen.*

(B. H. *L.* H.; *R.* Me.)

MANTIQUEIRA, SERRA DA. a range of mountains in southeastern Brazil, running for about 200 mi. in a southwest-northeast direction along the southern border of the state of Minac Gerais. The range comes to a distinct ending west of Juiz de Fora and does not connect with the Serra do Espinhaço as was formerly thought. It rises abruptly from the northwest side of the Paraiba valley. reaching a height of 9,144 ft. in Mt. Itatiaia, or Agulhas Negras.

The mountains were originally forest-covered except for the tops which stand above the tree line. They provide charcoal and pasture for cattle; on the lower slopes there are several health resorts, such as Campos do Jordão. (P. E. J)

MANTIS, an insect belonging to the family Manteidae of the order Orthoptera (*q.v.*). Probably no other insect has been the subject of so many and widespread legends and superstitions as the common praying mantis, *Mantis* religiosa, L. of southern Europe. The ancient Greeks endowed it with supernatural powers (*μάντις*, "a diviner"); the Turks and Arabs hold that it prays constantly with its face turned toward Mecca, and the Provençals call it Prega-Diou (Prie-Dieu). Notwithstanding these attributes, mantids are creatures of voracious habits. The front pair of limbs are very peculiarly modified—the coxae being greatly elongated, while the strong third joint or femur bears on its curved underside a channel armed on each edge by strong movable spines. Into this groove the stout tibia is capable of closing like the blade of a penknife, its sharp, serrated edge being adapted to cut and hold. Thus armed, with head raised upon the much-elongated and semierect prothorax, and with the half-opened fore-limbs held outward in the characteristic devotional attitude, it rests mutionless upon the four posterior limbs waiting for prey or occasionally stalks it with slow and silent movements. finally seizing it with its knife blades and devouring it. These insects destroy many flies, grasshoppers and caterpillars, and the larger South American species attack small frogs. lizards and birds. They are pugnacious, fencing with their swordlike limbs, the larger often devouring the smaller, and the females the males.

Mantis *religiosa* fixes its somewhat nutlike egg capsules on the stems of plants in September. The young are hatched in early summer. and resemble the adults, but are without nings. The green coloration and shape of the typical mantis are procryptic, serving to conceal the insect alike from its enemies and prey. The passage from leaf to flower simulation has been perfected in certain tropical species of Manteidae by the development on the prothorax and raptorial limbs of laminate expansions so coloured on the underside as to resemble papillionaceous or other blossoms, to which the likeness is enhanced by a gentle swaying kept up by the insect in imitation of the effect of a lightly blowing breeze. As instances of this may be cited *Idolum* diabolicurn, an African insect, and *Gongylus* gongyloides, which comes from India. Examples of another species (*Empusa* egena) when standing upon the ground deceptively imitate in shape and hue a greenish white anemone tinted at the edges with rose; and Bates records what appears to be a true case of aggressive mimicry practised by a Brazilian species which exactly resembles the white ants it preys upon. More than 800 species of mantids are known and about 20 of these occur in Europe, and a similar number in the United States, but none are found in the British Isles.

MANTIS FLY, insects of the family Mantispidae, order Neuroptera, related to the ant lions, lacewing flies, etc., and named from their superficial resemblance to a mantis (*q.v.*) because of the length of the prothorax and the shape and prehensorial nature of the anterior legs.

The larva, at first very active and having well-developed legs (campodeiform), makes its way into the egg case of a spider or the nest of a wasp to feed on the eggs or young. Subsequently it changes into a fat grub with short legs. When full grown it spins a silken cocoon in which it transforms into the pupa. Mantis flies are widely distributed in both the old and new worlds, but occur chiefly in warm countries.

MANTRAP, a mechanical device for catching or injuring a trespasser. Such traps include concealed pits, traps with jaws that close on the victim's leg, and spring guns, triggered when one steps on a concealed wire. Since 1827 their use in England has been a misdemeanor, except to protect dwellings between sunset and sunrise.

In the United States, a number of states have banned the use of such devices. In jurisdictions that have not outlawed them, the law is far from settled, but it appears that the trap setter may be both criminally and civilly liable for resulting death or injury and that liability may depend on whether the victim was bent on committing a felony, a circumstance which is hardly predictable in advance.

Thus it appears that one who sets such a trap may be imposing as grave a risk on himself as on the potential intruder.

(H. L. Pr.)

MANTUA (Ital. Mantova), fortified city, Lombardia, Italy, capital of the province of Mantova, see of a bishop and centre of a military district, 25 mi. S.S.W. of Verona and 100 mi E.S.E of Milan by rail. Pop. (1957 est.) 57,656 (commune). It is 88 ft. above the level of the Adriatic on an almost insular site among swampy lagoons of the Mincio. On the west lies Lago Superiore, on the east Lago Inferiore—the boundary between the two being marked by the Argine del Mulino, a long mole stretching northward from the northwest angle of the city to the citadel, along which run the road and the railway.

On the highest ground in the city rises the cathedral, the interior of which was built after his death according to the plans of Giulio Romano. The church of St. Andrea after plans by Leon Battista Alberti, has a single, barrel-vaulted nave 338 ft. long by 62 ft. wide (1472–1494 and later); the dome was added in 1732–82. It has a noble facade with a deeply recessed portico, and a brick campanile of 1414. Mantegna is buried there. The immense ducal palace was begun in 1302 for Guido Bonaccolsi, but many of the fine apartments are of much later date, and the internal decorations are largely by Giulio Romano and his pupils. In one of the rooms is a set of tapestries after Raphael's cartoons now at South Kensington museum. Castello di Corte, the castle of the Gonzagas (1395–1406), erected by Bartolino da Novara, the architect of the castle of Ferrara, now contains the archives, and has some fine frescoes by Mantegna nith scenes from the life of Ludovico Gonzaga. Close by are the Piazza dell' Erbe and the Piazza Sordello, with Gothic palaces. Outside the city stands the Palazzo del Te, Giulio's architectural masterpiece, erected for

Frederick Gonzaga in 1523–1535, with numerous fresco-covered rooms. At the villa of Marmiruolo are other works by him. The architecture of Giulio's own house in the town is also good.

Mantua has an academy of arts and sciences (*Accademia Vergiliana*), occupying a fine building erected by Piermarini, containing a theatre designed by Antonio Bibiena (1769), and a museum of antiquities.

Mantua had still a strong Etruscan element in its population during the Roman period. Its main interest is as the birthplace of Virgil (*q.v.*). In 568 the Lombards took Mantua with difficulty; recovered in 590 by the exarch of Ravenna, it was recaptured by Agilulf in 601. The 9th century was the period of episcopal supremacy, and in the 11th the city belonged to Bonifacio, marquis of Canossa. It passed to Geoffrey, duke of Lorraine, and afterwards to the countess Matilda, but was taken by the emperor Henry IV. in 1090. Reduced to obedience by Matilda in 1113, the city on her death instituted a communal government of its own. It afterwards joined the Lombard League. But after internal discords Ludovico Gonzaga attained to power (1328), and was recognized as imperial vicar (1329); and until 1708 the Gonzagas were masters of Mantua (*see* GONZAGA). Under Gian Francesco II., the first marquis, Ludovico III., Gian Francesco III. (whose wife was Isabella d'Este), and Federico II., the first duke of Mantua, the city rose rapidly into importance. It was stormed and sacked by the Austrians in 1630. It was claimed in 1708 as a fief of the empire by Joseph I. Besieged by Napoleon in June 1796, it held out till February 1797. In 1799 it fell to the Austrians; restored to the French by the peace of Lunéville (1801), it became Austrian again (1814–66).

MANU, the Hindu Noah. In post-Vedic myth he is warned by a huge fish to build an ark, and after the deluge his sacrifices bear him a daughter, by whom he becomes the ancestor of mankind. More historically he is the author of the Code of Manu, a compilation of laws reflecting Hindu thought in the Buddhist period, but only preserved in a metrical recension made probably about A.D. 100.

MANUCODE, the common name given to the more somber coloured birds of paradise (*q.v.*) comprising the genus *Manucodia* and found in northern Queensland and New Guinea. The males resemble the females and help them with nesting duties; for these and other reasons manucodes are often regarded as an early group in the family Paradiseidae.

MANUEL I. COMNENUS (*c.* 1120–1180), Byzantine emperor (1143–1180), the fourth son of John II, was born about 1120. Having distinguished himself as a soldier, he was nominated emperor in preference to his elder surviving brother. He endeavoured to restore by force of arms the predominance of the Byzantine empire in the Mediterranean countries. In 1144 he brought back Raymund of Antioch to his allegiance, and in the following year drove the Turks out of Isauria. In 1147 he granted a passage through his dominions to two armies of crusaders under Conrad III. of Germany and Louis VII. of France; but the numerous outbreaks of hostility between the Franks and the Greeks on their line of march, nearly precipitated a conflict between Manuel and his guests. In the same year the emperor made war upon Roger of Sicily, whose fleet captured Corfu and plundered the Greek towns, but in 1148 was defeated with the help of the Venetians. In 1149 Manuel recovered Corfu and prepared to take the offensive against the Normans. With an army mainly composed of mercenary Italians he invaded Sicily and Apulia, and although defeated both on land and sea, Manuel maintained a foothold in southern Italy, which was secured to him by a peace in 1155.

Manuel made treaties with Pisa and Genoa, and supported the free Italian cities with his gold and negotiated with pope Alexander III. In spite of his friendliness towards the Roman church Manuel was refused the title of "Augustus" and he nowhere succeeded in attaching the Italians permanently to his interests. None the less in a war with the Venetians (1172–74), he actually drove his enemies out of the Aegean Sea. On his northern frontier Manuel defeated the rebellious Serbs (1150–52) and made repeated attacks upon the Hungarians. In the wars of 1151–53 and 1163–68 he led his troops into Hungary but failed to maintain himself there; in 1168, however, a decisive victory near Semlin enabled him to conclude a peace by which Dalmatia and other frontier strips were ceded to him. In 1169 he sent a joint expedition with King Amalric of Jerusalem to Egypt, which retired after an ineffectual attempt to capture Damietta. In 1158–59 he fought with success against Raymund of Antioch and the Turks of Iconium. In 1176 he was decisively beaten by them in the pass of Myriocephalum. This disaster, though partly retrieved in the campaign of the following year, had a serious effect upon his vitality; henceforth he declined in health and in 1180 succumbed to a slow fever.

In spite of his military prowess Manuel achieved but in a slight degree his object of restoring the East Roman empire. His victories were counterbalanced by numerous defeats, and his lack of statesmanlike talent prevented his securing the loyalty of his subjects. The expense of keeping up his mercenary establishment put a severe strain upon the financial resources of the state. The subsequent rapid collapse of the Byzantine empire was largely due to his brilliant but unproductive reign. Manuel married, firstly, a sister-in-law of Conrad III of Germany; and secondly, a daughter of Raymund of Antioch. His successor, Alexis II, was a son of the latter. (M. C.)

MANUEL II, PALAEOLOGUS (1350–1425), Byzantine emperor from 1391 to 1425, was born in 1350. At the time of his father's death he was a hostage at the court of Bayezid at Brusa, but succeeded in making his escape; he was forthwith besieged in Constantinople, but with some loss, beat off the attack. Manuel subsequently set out in person to seek help from the west, and for this purpose visited Italy, France, Germany and England, but without material success. The defeat of Bayazet at the hands of Timur (1402) gave him a genuine respite from the Ottomans. He stood on friendly terms with the Mahammed I, but was again besieged in his capital by Murad II in 1422. Shortly before his death he was forced to pay tribute to the sultan. Manuel was the author of numerous works of varied character—theological, rhetorical, poetical and letters. Most of these are printed in Migne, *Patrologia graeca,* clvi; the letters were edited by E. Legrand (1893).

See Krumbacher, *Geschichte der byzantinischen Litteratur* (1897).

MANUEL, LOUIS PIERRE (1751–1793), French writer and revolutionary was born at Montargis (Loiret), and became a tutor in Paris. In 1783 he was imprisoned for three months in the Bastille for publishing his *Essais historiques, critiques, littéraires, et philosophiques.* He was one of the leaders of the *émeutes* of June 20 and Aug. 10, 1792, and was made *procureur* of the commune. On Sept. 7, 1792 he was elected one of the deputies from Paris to the convention and on Nov. 5 made an eloquent speech at the Jacobins club in defense of Robespierre. His missions to the king, however, reconciled him to Louis, and he had to resign from the convention. He retired to Montargis, where he was arrested. He was guillotined in Paris on Nov. 17, 1793. His works include *Coup d'oeil philosophique sur le règne de St. Louis* (1786); *L'Année francaise* (1788); *La Bastille dévoilée* (1789); *La Police de Paris dévoilée* (1791); and *Lettres sur la Révolution* (1792).

MANUEL DE MELLO, DOM FRANCISCO: *see* MELO, FRANCISCO MANUEL DE.

MANUFACTURING PRODUCTION: *see* ECONOMIC PRODUCTIVITY.

MANUL (*Felis manul*), often called Pallas's cat, a small desert and rock-dwelling wild cat, ranging from Tibet to Siberia. The coat is long and soft, of pale silvery gray or light buff, marked with black.

It has been suggested that the high-set eyes and low-set ears are adaptations for peering over rocky ledges; the supposition is that the manul thus exposes the smallest portion of himself to his prey, small mammals and birds.

MANURES: *see* FERTILIZERS AND MANURES.

MANUTIUS, the Latin name of an Italian family (Mannucci, Manuzio), famous in the history of printing as organizers of the Aldine press.

1. ALDUS MANUTIUS (1450–1515). Teobaldo Mannucci, better known as Aldo Manuzio, the founder of the Aldine press, was born at Sermoneta in the Papal states. After studying at Rome and at Ferrara, in 1482 he went to reside at Mirandola with his old friend, the illustrious Giovanni Pico, whose nephew Alberto Pio, prince of Carpi, supplied him with funds for starting his printing press, and gave him lands at Carpi. Settling in Venice in 1490, he gathered Greek scholars and compositors around him, and Greek was the language of his household. He soon published undated editions of the *Hero and Leander* of Musaeus, the *Galeomyomachia,* and the Greek Psalter. During 1495–98 he issued five volumes of Aristotle; in 1498 nine comedies of Aristophanes; Thucydides, Sophocles and Herodotus followed in 1502; Xenophon's *Hellenics* and Euripides in 1503; Demosthenes in 1504; an edition of the minor Greek orators in 1508; and in 1509 the lesser works of Plutarch. During the struggle of Venice with the allied powers of Europe, Aldo's labours were suspended until 1513 when he published his Plato. Pindar, Hesychius, and Athenaeus followed in 1514. Besides these Greek texts, Aldo published the *Asolani* of Bembo, the collected writings of Poliziano, the *Hypnerotomachia Poliphili,* Dante's *Divine Comedy,* Petrarch's poems, a collection of early Latin poets of the Christian era, the letters of the younger Pliny, the poems of Pontanus, Sannazzaro's *Arcadia,* Quintilian, Valerius Maximus, the *Adagia* of Erasmus and many reprints To promote Greek studies, Aldo founded an academy of Hellenists in 1500 under the title of the New Academy. Its rules were written in Greek; its members were obliged to speak Greek, and their names were Hellenized. The biographies of those enrolled in this academy, including Erasmus and Linacre, are given in Didot's *Alde Manuce.*

2. PAULUS MANUTIUS (1512–1574). After the death of Aldo, his brothers-in-law, the Asolani, carried on the Aldine press, until his youngest son, Paolo, took it over in 1533. The Asolani attempted the duties of editing. and to reserve the honours for themselves, dispensed nith the service of competent collaborators. The result was that some of their editions, especially their Aeschylus of 1518, are singularly bad. Paolo determined to restore the glories of the house, and in 1540 separated from his uncles. The field of Greek literature having been well-nigh exhausted. he devoted himself principally to the Latin classics. He was a passionate Ciceronian, and perhaps his chief contributions to scholarship are the corrected editions of Cicero's letters and orations. his own epistles in a Ciceronian style. his Latin version of Demosthenes, and his four treatises on Roman antiquities Because of Paolo's financial difficulties, Pius IV in 1561 invited him to Rome, offering him a yearly stipend of 500 ducats, and undertaking to maintain his press there. The profits on publications aere to be divided between Paolo and the Apostolic camera. Paolo accepted the invitation, and spent the larger portion of his life in Rome under three papacies.

3. ALDUS MANUTIUS, JUNIOR (1547–1597), eldest son of Paolo, produced at the age of 14 a work upon Latin spelling, called *Ovthographiae ratio.* Remaining in Venice to superintend the Aldine press after his father's move to Rome, he published in 1575 his *Epitome orthographiae.* In the same year, in concert with his father-in-law, Giunta. he edited an extensive collection of Italian letters, and in 1576 published his commentary upon the *Ars poetzca* of Horace. About the same time, he was appointed professor of literature to the Cancelleria at Venice. In 1585 Aldo moved to Bologna, but after two years went to Pisa where he made the curious mistake of printing Alberti's comedy *Philodoxius* as a work of the classic Lepidus. Sixtus V called him in 1588 to Rome. In 1597 he died, leaving children, but none who carried on the Aldine press. Aldo himself, though a precocious student, a scholar of no mean ability, and a publisher of some distinction, was the least remarkable of the three publishers.

MANWARING, ROBERT (fl. 1760), English 18th-century furniture designer and cabinetmaker. The dates of his birth and death are unknonn. He was a contemporary, imitator and rival of Thomas Chippendale (q v). His work shows the same surprising variations of quality characteristic of that of nearly all the English cabinetmakers of the second half of the 18th century. His best had an undeniable elegance. his uorst was squat and ill-proportioned. He introduced the small bracket between the front rail of the seat and the top of the chair leg. or at all events made such constant use of it that it has come to be regarded as characteristic of his work. Among Manwaring's writings were *The Cabinet and Chair Makers' Real Friend and Companion, or the Whole System of Chairmaking Made Plain and Easy* (1765, reissued, 1937); *The Carpenters' Compleat Guide to Gothic Railing* (1765); and *The Chair-makers' Guide* (1766)

MANX LANGUAGE AND LITERATURE. Manx is the Celtic speech of the Isle of Man (*q.v.*). The earliest vernacular material is contained in the version of the Book of Common Prayer made in 1610 by Bishop Phillips. The mode of spelling used was not that used in Ireland, but was as phonetic as a language system based on Anglo-Scottish orthography could be. It is, therefore, very difficult to discover the real sound values attached to the various symbols. Manx is more closely related to Scottish Gaelic than the Irish: both Manx and Scottish Gaelic may be reckoned as modern dialects of the original Irish Gaelic language. A dialectical difference between north and south shows in the treatment of short accented vowels before *ll, nn,* and *m*, and vocalic *s* or *sh* tends to become voiced to *d*. For further discussion of the Manx language and for bibliography on it, *see* IRISH LANGCAGE.

Literature. — The literary remains written in the Manx language are considerably slighter than those of any other Celtic dialect. With one small exception nothing pertaining to the saga literature of Ireland has been preserved. The little we possess falls under tno heads — original compositions and translations. With regard to the first we must give the place of honour to an Ossianic poem contained in a manuscript in the British museum (written in 1789), which relates how Orree, Finn's enemy, was tormented by the women of Finn's household when the latter was away hunting, how he in revenge set fire to the house, and how Finn had him torn in pieces by wild horses. Most of the literature of native origin consists of ballads and carols, locally called carvels. These used to be sung on Christmas eve in the churches, the members of the congregation each bringing a candle. Any one who pleased could get up and sing one. These carvels deal largely with the end of the world, the judgment day and the horrors of hell. About 80 of them were published under the title of *Carvalyn Gailckagh* (1891). An attempt has been made in the 20th century by *Yn Cheshaght Gailckagh* to revive the *Oiel Voirrey* (=Irish *Oidhche Fhéile Mhuire*), "Feast of Mary." as the festival used to be called, and gatherings in the old style have been held in Peel. Apart from the carvels there are other ballads in existence. The earliest is an 18th-century song of Manannan Mac y Lheir, traditionally supposed to have been written in the 16th century, which tells of the conversion of the island by St. Patrick. Then comes *Baase Illiam Dhône* (Death of Brown William), dealing with the death of William Christian. who was shot as a traitor in 1662. The best-known Manx song is *Mylecharaine* (=Irish *Maolchiarán*). It is directed against a man of this name who was the first to give a dowry to his daughter, the custom having previously been for the bridegroom to pay money to the father of the bride. Others are *Ny Kirree* fo *Sniaghtey* (The Sheep Under the Snow), a song about the loss of the Douglas herring fleet in 1787 (reprinted 1872) and *O Vannin Veg Veen* (Dear Little Mona). In 1760 Joseph Bridson wrote a "Short Account of the Isle of Man" in Manx (*Coontey Ghiare jeh Ellan Vannin ayns Gailck).*

The translated literature is almost entirely of a religious character. There is the translation of the English Prayer-Book by Bishop Phillips, 1610 (published 1895). The *Sermons* of Bishop Wilson (1783), intended to be in three volumes, of which only one was ever printed, is a very rare work, highly important for our knowledge of Manx prose. A later translation of the Church of England Prayer-Book was printed in 1765, but by far the most important of all is the translation of the Bible. The energetic Bishop Wilson managed to get parts of the Scriptures translated and the Gospel of St. Matthew was printed in 1748. Wilson's successor, Bishop Hildesley, completed the work, and in 1775 the whole Bible appeared. As a curiosity it may be mentioned that

Aesop's Fables were translated into the vernacular (1901).

MANYCH, a river and depression in the southern U.S.S.R., stretching between the lower Don river and the Caspian sea, through the north Caucasian region and the Kalmy autonomous oblast. During the greater part of the year the Manych is either dry or occupied in part by a string of saline lakes (limans or *ilmens*); but in spring when the streams swell which empty into it, the water flows in two opposite directions from the highest point (near Shara-Khulusun). One stream flows westward with an inclination northward, until it reaches the Don, though when the latter river is running high, its water penetrates about 60 mi. up the Manych.

The eastern stream dies away in the sandy steppe about 25 mi. from the Caspian, though it is said sometimes to reach the Kuma through the Huiduk, a tributary of the Kuma. Total length of the depression is 330 mi. For its significance as a former (geologic) connection between the Sea of Azov and the Caspian sea, see CASPIAN SEA.

MANZANILLO, a city in Oriente province, Cuba, about 85 mi. to the west and slightly north of Santiago de Cuba. Pop. (1953) 42,252. It is an important export-import centre, located at the head of the shallow Gulf of Guacanayabo. It is the centre of a rich sugar, tobacco and rice zone and serves as the outlet for the extensive Cauto plain.

The town was founded in 1784 as Puerto Real and was sacked by the French in 1792. Its development proceeded rapidly after it was opened to foreign ships in 1827. The name was changed to Manzanillo in 1837. (D. R. D.)

MANZANITA, the name given to numerous shrubs of the botanical genus *Arctostaphylos* belonging to the heath family (Ericaceae), comprising about 40 species, confined chiefly to western North America, 25 species being found in California. They are evergreen shrubs, mostly from 3 to 12 ft. high, with dark red or chocolate-coloured, smooth and polished bark; very crooked, usually stiff branches; small, mostly toothless, often vertical leaves, and handsome white or pink flowers borne in terminal, usually nodding, globose clusters. The fruit, which becomes brownish and berrylike at maturity, is suggestive when young of a tiny apple, from whence comes the Spanish name manzanita, "little apple."

MANZIKERT, BATTLE OF. In the spring of 1071 Romanus IV Diogenes, the Byzantine emperor, having collected an army of about 60,000 mon, marched into Armenia to recover the fortresses of Akhlat and Manzikert, captured by Alp Arslan and his Seljuk Turks. His forces were composite, consisting of Byzantine cavalry and infantry, German mercenaries and Franks. At Akhlat he divided his army, leaving a division to besiege the fortress. With the main body he marched on to Manzikert and reduced that place. Hardly had he done so when he fell in with Alp Arslan's advanced guard. The sultan's army was 100,000 strong and mainly consisted of horse archers. The tactics which the emperor should have employed were those laid down by Leo the Wise, namely: to maintain an unbroken front, to beware of surprise and never to fight with uncovered flanks or rear.

Romanus was a brave soldier, but impetuous. In the advanced guard encounter one of his generals, Basilaces, fell into an ambush, losing all his men. The emperor then drew up his army in front of his camp. The right wing was composed of Asiatic cavalry, the left of European and the centre of Byzantine horse. In rear he drew up a strong second line of Germans and Normans under Andronicus Ducas. As he advanced on his enemy, the Turks refused to close, hovering round the two lines and plying them with arrows. According to the Greek narratives the emperor, fearing that his camp was in danger, ordered a retirement. This order was misinterpreted, and confusion resulted, whereupon the Turks, closing in, compelled the emperor to face about. Andronicus refused to halt and retired to the camp, leaving the front line open to attack from the rear. According to the oriental sources, the Greek troops fell into an ambush, prepared by the Turks. In either event Romanus was decisively defeated and made a prisoner. The result of this defeat was disastrous: Asia Minor was overrun! and by 1080 the old Byzantine army had all but ceased to exist.

(J. F. C. F.; X.)

MANZONI, ALESSANDRO (1785–1873), Italian poet and the author of a novel that has been ranked with the chief masterpieces of European literature, was born at Milan on March 7, 1785. His mother was the daughter of Cesare Beccaria. Manzoni was brought up as a Catholic, but moved with his mother to Paris in 1805 and there began to consort with liberal and empiricist *"idéologues"* and to familiarize himself with Voltairian scepticism. In 1808, however, he married Henriette Blondel, a Calvinist from Geneva who became a fervent Catholic; and he then reverted to his former faith. Settling in his villa at Brusuglio in Lombardy, he led for many pears a retired life, devoted partly to literature and partly to farming. His wife died in 1833, and in 1837 he married again. His writing won him the esteem of Goethe, his religious thought made him a friend of Rosmini and he came eventually to be recognized as one of the leading spirits of his age. In 1860 he was made a senator of Italy. The Christian serenity of his life, however, was unaffected by his fame and unshaken by many blows (not only both his wives but also eight of their ten children predeceased him). He died in Milan on May 22, 1873. Verdi's *Requiem* was written to honour his memory.

Manzoni's early poems "Il trionfo della liberta" (written in 1801), "Adda" (1803), the series of "Sermoni" (1803–04) and "Urania" (1805; published 1809) show the influence of Vincenzo Monti and Giuseppe Parini; his elegy in blank verse In morte *di Carlo Imbonati* (1806), on the death of his mother's lifelong friend, reveals his individual gift. Then followed Inni *sacri* (1812; printed 1815; augmented ed. 1822), a series of sacred lyrics, one of which, "La Pentecoste," in the edition of 1822, is a masterpiece; *Osservazioni* sulla morale cattolica (1819), a treatise; and *Il* conte di Carmagnola (1820), a tragedy which, with its bold violation of all classical conventions and its passionate political inspiration, clearly showed that Manzoni had been conquered by the romantic movement. The Piedmontese revolution of 1821 inspired Manzoni's beautiful ode "Marzo 1821," and on the death of Napoleon in the same year he wrote another ode, "Il cinque maggio," which Goethe declared to be the greatest of the many written to celebrate that event. His second tragedy, *Adelchi* (1822), dealing with Charlemagne's overthrow of the Lombard kingdom and conquest of Italy, if it lacks dramatic power, is nevertheless rich in passages of deeply moving poetry, especially in the choruses depicting the arrival of the Franks and the death of Ermengarda.

Manzoni's greatest work, however, is his novel I promessi *sposi*. Having first published this work in 1827 (3 vol. with imprint 1825–26), Manzoni then revised it, carefully removing anything that was not pure Tuscan idiom from the language, and finally republished it in 1842 (with imprint 1840). It is the story of two peasant lovers! Renzo and Lucia, in 17th-century Lombardy under Spanish rule: a wicked local tyrant, Don Rodrigo, forbids their marriage, and the parish priest, Don Abbondio, bows to his will; but a courageous friar: Cristoforo, takes up the lovers' cause and helps them through many adventures to safety and marriage. The description of great historical events, for instance the Milanese insurrection, the Thirty Years' War and an outbreak of the plague, is cleverly woven into the narrative. But I promessi sposi is much more than a historical novel: it is one of the great literary works of modern times: comparable for richness of beauty and depth of meaning with Goethe's Faust and Cervantes' Don Quixote. Manzoni's Christian attitude of resignation to the evils of life combined with firm belief in the final triumph of a good cause and with the concept of religion as the ultimate comfort of mankind give his novel its moral import! while his poetical inspiration, the charm of his style and a pleasant vein of humour contribute to its excellence as a work of art.

His complete works were edited by G. Lesca, 9 vol. (1923).

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MAORI. This Polynesian people, composing about 10% of the population of New Zealand, came of a seafaring stock. Members of the great Polynesian linguistic and ethnic group which inhabits the far-scattered island groups of the eastern Pacific, they are the result of an intermixture of several distinct waves of canoe voyagers, the last of which, in the mid-14th century, came from Tahiti, with Rarotonga — about 1,800 mi. N.E. of New Zealand — as the port of call. Evidence of this is provided by comparison of the traditions and genealogies scrupulously preserved by the learned men in each tribe. The most important cultural influence in the Maori population was provided by the "great fleet" that arrived in 1350, and on this the traditional social organization largely depended. Prior to that time the islands were inhabited by the tangata whenua, "the people of the land," some of whom were descended from Toi-kai-rakau, a Polynesian immigrant of about 1150, and others probably from drift voyagers. With these folk the later arrivals intermarried and fought, ultimately gaining the ascendancy. The visit of Toi was in the nature of a search party for his lost grandson. The later migration, however, was a premeditated colonization; the kumara ("sweet potato"), taro, yam and other cultivated plants were introduced, as was also the native dog.

This article will discuss traditional Maori customs and ways of life; for history and modern conditions, see NEW ZEALAND.

Social Grouping. — The Maori people are divided into a score or more tribes, *iwi,* each with its own well-defined lands, and tracing kinship to a common ancestor. Thus all members of Ngati Maru, a tribe around Hauraki, claims descent from Marutuahu. the famous 14th-century chief whose name they bear. The principal canoes associated with the fleet are Tainui, Arawa, Matatua, Takitimu, Tokomaru and Aotea, and, generally speaking, the particular group of tribes descended from the captain and crew of each vessel occupy contiguous territory and form a separate unit of a loose political nature, known as a waka. Thus Ngati Maru, together with Waikato and the tribes of the King country make up the Tainui waka, a human canoe which extends from Hauraki to Mokau. A tribe is made up of several principal hapu or clans, each of which might in olden days include about 1,000 fighting men. The hapu was not a unilateral group, *i.e.,* a person could belong to it through either his father or his mother, nor was it exogamous, marriage within the group being favoured provided that the parties were not first cousins.

Within these major social units were lesser hapu, tracing descent to more immediate ancestors, and these in turn were composed of whanau, family groups of near relatives who together often occupied a dwelling hut. The individual family of parents and children existed, but, not forming a separate household, did nor play a large part in public life. Through all Maori social structure ran this principle of kinship by common descent, a bond which linked men together and welded whanau to form hapu, and hapu to form tribe. One hapu might fight another but on the approach of a tribal enemy their quarrel was laid aside and their arms were turned against the common foe.

The system of primogeniture played a leading part in the social organization. The highest chief was the ariki, eldest son in a line of first-born men of rank. His mana was very great; his word was law. The people of his tribe were his relatives, their rank being broadly represented by the closeness of their kinship to him. Next to him came the chiefs of his own family, then the rangatira, and finally the commonalty (ware). But every ordinary man, however undistinguished, could claim some sort of distant connection with his chief and with a noble family. Slaves (taurekareka) were mainly recruited from prisoners of war, and performed much of the menial labour.

Traditional Economy. — The Maori lived in villages (kainga), usually with a fort or defended position (pa) close at hand. The economic life of the different tribes varied according to the resources at their command. In the north, fertile soil and a warm climate allowed the cultivation of the *kumara* but in less-favoured districts forest products and the edible rhizome of the bracken (*aruhe,* Pteris esculenta) formed the staple food supply. Birds and the frugivorous native rat were snared and preserved by inland tribes, eels were taken by weirs on the Whanganui river, while around Rotorua and the adjacent lakes crayfish and the fresh-water mussel were obtained, while fish was the main food of the dwellers on the seacoast. In these economic pursuits the Maori were industrious.

Advantage was taken of the communal mode of life to secure co-operation in various tasks, and such labour was lightened by work songs. Division of labour was practised, though in somewhat rudimentary form. The men did harder work such as tree climbing, carving, fishing and fowling and tilling the ground for crops. The women weeded the crops, collected shellfish, plaited mats and wove garments from the useful harakeke and attended to the cooking of the t o daily meals. In each industry were specialists (tohunga) who had received training, including knowledge of the magic of the craft.

Warfare was frequent and each man was trained in the use of weapons. Hand-to-hand fighting was preferred, and ambuscade and stratagem were frequent. In later warfare against Europeans the Maori proved extraordinarily proficient in the military art. In time of peace the social side of life was developed, visits were made, and neighbouring tribes were invited to feasts at which dart throwing, wrestling, top spinning and posture dancing held the interest of the people. Such receptions were held on the marae, the temple enclosure in the centre of the village. Feasts also took place at tangi, the ceremonial wailing for the dead, at which many relatives assembled from long distances.

Religion. — The traditional religion of the Maori was closely bound up with social and economic life. The common people recognized a number of gods, as Tane-mahuta, guardian deity of the forest, trees and birds, or Tangaroa, the Polynesian Neptune, lord of the sea and fish. The higher priests and chiefs also held belief in Io, a supreme god of rather negative attributes, to whom appeals were made in birth, baptism and marriage ceremonies for people of rank. This knowledge was jealously kept from the common people, and from foreign anthropologists for many years. All Maori believed in a host of minor atua, rather malignant beings who provided omens, gave force to black magic, and punished breaches of tapu. The tapu was one of the strongest forces of law in the Maori community. With a sacred or unclean significance according to circumstances, it conveyed essentially the idea of a prohibition. For instance, the person of a chief, his goods, his place by the fire and the remnants of his meal; all things connected with the gods; a corpse and the surroundings of death were all tapu, as mere also a cultivated field or a new house or canoe. Thus things of social importance were protected from improper interference.

According to Maori belief, man was endowed with several spiritual potentiae, the wairua, the spirit which wanders abroad in dreams, the mauri and the hau, allied metaphysical concepts representing the vitality of a person, his essential life principle. At death the latter are dissolved, but the wairua, the soul, wends its way to Te Reinga, or Te Po, the underworld beneath the sea, a peaceful abode where men pursue their ordinary avocations as in life See NEW ZEALAND; PACIFIC ISLANDS; POLYNESIA; see also Index references under "Maori" in the Index volume.

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MAO TSE-TUNG (1893–), Chinese revolutionist and statesman, Communist party leader and founder of the Chinese Communist state. was born into a moderately prosperous peasant family in the central Chinese province of Hunan, on Nov. 19, 1893. He early betrayed a restless, rebellious temper and left the paternal farm; for ten years he attended school after school, and clutched at creed after creed, while China lapsed into chaos. An avid reader, he felt briefly attracted to constitutional monarchism and English idealism, utopian socialism and anarchism. He finished normal school in 1918 and went to Peking, where he took a humble post in the library of Peking university. There he met two professors whose social criticism drew him into their orbit; these were Li Ta-chao and Ch'en Tu-hsiu, eventually the principal founders of the Chinese Communist party.

Mao returned to Hunan in 1919 and briefly taught school before Marxism finally became his faith and revolution his career (1920). He helped to found the Chinese Communist party (1921), and as its leader in Hunan devoted his principal energies to launching a trade-union movement. His local successes earned him a place in the party's national leadership (1923); he went to Shanghai, then to Canton, to serve in its two biggest headquarters (1923–26). But his old restlessness reappeared in the headquarters atmosphere; he often changed posts and seized any pretext to return to Hunan. One such return, in 1925, became a historic turning point: Mao discovered the latent strength of the peasants and organized them for action. Other party leaders had done so before him and might have risen as high from their own rural bases if they had not met early deaths in subsequent wars with the Kuomintang (*see* CHIANG KAI-SHEK; KUOMINTANG).

So far, the Kuomintang remained an ally, and Mao received various posts in it, even that of chief propagandist (1925–26); but rather than wait for the certain split he returned once again to Hunan (summer 1926). While the alliance fell slowly apart, he staged his first peasant rebellions, each quickly suppressed by Kuomintang troops, until he had to flee to the mountains (1927). He turned his few hundred followers into a band of guerrillas; other fugitive bands joined his, until he had a small army (1928–30). Roaming the mountainous southeast, he found some tenable bases; he expanded these into Red enclaves and proclaimed them a "soviet republic" (1931). He became chairman but shared actual power with a Russian trained group of leaders, who considered his knowledge of Marxism weak and his policies opportunistic. Like other good Marxists, they thought that he showed an inborn peasant mentality, seeming content that backward peasants should fill a communist party. They also grew more and more distrustful of his guerrilla tactics and finally made the Red command switch to positional warfare. But the defenses that they ordered built broke under the next assault by superior Kuomintang numbers; and the defenders found themselves forced to abandon the "soviet republic" (1934). Mao, vindicated as a strategist, led his remaining forces across China to the northwest, where they settled on new bases (1935–36). During this trek, the so-called Long March, he gained full control of the party; henceforth he determined its policies and proclaimed them dogma.

War with Japan forced Mao and the Kuomintang into an uneasy armistice; it also made Mao adopt moderate policies that won him much liberal sympathy. But civil war quickly resumed after Japan surrendered; the Communists won, sooner than they had hoped, by superior morale and leadership. Once they controlled continental China they proclaimed a people's republic (1949); Mao became chairman (*i.e.*, chief of state), a post that he kept through the following decade. He visited Moscow (his first trip abroad) to conclude an alliance with Russia and to secure all possible aid for China's economic development (winter 1949–50).

After Stalin's death (1953), Mao's influence grew throughout the Communist orbit, and he became freer to assert claims to ideological leadership. These rested on his contributions to Marxist-Leninist doctrine: actually new adaptations of it, not additions of substance. As China's ruler, Mao soon abandoned his moderate wartime policies for radical programs to transform the country ever more quickly and thoroughly. He drove the bulk of the Chinese people into a collective existence and into a race to catch up with the west in industrial production. With a fixed vision and determination to translate it into reality, he built in ten years the most tightly controlled and most taut-nerved of modern societies. By the time he resigned his government though not his party chairmanship (1959), Mao had gone far toward making China more Communist than Soviet Russia.

See also CHINA: *History*. (C. BT.)

MAP (MAPES), **WALTER** (d. c. 1208/9), medieval ecclesiastic, author and wit, to whose authority the main body of prose Arthurian literature has, at one time or another, been assigned, flourished in the latter part of the 12th and early years of the 13th centuries. He studied at Paris under Girard la Pucelle, who began to teach in or about 1160, but as he states in his book *De nugis curialium* that he was at the court of Henry II before 1162, his residence at Paris must have been practically comprised in the decade 1150–1160.

Map was clerk of the royal household and justice itinerant; in 1179 he was present at the Lateran council at Rome, on his way there being entertained by the count of Champagne; at this time he apparently held a plurality of ecclesiastical benefices, being a prebend of St. Paul's, canon and precentor of Lincoln and parson of Westbury, Gloucestershire. There seems to be no record of his ordination, but as he was a candidate for the see of Hereford in 1199 it is most probable that he was in priest's orders. The last reference to him, as living, is in 1208, when an order for payment to him is on record, but Giraldus Cambrensis, in the second edition of his *Hibernica*, redacted in 1210, utters a prayer for his soul, "cujus animae propitietur Deus," a proof that he was no longer alive.

The special interest of Map lies in the perplexing question of his relation to the Arthurian legend (*q.v.*) and literature. To him have been attributed the *Lancelot* proper, the *Mort Artus* and the *Queste*. He is constantly referred to as an authority. It seems unlikely that a busy court official could have written the long prose romances that are attributed to him. But he seems to have been the man who linked up the Arthur legend proper to the cycle of the Holy Grail. His undoubted work is the *De nugis curialium*, and he is reputed to be the author of various witty goliardic verses.

Taking all the evidence into consideration it seems more probable that Map had, at a comparatively early date, before he became so important an official, composed a poem on the subject of Lancelot, which was the direct source of the German version, and which Chrétien de Troyes also knew and followed. (J. L. W.)

MAP, a systematic representation on a surface of the nature and distribution of phenomena in space. For example, terrestrial and celestial globes are maps of the earth and of the heavens, respectively, on a spherical surface. In a more restricted sense, a map depicts on a flat surface (plane) the relationships between selected items on or about the nearly spherical surface of the earth. Most maps are of this kind. A map projection is a system whereby horizontal positional relationships on the earth's curved surface are shown on a plane. There are innumerable projections, though only a few are in common use. Vertical relationships, essentially elevations above sea level, can be indicated on a flat map both quantitatively and qualitatively by various methods, which come under the general heading of relief representation.

Cartography is the art and science of map making. The development of the map is a part of the story of discovery, exploration and accumulation of detailed geographical knowledge; thus, in this article the history of cartography will be dealt with in its broadest sense. The article is outlined as follows:

I. ELEMENTS OF MAPS

A. Maps in the Modern World

1. Uses of **Maps.**—Maps provide an efficient and unique means for communicating certain types of information. Though a listing of all the countries in the world and their areas may be prepared, only a map can show the arrangements of these countries with respect to one another and the configuration of their boundaries. A map, unlike a photograph, does not reveal all the detail that can be seen in a landscape, but it provides a more comprehensive and selective picture. By a suitable choice of projection it is possible to prepare a map on which an observer can see at a glance a representation of the whole surface of the earth. This is not possible in the case of a terrestrial globe.

Maps are useful in many activities: in the appraisal, conservation and development of natural resources; in analyzing and forecasting weather conditions; in agriculture, fisheries and general commerce; in regional planning; in the building and development of communications; in the location of industry; in property surveys and the demarcation of boundaries. Governments need maps for aid in settling boundary disputes and in controlling floods and droughts, in taking censuses, levying taxes, organizing franchises, law enforcement and promotion of justice and health. Without maps the regulation of transportation and traffic control, on land and sea or in the air, cannot be undertaken efficiently. Maps aid in navigation by sea and air (*see* CHART). Planning and execution of military operations, defensive and offensive, tactical and strategical, would be impossible without maps. In fact, considerable mapping in the past was done for military purposes, and mapping activities were greatly stimulated and advanced during World Wars I and II.

One of the most significant uses of maps is that made by scientists concerned with the causes and effects of the distributions of phenomena, in such disciplines as geology, oceanography, meteorology, climatology! animal and plant ecology, agronomy, economics and the social sciences, as well as geography itself. In all these fields maps are indispensable tools. They record observations in succinct form; they aid in analysis; they stimulate ideas and aid in the formulation of working hypotheses; they make it possible to communicate findings.

Maps promote accessibility and freedom of movement by showing where places are and how they may be reached. They aid people to understand their own and others' environments, and they frequently accompany articles on important world events in newspapers and other periodicals. On occasion maps have been designed for propaganda — to promote local or national interests or to mislead for political purposes — in much the same way as statistics are sometimes abused. Fortunately such maps are rare; nevertheless all are not necessarily equally reliable in their content, and in the past cartographic sins of omission and commission frequently have been masked. wittingly or unwittingly, by excellent draftsmanship and reproduction. Thus an intelligent use of maps requires an appreciation of the factors that contribute to making maps reliable and an awareness of both the advantages and limitations of maps as mediums for the communication of factual information.

2. Concepts **of** Scale. — Scale means the size of the representation of an object in respect to its actual size. If a ship model's scale were to be given as 1 in. to 12 ft., few would fail to understand what is implied. On maps, more generally convenient methods of expressing scales are by means of the representative fraction or proportion as, for example. $\frac{1}{144}$ or 1:144, because these are independent of the unit of measurement employed. Thus $\frac{1}{144}$ is equivalent in meaning to 1 in. to 144 in. or 1 ft. to 144 ft. or 1 m. to 144 m. The scale of a map is smaller than the scale of another map if its scale denominator is larger: $\frac{1}{10,000}$ is a smaller scale than $\frac{1}{1,000}$.

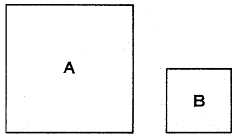

FIG. 1 — THE LINEAR SCALE OF SQUARE B IS ½ OR 1:2 IN RESPECT TO SQUARE A; ITS AREAL SCALE IS ¼ OR 1:4

On maps it is necessary to distinguish betneen linear and areal scale. In the fractional notation the areal scale denominator is equal to the square of the linear scale denominator (*see* fig. 1). Areal scale can be made constant by using a particular type of map projection (see *Map Projections,* below). On the other hand, it is impossible to maintain a precisely constant linear scale. Expressed in another way, the measured distance between two points will bear a definite scale relationship to the true curved distance on the earth, but this relationship will vary from one pair of points to another. When two points are extremely close a finite linear scale relationship still exists. A useful mathematical abstraction, therefore; is the concept of the scale at a point; *i.e.,* scale when the distance mapped is infinitely small. Such a concept gives meaning to such statements as "the scale is constant along a line on a map," or "the scale varies on a map as a function of distance and direction from a point."

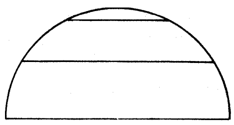

FIG. 2. — CHORD AND SURFACE ROUTES BETWEEN PAIRS OF POINTS ON A SPHERE

Because linear scale may vary from point to point, it is convenient to refer to the "nominal scale" of a map. This may mean the scale at a central point, or the constant scale along a particular line or set of lines on the map. It also may refer to the scale of a hypothetical globe from which the flat map has been projected. The term map scale without a qualifying statement usually refers to the nominal linear scale.

Scale ratio is a convenient term for the scale at a point divided by the nominal scale. For example, if the nominal scale is $\frac{1}{100,000}$ and the scale at the point is $\frac{1}{200,000}$, the scale ratio is 0.5, and if the scale at the point is $\frac{1}{50,000}$ the scale ratio is 2. The scale ratio at every point would be approximately equal to 1 only on a globe.

The difference between the chord distance and the surface distance between two points on the earth increases: of course, rapidly with distance. For example, the differences for 100 mi. and 1,000 mi. are 1 part in 39,458 and 378 respectively. These figures suggest that short distances can be scaled from a map with a fair degree of accuracy, even though in the mapping process the earth were to be considered flat. Consequently on large-scale maps of small areas it is customary to give a graphical scale as in fig. 3; on a very small-scale map, showing the whole world or large parts of it, a graphical scale of this sort may be misleading.

3. Classification **of** Maps. — Maps may be classified according to the method of their construction or according to their content and scale. In classifications of the first kind the major divisions

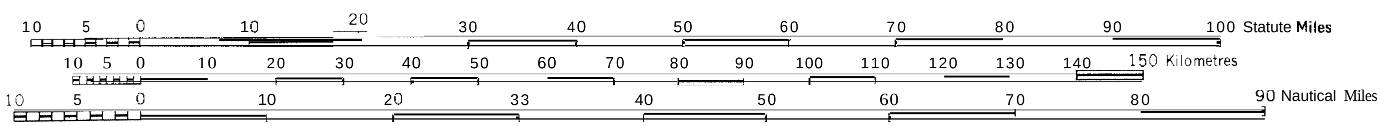

FIG. 3. — GRAPHICAL LINEAR SCALES

are usually between (1) surveyed maps made directly from precisely controlled surveys on the ground or from the air, and (2) maps compiled from a selection of the information contained in the surveyed maps. Surveyed maps are rarely on scales smaller than $\frac{1}{250,000}$ (roughly 1 in. to 4 mi.), usually on considerably larger scales and frequently on much larger scales. For example, the whole of Great Britain and Ireland with the exception of waste or mountainous areas has been mapped on the scale of $\frac{1}{2,500}$ or about 25 in. to 1 mi.

Though there is no hard and fast division between the scales of surveyed and compiled maps, the latter are usually on smaller scales and may be on very small scales indeed. A map of the world appearing in a book may show the equator as a straight line six inches in length; since the equatorial circumference of the earth is approximately 24,900 mi., the scale on the equator would be 1 in. to 4,150 mi., or approximately $\frac{1}{263,000,000}$.

Surveyed maps which show physical features such as rivers, lakes, forested areas and swamps, together with man-made features such as roads and towns, but with no representation of relief. are called planimetric (United States usage). When relief representation is added they are called topographic. Cadastral maps show property and political boundaries, roads and the shapes of buildings, etc., in sufficient detail so that dimensions may be recovered from them within the limits of accuracy controlled by the scale. Compiled maps may also be planimetric or topographical, but these terms usually are limited to map scales greater than $\frac{1}{1,000,000}$. On smaller scales, a general-purpose map is perhaps a preferable term.

An outline map, usually on a small scale and covering a large region, shows in simplified form coast lines, principal rivers and lakes and sometimes political divisions. Base maps may be simple outline maps or somewhat more complicated; as their name implies, their purpose is to present a base upon which specialized data can be plotted.

4. Modern Map Makers and the Status of Mapping. — Most of the topographical and cadastral mapping in the world is undertaken by national governments, though in the second half of the 20th century private corporations such as oil companies were still undertaking large mapping operations in underdeveloped regions.

Governments also produce maps compiled from their original source maps on smaller scales and from statistical and other data either as general-reference maps or for special purposes. The most important results of international co-operation in the production of compiled maps are the International Map of the World and the World Aeronautical Charts, both on the scale of $\frac{1}{1,000,000}$. The first consists of series of topographical or general-purpose maps prepared by the various participating countries according to internationally accepted standards. The second is a series containing for the most part less general information but a wealth of detail needed for air navigation. Total world coverage for neither of these series of maps was available in the decade following World War II.

Various geographical societies compile and publish maps showing the results of exploration and geographical discovery. Some of these societies — notably the National Geographic society (Washington, D.C.), the British Royal Geographical society (London) and the American Geographical society (New York)—undertake large cartographical projects. The National Geographic society produces many general reference maps for popular use, and the Royal Geographical society and the American Geographical society, among their numerous cartographical activities, have done much to promote the International Map of the World. For example, the American Geographical society, over a period of 25 years ending in 1947, compiled from thousands of original sources a series of 107 sheets covering the whole of Latin America on the scale of $\frac{1}{1,000,000}$ and conforming in essentials to the international scheme.

While most of the maps produced by commercial map publishers are based on surveys and compilations made by governments and private nonprofit organizations, this is by no means always the case. For example. the widely used road maps require special compilation and considerable research and revision to keep them up-to-date.

Maps appearing as illustrations in newspapers, other periodicals and books are often prepared by free-lance cartographers. These maps must often be prepared in a hurry, and to make them effective, special skills and artistry are required.

Not all national governments are willing to reveal the extent to which their countries have been mapped; hence it is not possible to give exact figures as to the status of mapping throughout the world. At the end of the first half of the 20th century, however, probably less than 25% of the world's land surface had been mapped adequately on topographical scales and far less than that on cadastral scales. Because of man's activities in changing the face of the earth, mapping is a continuous process, and map revision is almost as serious a problem as the initial surveying. A map satisfactory at one time may become quite unreliable within a very few years. The general use of aerial photography from World War I and especially from about 1930 has helped solve this problem; the mapping process has been greatly accelerated and mapping revision has become easier. Nevertheless, it cannot be positively stated that mapping as such has kept pace with the mapping needs of a rapidly expanding world population.

B. Techniques of Map Making

1. Compilation. — There are two principal steps in map compilation: (1) appraisal and selection of original source maps; and (2) selection of features to be shown and of the manner of their depiction, so that the compiled map, usually on a smaller scale than the original source material, will contain only essential information and will be legible and uncluttered. The first step poses no problem when the source material consists of accurately controlled survey maps, but difficulties occur when the area is poorly mapped or is mapped unevenly in patches by small local surveys or by reconnaissance surveys, the latter consisting largely of explorers' traverses and descriptions. For example, on a single sheet of the International Map of the World, hundreds of different sources, all varying in quality, may have been used. In such cases a small index map may be included in the margin to show the relative reliability of the source material. This procedure, now standard for sheets of the International Map, was first employed on the American Geographical society's maps of Latin America.

2. Drafting and Reproduction. — A completed map compilation is comparable with an author's typewritten manuscript. Before a finished map can be published, it must be redrawn in finished style and printing plates must be made. A draftsman must be able to draw smooth straight lines and curved lines varying both in their curvature and their width. He must be adept in the positioning of place names, so that important details are not masked. Up until about 1930, lettering was done mostly by hand; now, though there are still expert hand letterers, and hand lettering allows flexibility in size and spacing, large map-making establishments for the most part employ "stick up" lettering, in which names are printed. cut out, placed in position on the map drawing and stuck or burnished on. It is still an open question whether this process materially speeds up lettering; its main advantage is that it can be accomplished by relatively unskilled workmen. A similar procedure is frequently followed in laying down background patterns of fine lines or dots to differentiate among different types of areas. Patterns of many different kinds are printed for this purpose. When a map is to be printed in only one colour, the printing process may follow any one of a number of methods. Coloured maps are generally printed by photolithography rather than by letterpress, on rotary offset presses.

When colour is to be used, the finished map drawing is rarely hand coloured and reproduced by the kind of colour processing used in the reproduction of paintings. Instead, line copies of the compilation generally are made in nonphotographic blue. On these copies the draftsman makes separate finished dra ings in black for each solid printing colour to be used, using the blue lines as guides. When background tints are required, a colour guide is provided for the printer, who can produce in addition to the solid colours a wide variety of tints by means of half-tone screens, etc., used in conjunction with platemaking photography. In some cases, as many as a dozen printing plates have been used to produce a re-

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quired colour effect on a single map sheet.

The chief technical problem to be surmounted by colour separation in the drafting stage is to insure that on the composite reproduction of the separate drawings there will be no interference between the different-coloured symbols and place names and that there is precise register, or fit, among the different colours. To accomplish this, it is necessary before the printing plates are made to proofread and edit the composite. This can be done by superimposing the various drawings over a "light table," which has a translucent surface illuminated from below. This, however, is an exacting and time-consuming procedure, and after World War II, several proofing processes were developed to facilitate the final checks. Contact prints of each colour separation drawing are made onto a single base by using a new emulsion for each successive exposure; separate drawings thus can be reproduced in different colours on the same sheet, and necessary adjustments will be indicated before the printing plates are made.

This proofing process does not by itself solve the technical problem of obtaining good register. For this, the separate finished drawings must be made on material that will not expand or contract significantly because of use or of changes in temperature and humidity. Printing plates must be made with great precision, and temperature and humidity control are essential during the actual printing.

Before World War I, first-class coloured maps were published for the most part in small editions. After that time, and especially after World War II, technological developments made possible the economical production of highly precise maps in editions that may run into millions of copies. Register was brought under better control, for instance, by the development of synthetic plastic materials, which keep their shape better than paper does, on which to make the colour separation drawings. Again, most map printing is done on multiple-colour presses, reducing the danger of paper distortion that might occur when there is considerable time lapse between the printing of one colour and the next on single-colour presses.

After plastics were introduced, the trend in most of the big mapping organizations was to eliminate as far as possible pen and ink drafting. In addition to "stick-up" lettering, "scribing" is widely used. In this work, a transparent glass plate or plastic sheet is coated with a thin opaque film. A light-sensitive emulsion is then spread over the surface, an exposure of a negative of the original compilation is made onto it and a line image developed. The finished line drawing is prepared by means of a scribing tool that scrapes or cuts the opaque coating away as desired, leaving a sharp transparent line against the opaque background. The main advantage of scribing over pen and ink work lies in the fact that fine sharp lines can be produced by persons with comparatively little training.

3. Detailed Design. — The minimum width of line that can be reproduced by offset lithography is about 0.002 in. A single black line of this width against a white background can be perceived by the normal human eye at the usual reading distance of between 10 and 20 in. As the viewing distance is increased, the eye soon fails to resolve the line, and if the distance is decreased there is difficulty in focusing. If a series of parallel straight lines 0.002 in. in width spaced 0.004 in. from centre to centre is viewed at normal reading distance, the average eye will see this pattern only as a smooth tint against the background.

These limits of printing and visual acuity have great significance in the rendering of detail and in the over-all design of a map. On scales of $\frac{1}{100,000}$ and $\frac{1}{1,000,000}$, respectively, 0.002 in. represents 16 ft. 8 in. and 166 ft. 8 in., and it is evident that many line features on the ground, such as roads and minor streams, cannot be shown distinctly except on the largest scales without an exaggeration of their widths. This, however, immediately suggests that variations in the width of printed lines on a map can be used to distinguish between line features of greater and lesser importance. Two effects occur when the width of a line feature is exaggerated: details in the neighbourhood of the line are masked, and the true shape of the line is smoothed out or generalized.

As the scale of a map becomes smaller, more and more detail must be eliminated and there must be greater generalization of what is left. In many cases, the outlines of important features (for example, towns or airport runways) must be eliminated and purely artificial symbols substituted.

Thus, except on very large scales, the representation of pertinent information on maps is not a true simulation to scale of features of the landscape but rather a symbolization or codification of information which requires learning. A well-established convention is to orient maps so that in general the north direction is toward the top of the map sheet. Convention is also important in the use of colour to differentiate between different types of lines or different types of areas. There is often an association of ideas, such as blue for water and green for forested areas, but colour is used principally for distinctiveness rather than to portray the landscape.

Names, essential items on most maps, also are symbols, whose selection and positioning constitute a specially difficult problem in composition. They tend to mask essential details of the landscape and otherwise to cause clutter. Without the exercise of thought and skill, they either may be hard to read or else may dominate the map at the expense of all other features. If properly composed, they not only name and locate places but may also, by means of different styles of type, aid in differentiating among different classes of features; *e.g.,* size of lettering may give a general indication of the size of a town or city.

The foregoing considerations indicate that the functional elegance of a reliable map is dependent largely on a critical selection of detail and place names, and on the portrayal of these legibly, with the proper emphasis and with the right degree of generalization or symbolization. This is the cartographer's art.

Because the interpretation of symbols, or as they are sometimes called conventional signs, is not immediately obvious, it is customary to provide an explanation in the margins of a map. This, together with details such as the title of the map and its nominal scale, combine to form what is called the map legend. When a number of sheets cover a region on a uniform nominal scale and with the same system of symbolization, a separate conventional sign sheet is often printed.

4. Relief Representation. — Relief, the variation of the earth's continuous surface in slope and in elevation either above or below sea level, influences many of man's activities—transportation, agriculture, housing, flood control and military tactics, to name but a few. It is therefore important that relief be shown clearly. This, however, involves representing a third dimension on a two-dimensional surface, a representation that can be achieved only symbolically.

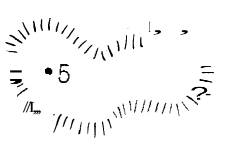
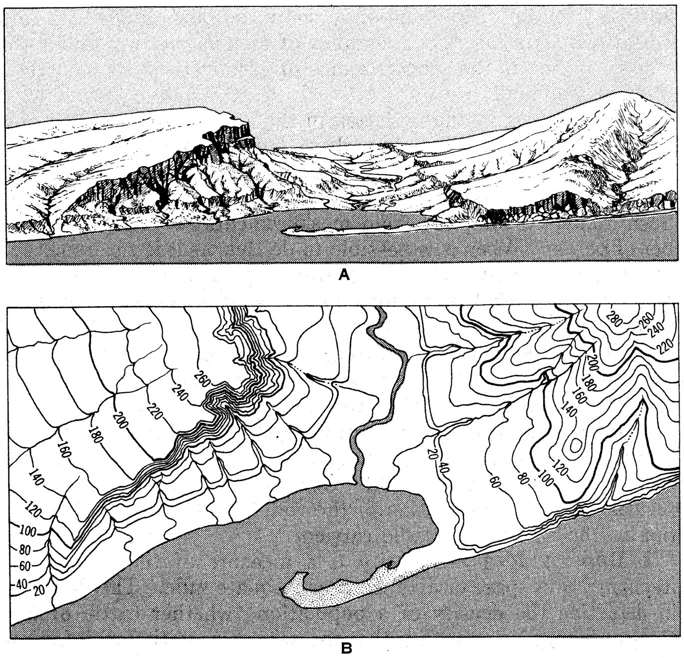


FIG. 4. — SPOT ELEVATION AND ROUGH OUTLINE OF HILL, PRIMITIVE METHODS OF SHOWING RELIEF (*see* TEXT)

In fig. 4, two primitive methods are shown. The number and dot show the elevation and position of a single spot, usually a hilltop or mountain whose general shape and location are indicated by the "caterpillar" type outline. On a map covered with a composite of such crude symbols, the character of the relief cannot be properly interpreted; there is no quantitative representation of slope. On most maps that show relief, such selected spot elevations do appear: usually they are supplemented with contouring, layer or hypsometric tinting, hill shading, hachuring or other symbolic representations, singly or in combination.

Contouring.—Contouring, which depicts relief both quantitatively and qualitatively, is by far the most important method. A contour line (q v.) on a map is the representation of an imaginary line on the earth's surface having a constant elevation above sea level. The nearest approach to a contour line in reality is the outline of a lake. The pattern produced by contour lines at uniform vertical intervals makes it possible to determine the elevations of points by interpolation. Slopes can be estimated from the horizontal spacing between adjacent contours, since the closer the contour lines the steeper the slope represented, and it is this feature of the contour method, together with the general arrangement of



ADAPTED FROM U.S. GEOLOGICAL SURVEY TOPOGRAPHICAL SHEET

FIG. 5.— LANDSCAPE SHOWN IN PERSPECTIVE (A) IS REPRESENTED WITH THE AID OF CONTOUR LINES ON MAP (B)

the contour lines, which gives expression to the relief character of the ground. The method has its limitations, however.

A uniform vertical contour interval on a particular scale may be adequate for representing major land forms but may fail to catch small but significant details. If the vertical contour interval is small enough to catch such details, the contour lines may have a tendency to merge on steep slopes; this occurs because it is necessary to show contours, theoretically of no width, as printed lines of finite width. For example, on the scale of $\frac{1}{63,360}$ (one inch to the mile) if the width of the printed contour lines is 0.004 in. 20-ft. contours will be hard to see separately (if at all) on slopes greater than about 26°, yet in otherwise flat country they will not portray steep rises of less than 20 ft., though these may be important features in the landscape.

In areas of moderate but complex relief, the visual picture given by contour lines is often hard to interpret. This difficulty can be partly obviated by emphasizing certain contour intervals as, for example, every 100-ft. contour when the regular contour interval is 20 ft. Finally, from a graphical standpoint, contours must be printed boldly. If they are subdued or overprinted by a multitude of names or other features, they lose their visual effectiveness.

Hypsometric Tinting.—With layer or hypsometric tinting! successive zones of elevation are coloured differently. This aids in the visualization of relative elevations and can be quickly understood even by schoolchildren. If the area mapped is of moderate relief, only a few tints may be sufficient and these may be in one hue, usually darkening as higher land is covered. More often, in order to obtain sufficient distinction between a large number of zones, variation in hue is introduced. Established convention generally demands that the hues follow the spectrum, starting with green for low land and proceeding through the buffs and oranges to dark red or brown or even purple for higher elevations. Even so, however, not enough colour differentiations are available to make the method altogether effective. For example, for the sheets of the International Map on the scale of $\frac{1}{1,000,000}$, it is specified that the elevation range of the colour zones increase with elevation and that above 3,000 m. (9,842 ft.) all land be shown in the same tint; thus, relief detail diminishes as elevation increases, and hills and valleys in high upland regions may have no representation at all.

Hill Shading.—Hill shading, a qualitative method of presenting relief features, gives a three-dimensional or plastic effect somewhat similar to that provided by an actual model of a landscape. It is based on the optical theory that the brightness of any small area on a perfectly diffusing undulating surface varies as the cosine of the angle of incidence of parallel light falling on it. The method thus has nothing to do with shadows cast by hill features. Oblique hill shading is customary. It usually assumes that the incident light is inclined at 45° to the vertical, and, for a reason not clear, the convention has arisen that the light is assumed-to come generally from a northwesterly direction. This convention is so strongly intrenched that if an oblique hill shaded map is turned around so that south is at the top of the map, many people have difficulty in retaining the plastic impression. In practice, the optical theory is not always strictly followed. Oblique hill shading is a specialized art, brought to a high degree of effectiveness notably in Switzerland and, during the 20th century, increasingly used on topographical maps in combination with contouring. The method loses its effectiveness as scale becomes smaller, though it can always be made to give a generalized plastic effect to the major mountain masses. In inexpert hands. the method can be misleading; for example, the artist may overemphasize the relief in gently undulating country so that it looks as rugged as more mountainous country.

Hachuring.—Hachuring consists in laying down a pattern, of short lines to indicate the directions of slopes. By varying the width of the lines, some indication of steepness of slope is also obtained. Well-executed hachuring reveals the character of the relief and when used as a supplement to contouring can be effective. Though this method should allow for a more precise interpretation than hill shading does, and was used extensively on topographical maps in the 19th century, it is more difficult to execute properly and in the 20th century has largely been abandoned as a technique.

Other Methods.—There are other methods of relief representation, many of which are ingenious and some of which are statistical or diagrammatic, but only two will be mentioned here. One is a technique that characterizes land form features on small scales by perspective or semiperspective symbols, a qualitative method requiring skill and considerable knowledge of geomorphology. The second is the depiction of zones of slope by succession of tints. This method, though not in common use, gives on very small scales a revealing characteristic pattern of landscape when combined with the representation of drainage features; it may be useful, for example, in assessing the suitability of regions for development projects such as housing.

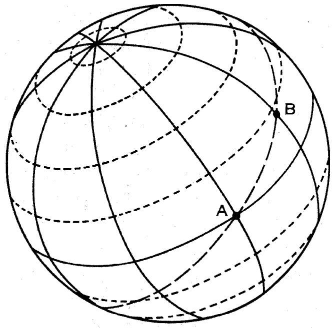
5. **Terrain** Models.—These are three-dimensional maps, which not only supply the user with a real plastic effect rather than the simulated effect obtained by hill shading, but also make possible the adequate representation of steep slopes and vertical precipices. The earth is, however, a remarkably smooth surface in respect to its radius. The elevation of Mt. Everest is only about $\frac{1}{7}$ of 1% of the earth's radius, and on a scale of $\frac{1}{1,000,000}$ its elevation is represented by about 0.35 in. In order, therefore, to give emphasis to the relief on models, the vertical scale on any but extremely large-scale models is usually made larger than the horizontal scale. This "vertical exaggeration" usually is increased as the horizontal scale becomes smaller. One effect of vertical exaggeration, not often noted, is that gentle slopes are given more exaggeration than are steep slopes. Obviously a vertical slope cannot be exaggerated by increasing vertical scale over horizontal scale.

Though vertical exaggeration actually distorts the representation of slope, the proponents of terrain models do not consider this to be a defect. In fact, in some cases, the vertical exaggeration is purposely varied with slope to emphasize the gentle slopes still further.

The principal difficulty in constructing a terrain model lies in the making of the master base model itself. Though this process is comparable to sculpturing, modern technology has reduced it to the point where it is nearly automatic. Modern methods for reproducing printed terrain models quickly and in quantity, which began to develop about the time of World War I and were greatly improved during and after World War II, involve printing the maps on flat sheets of opaque plastic. The sheets are vacuum pressed onto the master model or a facsimile and heat is applied so that the plastic nearly melts and molds itself to the model.

When it is cooled and removed, a lightweight printed model is produced.

6. Geographical Names.—Names of places are established, for the most part, from a multitude of complex considerations. Only an indication of the intricacies of toponymy (the study of place names) can be attempted here. If all nations used the same alphabet and spoke and wrote in one language, the rendering of geographical names on maps would be a comparatively simple matter. though this is not the only difficulty in place names: the same name is often given to different places (for example, Boston, Columbus, Washington and Lincoln); sometimes local usage varies from official usage (a mountain may be called by different names by the peoples living on opposite sides of it); the same place name has various spellings or is entirely different in different languages ("Wien" in German is "Vienne" in French, "Vienna" in English and "Becs" in Hungarian, and the English channel and the Straits of Dover in English become respectively La Manche and Pas de Calais in French).



MODIFIED FROM JOHN Q. STEWART & NEWTON L. PIERCE "MARINE AND AIR NAVIGATION" (1944)

FIG. 6.—SOLID AND LONG-DASH LINES INDICATE GREAT CIRCLES, SHORT-DASH LINES ARE SMALL CIRCLES. AND THE PORTION BETWEEN A AND B IS A GREAT CIRCLE ARC

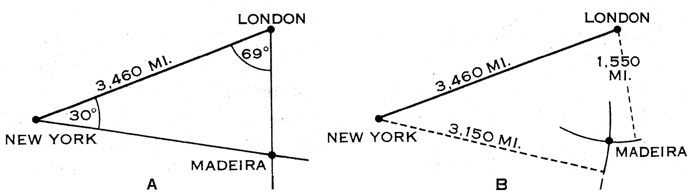
The greatest difficulties in the rendering of geographical names, however, occur because there are numerous different scripts and because sounds in one language may have no adequate representation in the alphabets used for another language. Sometimes names are translated; the Cabo da Boa Esperanca in Portuguese, for instance, has become the Cape of Good Hope in English. More often, the transcription of alphabets or the transliteration of syllabic symbols is attempted.

In passing, it may be noted that explorers not sufficiently versed in local languages to fully comprehend answers to questions have been known to place on their maps absurdities with meanings such as "I don't know."

In the English-speaking world since the beginning of the 19th century, the Royal Geographical society has pioneered in establishing order in the rendering of geographical names, and in 1919 it established the Permanent Committee on Geographical Names. In the United States. the Board on Geographic Names was established under a slightly different name in 1890. These two organizations deal specifically and exclusively with the subject, and considerable co-operation and co-ordination have been effected between them.

C. Special-Purpose Maps

1. Categories.—Special-purpose maps fall into several distinct categories. Air navigation charts and road maps, for instance, comprise one. Another divides the land up into areas or regions according to a system of classification. For example, a geological map may show the areas occupied by different kinds of outcropping rock. Land-cover maps may show forests, grasslands, swamps, tundra or deserts. The soil map is another important type. Such maps as these are compiled from intensive observations in the field. Other types within this category may have been derived from a combination of field observations and statistical analysis; for instance, maps may show the land divided up into climatic regions based on a complex of criteria, or may divide the land according to the predominance of certain crops or of certain races of mankind.



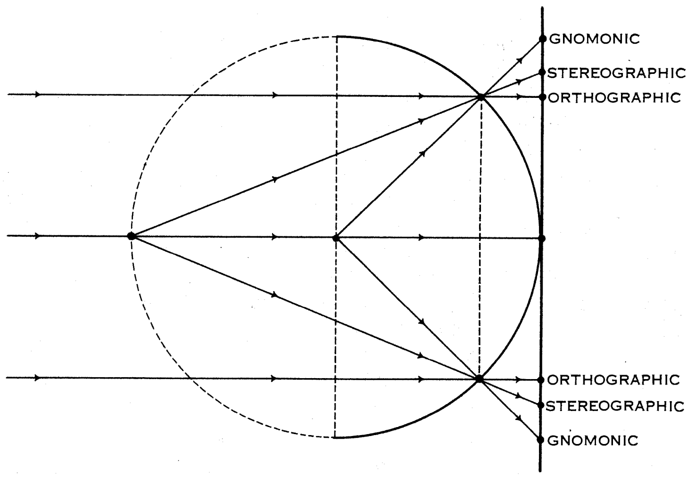
MODIFIED FROM IRVING FISHER & O M MILLER WORLD MAPS AND GLOBES

FIG. 7.—(A) MADEIRA PLOTTED SO THAT ITS AZIMUTHS FROM LONDON AND NEW YORK ARE CORRECTLY SHOWN; (B) MADEIRA SHOWN AT ITS CORRECT SCALE DISTANCE FROM BOTH POINTS

A map may show the variation in the amount of intensity of a single phenomenon. This is perhaps best exemplified in climatic maps that show the distribution of such items as temperature, barometric pressure or rainfall averaged over periods of time. Such maps are compiled from measurements at a discrete number of points. When it is possible to do this, as it is for numerous kinds of phenomena, it is also permissible to interpolate isolines, or lines of equal intensity, in the same way as contour lines may be interpolated from spot elevations.

Another category of special-purpose maps comprises those that show flow lines, such as sea currents or winds. The rate or amount of flow can be indicated. For example, a useful type of map for analyzing road traffic problems is one that differentiates between the number of cars passing over different sections of a road system in a given period. One way of depicting this is by regulating the representation of the width of the roads in proportion to the amount of traffic carried.

2. Density Maps.—Density is a measure of the number of items in a unit space or area, such as a square mile. The difficulty in depicting the density of a population (whether cattle or oak trees or human) on a map is that the necessary statistical information is summated over areas varying in size and shape; *e.g.,* minor civil divisions. If the population densities in counties are given as so many items to a square mile, there is no assurance that these items are regularly distributed over each area. In fact, quite a different picture generally will be obtained if it is possible to obtain statistics for areas considerably smaller than counties.

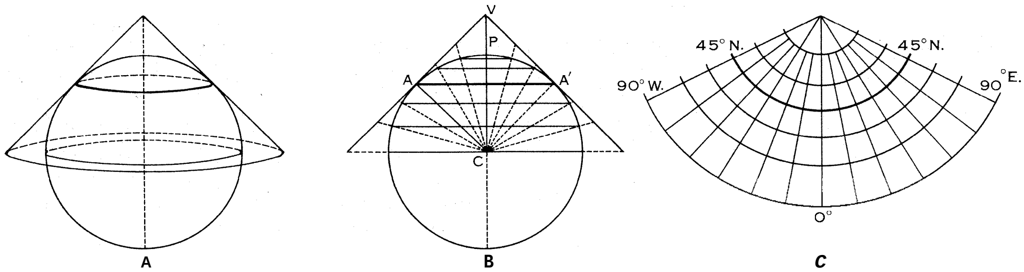


MODIFIED FROM IRVING FISHER & O. M. MILLER "WORLD MAPS AND GLOBES"

FIG. 8.—ORTHOGRAPHIC, STEREOGRAPHIC AND GNOMONIC PROJECTIONS OF A SPHERICAL SURFACE ONTO A TANGENT PLANE BY PERSPECTIVE RAYS

Because density is associated with area, the most valid method of indicating it on a map is to show by colour or pattern differentiation the density variation among the statistical areas; but this method may fail to give a revealing over-all picture graphically. If, on the other hand, the centres of the statistical areas are adopted as points of average density and isolines are then interpolated, the pattern of the isolines will depend to a large extent on the size and shape of the areas and on the compiler's judgment. Isoline patterns of density, therefore, must be viewed with suspicion except insofar as they show very general relationships.

The dot method in its simplest form would show each individual item in its correct position, and a map thus compiled would give a revealing over-all picture of density. However, because of considerations such as scale and the impossibility of collecting the necessary information, individuals are usually grouped, and each dot may represent hundreds or even thousands of individual items not necessarily at the mean position of the group. This method thus requires skill and judgment to be successful.



MODIFIED FROM IRVING FISHER & O. M. MILLER "WORLD MAPS AND GLOBES"

FIG. 9.—THE DEVELOPMENT OF A PERSPECTIVE CONIC PROJECTION (*see* TEXT)

D. Map Projections

1. Basic Concepts.—It is impracticable to record detailed surveys on topographic and cadastral scales and. in general, to compile maps from these surveys on anything but a plane surface. Nevertheless, these surveys and compilations must be tied to geodetic control points, whose positions have been determined with reference to the surface of an oblate spheroid which is a close approximation to the form of the earth. In practice, this problem is solved by expressing the positions of the control points in terms of their projected positions on a plane.

Though the subject of map projections is a highly specialized branch of applied mathematics, the principles involved and the properties of most map projections can be described quite simply in terms of elementary geometry and trigonometry by assuming the earth to be a sphere. (See SPHERE; SURFACE.) The following concepts and definitions are valid on the basis of this assumption.

The geographical poles (north and south) lie on the surface of the terrestrial sphere on its axis of rotation. The plane of the equator is perpendicular to this axis. The equator is only one of an infinite number of circles, called great circles, which divide the surface of the sphere into two equal parts. All other circles on the surface of the sphere are called small circles. Two points on the surface of the sphere can always be connected by a great circle, and the shortest surface distance between them lies along it. The portion of a great circle between two points is called a great circle arc. Because an arc subtends an angle at the centre of the sphere, it is convenient to express it either in arc measure (degrees, minutes and seconds) or in circular measure (radians). (See TRIGONOMETRY: Spherical Trigonometry.)

At all points on the surface of the terrestrial sphere, the vertical direction is assumed to be perpendicular to the surface. **A** horizontal line or area, therefore, lies on or parallel to this surface. Horizontal position on the terrestrial sphere is stated in terms of the geographical co-ordinates latitude and longitude (see LATITUDE and LONGITUDE). Lines of equal latitude are small circles parallel to the plane of the equator and are thus frequently referred to as parallels of latitude. Latitude as shown on maps varies between 0° on the equator to 90° N. and 90° S. at the poles.

Meridians are arcs of great circles connecting the two geographical poles. The angular difference between two meridians at the poles is called a difference of longitude. By international agreement in 1884, the meridian passing through the Greenwich observatory near London, Eng., long used by the British as a zero or prime meridian, was accepted as standard, and by 1950 the system was in universal use on the maps of practically all nations.

Longitude on maps is given almost invariably in arc measure up to 180° E. or 180° W. of the prime meridian.

The azimuth or direction at one point A of a second point B on the terrestrial sphere (see fig. 6) is the angle usually measured clockwise from the north direction of the meridian passing through A and the great circle arc passing through both **A** and B. Because of the convergence of the meridians toward the poles the reverse azimuth of A from B is in general not equal to the azimuth of B from **A** plus 180°.

The sides of a spherical triangle consist of great circle arcs. It is shown in spherical trigonometry that the sum of the angles of any spherical triangle exceeds 180°, and this excess is in direct proportion to the area of the spherical triangle. Thus, it is impossible to represent any spherical triangle on a plane without distorting some of the angles and sides. The two-point equidistant and two-point azimuthal projections are simple kinds of map projection that demonstrate this clearly. In both projections two points on the sphere are chosen and shown on a map at their correct scale distances apart. In the first projection, the position of any other point is mapped so that it is shown at its correct scale distance from both points. In the second projection, it is mapped so that its azimuths from the two points of origin are correct.

2. Properties of Projections.—A representation of meridians and parallels of latitude at regular intervals is often referred to as the map projection itself; more correctly, it is called a map graticule. **A** primary classification of map projections separates them into three groups: (1) equal-area, sometimes called equivalent or authalic; (2) conformal, frequently called orthomorphic; and (3) any other types. On equal-area projections the areal scale is constant from point to point; linear scale at a point, however, will in general vary with direction, and differences of direction will be distorted. On a conformal projection, the linear scale at a point is constant in all directions and angles around a point are shown correctly; in general, however, the scale varies from point to point. It is obvious that no map projection can be both equal-area and conformal.

The properties of map projections can be precisely described mathematically with the aid of the infinitesimal calculus. A. Tissot in his *Mémoire sur* la reprksentation des *surfaces* et *les* projections *cartographiques* (1881) demonstrated that when projecting a surface onto a plane in a continuous fashion so that there is a one-to-one point correspondence, an elementary (infinitesimally small) circle becomes an ellipse. Such an ellipse has consequently been called a Tissot indicatrix. It is possible, once a map projection has been defined. to calculate the relative dimensions of the elliptical indicatrix and the orientation of its major and minor axes for any point mapped. On an equal-area projection, the area enclosed by the ellipse will be the same as that within the elementary circle, but the shape of the ellipse and its orientation will vary from point to point. On a conformal projection the ellipse degenerates into a circle, but its relative size will vary

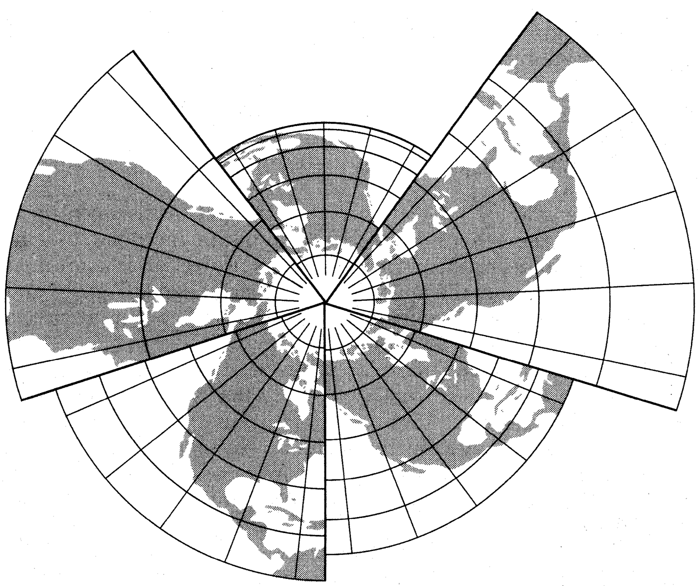


FIG. 10.—FIVE AZIMUTHAL PROJECTIONS FROM THE POLAR ASPECT. CLOCKWISE FROM TOP RIGHT THEY ARE STEREOGRAPHIC, EQUAL-AREA. EQUIDISTANT, GNOMONIC, ORTHOGRAPHIC

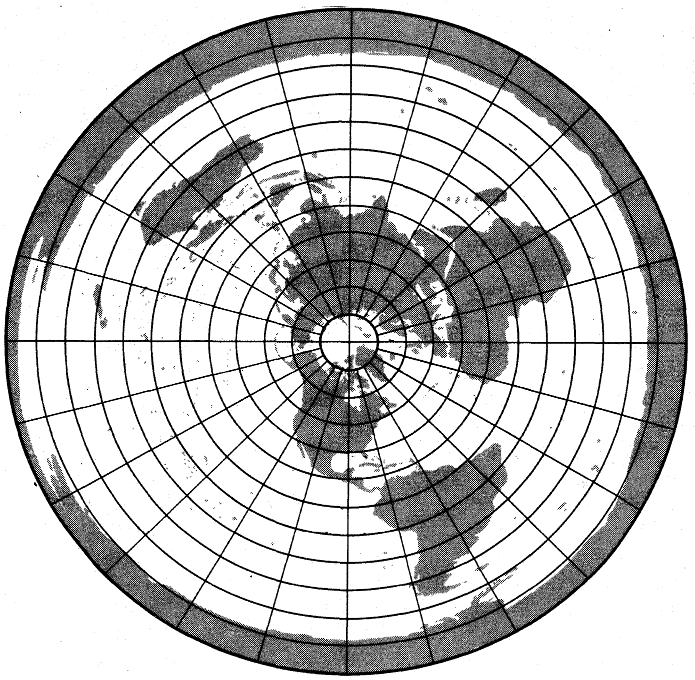


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FIG. 11.—A POLAR AZIMUTHAL EQUIDISTANT PROJECTION OF THE WORLD. WITH THE SOUTH POLE REPRESENTED AS THE BOUNDARY LINE OF THE PROJECTION

from point to point. On all other projections the ellipse does not degenerate into a circle, nor is it equal-area at all points.

It is a necessary. but not a sufficient, condition for conformality that the meridians and parallels on a map projection intersect at right angles as they do on a sphere. However. conformal map projections are no exception to the general rule that shapes of areas of considerable extent will be distorted.

Any properly conceived map projection can be defined by means of a pair of mathematical formulas nhich enable the positions of the intersections betneen meridians and parallels of latitude to be calculated in terms of plane co-ordinates on the map projection. When these calculated positions have been plotted, the graticule is obtained by drawing smooth. continuous curves through all the points plotted for each meridian and for each parallel of latitude.

3. Perspective Projections.—Certain projections can be constructed by using the principles of perspective (*q.v.*). Points on a sphere of nominal scale are projected onto a plane tangent to it by perspective rays from a perspective centre.

The orthographic projection puts the perspective centre at infinity. Thus, the projecting rays are parallel to each other and perpendicular to the plane of projection. A map plotted on this projection gives the impression of the world as seen at a great distance away.

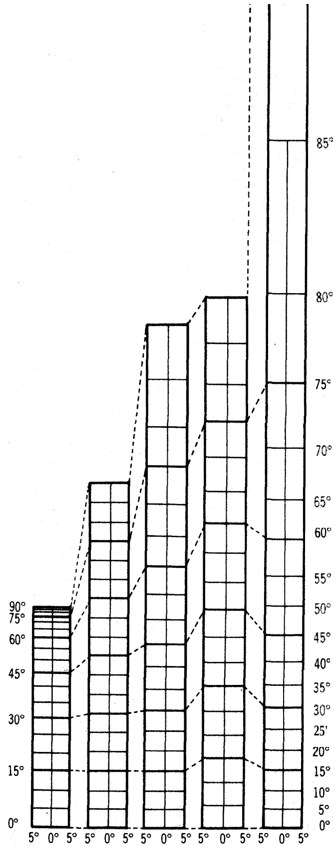
The stereographic projection places the perspective centre at the point on the sphere diametrically opposite the point of tangency of the plane of the projection. This projection is conformal and has in addition the remarkable property that all great and small circle arcs on the sphere are shown as either arcs of circles or as straight lines on the projection.

The gnomonic projection places the perspective centre at the centre of the sphere. It has the property that all great circle arcs are shown as straight lines, and this is useful for laying out the shortest route between two points. An innumerable variety of projections that will show great circles as straight lines can be derived from the gnomonic by making other perspectives of the plane of the gnomonic onto other planes inclined to it. This is because any projection of one plane onto another transforms straight lines into straight lines. Two-point azimuthal projections result from this procedure, and any particular case can be derived easily by orthogonal projection.

With the perspective centre at the centre of the sphere, a projection can be constructed onto a conical surface tangent to the sphere along any small circle. By cutting the conical surface along any straight line from the vertex, it can be developed into a plane by unrolling it. In such a projection, the scale ratio along the circle of tangency is equal to one. This circle is sometimes called the standard small circle or standard parallel when the centre of the projection is at one of the geographical poles. In fig. 9(B) AA' is the diameter of a circle of tangency and V is the vertex of the cone. The projected distance V is equal to the tangent of the angle VCA. When the cone is unwrapped as in fig. 9(C) all circles parallel to AA' will be shown as concentric arcs of circles centred on V. All great circles passing through P on the sphere will be straight lines passing through V. Their angles of intersection at V will be smaller than on the sphere. It can be shown that this angular compression, called the constant of the cone, is equal to the cosine of the angle VCA. Thus this constant, usually denoted by n, varies between the limits one and zero. When n is 1, the vertex V coincides with the point P and the gnomonic projection results. When n is zero the vertex V can be considered as being at infinity so that the cone becomes a cylinder and the resulting projection is called a perspective cylindrical projection. The great circles passing through P and the small circles concentric around P are shown in this cylindrical version as sets of parallel straight lines, one set cutting the other at right angles.

Except for the limiting case of the gnomonic projection, these perspective conical projections have no practical value. They are, however, the genesis of a much larger category of projections that fall under the general heading of conic.

4. Conic and Related Projections.—Conic projections include equal-area, conformal, so-called equidistant and other variants. All have the common characteristics that great circles radiating out from the origin, corresponding to V in fig. 9(B) in the perspective variant, are shown as straight lines and that concentric circles around the origin are shown as arcs of concentric circles. Geometrically, they vary one from another only in the manner in which the concentric circular arcs are spaced and in the value adopted for the constant n.



MODIFIED FROM "NOTES ON CYLINDRICAL WORLD MAP PROJECTIONS," "GEOGRAPHICAL REVIEW," VOL. 32 (1942)

FIG. 12.—SPACING OF PARALLELS FOR FIVE NORMAL CYLINDRICAL PROJECTIONS

From left to right: cylindrical equal-area, simple, Miller's modified Mercator, Gail's stereographic and Mercator

When n equals one the various projections are called azimuthal (azimuths of all points are correct at the centre) or zenithal (British usage). The group includes the orthographic, stereographic and gnomonic described above, the important azimuthal equal-area projection devised by Johann Heinrich Lambert and the azimuthal equidistant projection which represents all points at their correct distances to scale from the centre. When the centre of an azimuthal projection is at one of the geographical poles, it is called a polar azimuthal projection; when on the equator it is called a normal or equatorial azimuthal projection. With any other centre it is called an oblique or horizon azimuthal projection.

Mercator and Other Cylindrical Projections.—When n is zero the various projections are called cylindrical; and normal, transverse and oblique when the equator, a meridian and any other great circle is represented by the central straight line. The normal

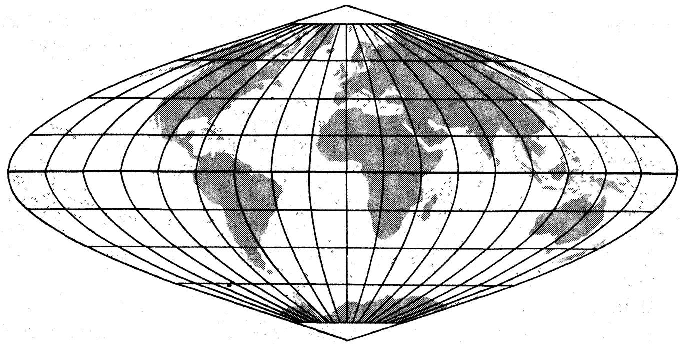


FIG. 13.—SINUSOIDAL OR SANSON-FLAMSTEED EQUAL-AREA PROJECTION OF THE EARTH

cylindrical projections in common use are the Mercator, the simple or equidistant (parallels of latitude are spaced correctly to scale), Gall's stereographic and Miller's modified Mercator. The equal-area variant is little used for world maps because the spacing of the parallels of latitude must of necessity become extremely compressed in high latitudes. Gerardus Mercator's (*q.v.*) famous projection, besides being conformal, shows all lines of constant azimuth (rhumb lines or loxodromesj as straight lines. These properties combine to make this projection more useful for navigation than the gnomonic even though the rhumb line route between two points is longer than the great circle route.

When n is greater than zero and less than one it is always possible to select two small circles less than go° from and concentric about a centre as standard. Thus, these may be chosen best to suit a given region. In the normal cases when one of the geographical poies is the centre, the important variants of the conic projections with two standard parallels are Alber's equal-area, Lambert's conformal and the "simple," which last has the property that the meridians as well as the two standard parallels have constant scale ratios equal to one.

Closely related to the conic family of projections are Bonne's equal-area projection and the polyconic projections. In Bonne's a standard parallel is developed as in the case of the perspective conic. All other parallels are concentric arcs of circles of constant scale ratio equal to one and spaced along a central straight line meridian at their correct scale distances apart. ,411 other meridians are curved lines which do not cut the parallels of latitude at right angles. One limiting case of this projection is nhen the equator is taken as the standard parallel. The resulting projection is called the sinsusoidal or Sanson-Flamsteed. In this case! the equator, the parallels of latitude and the central meridian are straight lines true to scale and the remaining meridians are sinusoidal curves.

One form of the polyconic projection is developed by constructing the parallels of latitude as if they were standard parallels on a perspective conic and then spacing them at their correct scale distances apart on a central straight-line meridian. The other meridians are curves and the projection is neither conformal nor equal-area.

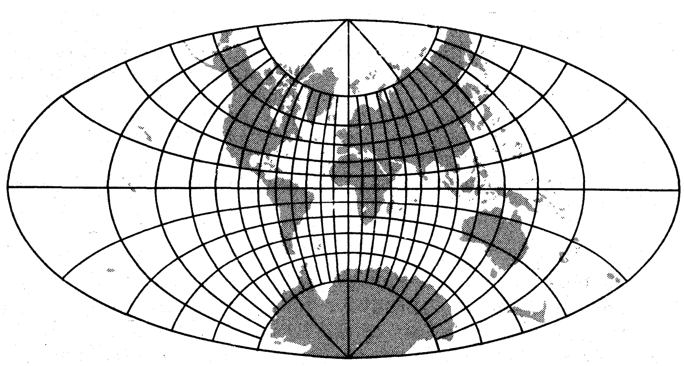


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FIG. 14.— ADAM'S CONFORMAL PROJECTION OF THE EARTH WITHIN AN ELLIPSE

5. Shape of World Maps.—Many other types of map projections have been conceived, but only a few can be mentioned here. Many world map projections are characterized by the shape of the area on the map which portrays the whole sphere. It is possible, for example, to obtain conformal maps of the world within the confines of a square, a rectangle, a circle and an ellipse. Two types of equal-area projection which represent the whole earth within an ellipse are the Mollweide and the Hammer (often wrongly called the Hammer-Aitoff or even the Aitoff). The Mollweide in its normal form represents the equator and parallels of latitude as parallel lines. The Hammer projection encloses the whole world within an ellipse of the same dimensions but, in this case, the parallels are curved. Both these projections have been used in their oblique forms with centres at latitude 45° N., and when the central meridian is the Greenwich meridian or one somewhat west of it, the general relationships between the land masses on the earth are shown well.

6. Discontinuities.— A spherical surface is continuous. When it is projected onto a plane, this continuity must be interrupted at least one point: more often at two points, and frequently along the whole or part of one or more small or great circles. Azimuthal equidistant and equal-area projections interrupt the sphere at only one point, which is diametrically opposite the centre of projection. This point becomes the boundary of the projection. The cylindrical projections are interrupted at two points diametrically opposite one another. These become straight lines on the map unless, as in the case of the Mercator projection, the points

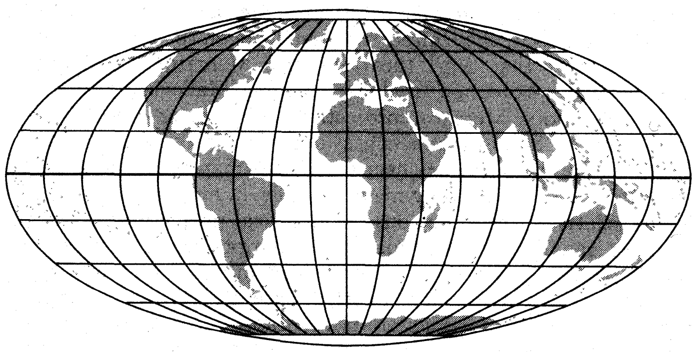

FIG. 15.— HOMOLOGRAPHIC OR MOLLWEIDE'S EQUAL-AREA PROJECTION OF THE EARTH WITHIN AN ELLIPSE

project at infinity. The cylindrical projections, however, have the useful property of being periodic or continuous in the direction of their central lines. The world shown enclosed in an ellipse is interrupted along the half of one great circle. Sometimes interruption is purposely introduced in order to reduce over-all shape distortion. This is done usually in the ocean areas in order to show the principal land areas with good shape characteristics. It is an open question whether much is to be gained by sacrificing continuity when these interruptions are asymmetrical.

When the nominal scale of a map is so large that the whole world or the region to be mapped cannot be shown on one sheet, another problem of continuity occurs. A single projection can be used so that all sheets can be assembled together. If. however, a separate projection is used for each sheet so that scale anomalies and shape distortion are limited to the single sheets, then, though it is possible to maintain fit along the edges of adjacent sheets, over-all continuity will be lost. Such a system is adopted, for example, for the sheets of the International Nap of the World on the scale of $\frac{1}{1,000,000}$. Compromises between the two systems are to be found in the use of the polyconic projection for the topographical sheets of the United States geological survey. In this system, sheets falling into one zone of longitude are on the same projection. The World Aeronautical Charts are on a system of conformal conic projections with two standard parallels. Here sheets falling into one zone of latitude are on the same projection.

7. Modern **Uses.**—Map projections in actual use to any great extent are limited in number! especially in the case of large-scale maps. On topographic and cadastral maps, the fact that the shape

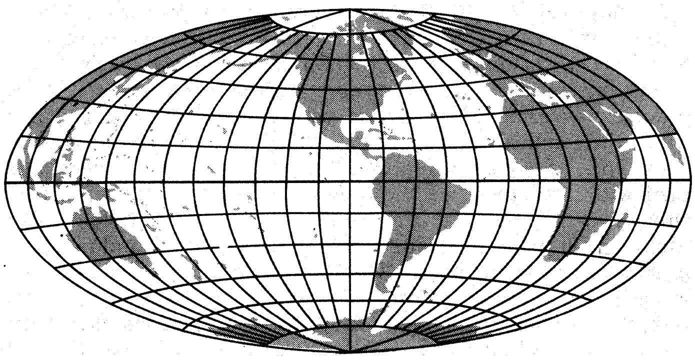

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FIG. 16.— HAMMER'S EQUAL-AREA PROJECTION OF THE EARTH WITHIN AN ELLIPSE

of the earth more nearly corresponds to an oblate spheriod than to a sphere is invariably taken into account. Equal-area projections such as Bonne's and nonconformal projections such as the transverse simple cylindrical (Cassini) were sometimes adopted for the maps of small countries. From the turn of the 20th century, however, the trend has been to base large-scale maps on conformal projections such as the transverse Mercator for regions having their greatest extent north and south; on the Lambert conformal conic with two standard parallels for regions having their greatest extent east and west, and the oblique stereographic for regions roughly circular. For example, until 1935 the topographical sheets of the United Kingdom were on the Cassini projection but after that time, the transverse Mercator was adopted. The Laborde projection used for mapping Madagascar is essentially an oblique Mercator projection. The latter type also has been used for strip maps along established air routes.

For world maps on one sheet equal-area map projections are in great demand because they make possible an over-all visualization of the relative sizes of regions. Cylindrical projections often are used for general reference maps over the populated areas of the world, because parallels of latitude and meridians are shown in the form of a rectangular network. Except for special purposes, conformal map projections are not suitable for world maps. On the other hand, they have certain technical advantages over other types for compiled maps on intermediate scales such as $\frac{1}{5,000,000}$. Principally, they permit compilation from sources on large-scale maps having little significant shape distortion to be accomplished quickly and accurately, since small areas on the large-scale maps, when suitably reduced in size, can be made to fit into the conformal small-scale projection with little adjustment.

A rectangular, usually square grid often is superimposed or indicated on a map in addition to the map graticule. Grids are useful for determining the relative positions of points in terms of map rectangular co-ordinates on large-scale maps of limited areas when the map projection distortion is relatively insignificant. They are also useful for locating place names on maps from an alphabetical index, in which a reference is given to the grid areas.

The mathematical aspects of projection are discussed further in ANALYTIC GEOMETRY; DESCRIPTIVE GEOMETRY; DIFFERENTIAL GEOMETRY; GEODESY; TRIGONOMETRY: *Spherical Trigonometry.*

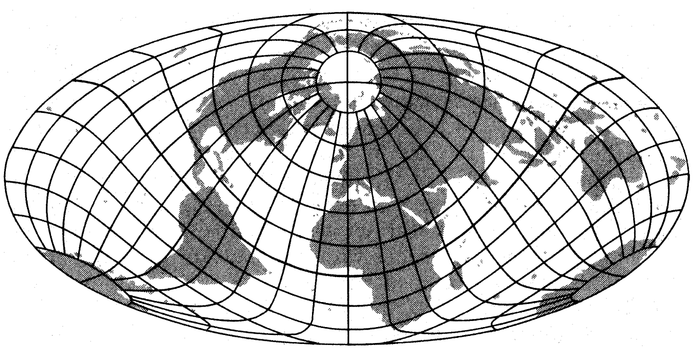

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FIG. 17.— OBLIQUE MOLLWEIDE PROJECTION WITH CENTRE AT 45° N.

E. GLOBES AND GAZETTEERS.

Terrestrial globes are maps of the earth on spherical surfaces, and because they show shapes without distortion, they are ideal objects wherewith to learn and visualize geographical relationships. However, they are difficult to construct precisely, and few have been made with a diameter of more than six feet. The schoolroom or office globe is generally not more than 18 in. in diameter and often less.

It must be appreciated that a map on a globe cannot be constructed until geographical features have been depicted on flat maps. When printed information is on a globe, this usually means that flat maps of narrow sections of the earth, usually gores, have been cut out and stuck on.

Gazetteers are the antitheses of globes. They list place and physical names alphabetically and also supply in varying degrees written information concerning the places or features referred to. The minimum information given in any gazetteer is the location of named places. Additional information may include the size and population of towns, cities, states and countries, their industries and histories, and descriptions of physical features such as rivers and mountain ranges. The more detailed gazetteers are usually national.

Maps are the practical compromise between globes and gazetteers. They are not limited in scale as are globes and they show spatial relationships which gazetteers cannot.

BIBLIOGRAPHY.—Few books in English deal comprehensively with modern techniques of map compilation, drafting and reproduction or with map design. The authoritative literature on the subject is mostly scattered in the technical publications issued by various government mapping agencies and in periodicals such as the *Geographical Journal* (Royal Geographical society, London), the *Geographical Review* (American Geographical society, New York), *Surveying and Mapping* (American Congress on Surveying and Mapping, Washington, D.C.), *Cartography* (the Australian Institute of Cartographers, Melbourne, Austr.). Most of the following books include extensive or specialized bibliographies and references: Arthur R. Hinks, *Map Projections,* (1912; 2nd ed., 1921), *Maps and Survey,* 4th ed. (1942); H. S. L. Winterbotham, *A Key to Maps* (1936); Irving Fisher and O. M. Miller, *World Maps and Globes* (1944); Charles H. Deitz and Oscar S. Adams, *Elements of Map Projections,* jth ed., Special Publication No. 68, U.S. Coast and Geodetic Survey (1945); W. Chamberlin, *The Round Earth on Flat Paper* (1947); Erwin Raisz, *General Cartography* (1938); T. W. Birch, *Maps, Topographical and Statistical* (1949); Arthur N. Strahler, *Physical Geography* (1951); Arthur H. Robinson, *The Look of Maps* (1952), *Elements of Cartography* (1953); J. A. Steers, *An Introduction to the Study of Map Projections,* 8th ed. (1950); M. Aurousseau, *The Rendering of Geographical Names* (1957); Eduard Imhof, *Gelande und Karte* (1950); François Reignier, *Les Systèmes de projection,* 2 vol. (1957). (O. M. M.)

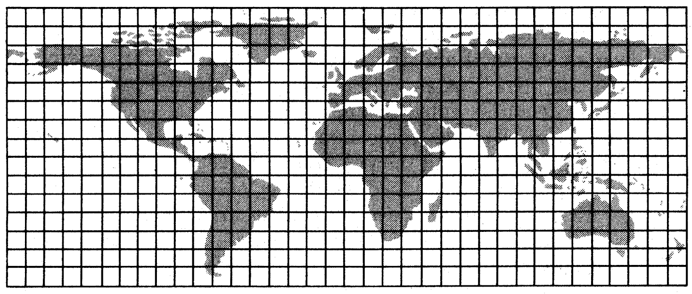

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FIG. 18.— SIMPLE CYLINDRICAL EQUAL-SPACE PROJECTION OF THE EARTH

II. HISTORY

Human existence would be impossible without knowledge of the sort that maps convey. Primitive folk carry such knowledge in their minds—mental "maps" of the areas where they live or hunt, fish or fight. As culture develops, such mental maps no longer suffice. and real maps are made to meet countless practical needs, to satisfy scientific curiosity and to give aesthetic pleasure. The history of maps and of all that the; have meant to mankind is

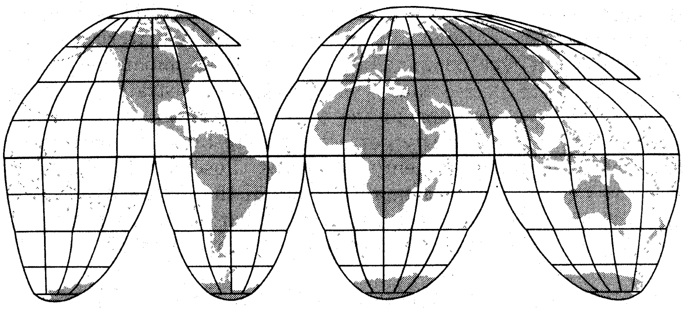


FIG. 19.— GOODE'S HOMOLOSINE EQUAL-AREA PROJECTION

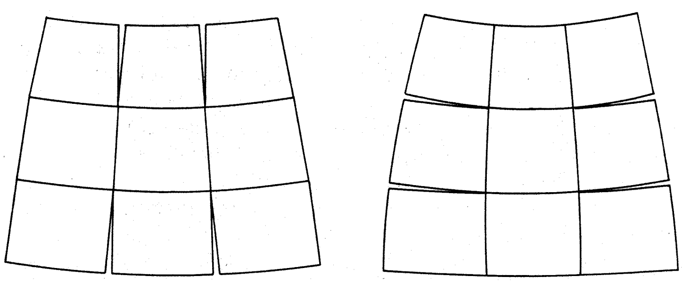
therefore an immense field, potentially as vast, perhaps, as the history of art or of literature.

Like modern science and technology, modem cartography throughout the world is essentially of western origin. It represents a phase in the development of a cartographic tradition that stems from ancient Greek times and that may have been stimulated in its beginnings by borrowings from the earlier cultures of southeastern Asia and Egypt. Four distinctive periods may be roughly blocked out (with highly arbitrary dividing dates): (1) the Greco-Roman (600 B C. to A.D. 400); (2) the medieval (400 to 1500); (3) the early modern (1500 to 1700); and (4) the modern (after 1700).

No maps, at least in their original form. have come down to us from the Greco-Roman period. Hence the nature of Greco-Roman cartography can only be inferred from what ancient authors wrote about geography and maps and from examination of a few extant medieval versions of ancient maps. There is enough evidence, however, to show that, until about the mid-2nd century of the Christian era, cartography made substantial if often halting progress and that many of its basic mathematical problems were recognized and understood, if not fully solved. Thereafter several centuries of retrogression and stagnation ensued.

Of the many late medieval and early modern maps that have been preserved, a goodly proportion have been reproduced and studied in detail from the beginning of the 19th century. Indeed, of the entire field of cartographic history, this part has been cultivated in by far the most systematic and intensive manner, and for two chief reasons: (1) medieval and early modern maps have, to our eyes, a quaintness. a naïveté and an artistic quality that make them exceedingly attractive; and (2) perhaps more significantly, early modern maps, in a way and to a degree achieved by the maps of no other age, record and illumine events of supreme historical importance — the voyages and travels of the great age of geographical discovery and the widening of man's geographical horizons that they brought about.

During the modern period maps have increasingly come to be based on accurate measuring. counting and computing, rather than mainly on speculation and guesswork. Modern cartography has stressed the scientific and the practical functions of maps at the expense, if not to the total neglect, of their aesthetic functions. The development of scientific instruments and statistical techniques and the accumulation of scientific data have enormously enlarged the variety and quantity of mappable facts and consequently of maps and their uses. So many and so diverse are these uses today that maps have become indispensable.



FROM IRVING FISHER & O M. MILLER WORLD MAPS AND GLOBES'

FIG. 20.— TWO METHODS OF ASSEMBLING SHEETS OF THE INTERNATIONAL MAP OF THE WORLD. BOTH INVOLVING DISCONTINUITY

A. Primitive Peoples

Travelers have described the remarkable ability of certain primitive folk — particularly those who, like the Eskimos or Bedouins or Polynesians, wander far and wide—to draw sketch maps of their territories, and a goodly number of crude maps that such people have carved on wood or bone or put together with sticks and shells or made in other ways may be seen in ethnographical museums. Better maps were produced by early civilized peoples — Egyptians, Babylonians, Chinese, Aztecs and Peruvians of the Inca empire. Their cartography was practical: they made cadastral plans, real-estate plots, specifications for the construction of temples, palaces, canals, roads — the equivalent of the blueprints of modern engineers. None of these peoples except the Babylonians gave much heed to speculative mapping of the world as a whole. A diagrammatic world map on a late Babylonian tablet (6th century B.c.), suggests that the Ionian Greeks may have borrowed from, or shared with, the Babylonians the long-lived belief in a flat, disk-shaped earth surrounded by an ocean stream and bordered on the north by a great range of mountains.

(J. K. W.)

B. Greece and Rome

The Greeks, more than any other people in the ancient world, were fitted to pursue and develop geographical knowledge. Shortage of arable land and adverse economic or political conditions at home induced impoverished or adventurous men to seek a livelihood overseas. Travel tales of Jason and his Argonauts and of Odysseus indicate that the Greeks were attracted to sailing from early times. During the great age of colonization (8th to 6th centuries B C) they established maritime settlements from the east coast of Spain to the far reaches of the Black sea. Miletus, the leading colonizing city, alone founded more than 40 city-states. Daughter colonies usually maintained close relations with the mother city, and these opportunities to exchange information about distant regions greatlv stimulated the Greeks to speculate about the shape of the world and the causes of physical phenomena.

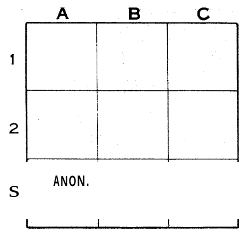


FIG. 21.—SIMPLE GRID REFERENCING SYSTEM
ANON followed by A3 in an alphabetical index indicates the approximate location of the place on the map (see text)

By 600 B.C. Miletus had become the leading centre of cosmographical speculation and geographical knowledge. Thales of Miletus (*q.v.*) was the founder of natural philosophy. His pupil Anaximander (*q.v.*), also of Miletus, was reputed to have been the first to publish a geographical map. Hecataeus of Miletus (*q.v.*) may have produced the first book on geography (c. 500 B.c.). surviving fragments of which make it possible to reconstruct the author's conception of the earth (fig. 23) as a circular plane, surrounded by a continuous belt of ocean. He located Greece at the centre. A generation after Hecataeus, the celebrated historian Herodotus (*q.v.*) traveled uidely and had more precise and extensive knowledge of geography than did his predecessors. He expressed contempt for the map makers of his day who supposed Europe and Asia to be of equal size and represented the earth as circular, surrounded by an assumed ocean. He himself presumed to know the size and actual shape of each region. Herodotus' *History* includes accounts of the Phoenician circumnavigation of Africa (c. 600 B.C.) and of the voyage of Scylax down the Indus river, concrete evidence of the broadening effect that reports of early explorations were having upon Greek geographical horizons. Herodotus found no evidence for a northern ocean but concluded from the report of the Phoenician voyage that the southern ocean extended from India to Spain. He regarded the Caspian as an inland sea, opposing the prevailing view that it was a gulf of the northern ocean (fig. 24).

Numerous other military and sailing expeditions, conducted by Greeks or reported by Greek writers, served to enlarge geographical conceptions. Early in the 6th century B.C. tno Carthaginian navigators cruised along the Atlantic coast, Hanno along west Africa to Cape Palmas and Himilco along the Spanish and Gaulish coasts to Brittany. Xenophon's account of the campaign of 10,000 Greek mercenaries (401 B.C.) against the Persian king, deep into Persia, and of their subsequent retreat across Armenia to the eastern shores of the Black sea, provided much geographical information. Far more important to geographers than these expeditions was the campaign of Alexander the Great, who in the 4th century penetrated to the shores of the Caspian sea and into northern India, sailing down the Indus, and dispatched his admiral Nearchus with a fleet along the coast of southern Asia and the Persian gulf while he was returning with his army through Gedrosia and Persia. A few decades later, Megasthenes, a Greek ambassador sent by Seleucus I to King Chandragupta, resided at his court on the Ganges river and wrote a book on India. About this time the Greek navigator Pytheas of Massilia rounded Spain and circumnavigated Britain; his precise recording of the sun's declination in northern latitudes served as the basis for Eratosthenes' research in mathematical geography.

Meanwhile a city was being built at Alexandria which was to serve as the Greek administrative capital of Egypt and to become the focal point of the highest developments of Greek science. Alexandria quickly became the new centre of geographical knowledge and research. Eratosthenes (*q.v.*), head of its famed library, a mathematician as well as scholar, succeeded in measuring the earth's circumference within an error of a few hundred miles,

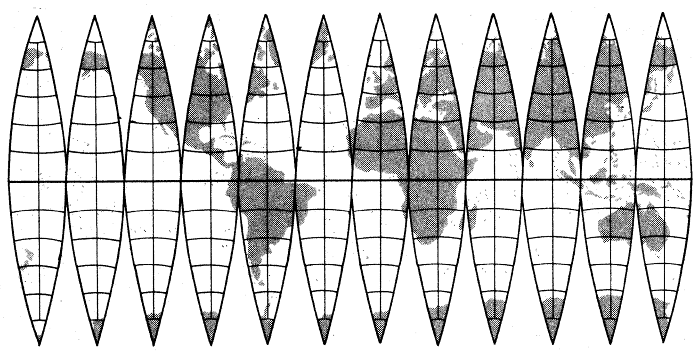


FIG. 22.— THEWORLD DIVIDED INTO 12 GORES SUITABLE FOR MOUNTING ON A GLOBE

and employing the recorded observations of Pytheas and others who had ascertained the latitudes of various places on the globe by measuring the sun's angle, he was able to produce a map based upon astronomical principles (c. 225 B.C.). Hipparchus, greatest of Greek astronomers and a leading mathematician, criticized this work (c. 130 B.c.), rebuking Eratosthenes for basing his map upon previously determined positions of latitude of a small number of places. He proposed instead a grid scheme of 360° of latitude and longitude for a map based solely upon astronomical observations, devising a method of determining longitudes by timing observations of eclipses. But precise determinations of geodetic positions depend upon precise instruments of timing and observation, and consequently Hipparchus' scheme could not be successfully applied until modern times. Nevertheless he laid the foundations for scientific cartography.

Poseidonius (*q.v.*) not himself an important original thinker, indirectly exerted-an extraordinary influence upon the science of western Europe until the Renaissance. The intellectual age to which Poseidonius belonged was lacking in creative genius. Many of the best minds were engaged in synthesizing and reconciling the more plausible views of earlier Greek philosophers and scientists. Of these compilers Poseidonius proved to be the most apt at assimilating the work of his predecessors and embodying their 'findings in readable compendiums of knowledge in many fields. The Greek compilations of this period provided the bulk of the scientific material of leading Roman intellectuals — Varro, Lucretius, Cicero, Seneca and Pliny the Elder — who in turn transmitted this body of handbook information to the Latin middle ages. And so, whereas Greek science went on to reach new heights at Alexandria in the 2nd century A.D. and to flourish at a high level at Byzantium and among the Arabs during the middle ages, scientific studies in the Latin west stagnated for 1,000 years in the hands of bookish laymen who were satisfied to copy or revise stock material largely originating in Greek compendiums of the Poseidonian age. The sort of influence Poseidonius wielded was demonstrated when he made a revised calculation of the circumference of the earth, reducing Eratosthenes' nearly correct estimate by over one-fourth; two centuries later, Ptolemy preferred Poseidonius' estimate. Ptolemy's acceptance of a smaller figure of the earth's dimensions and his enormous reputation as a geographer in the 15th century afforded Columbus encouragement to attempt a westward sailing to the Indies.

Strabo's *Geography,* in 17 books, is one of the two major works on the subject to survive from antiquity. He presents conventional handbook information on mathematical geography, sometimes without understanding it, yet has the temerity to criticize Pytheas, Eratosthenes and Poseidonius. Strabo traveled widely in Mediterranean regions and his extensive geographical treatment of the countries of the knoan world contains much valuable information. His book is the chief source on the history of earlier geography.

The Romans were not interested in the theoretical aspects of geography. While the Greeks were attempting to fix locations on the earth's surface and to ascertain the dimensions of the known world and of the entire globe, the Romans were producing crude but practical maps of battlefields and itineraries. As the empire expanded, the realization grew that maps were essential not only for military operations but for provincial administration as well. The emperor Augustus put his general Marcus Agrippa in charge of a mapping project of the entire empire, an undertaking that teams of surveyors required almost 20 years to complete. A survey of over 50,000 mi. of paved highways, recording mileages marked on milestones, served as a framework for the map, and other vital information, such as junctions of rivers and highways, provincial boundaries and facilities available to travelers in towns and cities along the highways, was compiled in the survey. At the conclusion a large master map, engraved in marble, was erected on a wall near the Roman forum. Countless copies were made on papyrus rolls and distributed among military and administrative bfficers.

A late copy of this map, known as the Peutinger Table (fig. 25), has survived, presumably belonging to the 3rd century A.D., although the present copy was reproduced in the 13th century. Because the map is in the form of a parchment roll, 21 ft. long and 1 ft. wide, designed to be folded in a portfolio, it grossly distorts the shape of the known world. Roman officials, interested only in the data recorded on the map, were not disturbed by its elongated form, which made rivers like the Nile take an east-west direction and made the Mediterranean and Black seas resemble canals. The 11 sheets of the map include the territory from the eastern tip of England and the Pyrenees to China and the supposed shores of the eastern ocean. A missing segment included the British Isles and Iberian peninsula. The segment in fig. 25 shows the southeastern tip of Britain, the northeastern part of Spain, and Gaul. The entire map contains 534 illustrations: 311 in Europe, 62 in Africa and 161 in Asia. The vignettes may have indicated the kinds of facilities available in towns; *e.g.,* 33 temples and 38 bathing establishments appear on this map. Distances between towns along the highways are fairly accurately recorded in Roman miles.

Meanwhile, scientific studies continued to flourish among the Greeks, particularly at Alexandria. Geographical and astronomical research reached its apex in antiquity in the work of Ptolemy (*q.v.*), whose *Geography* (c. A.D. 150), in eight books, culminated the researches of his predecessors. Ptolemy appeared to the ancient world to have fulfilled Hipparchus' scheme of constructing a map of the known world from geodetic positions located precisely upon a network of 360° of latitude and longitude. Book I of his *Geography* discusses the principles of mathematical cartography and the methods of representing a spherical surface on a plane. The remaining seven books are little more than a list of some 8,000 place names — cities, islands, mountains, river mouths, etc.,—whose locations were presumably determined even to min-

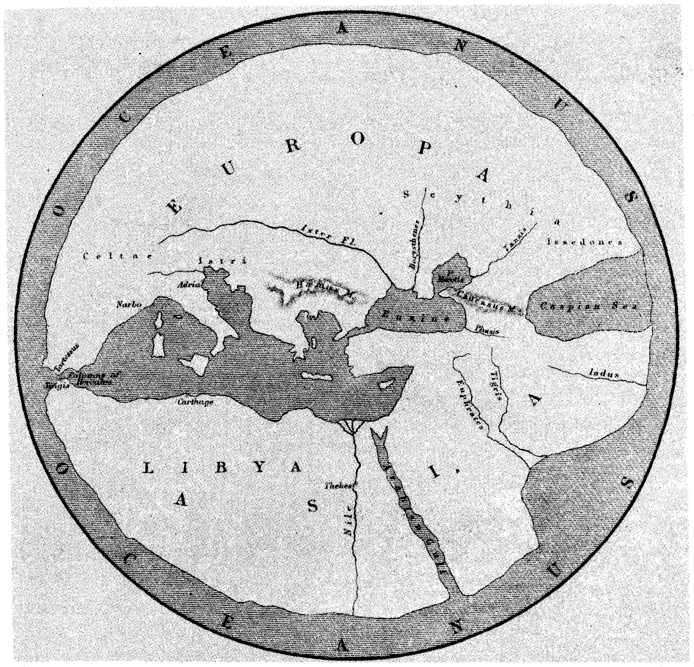


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FIG. 23.—HECATAEUS' MAP OF THE WORLD

utes and seconds. Ptolemy's theory was excellent but his practice shoddy. Actually he had almost no scientific cartographic data—a few latitudes determined astronomically and a token attempt to ascertain longitudes by timing of eclipses. Instead he depended mainly on dead reckoning from reports of travelers. His book was accompanied by an atlas of sectional maps, 10 for Europe, 4 for Africa, 12 for Asia and a map of the known world. A modern reconstruction of his world map, based upon his 8,000 co-ordinates, reveals its most glaring defects (fig. 26). The Eurasian land mass covers 180° (instead of 130°), Scotland is at a right angle to England, lower Italy askew, the Sea of Azov exaggerated and too far north, the Caspian sea in a prone instead of upright position, the triangular shape of India not realized, Ceylon grossly exaggerated and the China coast. beyond the Malay peninsula, verging into Terra Australia and enclosing the Indian ocean. Despite its defects Ptolemy's work had canonical authority for 1,500 years, Maps in the "Ptolemaic style" continued to appear in atlases more than a century after Columbus and Magellan had disproved Ptolemy's conceptions, and some of his errors persisted on maps even in the 18th and 19th centuries.

Solinus early in the 3rd century wrote a geographical book largely copied from Pliny and Mela. In order to make his book entertaining. he culled the more incredible statements from Pliny's *Natural* History and inserted them in his geographical account. The result was a fascinating book of wonders that did much to popularize in later ages the tales of monstrous creatures in Africa and India. (W. H. S.)

C. Medieval Europe and Orient

Three main sources were used by the makers of medieval maps: the classics, Scripture and its interpretation by the fathers of church, and the information provided by the world of Islam. To the writers of the classical schools of geography the medieval map maker was indebted for names of places, for staristical and historical information; to the Christian sources, for authority to support the framework of the map and for references to religious matters; to the Arabs, for topographic detail, and possibly for the knowledge of the magnetic compass. A fourth source was first-hand observation, the results of which are evident in many maps.

Little survives of the maps of the late Roman empire. Besides some fragments of surveyors' sketches, part of ong unusual map escaped destruction, the mosaic map of Madeba (Ma'daba), which formed the floor of a Christian church in modern Jordan, southeast of the Dead sea. The fragments, found in the 1890s, show that it was a large map of the Holy Land, made during the first half of the 6th century. Its outstanding feature is a plan, in the form of a bird's-eye view, of Jerusalem before the Arab conquest.

Pilgrims' guidebooks, some undoubtedly illustrated with crude maps, were popular as early as the 4th century A.D. The concern of theologians with an accurate interpretation of the world also led to the preparing of maps, the most famous and earliest of these being the world map of Cosmas (*q.v.*), a merchant of Alexandria turned Christian monk, who wrote his *Christian Topography* during the 6th century. Although only later copies of his world map survive, the book itself described the map in detail. It was a rectangular one, showing the world surrounded by the ocean sea, and surmounted by the heavens, the whole in the image of the tabernacle as described in the Bible. A later but equally primitive world map accompanied the commentaries written by Beatus, a Spanish monk, on the Revelation of St. John, during the 8th century. There are many variants of the Beatus world map, the earliest dating from the 10th century, all of them presenting a distorted, inaccurate view of the world.

1. "T" and "O" Maps.—The notion of the earth being round, though at times condemned by the church, never completely disappeared. Yet medieval maps, practically without exception, appear to show the earth as a flat disk. On this type of map, which often accompanied such church-approved encyclopaedias as that of Isidore of Seville (*q.v.*), the world is shown consisting of the three continents of Europe, Asia and Africa, with the top of the map being east, and the centre of the earth, in accordance with Scripture, at Jerusalem.

The threefold division of the world was best shown in the maps called "T and O" maps. These, popular throughout the medieval period, showed the world surrounded by a circular ocean, the "O"; the three continents of Europe, Asia and Africa were divided by a perpendicular line, the stem of the "T," representing the Mediterranean, and a horizontal line, the top bar of the "T," consisting of the Nile, separating Africa and Asia, and the Dnieper, separating Asia and Europe.

The simple frame ork of the "T and O" map eventually came to be embellished by a wealth of detail, some real, some imaginary, taken from Pliny, from Iater Roman and from early medieval writers. While some of the originals of this type barely measured an inch across and fitted into the top of the letter "P," as an illuminated initial, others were as much as 60 in. wide. The two most famous of this latter type, both made during the 13th century, are the Hereford map, in England, and the Ebstorf map, in northwest Germany. There existed also simple map sketches which, in defiance of the denial that life could exist beyond the torrid zone around the equator, showed the world divided into five climates, following closely the classical Greek scheme.

2. Portolan Charts.—The maps of Britain by Matthew Paris, an English chronicler of the 13th century, are among the very few medieval maps that show a definite attempt to present an accurate image of a single country. It was not until the latter part of

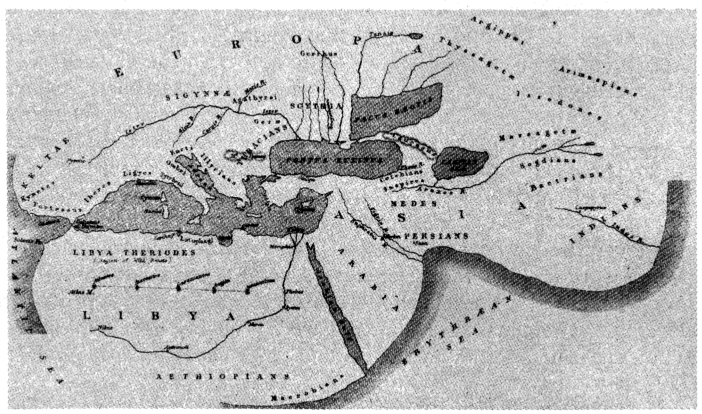

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FIG. 24.—HERODOTUS' MAP OF THE WORLD

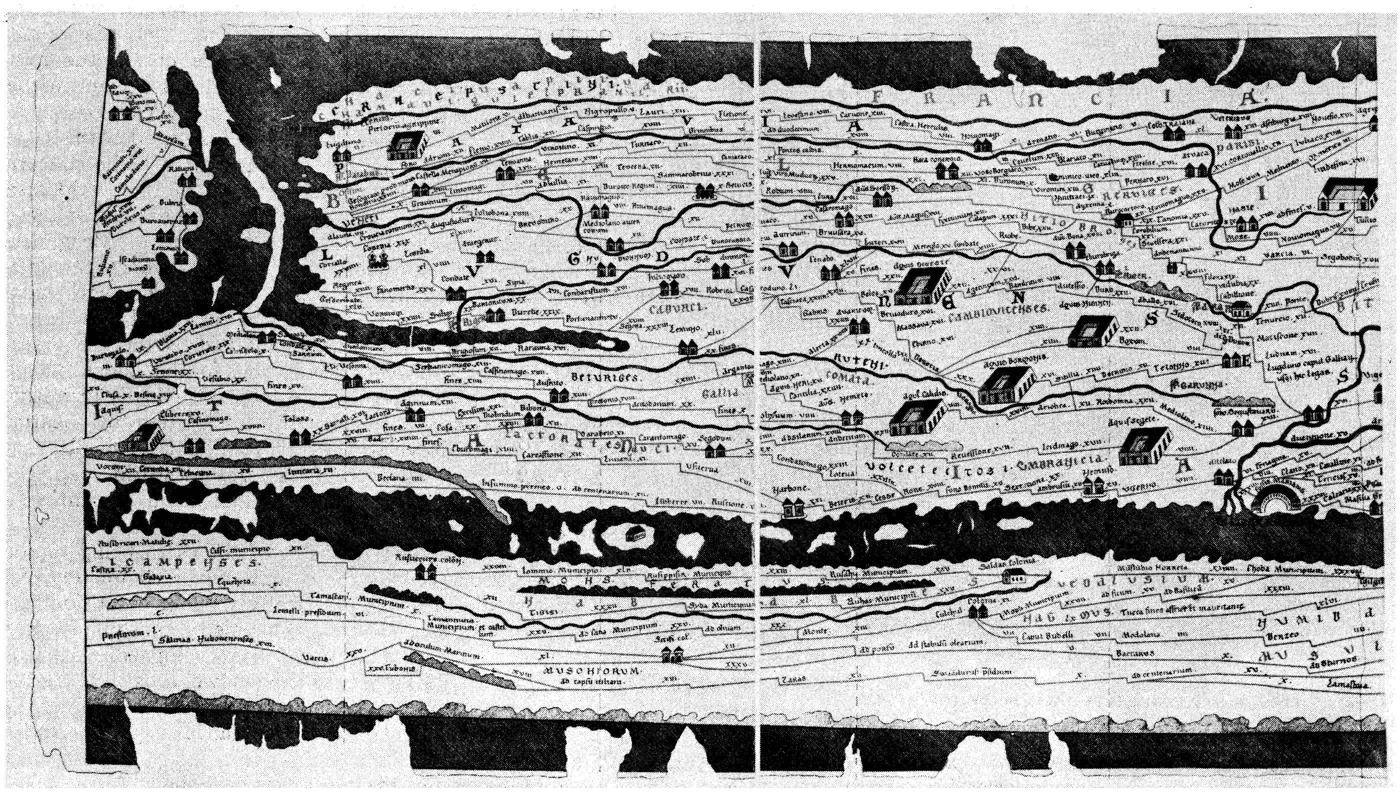

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FIG. 25. — SECTION OF THE PEUTINGER TABLE

the 14th century that a successful attempt was made to include in a map of the world at least some of the recently acquired knowledge of Africa and Asia. The Catalan map of the world of 1375, prepared for the king of France, was the work of a new and much improved technique of map making. The "T and O" and other medieval maps were schoolmen's maps, made to illustrate a preconceived and highly stylized view of the world. The Catalan map, on the other hand, derived much of its contents from portolan, or seamen's charts, which were drawn in as strictly factual a manner as the tools of the time allowed. While there is some doubt as to the originals of the portolan charts, there is agreement on certain points in their history. They were made possible by the extensive use of the magnetic compass; they conformed to a common, now lost, model in their outline, in their scale and in many minor details; and they were based, in part at least, on the pilot books or *periploi* of Greco-Roman origin.

The oldest portolan chart is the so-called Pisan chart, made around 1300. Its name is derived from the portolano, the pilot book that listed courses, anchorages and ports. Some 30 or so portolan charts made during the first half of the 14th century survive. All were drawn by Italians, of whom several are known by name, John of Carignano, Petrus Vesconte and Angelino Dalorto among them. All of these charts show the Mediterranean sea, the Black sea and parts of the Atlantic. There is evidence that they were used as early as 1270, and the general outline of the map itself, and much of the detail of the coast lines, did not change between 1300 and 1600. The portolan charts are more accurate than any medieval map. When the centre of chart making shifted from north Italy to the Balearic Islands and to Catalonia, much of the detail so well presented in these maps was incorporated in the Catalan map of 1375.

One of the important characteristics of all portolan charts is the network of lines radiating from several centres distributed all over the chart. These lines conform to the 8 or 16 principal parts of the compass rose, and they were probably used by seamen to lay out courses from port to port, in the manner used on modern navigation charts.

3. Mauro and **Behaim.**—The map makers' art of the middle ages culminated in the works of two men of the 15th century. Fra Mauro, a monk and cartographer of Venice, completed his world map in 1459. It shows the world in the shape of a wheel, and contains a wealth of accurate and important detail on Asia and Africa, taken from the intelligence accumulated during the previous two centuries. Martin Behaim (*q.v.*), a German who served the court of Portugal as astronomer during the great age of Portuguese discoveries, prepared a globe, the oldest terrestrial globe extant, for his native city of Niirnberg in 1492. On it the western coast of Europe and the east coast of Asia face each other across the waters of the Atlantic, and there is no indication as yet of the new world, to be discovered within a few months by Columbus.

4. Islamic Maps.——Map making among the Moslems did not match the accomplishments of their European contemporaries. The mathematical and astronomical skill of the Moslems. and the fact that Moslems sailing the Indian ocean used maps that had much in common with the European portolan charts, was not reflected in the primitive sketches that illustrate Moslem works of geography. The only medieval Moslem map of note, known through later copies, is the famous map of Idrisi, prepared in Sicily at the court of the Norman kings during the 12th century. Idrisi's map was based, in part, on Ptolemy, following his scheme of climates, and its portrayal of the Mediterranean and of the near east was far superior to that of any European map of the time.

5. Far East.—Maps were well known in China, Japan and Korea during the middle ages, yet no original maps are known to have survived. There were prototypes, such as the Gyogu map of Japan, probably first prepared during the 9th century, and maps of China and of the world known to the Chinese were made during the first centuries of the Christian era. The maps drawn in the far east were as self-centred as were medieval maps, and the mythical element occupies fully as important a place on them, regarding Europe, western Asia and much of Africa, as it does on their European counterparts, regarding the far east. (G. Kh.)

D. Early Modern Period

1. Revival of **Ptolemy.**—By 1400 Greek manuscripts of Ptolemy's *Geography* had reached Italy, and its contents became known to western Europe in the Latin translation made by

Jacobus Angelus in 1410, first in manuscript copies and from 1475 in printed editions. The world map and 26 regional maps derived from Ptolemy's text, drawn on a conical projection and graduated in latitude and longitude, were first printed at Bologna in 1477, from copperplates. The maps were redrawn in Florence, on a new trapezoidal projection, by the German monk Donis Nicolaus, whose maps were printed in the woodcut edition of Ulm (1482). The Geography was the first world atlas; it coloured geographical thought until the end of the 16th century, and 31 Latin or Italian editions with maps were printed before 1600.

"Modern" maps (tabulae novae) were early added to the Ptolemaic atlas, both in manuscripts and printed editions. The earliest was a map of the north drawn at Rome in 1427 by the Dane Claudius Claussøn Swart, known as Claudius Clavus. Cardinal Nicholas Krebs (1401–64), of Cusa (Cues, on the Moselle), drew the first modern map of Germany, which mas engraved in 1491. By the beginning of the 16th century the hemispheric division of the world, into the "old world" of Ptolemy and the "new world" of the discoveries in the west, was becoming familiar. The enlargement and correction of Ptolemy's world map by new knowledge derived from exploration called for increasing numbers of maps. The Strasbourg edition of Ptolemy (1513) had no fewer than 20 modern maps by its editor Martin Waldseemüller; and the edition by Sebastian Münster printed at Basel in 1545 had 32.

2. Cartography of the Discoveries.—The great discoveries of the 15th and 16th centuries, both those to the east and those to the west by Columbus and John Cabot and their successors, were laid down on compass charts. or portolan charts (see above), of traditional type, developed from that of the Mediterranean area. Chart making flourished in the Italian ports, notably Genoa, Ancona and Venice; and it is on charts drawn in these centres that the Portuguese voyages along the coasts of Africa are recorded, since only one Portuguese chart made before 1500 has survived. The Casa da India at Lisbon had however from an early date been responsible for training pilots and cartographers, and Portuguese chart makers were held in high repute throughout the 16th century, although the Portuguese authorities sought to keep their work secret. The Cantino world chart, which depicts the lands discovered in the east and west, was obtained surreptitiously in Lisbon in 1502 by Alberto Cantino, agent of Duke Ercole d'Este, of Ferrara. The leading Portuguese cartographers of the 16th century were Pedro Reinel and his son Jorge, Lope Homem and his son Diogo, Diogo Ribeiro, Fernão Vaz Dourado and Luis Teixeira. In Spain the Casa de la Contratación de las Indias, established at Seville in 1508, was charged with the supervision of charts and the maintenance of a master chart (*padrón* general); among its cosmographers were Nuño Garcia de Toreno (who prepared the charts for Magellan's circumnavigation), Ribeiro (who spent his working life in Spanish service) and Alonso de Santa Cruz. Between 1540 and 1566 a number of manuscript world maps were drawn, largely from Portuguese sources, by hydrographers of Dieppe, notably Pierre Desceliers and Nicolas Desliens.

Columbus' belief that Cathay could be reached by sailing westward was no doubt inspired by the study of a globe. Like the (now lost) world chart which the Florentine Paolo Toscanelli appears to have sent Columbus in 1474, Martin Behaim's globe (see above) encouraged belief in the western route by ascribing a width of only 126° longitude to the ocean separating Europe from Asia. Juan de la Cosa, who sailed with Columbus in 1492–94, drew the earliest surviving world chart showing the discoveries

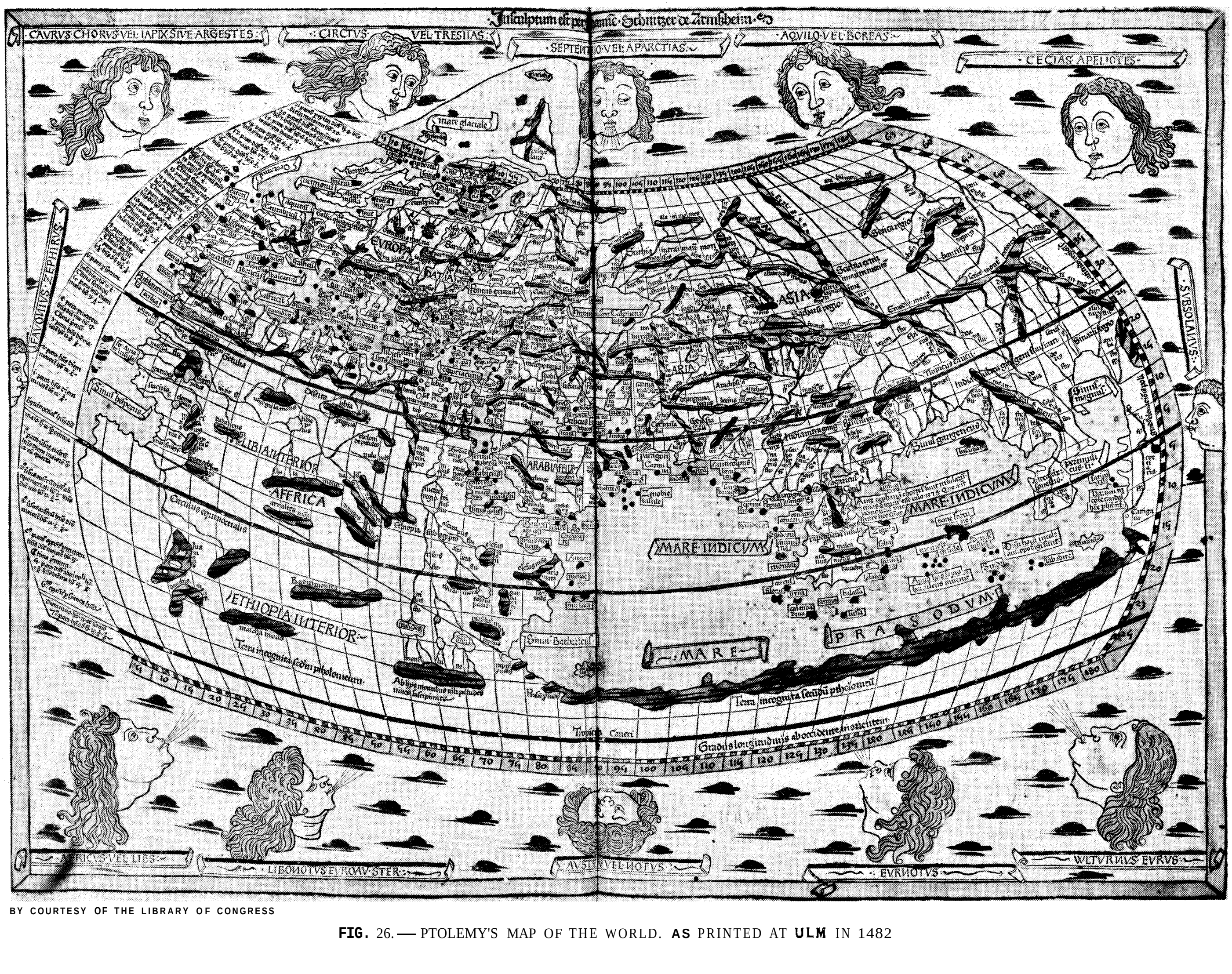

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FIG. 26.— PTOLEMY'S MAP OF THE WORLD. AS PRINTED AT ULM IN 1482

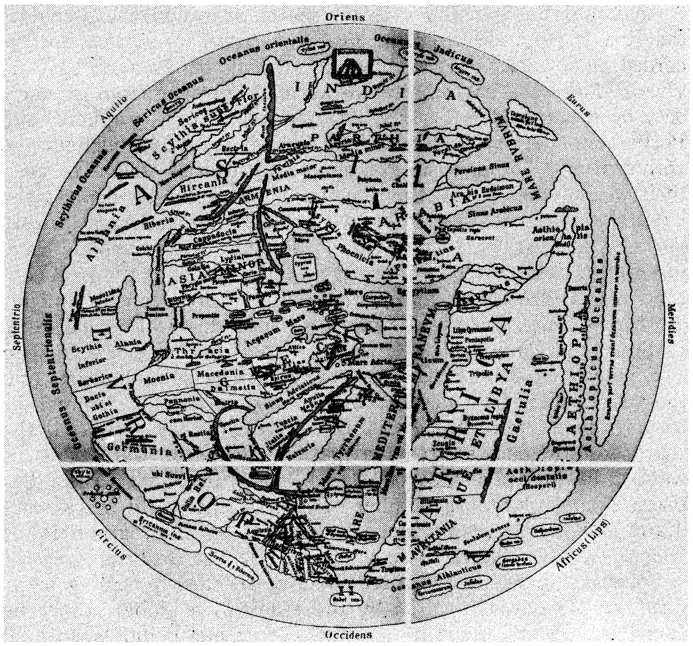

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FIG. 27.— MAPFROM ISIDORE OF SEVILLE'S ENCYCLOPAEDIA

in the new world by John Cabot, Columbus and the Spanish; this is dated 1500.

3. 16th-Century Chart.—The "plane chart," drawn from compass bearings and dead reckoning, with north-south lines parallel, had two serious defects for navigation. It did not represent the convergence of the meridians, and therefore falsified east-west distances in higher latitudes; and it did not allow for differences in magnetic variation. The first of these problems was to be solved only when Mercator's projection, employed in his world chart of 1569, came into use. The second was serious for navigation in American waters, where a large westerly variation was found; among the devices adopted to overcome it was the drawing of a second, "inclined" meridian, as on the chart of the North Atlantic by Pedro Reinel (*c.* 1504), to indicate local variation. Coastal charts, with "rutters" or sailing directions, were developed by northern seamen from the early 16th century. In the first printed sea atlas, the *Spieghel der zeevaerdt* (1584), by Lucas Janszon Waghenaer of Enkhuizen, the chartwork already shows many modern characteristics, notably soundings and the profile representation of shore marks.

4. 16th-Century Cartographers.— The maps and globes of the 16th century, as an index of contemporary geographical knowledge, illustrate the gradual modification of the Ptolemaic world picture to admit new concepts derived from discovery—the outlines of Africa, India and southeast Asia as revealed by the Portuguese voyages; the unbroken extension of America from the Arctic circle to Magellan strait; the existence and longitudinal span of the Pacific ocean, disclosed by Magellan.

The principal centres of cartographic activity, outside the Iberian peninsula, were Italy, the Rhineland, the Netherlands, France, Germany and Switzerland. Martin Waldseemüller (1470?–1518?), who worked at St. Dié in the Vosges, produced tuo large woodcut world maps; that of 1507, the earliest to use the name America, was compiled from "the tradition of Ptolemy and the voyages of Amerigo Vespucci and others," while the *Carta marina* of 1516 was drawn in chart style. Waldseemuller's world view was popularized by other German cartographers, notably Johannes Schoner (1477–1547), who worked at Niirnberg and produced four globes between 1515 and 1533; Peter Apian (1495–1552) of Ingolstadt; Kaspar Vopel (1511–61) of Cologne; and Sebastian Miinster (*q.v.*), who worked at Basel. The leading cartographer in France during the century was Oronce Finé (1494–1555) and in Italy Giacomo Gastaldi (*c.* 1500–65).

The Netherlands school of cartography stems from Gemma Frisius (1508–55) of Louvain, whose enlarged edition of Peter Apian's *Cosmographia,* with its world map, was frequently reprinted from 1533. Gemma applied himself to many geographical problems, including those of the longitude and the convergence of meridians. Among his pupils was Gerardus Mercator (*q.v.; see* also *Map Projections,* above), who assisted in the preparation of Gemma's pair of engraved globes (1535 and 1537) and published his own globes in 1541 and 1551. Mercator, who worked at Louvain until 1552 and thereafter at Duisburg, became the leading cartographer of the age; his principal maps were those of Palestine (1537), the world (1538), Flanders (1540), Europe (1554 and 1572) and the British Isles (1564), besides his world chart of 1569 (*see* fig. 31), his Ptolerny edition and his *Atlas.*

By the last quarter of the 16th century the main European centre of map production had shifted from Italy to the Netherlands, and particularly to Antwerp, where Abraham Ortelius and Gerard de Jode published their atlases (*see* below). In the northern Netherlands cartography developed with overseas enterprise. Petrus Plancius (1552–1622), first cartographer to the Dutch East India company, had a copious output, including two large printed world maps (1592 and 1594). In England, Flemish cartographers and map engravers gave an impetus to the art; the first English globes, those of Emery Molyneux, were engraved by Jodocus Hondius in 1592. In 1599 Edward Wright explained the construction of Mercator's projection in mathematical terms, and a world chart on this projection, ascribed to Wright, accompanied Richard Hakluyt's *Principall Navigations* (1598).

5. Regional Cartography.— The regional maps of the middle ages had been drawn from route surveys or eye sketches, supplemented by linear measurement. During the 15th century local maps constructed from the road system were made in Italy; and a woodcut map by Erhard Etzlaub of Niirnberg, printed in 1500 with the title *Das ist der Romweg,* showed the roads of central Europe and Italy with mileages between towns.

In the first half of the 16th century geometrical methods of survey, with more precise instruments for observation of angles, were introduced by geographers of Germany and the Netherlands, and the principle of triangulation was described in 1528 by Miinster and in 1533 by Gemma Frisius. This enabled a relatively large area to be surveyed more rapidly as well as more accurately

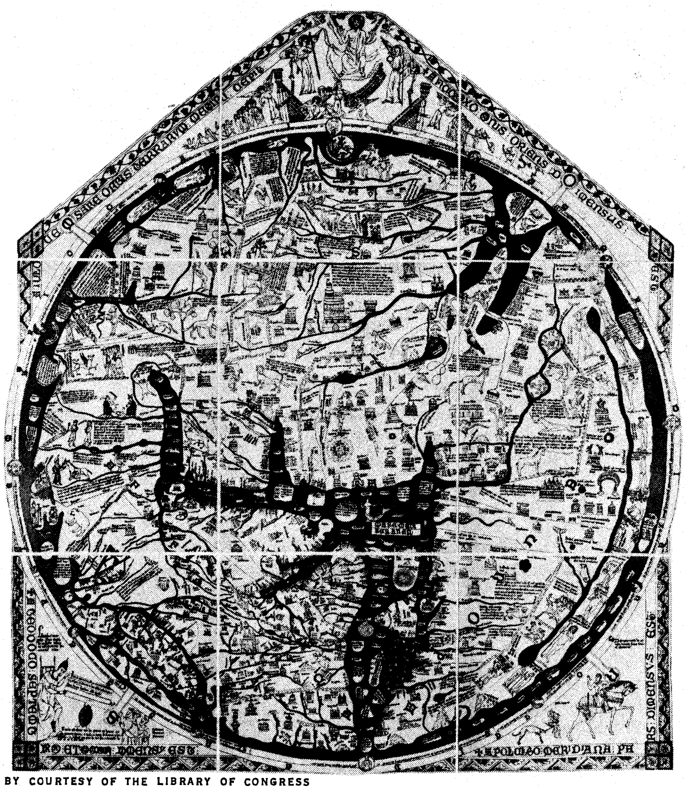

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FIG. 28.— THEHEREFORD YAP (13TH CENTURY)

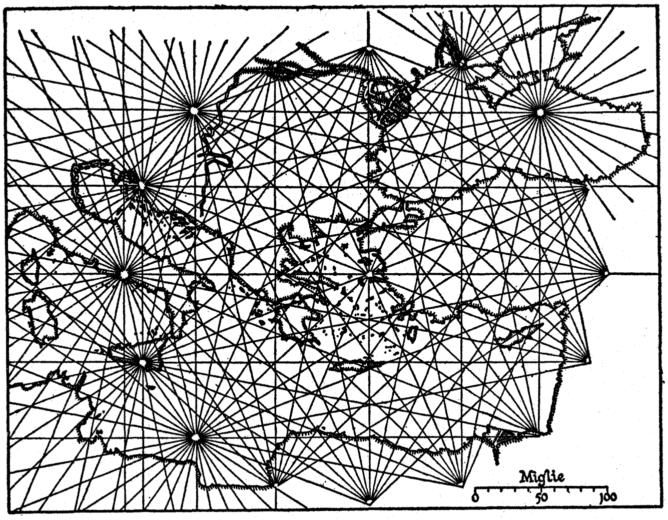

FIG. 29.— PORTOLAN CHART OF THE EASTERN MEDITERRANEAN AREA (1311) BY PETRUS VESCONTE

and many countries or regions were first mapped during the century. Among such maps may be mentioned Finé's France (152j), the maps of parts of Germany published by Miinster from 1545, Prussia (1542) by H. Zell, maps of Switzerland by Konrad Tiirst, Johann Stumpf and Aegidius Tschudi between 149j and 1538, the provinces of the Netherlands (1556–60) by Jacob van Deventer, Austria (1561) by Wolfgang von Lazius, Bavaria (1568) by Philip Apian. Scandinavia and the north were delineated by Olaus Magnus (1539); Russia and eastern Europe by Anton Wied (1542), Sigismund von Herberstein (1549) and Anthony Jenkinson (1562). The prototype for maps of Great Britain was that by "G. L. A." (George Lily) engraved at Rome in 1546 Many of these regional maps, including those of the British Isles by Humphrey Lhuyd (1j27–68), were reproduced in Ortelius' *Theatrum (see* below). The first survey of the English counties was made by Christopher Saxton (c. 1542–1606); his county maps were engraved during 1574–79 and his large map of England and Wales in 1583. The earliest atlas of the French provinces was published by Maurice Bouguereau at Tours in 1594. Here too may be mentioned the popular collection of views or plans of cities, the *Civitates orbis terrarum* (1573–1618), by G. Braun and Frans Hogenberg.

6. Printed **Maps** and Atlases.—Although the maps in the Italian editions of Ptolemy of the 15th century had been printed from engraved copperplates, the woodcut was the dominant medium for map reproduction until nearly the middle of the 16th century. From about 1540 copperplate engraving established itself, first in Italy, as the fittest technique for map printing, and this process was to maintain its ascendancy for four centuries.

The prototype of the atlas was the collection of Ptolemaic maps, increasingly supplemented by "modern" maps. In 1528 Münster appealed to German geographers to survey their regions and send him their maps, many of which were included in his edition of Ptolemy (1540) and in the successive editions of his *Cosmographia* from 1545. In Italy there was a copious production of engraved sheet maps, and such map dealers as Antonio Lafreri at Rome and G. F. Camocio and P. Forlani at Venice offered for sale sets of maps from their stock, covering the world and systematically arranged "in Ptolemy's order." The first modem atlas, however, compiled on uniform principles laid down by its editor, is the *Theatrum orbis terrarum* published at Antwerp in 1570 by Abraham Ortelius (*q.v.*). Its 70 maps on 53 plates, mainly engraved by Frans Hogenberg, were compiled from the best sources available and reduced to a common size and style; and the *Theatrum* was enlarged and kept up to date in successive editions until the last in 1612. Its rival, the *Speculum orbis terrarum* of Gerard de Jode (1509–91), published at Antwerp in 1578, was less popular.

Mercator planned his ***Atlas*** (the first book of maps to which this name was given) as part of a great cosmographical project, earlier stages of which were represented by his world map (1569) and his edition of Ptolemy's maps (1578). The first two parts of the *Atlas,* engraved in his Duisburg workshop, appeared in 1585 and 1589; the third was published after his death by his son Rumold in 1595. In 1604 the plates were acquired from Rumold's heirs by the Amsterdam mapseller Jodocus Hondius.

7. 17th Century.—By 1600 Amsterdam had succeeded Antwerp as the centre of cartographic industry in the Netherlands, and the 17th century was the great age of Dutch map production. From the Amsterdam workshops of Jodocus Hondius (1563–1611), Willem Jansz Blaeu (1571–1638) and Jan Jansson (1596–1664), Frederik de Wit (*fl.* 1648–89) and other mapsellers, the European market was supplied with printed charts and sea atlases, globes. wall maps, town plans and views and (above all) atlas maps. Mercator's atlas was continually enlarged by Hondius and, after him, Jansson; Blaeu's first atlas, in two volumes, was published in 1635, and, like Jansson's, it had by 1660 expanded to 11 or 12 volumes. Blaeu became hydrographer to the East India company and the states-general, and his *Zee-spiegel* (1623) was the prototype of a long series of fine sea atlases by various map makers, notably Pieter Goos, J. A. Colom, A. Jacobsz and Hendrik Doncker. The earliest sea atlas drawn throughout on the Mercator projection was *L'Arcano del Mare*, compiled by Sir Robert Dudley and published at Florence in 1646. *Le Neptune françois ou atlas nouveau des cartes marines*, published at Paris in 1693, marked a further advance in hydrography; drawn on the Mercator projection, its charts laid down the positions of many places from "fixes" made by the French astronomers.

The most prolific and influential French cartographer of this period was Nicolas Sanson of Abbeville (1600–67), who established his Paris workshop about 1634 and published his first atlas in 1654. After his death his business was carried on, in turn, by his sons and by A. H. Jaillot (1640–1712); and his son-in-law Pierre Duval (1619–83) was also a productive cartographer. Their work foreshadowed the authority enjoyed by French cartography in the first half of the 18th century.

At the end of the century Johann Baptist Homann (1664–1724) of Niirnberg established a vigorous map business which continued into the next century. V. M. Coronelli (1650–1718), cartographer to the republic of Venice, produced many fine globes and maps, based on careful research.

In England, apart from the popular county atlas of John Speed, *The Theatre of the Empire of Great Britain* (1611–12), in which

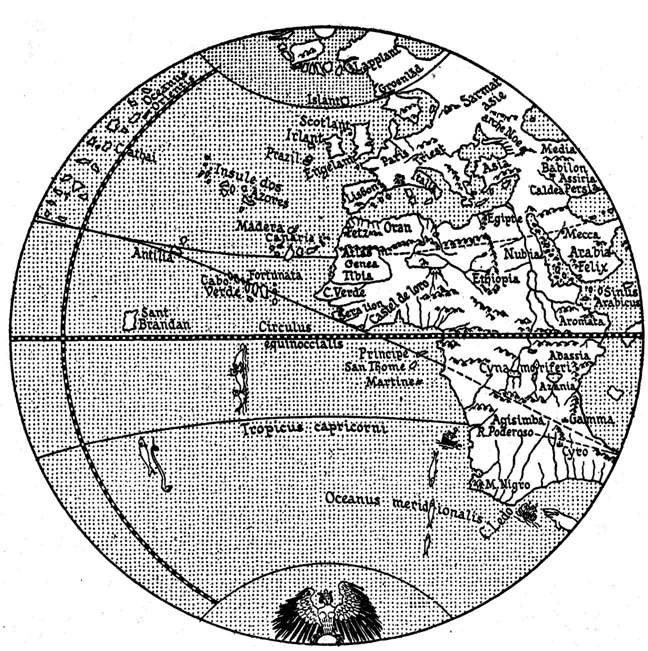

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FIG. 80.— THE WESTERN HEMISPHERE ACCORDING TO MARTIN BEHAIM'S GLOBE (1492)

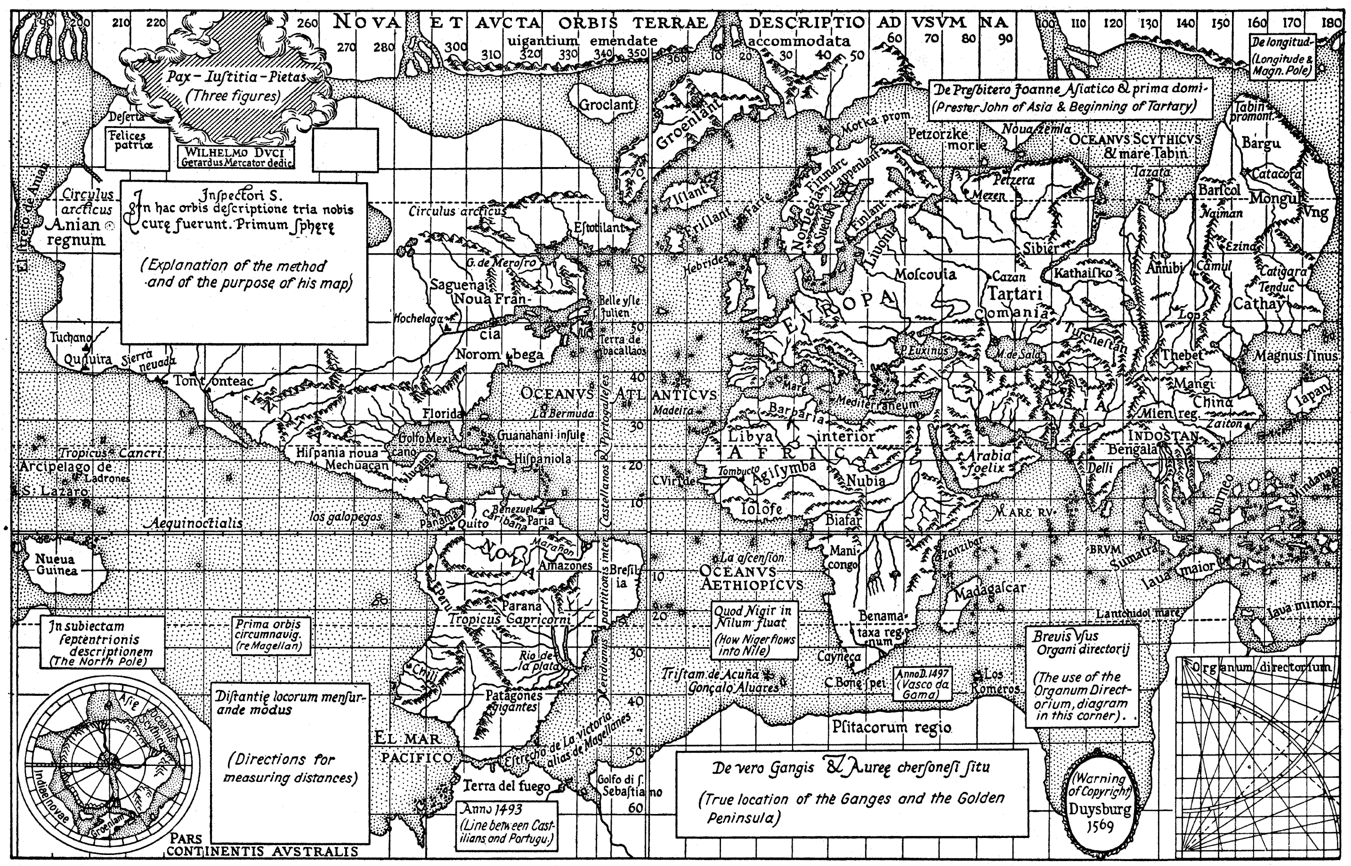


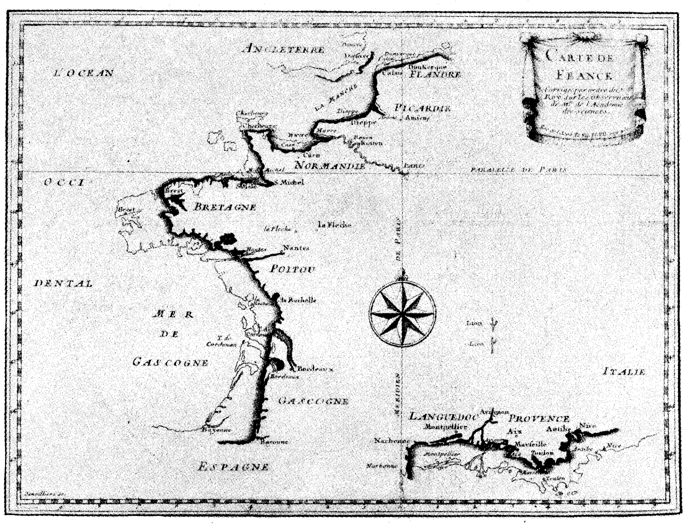
FIG. 31.—MERCATOR'S CHART OF THE WORLD (1569)

the maps were engraved by Hondius, map production languished until after 1660. The Restoration period saw a revival of activity; John Ogilby made the earliest survey of the English roads, published in his *Britannia* (1675), and the printing of charts began with the work of John Seller, John Thornton, Greenville Collins and others. In 1681–88 Collins first surveyed the coasts of Great Britain. Not until the 18th century, however, was English map production to overtake that of the Netherlands and France.

Reformation of Cartography.—During the 17th century few major new data were added to the world map by discovery, although these included the coast of Australia revealed by Dutch voyages, parts of the interior of North America explored by the French, and fuller knowledge of China contributed by Jesuit missionaries. Yet in this period the foundations of the modern map were laid by improvements in the technique of instrumental observation and survey, particularly the introduction of telescopic sights and the development of instruments for leveling and for the precise measurement of horizontal and vertical angles. In 1671 the Paris observatory was established, and from this time the latitude and longitude of an ever-increasing number of points were fixed by instrumental observations under the auspices of the French Académie Royale des Sciences.

The framework of an accurate world map depends on determinations of the size and shape of the earth, derived from measurement of the length of a degree along a meridian. Arcs of a meridian had been measured in 1606 by Willibrord Snell, in Holland, and in 1635 by Richard Norwood, in England. The measurement was attempted by more scientific methods in France in 1669–70 by Jean Picard, whose measured arcs were extended between 1700 and 1718 by J. D. Cassini (1625–1712) and his son Jacques, the first two directors of the Paris observatory. The geodetic data thus obtained served as the basis for the redrawing of the world map by French cartographers of the early 18th century.

Special Maps.—During the 17th century some of the earliest experiments were made in the drawing of maps to represent the data of special sciences in their geographical relationship. Edmund Halley's chart of the trade winds (1686) is the first meteorological map; and maps of the ocean currents were published by Athanasius Kircher in 1665 and by E. W. Happel in 1675. Attempts to illustrate magnetic variation on maps had been made by C. Burrus in 1630 and by Kircher in 1643; but the first variation charts based on observation were those of Halley (the Atlantic, 1701; the world, 1702). In these Halley introduced the isopleth, or curve-line of equal value, which was long known as the "Halleyan line." (R. A. Sn.)



BY COURTESY OF THE TRUSTEES OF THE BRITISH MUSEUM

FIG. 32.—MAP OF THE RESURVEY OF FRANCE, 17TH CENTURY, BY J. D. CASSINI AND JEAN PICARD INDICATING THE FORMERLY ACCEPTED AND THE CORRECTED COAST LINE OF FRANCE

E. Modern Period

In 1700 nearly half of the earth's surface was still unexplored or little known. After World War II the initial reconnaissance mapping of the earth was brought to its close in the antarctic wastes. For millenniums this task, with the related riddle of what lay beyond the margins of the "known world," had confronted the cartographer with his most challenging problem. From the beginning of the 18th century a more difficult problem has replaced it—that of mapping the known world to meet the demands of a civilization that has come to use maps for purposes never before dreamed of.

1. Transportation, Travel and Maps.—Transportation and travel always have been powerful stimulants to mapping. In the modern period, mapping the world's coast lines has been pushed forward along traditional lines, and many maps of wholly new kinds have been made to help ships move from place to place—maps of the sea floor, ocean currents, winds, storm tracks, air and water temperatures and the like—the making of which has yielded great quantities of scientific data as by-products. In the sparsely settled parts of Australia, Siberia, Latin America, western North America, and elsewhere, the first detailed reconnaissance mapping was often carried out as part of the search for routes for railways, and the precise leveling done in connection with the construction of railnays, canals and highways supplied many of the data upon which the earliest hypsometric mapping was based. Successive improvements in travel by road gave rise to the post-route and stage-route maps of earlier times and to the modern motorists' maps. The airplane. like the ship, has occasioned world-wide programs of surveying and observation to procure air navigation charts and meteorological maps for air traffic guidance and protection; it also has facilitated the task of mapping for countless other purposes. The airplane brought these revolutionary changes in cartography within three decades.

2. War and Maps.—War is another stimulant of human mobility and hence of cartography. The campaigns of Alexander the Great and Genghis Khan opened vast and little-known tracts for subsequent mapping, but in modern times the influence upon mapping of preparations for war has been greater than that of military campaigns as such. The small, lightly equipped armies of pregunpowder ages had little need for maps; local guides showed the way, and arrows and spears could find their targets without the aid of cartography. The advent first of artillery and later of the nation-in-arms changed the situation. The topographic mapping of modern Europe, which began in the 16th century and has been pursued comprehensively from the mid-18th century, was undertaken largely to facilitate the aiming of field guns, the finding of cover and the moving of large bodies of men and matériel. Napoleon was alert to the military value of topographic maps and did much for cartography.

World War II, coming as it did after aviation and photogrammetry had been well developed, far exceeded all previous wars in the extent of its effects upon map making. During its course immense areas, even in regions remote from the theatres of war, were flown over, photographed and mapped on the chance that the maps might be needed; and totally unprecedented in magnitude was the work of making new and reproducing old maps to show not only routes and targets of concern to the planners of military operations but also a variety of special matters of possible value to those directing the political, economic and psychological phases of the war.

During World War II two agencies of the United States armed forces are said to have printed about 650,000,000 copies of some 50,000 different maps.

3. Governmental Mapping.—As long as maps were used for relatively few socially indispensable purposes, cartography was left mostly in private hands. As the essential uses of maps have multiplied, however, certain basic cartographical enterprises, such as police, postal, water supply and other indispensable services, have been taken over by governments. At first these enterprises consisted mostly in the production of topographic maps and marine charts, but they have been extended to the mapping of minerals, soils, geological formations, climate, vegetation, land use and much else. Before the 19th century in most countries and until well into it in some, topographical mapping was based upon occasional surveys, and the maps were usually known by the names of the surveyors or engineers in charge (*e.g.*, the Cassini map of France, 1750–93; the Rizzi Zannoni map of Poland, 1772; the Dufour map of Switzerland, 1842–72). Eventually, however, the work was taken over on a continuing basis by great technical organizations such as the Ordnance survey of Great Britain (founded 1791), the Service Géographique de l'Armée in France (replaced in 1940 by the Institut Géographique National) and the Federal Topographic bureau of the Swiss general staff. Most of these. at least in Europe. have been set up by the armed forces or their responsible ministries. In the United States and Canada, by contrast, the principal governmental mapping agencies (*e.g.*, the U.S. coast and geodetic survey, founded as the U.S. coast survey in 1807; and the U.S. geological survey, founded in 1879) have been under civilian administration, a result in part, no doubt, of the freedom from fear of invasion that the geographical isolation of North America fostered until as late as World War II. During and after World War II the armed forces in the United States and Canada greatly enlarged the scope of their cartographical work.

4. Influence of Science and Technology.—The development of cartography during the modern period also has been affected profoundly by the general advancement of science and technology, and in particular by adaptations that have been made, one after another, of certain instruments and techniques to the uses of surveyors and cartographers. Foremost among these, in so far as the basic mapping of the visible features of the earth's surface is concerned, were the telescope in the 18th century and the camera in the 20th.

During the zoo years following its invention (about 1608), the telescope (*q.v.*) was increasingly put to use in the making of astronomical observations to determine geographical positions. It was also introduced into surveying and navigational instruments as an integral part of their structure, thus greatly enhancing their precision. By the mid-18th century, the telescope had had two important effects upon cartography: it had made possible the accurate construction of modern map projections (as, *e.g.*, in the work of J. H. Lambert) and it had helped furnish a quantity of astronomically and trigonometrically determined control points for topographic maps, marine charts and reference maps in general. Thus, largely by means of the telescope were obtained many of the new data upon which Guillaume Delisle, J. B. d'Anville and others based the extensive revision of earlier maps that has been called the cartographic reformation of the 18th century. Since this movement was mainly directed toward the correction of errors, it was, indeed, a reformation rather than a revolution. It led, however, to genuinely revolutionary changes toward the close of the century. Max Eckert, the German cartographer, writing in 1921, maintained that since the Renaissance no greater change had taken place in the general appearance, accuracy and construction of maps than that which differentiated the maps of the 19th century from their predecessors.

The years after Eckert expressed this view, however, saw a second and even more radical cartographical revolution, in which the camera played a part comparable to that of the telescope in the earlier reformation. Carried aloft in airplanes, the aerial camera advanced the mapping of the visible face of the earth at a speed and with a fullness of detail never before remotely approached and disclosed for mapping much that had remained invisible to earthbound observers (*e.g.*, facts of archaeological or botanical interest). Also, in the rooms where maps are actually produced, special cameras have effected hardly less spectacular improvements in the processes of compilation, drafting and reproduction. The application of photography to mapping gave birth to that new handmaiden of cartography and surveying, photogrammetry, with a whole repertory of techniques and a battery of instruments of its own.

During and after World War II, moreover, the cartographic revolution entered a second stage in which, for many operations, the use of electronic devices came to supplement or supersede the older optical and photographic techniques. (See also PHOTOGRAMMETRY.)

Another development of the modern period is maps that show,

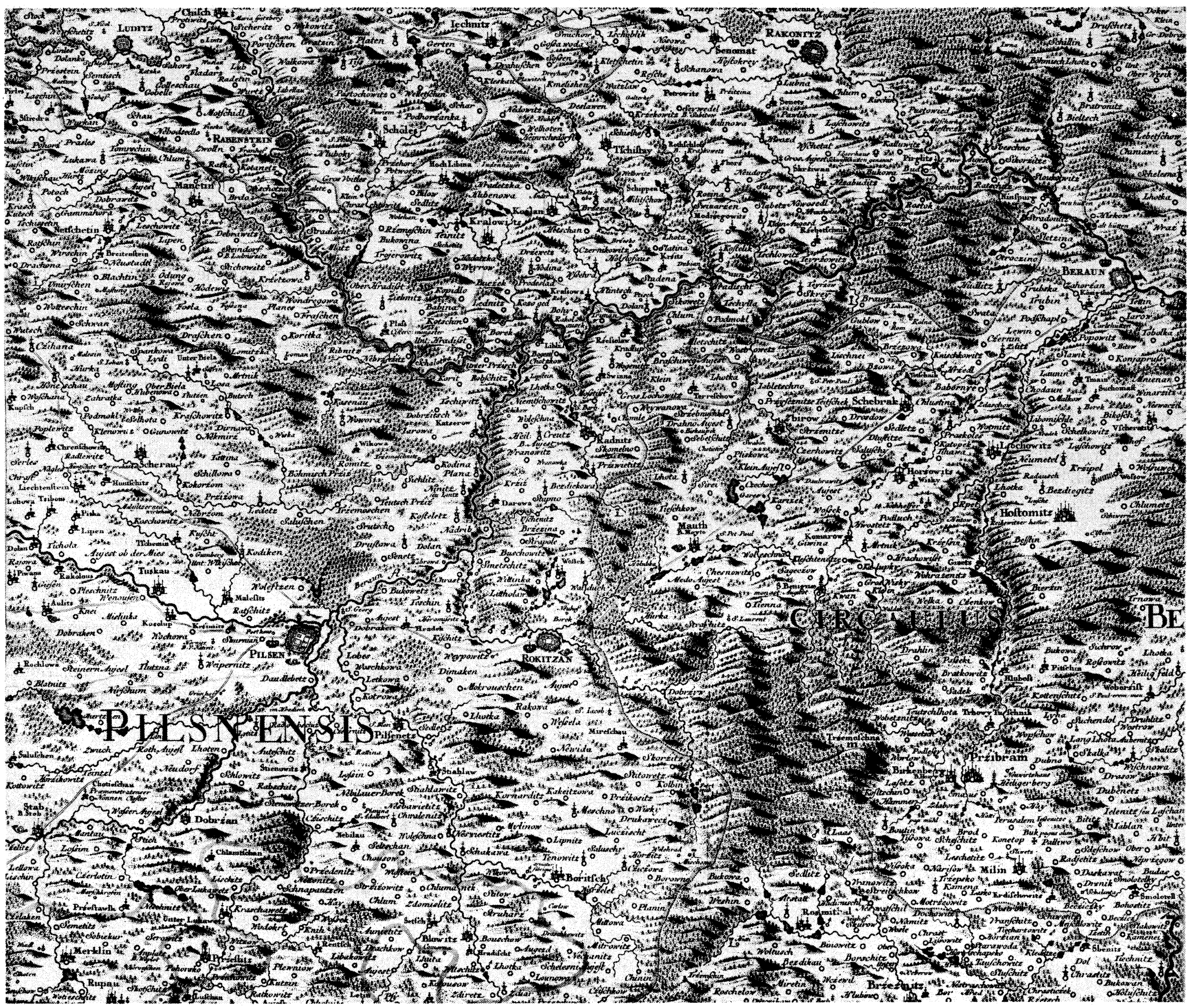


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FIG. 33.— PARTOF ERZ MOUNTAINS SOUTHEAST OF DRESDEN AS SHOWN ON JOHANN CHRISTOPH MULLER'S MAP OF BOHEMIA (1714–20). AN EARLY TOPOGRAPHICAL MAP ON WHICH RELIEF IS STILL REPRESENTED AS ON MEDIEVAL MAPS

by means of isolines or other symbols standing for specified quantities. the distribution of variables such as elevations, depths, temperatures, population densities, differences in wealth, etc. Such quantitative maps, now in universal use, were almost totally unknown before 1700. Edmund Halley's isogonic (compass-declination) map of certain oceans (1702), though not the very first of its kind, is the first known upon which isolines were used with fair success to show quantitative differences over large areas, and it inspired Alexander Humboldt many years later to propose that temperatures might be similarly shown by means of isotherms (1817). About 1730 Samuel Cruquius made the first recorded use of contour lines, when he employed them (not altogether correctly) to represent the depths of certain estuaries and rivers of the Netherlands coast, but contours were seldom used in the representation of land relief until the mid-19th century. While the barometer, thermometer and hygrometer were all greatly improved during the 18th century, they, too, were but little applied in hypsometric or meteorological mapping until the mid-19th century, for not until then had comparable data sufficiently numerous for cartographic purposes been assembled with their aid. Later a profusion of mechanical, optical, photographic, acoustical and electronic instruments for measuring conditions and forces in the depths of ocean, atmosphere and solid earth brought about an immense efflorescence of quantitative maps as tools of research and exposition in the various earth sciences (notably geophysics, geology and their allied fields of geomagnetism, meteorology, physical oceanography, geomorphology).

In many branches of the study of man and his affairs, historians, anthropologists, economists, sociologists, demographers and others also have come to depend, though to a lesser degree, upon quantitative maps based upon censuses and similar statistical inventories that likewise were unknown before 1700 and little used before the second half of the 19th century. Although such censuses are mentioned in the Bible. nobody seems to have thought of mapping the results until the early 19th century, when modern national census bureaus and the like had begun to gather large quantities of data for extensive areas. Notable pioneers in the advancement of statistical mapping were a British engineer, Henry Drury Harness (1804–83), whose population and traffic maps of Ireland appeared in 1837, and a German geographer, August Heinrich Petermann (1822–78), founder of the well-known geographical and cartographic journal Dr. *A. Petermanns Mitteilungen* (1855).

5. Outstanding Characteristics of Modern Cartography.—As a result of these various influences, cartography during the modern period differs essentially from the cartography of all earlier periods by reason of the great gains that have been made in the diversity, accuracy and quantity of maps produced.

Before 1700 the facts presented on maps were restricted mostly to the salient, visible features of the earth's surface—bodies of water, mountains, towns, roads, forests—and to such portrayals of human beings, animals, monsters and curiosities as the draftsman saw fit to add in the blank spaces. Since most modern maps have been designed to serve utilitarian, educational or scientific purposes, few carry the pictorial embellishment that added charm to the maps of earlier times. In this respect the 18th century mas transitional: although 18th-century maps were somewhat more austere and accurate than those of the 17th century, a good deal of pictorial decoration was retained. By the 19th century it was almost wholly gone and today is found only on maps made in imitation of medieval and Renaissance models; indeed, all too many modern maps are in fact ugly. Nevertheless, it always has been understood that cartography can be not only accurate but also pleasing to the eye, and exquisite maps have been produced during the modern period, more, perhaps, in continental Europe than elsewhere. The artistry that the early cartographers lavished on embellishment has been largely replaced by ingenuity in the finding of new types of phenomena to map and new symbols with which to map them.

Every map obviously presents a definite, if not readily measurable. amount of information. If it were possible to measure the total amount of information concerning any area presented by all maps that cover it, and then divide this figure by the area's extent in square miles or similar units, a figure would result that might be called the "map-area ratio" of the area. Could maps be made showing the values of this ratio, they would disclose at a glance how relatively well mapped (or, at least, thoroughly mapped) different areas are or have been (as is now suggested by coverage maps, but only with respect to maps of specific types; *e.g.*, large-scale topographic maps, coast charts). World maps of map-area ratios for different dates during the modern period would show patterns conforming broadly with densities of population, but with the highest ratios and the greatest gains in areas where economic and educational levels have stood highest and risen most. Throughout the period by far the most numerous and extensive tracts of very well-mapped territory have doubtless lain in western Europe (including Germany). where topographic mapping to large scales has been supplemented by the intensive special mapping of a multitude of natural and cultural circumstances, past and present. Where such cartographical treasures have been accumulated, they have frequently, though not invariably, inspired the publication of national or regional atlases (see ATLAS).

Correlation between population and map-area ratios of course is not perfect; certain uninhabited or sparsely settled areas—such as frontier zones of strategic importance (*e.g.*, northeastern France). strips of wilderness along international boundary lines (*e.g.*, Alaska-Canada). submarginal farming areas under paternalistic governments. undeveloped areas that attract tourists or present problems of special scientific interest, and, especially, areas believed or known to contain valuable natural resources—have been well mapped. Conversely, certain areas have been less well mapped than the comparative prosperity and enlightenment of their inhabitants might suggest; this has been true of large parts of the United States, and perhaps also of the country as a whole.

The number of maps that the people of a village or city or nation own or make or use per capita could be called a map-population ratio. Such ratios, like map-area ratios. though not readily determined as actual figures. are useful as concepts. in that they suggest realms of investigation that have been neglected by historians of cartography, most of whose work has dealt with individual maps and cartographers rather than with the larger historical bearing of the subject.

Map-population ratios nould signify varying degrees of "map-mindedness," "map-dependence." and the like, and would also be found to correspond roughly mith differing economic and educational levels. In their map-population ratios, France, Germany, the Netherlands and Great Britain must have led the world by a wide margin in 1700, and, along with the United States, Canada

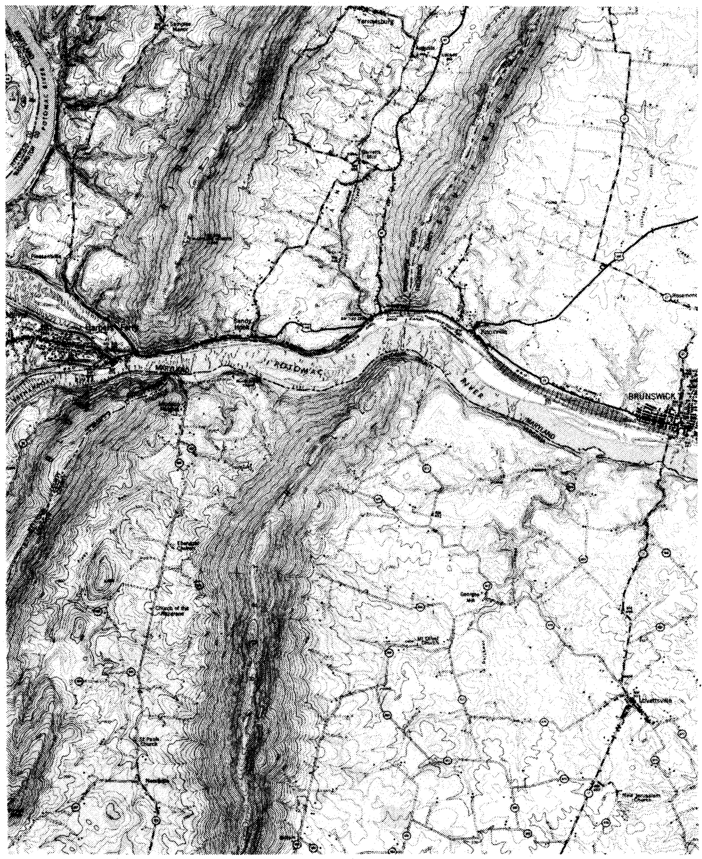

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FIG. 34.— TOPOGRAPHIC MAP OF HARPERS FERRY, W.VA., ALSO SHOWING PART OF VIRGINIA AND MARYLAND (1953)

and the other more fully industrialized countries, are doubtless still in the lead. Here again, the ratios have probably stood higher in western European countries and lower in the United States than the respective relative levels of prosperity and education might lead one to expect. While it cannot be stated categorically that western European peoples make and use more maps per capita than Americans or Russians do, western European pre-eminence throughout the modern period in the production and use of maps for educational, scientific and scholarly purposes can hardly be questioned. This superiority is due, in part at least, to the high standards that have been set and consistently maintained by the great governmental cartographic establishments and certain of the geographical societies and geographical departments in the universities of western Europe, and also by such renowned old map-publishing houses as Justus Perthes in Gotha (name changed to Veb Hermann Haack Geographisch-Kartographische Anstalt in 1954), Bartholomew in Edinburgh and Hachette in Paris. Throughout the 19th century and until the eve of World War II Germany produced the best general reference atlases, but after that the lead passed to the U.S.S.R. American standards in atlas and school-map production rose after the 1920s.

Other articles related to maps and mapping are referred to in the article GEOGRAPHY (ARTICLES ON). See ATLAS; CHART: GEODESY; NAVIGATION; PHOTOGRAMMETRY; SURVEYING: etc. *See* also Index references under "Map" in the Index volume.

BIBLIOGRAPHY.—G. R. Crone, *Maps and Their Makers* (1953) and the first four chapters of Erwin Raisz, *General Cartography* (1938), give concise, well-balanced general accounts of the history of cartography. Raisz's chronological charts are useful for quick reference, and his iourth chapter deals mith American cartography. More elaborate are Leo Bagrow, *Die Geschichte der Kartographie* (1951), which deals with the development oi mapping, especially as an art and craft, until the mid-18th century; R. V. Tooley, *Map and Map-makers* (1949), essentially an annotated catalogue of maps dating mostly irom the period 1475–1877; R. A. Skelton, *Decorative Printed Maps of the 15th to 18th Centuries* (1952) and *Explorers' Maps* (1958). Max Eckert's monumental *Die Kartenwissenschaft* . . ., a vol. (1921, 1925), is a store-

house of detailed information concerning the history of cartography arranged according to categories of maps.

All these works include bibliographical references. *Inzago Mundi: A Periodical Review of Early Cartography* (1935–) contains articles and book reviews. For further bibliographical guidance *see* W. W. Ristow and Clara E. LeGear, *A Guide to Historical Cartography* (1954), the general cartographical periodical *Surveying and Mapping* (1941–), and current bibliography, *Bibliographie cartographique internationale* (1949–), as well as geographical periodicals and bibliographies, a fundamental source of data: since the history of cartography is inextricably interwoven with that of geography (*see* J. K. Wright and E. T. Platt, *Aids to Geographical Research*, 2nd rev. ed. (1947).

The history of cartography was in general neglected until the mid-19th century, when the first great collections of reproductions of early maps mere published (M. F. de Santarem, *Atlas composé de mappenzondes, de portulans . . . depuis le VIe jusqu'au XVII siècle*, 1842–53; E. F. Jomard, *Les monuments de la geographie . . .*, 1842–62). These paved the way for a succession of similar works, of which four may be cited as representative examples, covering broad subjects with great erudition: A. E. Nordenskiöld, *Facsimile Atlas to the Early History of Cartography* (1889), *Periplus: An Essay on the Early History of Charts and Sailing Directions* (1897); Konrad Miller, *Mappaemundi: Die altesten Weltkarten*, 6 vol. (1895–98), *Mappae arabicae*, 6 vol. (1926–31). Growing interest in the history of the geographical discovery, exploration and early surveying and mapping of particular parts of the world, especially the Americas but also notably Africa, central and northern Asia and the Pacific, inspired the publication of similar collections, together with commentaries and pertinent monographs and periodical articles (partially listed by Bagrow, *op. cit.*, pp. 378–383).

The 19th and 20th centuries have been given comparatively little attention in the study of the history of cartography. The characteristic plainness or austerity of most modern maps, together with their superabundance and the many complexities that are involved in studying them, have made them less appealing to scholars and collectors than the maps of earlier times have been. Three publications bearing on cartography in the modern period may be cited as representative: G. M. Wheeler, *Facts Concerning the Origin, Organization, Administration, Functions, History, and Progress, of the Principal Governnzent Land and Marine Surveys of the World* (1885); Walter Thiele, *Official Map Publications* (1938); W. W. Ristow, *Aviation Cartoguaphy: A Historico-Bibliographic Study of Aeronautical Charts* (1956).

(J. K. W.)

MAPLE, the name of approximately 150 species of trees and shrubs belonging to the genus *Acer* of the family Aceraceae (*q.v.*). Two unrelated species, *Flindersia brayleyana* and *Cryptocarya oblata,* are productive of timber known as Queensland maple and Macquarie maple, respectively.

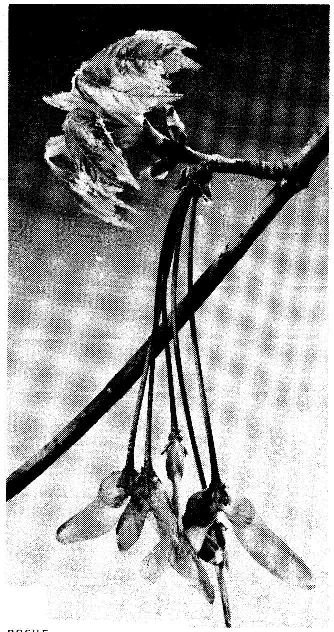
Maples feature opposite, deciduous (rarely persistent), mostly palmately lobed leaves. Their small (but en masse often showy) red, orange or greenish flowers appear before, with, or after leaf emergence. The two-winged samaralike fruits, sometimes referred to as keys, are also diagnostic. Several species are noted for their excellent timber; others are better known because of their ornamental use.

The North American flora includes 13 maples. Big-leaf maple (A. *macrophyllum*), the only commercial western species, is the second most important hardwood in the Pacific northwest. Ranging from Alaska to southern California, it often attains a height of 100 it. The wood is used for furniture and flooring; large burls occasionally found on old trees are sliced into fancy face veneers for decorative panels. A small, often prostrate or vinelike, understory tree, vine maple (A. *circinatum*) is the only other maple indigenous to the areas bordering the Pacific.

Box elder (*A. negundo*), a small transcontinental tree that occurs sparingly in nearly every state, features three- to seven-pinnately compound leaves, a characteristic rare among maples. Big-tooth maple (*A. grandidentatum*) and Rocky Mountain maple (A. *glabrum*) are small, little known trees of the Rocky mountain region.

Eight eastern species are divided into the hard, soft and mountain maple groups. Hard maples include the sugar (A. *saccharum*), black (A. *nigrum*), Florida *(A, barbartum)* and chalk *(A. leucoderme)* maples. The latter two species are small southern trees of little commercial value. Sugar maple, an important timber and shade tree, and with black maple the principal source of maple sirup (*q.v.*), extends from Newfoundland to North Dakota and south to Georgia and Texas. Often 90 ft. tall, its hard, pinkish-white wood is fabricated into furniture, flooring, musical instruments, sporting goods and a host of other commodities. Timber with wavy or curly grain or bird's-eye figure is prized for cabinetry. Black maple, restricted to the northeast and lake states, produces timber of comparable quality.

The soft maples, red (A. *rubrum*) and silver (A. *saccharinum*), respectively, are medium-sized trees of wide distribution east of the Great Plains. The former, the leaves of which are silvery white below, grows very rapidly and is used as a street and shade tree. Nowhere is there a tree more resplendent in its flamboyant crimson autumn foliage than the red maple. While the wood of neither species is the mechanical equal of the hard maples, both are similarly used.



ROCHE

LEAVES AND SEEDS OF THE RED MAPLE (ACER RUBRUM)

Striped maple (A. *pensylvanicum*), featuring smooth greenish bark striped with white, and the shrubby mountain maple (A. *spicatum*), are two understory species of northern forests. Hedge maple (A. *campestre*), of northern Europe and western Asia, is the only maple indigenous to Great Britain. Seldom exceeding a height of 20 ft., it is easily identified by its small leaves with rounded lobes.

The handsome sycamore maple (A. *pseudoplatanus*), an important timber tree of central Europe and western Asia, is a commonly used ornamental in the United States and Great Britain, as is also the Norway maple (A. *platanoides*), a lofty European and Asiatic timber tree. A variety, the Schwedler maple (var. *schwedleri*) with greenish-red to reddish-bronze leaves, is a widely planted ornamental.

Among the Asiatic species especially well suited for decorative and ornamental use, both in Europe and North America, are the small chinese maple *(A. truncatum)*, featuring deeply lobed, purplish-green leaves with truncate bases; dwarf maple *(A. ginnala)*, a compact shrub with three-lobed leaves; Japanese maple *(A. palmatum)* and its many varieties, featuring deeply dissected reddish to purplish foliage; and the hornbeam maple *(A. carpinifolium)* with unlobed foliage similar to the hornbeams.

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(E. S. HR.)

MAPLE SIRUP is one of the few crops produced solely in North America and is one of the oldest, having been produced by Indians of the Great Lakes and St. Lawrence river regions prior to the arrival of white settlers. Maple sirup is obtained mostly from the "sap" (sweet water) of the sugar maple (*Acer saccharum*) but some is obtained from the black maple (A. *nigrum*). It is produced in commercial quantities in the United States in Vermont, New York, Pennsylvania, Michigan, Ohio, New Hampshire, Wisconsin, Massachusetts, Maine, Maryland, Minnesota and West Virginia, and in Canada in Quebec and Ontario, ranked in order of production. The same type and quality of maple products are produced throughout the area. Differences merely reflect idiosyncrasies of producers and equipment.

The production of maple sirup is subject to yearly climatic and economic fluctuations. A record crop was produced in 1860 and a very small crop in 1959. The sweet water "sap" of the maple tree from which sirup is made is different from the circulatory sap of the growing tree. When the tree is dormant the sap will flow from any wound, such as a tap hole, in the sapwood each time a period of freezing is followed by a period of thawing. The sap contains $1\frac{1}{2}\%$ to 3% solids, mostly sucrose. It does not contain either the colour or the flavour of maple sirup. These are imparted to it as the sap is concentrated by evaporation in open pans to 65.5° Brix.

Thirty to fifty gallons of sap are required to yield one gallon of sirup.

The usual maple sirup season begins in mid-January in the more southern states and ends in mid-April in the northern states, lasting four to six weeks in each place. Until the late 1910s the method of making maple sirup had remained almost unchanged over the more than 300 years of its history, with the exception of the development of the flue evaporator.

During the next 10 years modernization began. The equipment for drilling tap holes was mechanized, sanitary methods of sap handling effected. precision instruments for sirup making developed. plastic tubing adapted for the transportation of sap from the tap holes of entire sugar bushes to storage tanks, and central evaporator plants established which serve whole communities of sap producers.

All of these modernized methods improved and standardized maple products.

The major products of maple sap are pure and blended table sirups. confections (cream. hard and soft candies'), toppings for ice cream. flavourings and casing for cigarette tobaccos.

(C. O. R.)

MAPLEWOOD: see SAINT LOUIS (Mo.).

MAQDISI (MUQADDASI), **AL-** (IBN ALMAD AL-MUKADDASI, *i.e.*, "the Jerusaleniite") (*c.* 946–*c.* 1000). Arab traveler and geographer, author of a noted work in Arabic on the lands of Islam entitled in one manuscript *Kitab al-Aqalim* ("The Book of Countries"), though another rnanuscript has a longer title. This work, published in 985 and based mainly on his personal observations during 20 years of travel (in the course of which he visited all the Moslem lands except Spain, Seistan and Sind), is a mine of detailed information on the populations. manners and economic life of these lands in the 10th century.

See *Bibliotheca Geographorum arabicorum,* ed. by M. J. de Goejc, vol. iii (1877; rev. 0 6) *See* also introduction tn vol. iv of the same work for a discussion by M. J. de Gocje of al-Muqaddasi and his work.

(H. A. R. G.)

MAR, EARLDOM OF. Mar. one of the ancient divisions of Scotland, comprised the larger portion of Aberdeenshire. extending from north of the Don southward to the Mounth. Like other such districts. it was in Celtic times under the rule of a mormaer. In the 12th century his place was taken by an earl, but no definite succession of earls appears until the 13th century. Earl Gratney (*fl. c.* 1300) married a sister of (King) Robert Bruce. who brought him the lordship of Garioch and castle of Kildrummy. which she held against the earl of Athole. an ally of the English (1335). Their son Donald was made regent in July 1332, but was defeated and slain at Dupplin the next month. His daughter and eventual heir. Margaret, brought the earldom to her husband. William. earl of Douglas. and on the accession of her daughter Isabel a troublous time followed. While she was living as a widow at her castle of Kildrummy. it was stormed by Alexander Stewart. a bastard, who forced her to execute a charter (Aug. 1404) settling the reversion to the earldom on himself and his heirs. This act she revoked by a charter of Sept. 1404. but on marrying him in December. she granted him the earldom for liie. the king confirming this in June 1405. After her death in 1408 the earl commanded the royal forces at the battle of Harlaw. when the lord of the Isles was defeated in 1411, and afterward acted as warden of the Marches.

In 1426 he resigned the earldom to the crown. the kina granting it by a fresh creation to him and certain heirs. with reversion to the crown. In the following centuries the earldom had a complicated and chequered history, the title eventually remaining in the Erskine family. As a result of the attainder of the 11th earl. John (16; j–1732). a prominent Jacobite (*see* below), the earldom remained under forfeiture for 108 years.

Alloa and other Erskine estate.: of the attainted earl were repurchased for the family. and descended to John Francis Erskine (1741–1825), his heir male, who was also his heir of line through his daughter. To him, in his 83rd year, as grandson and lineal representative of the attainted earl. the earldom was restored by act of parliament. His grandson. who succeeded him in 1828, inherited the earldom of Kellie (1619) and other Erskine dignities by decision of 1835.

At his death in 1866, his earldom of Mar was the subject of rival claims, and the right to the succession was not determined until 187j. For the prolonged proceedings for the settlement of this case, in which the decision of the house of lords (Feb. 25, 1875), in favour of the late earl's cousin and heir male, was reversed by a special act, the Earldom of Mar Restitution act in 1885, in favour of the son of the late earl's cousin, J. F. E. Goodeve (Erskine), see the authorities quoted below.

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MAR, JOHN ERSKINE, 1ST OR 6TH EARL OF (d. 1572), regent of Scotland. was a son of John. 5th Lord Erskine (d. 1552), who was guardian of King James V, and afterward of Mary Queen of Scots. The custody of Edinburgh castle was in his hands. and during the struggle between the regent, Mary of Lorraine, and the lords of the Congregation he appears to have acted consistently in the interests of peace. When Mary Stuart returned to Scotland in 1561 Lord Erskine was a member of her council, and favoured her marriage with Lord Darnley. In 156j Erskine was granted the earldom of Mar (*q.v.*). As guardian of James, afterward King James VI. he prevented the young prince from falling into the hands of Bothwell. and when the Scottish nobles rose against Mary and Bothwell, Mar was one of their leaders. He took part in the government of Scotland during Mary's imprisonment at Lochleven, and also after her subsequent abdication. In 1571 he was chosen regent of Scotland, but he was overshadowed by the earl of Morton. He died at Stirling on Oct. 29, 1572.

MAR, JOHN ERSKINE, 2ND OR 7TH EARL OF (*c.* 1558–1634), Scottish politician. was the only son of the preceding. He was nominally the guardian of the young king James VI, n-ho lived with him at Stirling; but he was in reality a puppet in the hands of the regent, the earl of Morton; and he lost power when Morton was imprisoned. He was concerned in the seizure of James VI in 1582; but when James escaped the earl fled into the west of Scotland. Leaving his hiding place Mar seized Stirling castle. whereupon James marched against him, and he took refuge in England. Queen Elizabeth I interceded for him in vain, and Mar and his iriends gathered an army. entered the presence of the kina at Stirling. and were soon in authority (1585). Mar was restored to hia lands and titles. He became governor of Edinburgh castle and tutor to James's son. Prince Henry. and for his second wife he married Mary, daughter of Esmé Stewart. duke of Lennox.

In 1601 the earl was sent as envoy to London; there Elizabeth assured hirn that James should be her successor, and his mission was conducted with tact and prudence. Mar was created Lord Cardross in 1610; he was a member of the Court of High Commission and was lord high treasurer of Scotland from 161j to 1630. He died at Stirling on Dec. 14. 1634.

MAR, JOHN ERSKINE, 6TH OR 11TH EARL OF (1675–1732), Scottish Jacobite, was the eldest son of Charles. the jth earl (1650–89). He was associated with the party favourable to the English government; he was one of the commissioners for the union. and was made a Scottish secretary of state, becoming after the union of 1707 a representative peer for Scotland, keeper of the signet and a privy councillor. In 1713 Mar was made an English secretary of state by the Tories. hut under George I he was deprived of his office, and in 1715 he went in disguise to Scotland and placed himself at the head of the adherents of James Edward, the Old Pretender. Meeting many Highland chieftains at Aboyne he avowed a desire for the independence of Scotland,

and at Braemar in Sept. 1715 he proclaimed James VIII king of Scotland. England. France and Ireland. At Sheriifmuir, in Nov. 1715, Mar's forces were defeated by those of his opponent, Archibald Campbell, afterward 3rd duke of Argyll. Mar then met James Edward at Fetteresso; he fled with him to France. In the course of time he became thoroughly distrusted by the Jacobites. In 1721 he accepted a pension of £3,500 a year from George I, and in 1724 he left the Pretender's service. His later years were spent in Paris and at Aix-la-Chapelle. where he died in May, 1732. He had been attainted in 1716, and his only son, Thomas, Lord Erskine, died childless in March 1766.

Mar's brother. JAMES ERSKINE (1679–1754), was educated as a lawyer and became lord justice clerk of the court of session and Lord Grange in 1710. He took no part in the rising of 1715, although there is little doubt that at times he was in communication with the Jacobites, but was rather known for his sympathy with the Presbyterians. He became more famous, however, in connection with the story of his wife's disappearance. This lady, Rachel Chicelp, was a woman of disordered intellect; probably with reason she suspected her husband of infidelity. and after many years of unhappiness Grange arranged a plan for her seizure. In Jan. 1732 she was conveyed with great secrecy from Edinburgh to the island of Hesker, thence to St. Kilda, where she remained for about ten years: thence she was taken to Xssynt in Sutherland and finally to Skye. To complete the idea that she was dead. her funeral was publicly celebrated, but she survived until May 1745.

Meanwhile in 1734 Grange had resigned his judgeship and had become an English member of parliament; there he was a bitter opponent of Sir Robert Walpole.

He died in London on Jan. 20, 1754.

See the *Journal of tlze Earl of Mar* (1716); R. Patten, History *of the Late Rebellion* (1717); and A. Lang, History *of Scotland,* vol. iv. (1907).

MAR, SERRA DO, the name given to the Great Escarpment on the eastern margin of the Brazilian highlands. The escarpment extends all the way from Rio Grande do Sul to southern Bahia, but it is known as the Serra do Mar only in the middle section in Rio de Janeiro and São Paulo. Because of its name ("mountains of the sea") many map makers show this as a range of mountains rather than escarpment on the edge of a plateau. The escarpment stands between 2.600 and 3,000 ft. above sea level at its top; but in Rio de Janeiro state it is surmounted by the Serra dos Orgãos (7.36j ft.) which overlooks Guanabara bay at Rio de Janeiro. The escarpment was originally covered with a dense rain forest.

(P. E. J.)

MARABOUT, in Islam a hermit or devotee (Fr. from Arab *murabit,* "one who pickets his horse on a hostile frontier"). The word is derived from *ribat,* a fortified frontier station, which later came to mean a religious house or hospice (*zawiya*). In North Africa the marabouts enjoy extraordinary influence, being esteemed as living saints and mediators. They are liberally supported by alms, direct all popular assemblies, and have a decisive voice in intertribal quarrels and all matters of consequence. On their death their sanctity is transferred to their tombs (also called marabouts). where chapels are erected at, and gifts and prayers offered to, their tombs.

See DERVISH.

MARACAIBO, second largest city in Venezuela, the country's most important seaport and capital of the state of Zulia, is situated in the northwestern corner of the country on the west shore of the channei connecting Lake Maracaibo with the Gulf of Venezuela. Pop. (1961) 432,902. The city was a primitive coffee-exporting port of 40,000. mostly Indians and Negroes, until petroleum was discovered in' 1917. Within a decade Maracaibo became the country's oil metropolis: with paved streets, modern public services, tall office buildings, golf clubs, air-conditioned hotels, supermarkets and very substantial dwellings. Its population more than doubled during the 1920s, in spite of the climate. The city is located in a basin surrounded by higher land which prevents the steady trade winds from relieving the oppressive humidity. The annual average temperature is 82.4° F., ranging from an average of 80.6° F. in January to an average of 84.4° in August. The oil companies set up headquarters there. the government erected new buildings, the city installed electricity. Attractive modern suburbs reached out in all directions. Commerce thrived but living costs doubled.

Because of its strategic location near the outlet of the lake, Maracaibo has long been important as a trading centre although the channel connecting the lake with the Caribbean mas too shallow to permit the passage of large ocean freighters and tankers. A major dredging operation completed in 1957 (see MARACAIBO, LAKE) provided a major stimulus to the economy of all of northwestern Venezuela and quickened the entire maritime life of the city.

In addition to being one of the most important petroleum-exporting ports in the world, the city exports cacao. coffee, hides, fruits, vegetable oil and rimber. It imports manufactured products of all kinds and considerable food. It also serves as the transshipment point for nearly all the trade for northwestern Venezuela.

Maracaibo's oil industry is the result of foreign enterprise. Pou·erful oil groups own all the major concessions. Billions of dollars of American, British and Dutch capital have been invested, but in 19j6 Venezuelan capital, in alliance with foreigners, entered the industry. (L. WE.)

Maracaibo's wealth dates from the 20th century but its history goes back to the age of exploration. It was founded in 1571 by Alonso Pacheco. who gave it the name of Nueva Zamora. The shipment point for the inland settlements was originally a station named Gibraltar at the head of the lake, but its destruction by pirates in 1669 transferred this trade to Maracaibo. The city did not figure actively in the war for independence until Jan. 28, 1821, when the province declared its independence and alliance with Colombia. This ended the armistice between Simón Bolivar and Pablo Morillo and thereafter the city experienced the changing fortunes of war until its final capture by the revolutionists in 1823. In the years of destructive civil war, Maracaibo was usually much less involved than eastern and central Venezuela.

MARACAIBO, LAKE (LAGO DE MARACAIBO) a large lake in the northwestern corner of Venezuela. lies in the Maracaibo lowland immediately to the east of the Sierra de Perijá. It extends southward from the Gulf of Venezuela, into which it opens through a long neck. Roughly shaped like an oil drop hanging from a spout, the lake is 133 mi. long and 72 mi. wide and covers an area of about 5,000 sq.mi. In the southern portion the lake water is fresh but in the northern portion, where the tidal influence is stronger. it is somewhat brackish.

Lake Maracaibo receives the waters of many rivers, principally from the west and south sides. The heavy rainfall on the eastern slopes of the Eastern Cordillera (more than 86 in. annually) is responsible for the great volume of water discharged into the lake. The average annual precipitation over the entire basin is about 70 in. The area around the lake is hot and humid and its average temperature is reported to be the highest in South America.

Lake Maracaibo is the centre of the petroleum industry of Venezuela and of Latin America. About 90% of the oil produced is exported. hut untii 1957 the northern outlet of the lake was obstructed by a very large sand bar which allowed only shallow-draft (17,000 ton') tankers to enter and leave the lake. In that year, after many months of dredging and at a cost of $48,000,000, a new channel 3j ft. deep and 21 mi. long was opened. Now fully loaded 33.000-ton tankers are able to leave the lake.

The Lake Maracaibo basin (including the lake and adjacent land area) is one of the world's richest and best located oil-producing areas. Particularly outstanding are the 65 mi. along the east shore and the 15 mi. out into the lake. Thousands of derricks protrude from the water and thousands more line the shore. Underwater pipelines transport the oil to storage tanks on the land. Well over one-third of Venezuela's total oil production comes irom Lake Maracaibo. As oil contributes over 90% of the country's foreign exchange and many national revenues, the economic importance of Lake Maracaibo is considerable.

Much natural gas (wet gasj is obtained with the oil. For many years billions of cubic feet of this fuel were flared off: since there was no appreciable market. In the middle 1950s a petroleum corporation installed three plants several miles offshore for reinjecting gas into the oil-bearing formation with the purpose of recovering more oil and of conserving gas for potential future use. Enough pressure is put on the oil in the deposit to increase immediate production by 50% and ultimate recovery by 30%. One of these plants injects 300,000,000 cu.ft. of gas per day into the reservoir it serves.

Until 1918 Lake Maracaibo basin was one of the poorest and least important areas in the country. The people made a miserable living ignorant of the potential wealth at their feet. The oil industry there is the result of foreign (chiefly American. British and Dutch) enterprise, technological skills and capital. In the early 1960s less than 5% of the total production came from Venezuela-owned wells. (L. WE.)

MARACAY, capital of Aragua state in Venezuela. Pop. (1961) 134.123. A handsome city, it lies about 76 mi. W. of Caracas in the central highlands at an elevation of 1,500 ft. It was but a sleepy town until the dictator Juan Vicente Ghmez transferred his centre of activities there from Caracas. During his long dictatorship (1908–3j) he built up hlaracay until it became the actual if not the nominal capital of the country. The city is situated in excellent cattle country; by gaining possession of these pastures. Gómez virtually cornered the entire Venezuela cattle industry. He built a modern dairy plant and slaughterhouse at Maracay, with whose products he supplied the urban market in Caracas.

Determined to make the city the cultural and social centre of the nation. Gómez constructed the Hotel Jardín, with its Moorish arcades, second-story balconies, gracious patio and beautiful park and fountain; an opera house (never completed); a bull ring (an exact replica of the one in Seville); and military airports. The current importance of the city lies in its military training institutions and its school of agriculture and experiment station. (L. WE.)

MARAGHEH (MARAGHA), a town of Iran in the province of E. Azerbaijan. on the Safi river, in 37° 23′ N., 46° 16′ E., 80 mi. from Tabriz. Pop. (1956) 36,556. It is pleasantly situated in a narrow valley running nearly north and south at the eastern extremity of a well-cultivated plain opening toward Lake Urmia, which lies 18 mi. to the west. Two stone bridges in good condition. said to have been constructed during the reign of Hulagu Khan (1256–65), and since then several times repaired, lead over the Safid rud on the western side of the town. But the most notable monuments are five tomb towers, several badly ruined, dating from the 12th through the early 14th century. the earliest being the Gunbad-i-Surkh (1147). It is one of the finest examples of brickwork in Iran. The place is surrounded by extensive vineyards and orchards, well watered by canals led from the river. and producing great quantities of fruit. On a hill west of the town are traces of a famous observatory (*rasad*) constructed under the direction of the great astronomer Nasr-ud-Din of Tus. The building. which no doubt served as a citadel as well, enclosed a space of 380 yd. by 150 yd.. and the foundations of the walls were 4½ to j ft. in thickness. The marble. which is known throughout Iran as Maragha marble. is a travertine obtained at the village of Dashkesen (about 30 mi. N.W. of Maragheh). It is deposited from water. which bubbles up from a number of springs, in the form of horizontal layers. which at first are thin crusts and can easily be broken, but gradually solidify and harden into blocks with a thickness of 7–8 in. It is a singularly beautiful substance, of yellow. pink, greenish or milk-white colour, streaked with reddish. copper-coloured veins.

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MARAJO, an island at the mouth of the Amazon river in Brazil. 183 mi. long and 124 mi. wide; area 15,444 sq.mi. The main flow of the Xmazon passes to the north of Marajó, but numerous *furos* or narrow passages direct part of the water into the Pará river. an estuary that separates the island from the mainland to the south. The densely forested western half of the island is part of the overflow land (*várzea*) of the Amazon, but the slightly higher eastern half, underlain by sandstone, has extensive areas of treeless savannas (*campos*), which support large herds of cattle. Numerous archaeological mounds in the northeastern part of the island are rich in well-made pottery vessels and other objects that suggest an affinity with pre-Columbian Andean cultures. Soure, a modern town and beach resort on the Atlantic coast, is linked to Belém by overnight ferry service. (Js. J. P.)

MARANHÃO, a northern state of Brazil, bounded north by the Atlantic, east and southeast by Piaui, southwest and west by Goiás and Pará. Area 128,252 sq.mi. Pop. (1956 est.) 1,842,000. The coastal zone and the northwest corner of the state belong to the Amazon valley region. being a heavily forested plain traversed by numerous rivers. The eastern and southern parts, however, belong to the lower terraces of the great Brazilian plateau. broken by eroded river courses between which are high open plains. There are no true mountain ranges in Maranhão. those indicated on the maps being only plateau escarpments marking either its northern margin or the outlines of river valleys. The climate is hot. and the year is divided into wet and dry seasons, extreme humidity being characteristic of the former, but no part of the year is rainless. The heat, however, is greatly modified on the coast by the southeast trade winds.

The coast itself is broken and dangerous. there being many small indentations, which are usually masked by islands or shoals. The largest of these are the Bay of Turiaçu, facing which is the island of Tocansa, and several others of small size and the contiguous bays of Sio Marcos and Sio José, between which is the large island of Sio Luis, on which is the city of São Luis. The rivers of the state all flow northward to the Atlantic, and a majority of them have navigable channels. The Parnaiba forms the eastern boundary while the Tocantins and the Gurupí bound the state on the west.

The principal industries of Maranhão are agricultural, the highly fertile river valleys and coastal zone being devoted to the cultivation of sugar cane, cotton, rice, coffee. tobacco. *manioc* (cassava) and a great variety of fruits. Babassu nuts are an important export. The southern highlands are devoted to cattle raising. Phosphatic bauxite deposits that occur on Turiaçu Island at the mouth of the Maracaçumé river are undeveloped. In 1956 oil was discovered at Balsas, deep in the interior near the Goiás border. A railway, 250 mi. long, crosses the eastern part of the state connecting São Luis on the coast with Teresina, the capital of Piaui.

The capital is São Luis, pop. (1956 est.) 147.067 (mun.); other principal towns, with their population in 1950 are: Caxias 14.443'; Pedreiras 7,185; Rosário 5,316 and Viana 4,995.

The coast of Maranhão was first discovered by Vicente Yáñez Pinzhn in 1500. but it was included in the Portuguese grant of captaincies in 1534. The first European settlement was made by a French trading expedition under Jacques Riffault of Dieppe in 1594, who left a part of his men there when he returned home. Subsequently Daniel de la Rivardière. commissioned by the French crown. founded a colony on São Luis Island in 1612. The French were expelled by the Portuguese in 1615 and the Dutch held the island from 1631 to 1644.

In 1621 Ceará. Maranhão and Pará were united and called the Estado do Maranhão, which was made independent of the southern captaincies. Ceará was later detached, but the state of Maranhão remained independent until 1774, when it became subject to the colonial administration of Brazil. Maranhio did not join in the declaration of independence of 1822. but in 1823 the Portuguese were driven out by Admiral Lord Cochrane and the province became a part of the empire of Brazil. (Js. J. P.)

MARAÑÓN, a river of northeast Peru, rising in Lake Lauricocha in the southwest of Huánuco department, just north of Cerro de Pasco. about 100 mi. from the Pacific ocean. It flows 350 mi. northn-est between mountain ranges before descending eastward to enter the Amazon basin.

The Marañón, together with the Ucayali and Huallaga rivers which join it downstream, is one of the principal affluents of the Amazon (*q.v*). From its source, a series of unnavigable rapids characterize the Marafion for a distance of 350 mi.; it drops from a height of 12,000 ft. in the Andes to 575 ft. above sea level at Pongo de Manseriche. Navigation is only possible below Manseriche. The Marañón is navigable to Puerto Limón, a distance of 484 mi. (during both high and low water), for steamers of 4- to 8-ft. draft. From Puerto Limón to Manseriche, a distance of 74 mi., it is navigable by vessels of 2- to 4-ft. draft at any season.

The Marañón flows through a forested, sparsely inhabited region. Climatic conditions vary from a mountain climate in the upper extension of the river to rainy tropical in the Amazon basin. (J. L Tr)

MARANTACEAE, the arrowroot family. monocotpledonous perennials, comprising 26 genera and 300 species, all tropical and mainly American. The West Indian *Maranta arundinacea* is the source of arrowroot (*q* v.).

Various species of *Calathea* are cultivated for their ornamental foliage.

MARAS (Marash), a city in Turkey, east of the Jihan river at the foot of Mt. Taurus; pop. (1955) 44.306, and capital of the *vilayet* of the same name.

The American mission has a college there and the Americans and Jesuits, churches and schools. The climate for the greater part of the year is good. A railway connects hlaras with the Istanbul-Baghdad line.

History.——Maras was anciently a Hittite town and several Hittite monuments have been discovered including an inscribed lion and several stelae. As Marasi it appears in Assyrian records, but little or nothing is known of the town at that period. It reappears in history in the 2nd century A.D. with the name Germanicia. The identification of Germanicia with Maras has been questioned without any real justification. Nor is the attempt by Honigmann to distinguish two Germanicias in fairly close proximity likely to meet with favour. The Armenians have called Maras Kermanig since the 12th century at least. Heraclius visited the town in A.D. 640. Before 700 it had passed into Moslem hands. The Khalif Mu'āwiya rebuilt it and it figured in the struggles with the Byzantines; after 770, however, it remained definitely in Moslem hands. Hārūn al-Rashēd (786–809) strengthened its fortifications. The crusaders captured the town (1097), as did the Seljuks half a century later. It became part of the Turkish empire in the 16th century. In 1832 the Egyptian army in its march toward Constantinople stayed its advance there at the bidding of the powers. Maras was brought within the sphere of military operations consequent on the Franco-Turkish dispute of 1920–21.

See G. Le Strange, *Palestine Under the Moslems, 37 seq., 502 seq.* (for Arab texts) (1890), F. Cumont, *Etudes Syriennes,* 169 *seq.* (1917); *E* Honigmann, *Historische Topographie von Nord Syrien im Altertum,* nos 192. 193 (1923) (E Ro.; X.)

MARAT, JEAN PAUL (1743–1793), French revolutionary leader, son of Jean Paul Marat, a designer of Cagliari in Sardinia. and Louise Cabrol of Geneva, was born at Boudry, Neuchâtel, on May 24, 1743. On his mother's death in 1759 Marat set out on his travels, and studied medicine for two years at Bordeaux, whence he moved to Paris, where he made use of his knowledge of optics and electricity to subdue an obstinate disease of the eyes. After some years in Paris he went to the Netherlands, and then to London, where he practised medicine. In 1773 he published a *Philosophical Essay on Man*. The book directly attacks Helvétius, who had in his *De l'esprit* declared a knowledge of science unnecessary for a philosopher. Marat declares that physiology alone can solve the problems of the connection between soul and body, and proposes the existence of a nervous fluid as the true solution. In 1774 he published *The Chains of Slavery,* which was intended to influence constituencies to return popular members, and reject the king's friends. In 1775 he published in London his *Essay on Cleets,* and in Amsterdam a French translation of the first two volumes of his *Essay on Marc.* In this year he visited Edinburgh, and was made an M.D. of St. Andrews. On his return to London he published an *Enquiry into the Nature, Cause, and Cure of a Singular Disease of the Eyes,* with a dedication to the royal society. In the same year there appeared the third volume of the French edition of the *Philosophical Essay on Man,* which exasperated Voltaire, whose attack made the young author more conspicuous. His fame as a doctor was now great, and on June 24, 1777, the comte d'Artois. afterward Charles X of France, made him physician to his guards with 2,000 livres a year and allowances.

Marat soon had an aristocratic practice. He presented memoirs on heat, light and electricity to the Académie des Sciences, hut the academicians were horrified at his temerity in differing from Newton and uould not receive him. In 1780 he had published at Neuchâtel a *Plan de législation criminelle,* founded on the principles of Cesare Beccaria. In April 1786 he resigned his court appointment. The results of his leisure were in 1787 a new translation of Sir Isaac Newton's *Optics,* and in 1788 his *Mémoires académiques, ou nouvelles de'couvertes sur la lumière.*

In the notoriety of the political life which was now to begin, his scientific and philosophical knowledge was to be forgotten, the high position he had given up denied, and he himself scoffed at as an ignorant charlatan, who had sold quack medicines about the streets of Paris, and been glad to earn a few sous in the stables of the comte d'Artois. In 1788 the elections for the states-general were the cause of a flood of pamphlets, of which Marat's *Offrande à la patrie* dwelt on much the same points as the famous brochure of the Abbé Siéyès: *Qu'est-ce que le tiers état?* In June 1789 he published a supplement to his *Offrande,* followed in July by *La constztution,* in which he embodies his idea of a constitution for France. and in September by his *Tableau des vices de la constztution d'Angleterre,* uhich he presented to the assembly. The latter alone deserves remark. The assembly was at this time full of anglomaniacs, who desired to establish in France a constitution similar to that of England. Marat had seen that England was at this time being ruled by an oligarchy using the forms of liberty, which, while pretending to represent the country, was really being gradually mastered by the royal power. His heart was now all in politics; and he decided to start a paper. At first appeared a single number of the *Moniteur patriote,* followed on Sept. 12 by the first number of the *Publiciste parisien,* which on Sept. 16 took the title of *L'Ami du peuple* and which he edited, with some interruptions, until Sept. 21, 1792.

The life of Marat now becomes part of the history of the French Revolution. From the beginning to the end he stood alone. He was never attached to any party, the tone of his mind was to suspect whoever was in power. About his paper, the incarnation of himself, the first thing to be said is that the man always meant what he said; no poverty, no misery or persecution, could keep him quiet; he was perpetually crying, "Nous sommes trahis." Whoever suspected any one had only to denounce him to the *Ami du peuple,* and the denounced was never let alone till he was proved innocent or guilty. Marat began by attacking the most powerful bodies in Paris—the constituent assembly. the ministers. the corps municipal, and the court of the Châtelet. Denounced and arrested, he was imprisoned from Oct. 8 to Nov. 5, 1789. A second time. owing to his violent campaign against Lafayette, he narrowly escaped arrest and had to flee to London (Jan. 1790). There he wrote his *De'nonczation contre Necker,* and in May dared to return to Paris and continue the *Ami du peuple.* He was embittered by persecution, and continued his vehement attacks against all in power. and at last, after the day of the Champs du Mars (July 17, 1790), against the king himself. All this time he was in hiding in cellars and sewers, where he was attacked by a horrible skin disease, tended only by the woman Simonne Evrard. who remained true to him. The end of the constituent assembly he heard of with joy and with bright hopes for the future, soon dashed by the behaviour of the legislative assembly. When almost despairing, in December 1791, he fled once more to London, where he wrote his *École du citoyen.* In April 1792, summoned again by the Cordeliers' club, he returned to Paris, and published no. 627 of the *Ami.*

The war was now the question, and Marat saw clearly that it was to serve the purposes of the Royalists and the Girondins, who thought of themselves alone. Again denounced, Marat had to remain in hiding until Aug. 10. The proclamation of the duke of Brunswick excited all hearts; who could go to save France on the frontiers and leave Paris in the hands of his enemies? Marat, like Georges Danton, foresaw the massacres of September. After the events of Aug. 10 he took his seat at the commune, and demanded a tribunal to try the Royalists in prison. No tribunal was formed, and the massacres in the prisons were the inevitable result. In the elections to the convention, Marat was elected 7th out of the 24 deputies for Paris, and for the first time took his seat in an assembly of the nation. At the declaration of the republic, he closed his *Ami du peuple*, and commenced, on the 25th, a new paper, the *Journal de la république française,* which was to contain his sentiments as its predecessor had done, and to be always on the watch. In the assembly Marat had no party; he would always suspect and oppose the powerful, refuse power for himself. After the battle of Valmy, Charles Dumourierz was the greatest man in France; he could almost have restored the monarchy; yet Marat did not fear to denounce him in placards as a traitor.

His unpopularity in the assembly was extreme, yet he insisted on speaking on the question of the king's trial, declared it unfair to accuse Louis for anything anterior to his acceptance of the constitution, and though implacable toward the king, as the one man who must die for the people's good, he would not allow Chretien de Malesherbes, the king's counsel, to be attacked in his paper, and speaks of him as a "sage et respectable vieillard." The king dead, the months from January to May 1793 were spent in an unrelenting struggle between Marat and the Girondins. Marat despised the ruling party because they had suffered nothing for the republic, because they talked too much of their feelings and their antique virtue, because they had for their own virtues plunged the country into war, while the Girondins hated Marat as representative of that rough red republicanism which would not yield itself to a Roman republic, with themselves for tribunes, orators and generals.

The Girondins conquered at first in the convention, and ordered that Marat should be tried before the Revolutionary Tribunal. But their victory ruined them, for on April 24 Marat was acquitted, and returned to the Convention with the people at his back. The fall of the Girondins on May 31 was a triumph for Marat. But it was his last. The skin disease he had contracted in the subterranean haunts was rapidly closing his life; he could only ease his pain by sitting in a warm bath, where he wrote his journal, and accused the Girondins, who were trying to raise France against Paris. Sitting thus on July 13, he heard in the evening a young woman begging to be admitted to see him, saying that she brought news from Caen, where the escaped Girondins were trying to rouse Normandy. He ordered her to be admitted, asked her the names of the deputies then at Caen, and, after writing their names, said, "They shall soon be guillotined," when the young girl, whose name was Charlotte Corday (*q.v.*), stabbed him to the heart.

The Convention attended his funeral, and placed his bust in the hall where it held its sessions. Louis David painted "Marat Assassinated," and a veritable cult was rendered to the Friend of the People, whose ashes were transferred to the Panthéon with great pomp on Sept. 21, 1794—to be cast out again in virtue of the decree of Feb. 8, 1795. (R An.)

Besides the works mentioned above. Marat nrote: *Recherches physiques sur l'électricité*, etc. (1782); *Recherches sur l'électricité médicale* (1783); *Notions élémentaires d'optique* (1764); *Lettres de l'observateur Bon Sens à M. de M. . . . sur la fatale catastrophe des infortunés Pilatre de Rozier et Romain, les aéronautes et l'aérostation* (1785); *Observations de M. l'amateur avec à M. l'abbé Sans* . . . etc. (1785); *Éloge de Montesquieu* (1785), published 1883 by M de Bresetz; *Les Charlatans modernes, ou lettres sur le charlatanisme académique* (1791); *I es Aventures du comte Potowski* (published in 1847 by Paul Lacroix, the "bibliophile Jacob"); *Lettres polonaises* (unpublished). Marat's works were published by A. Vermorel. *Oeuvres de J P. Marat, l'ami du peuple, recueillies et annotées* (1869). Tno of his tracts (1) *On Gleets,* (2) *A Disease of the Eyes,* were reprinted, ed. J. B. Bailey, in 1891.

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MARATHI (or *Marāṭhī*) is the name of an important Indo-Aryan language spoken in western and central India.

Marathi occupies an irregular triangular area of approximately 100,000 sq.mi., having its apex about the district of Balaghat in the Madhya Pradesh (old Central Provinces) and for its base the western coast of the peninsula from Daman on the Gulf of Cambay in the north to Karwar on the open Arabian sea in the south. It covers parts of Maharashtra and Madhya Pradesh states with numerous settlers in central India and Madras. and is also the principal language of Portuguese India and of the northwestern portion of Hyderabad. The standard form of speech is that of Poona in Maharashtra, and in its various dialects it covers the larger part of that state.

Dialects.—Besides the standard form of speech, there is only one real dialect of Marathi. viz., Konkani (*Kōnkaṇī*), spoken in the country near Goa. There are also several local varieties; the Marathi of the Deccan. that of Madhya Pradesh (including Berar) and that of the northern and central Konkan are distinguishable. In the southern part of the district of Ratnagiri this latter Konkani variety of Marathi gradually merges into the true Konkani dialect through a number of intermediate forms of speech. There are also several broken jargons, based upon Marathi. employed in the hill country.

Relations With Other Indo-Aryan Languages.—Marathi has to its north, in order from west to east. Gujarati. Rajasthani. Western Hindi and Eastern Hindi. To its east and south it has the Dravidian languages, Gondi, Telugu and Kanarese. Marathi does not merge into any of the cognate neighbouring forms of speech, but possesses a distinct linguistic frontier. This isolated character of Marathi is partly due to the barrier of the Vindhya range which lies to its north and partly to the fact that none of the northern languages belongs now to the Outer Band. but they are in more or less close relationships to the language of the Midland (according to G. A. Grierson's classification). Eastern Hindi is more closely related to Marathi than the others, and in its bordering dialects may be found few traces of the influence of Marathi.

Written **Character.**—Marathi books are generally printed in the Nagari character (*see* SANSKRIT LANGUAGE), and this is also used in private transactions and correspondence. In the Maratha country it is known as the *Bālbōdh* ("instructing children." *i.e.,* "easy") character. A cursive form of Nagari called *Mōḍī*, or "twisted." is also employed as a handwriting. It is said to have been invented in the 17th century by Balaji Avaji. the secretary of the celebrated Sivaji. Each word can be written as a whole without lifting the pen from the paper.

Origin of the Language.—The word "Marathi" signifies the language of the Maratha country. It is the modern form of the Sanskrit *Māhārāṣṭrī* just as "Maratha" represents the old *Māhārāṣṭra,* or Great Kingdom. *Māhārāṣṭrī* was the name given by Sanskrit writers to the Prakrit spoken in Māhārāṣṭra. the great Aryan kingdom extending southwards from the Vindhya range to the Kistna, broadly corresponding to the southern part of Bombay state and to the state of Hyderabad. This Māhārāṣṭrī became the form of Prakrit employed as the language of lyric poetry and of the formal epic (*kāvya*). Dramatic works were composed in it, and it was the vehicle of the noncanonical scriptures of the Jaina religion. The oldest work in the language is the *Sattasai,* or "Seven Centuries of Verses," compiled at Pratiṣṭhāna on the Gōdāvarī. the capital of King Hāla, at some time between the 3rd and 7th centuries A.D.

General Character of the Language.—The Prakrits fall into two well-defined groups, an Inner, Śaurasēnī, and its connected dialects on the one hand, and an Outer, Māhārāṣṭrī, Ardhamāgadhī, and Māgadhī with their connected dialects on the other. These two groups differed in their phonetic laws. in their systems of declension and conjugation. in vocabulary and in general character. Suffixes such as *-alla, -illa, -ulla,* etc., can be added to any noun, adjective or particle in Māhārāṣṭrī and Ardhamāgadhī, but are hardly ever met in Śauraśēnī. These give rise to numerous secondary forms of words, which give a distinct flavour to the whole language.

Vocabulary.—Māhārāṣṭrī Prakrit. the most independent of the Outer languages, was distinguished by the large proportion of *dēśyas* (vocables whose origin cannot be traced to original Indo-Aryan sources) found in its vocabulary. and the same is consequently the case in Marathi, although the proportion of *tatsamas* (words identical with Sanskrit words) to *tadbhavas* (words derived from Sanskrit) in the language is fairly high. The proportion of Persian and. through Persian, of Arabic words in the Marathi vocabulary is comparatively low.

Phonetics.— In the standard dialect the vowels are the same as in Sanskrit, but *ṛ* and *l* only appear in words borrowed directly from that language (tatsamas). Final short vowels (a, *i* and u) have all disappeared in prose pronunciation, except in a few local dialects! and final i and u are not even written. After an accented syllable a medial a is pronounced very lightly. even when the accent is not the tnain accent of the word. Almost the only compound consonants which survived in the Prakrit stage were double letters, and in Marathi these are usually simplified, the preceding vowel being lengthened in compensation. It is not usual to lengthen the vowel in compensation in Ronkani, which appears to contain many relics of the old Prakrit (Saurāṣṭrī) spoken in the Gujarat country before the invasion from the Midland.

On the whole, the consonantal system is much the same as in other Indian languages. Nasalization of long vowels is very common, especially in Konkani. The palatals are pronounced as in Sanskrit, in words borrowed from that language or from Hindustani. and also in Marathi *tadbhavas* before i, i, *ẹ* or y. In other cases they are pronounced ts, *tsh,* dz, *dzh* respectively. There are two s-sounds in the standard dialect which are very similarly distinguished. *ś,* pronounced like an English sh, is used before i, i, *ē* or *y;* and *s,* as in English "sin," elsewhere. In the dialects *s* is practically the only sibilant used, and that is changed by the vulgar speakers of Konkani to h. Aspirated letters show a tendency to lose their aspiration, especially in Konkani. Generally speaking Marathi closely follows *Māhārāṣṭrī* when that differs from the Prakrits of other parts of India. There is similarly both in Marathi and *Māhārāṣṭrī* a laxness in distinguishing between cerebral and dental letters.

Declension.——Marathi retains the three genders, masculine, feminine and neuter. In Marathi the neuter denotes both inanimate things and animate beings when both sexes are included, or when the sex is left undecided. In the Konkani the neuter gender is further employed to denote females below the age of puberty. Numerous masculine and feminine words, however, denote inanimate objects. The rules for distinguishing the gender of such nouns must be learned from the grammars. For the most part. but not always, words follow the genders of the Sanskrit originals. Strong bases in *ā*—and these do not include tatsamas— are masculine. and the corresponding feminine and neuter words end in i and *ē* respectively. Sex is usually distinguished by the use of the masculine and feminine genders, and large and powerful inanimate objects are generally masculine, while small delicate things are generally feminine. In the case of some animals sex is distinguished by the use of different words.

A pleonastic suffix of *-(a)ka* (masculine and neuter), could in Sanskrit be added to any noun, whatever the termination of the base tnight be. Modern forms made with this pleonastic suffix, and ending in *ā,* i or *ē* are called strong forms, while all those made without it are called weak forms. As a rule the fact that a noun is in a weak or strong form does not affect its meaning. but sometimes the use of a masculine strong form indicates clumsiness or hugeness. Other pleonastic suffixes are employed in Marathi, usually with specific senses. Thus the suffix *-illa* generally forms adjectives, while *-da-ka* implies contempt.

The synthetic declension of Sanskrit and Prakrit has been preserved in Marathi more completely than in any other Indo-Aryan language. In the formation of the plural the Prakrit declensions are very closely followed by Marathi

The usual postpositions are: (1) Instrumental: *nẽ,* plural *nī̃,* "by " (2) Dative. *lā,* plural also *nā,* "to" or "for " (3) Ablative: *hū̃n, ūn,* "from." (4) Genitive: *tsā,* "of." (5) Locative: it, "in."

The accusative is usually the same as the nominative. but when definiteness is required the dative is employed instead. The termination ng, with its plural nī̃, is really the oblique form, by origin a locative, of the *nā* or *nō*. The suffix *nā* of the dative plural is derived from the same word. For the postposition *lā,* "for the benefit of," compare Hindi *liyē* and Gujarati *līdhē*. The genitive *gharātsā* is really an adjective meaning "belonging to the house," and agrees in gender, number and case mith the noun which is possessed. The suffixes *tsā,* ci, *cẽ,* are derived from the Sanskrit suffix tyakas, Prakrit *caō*, which is used in much the same sense.

Strong adjectives. including possessive adjectives, can be declined like substantives, and agree mith the qualified noun in gender, number and case Weak adjectives are not inflected in modern prose, but are inflected in poetry. Comparison is effected by putting the noun with which comparison is made in the ablative case.

The pronouns closely follow the Prakrit originals. There is no pronoun of the third person. its place being supplied by the demonstratives. In all the plural is employed honorifically instead of the singular.

Conjugation.— Marathi has two conjugations. The first as a rule consists of intransitive verbs, and the second, corresponding to the *e-* or causal-class. of transitive verbs but there are numerous exceptions.

In Marathi the old present has taken on the meaning of a habitual past. It is also the base of the Marathi future. which is formed by adding 1, or in the first person singular *n,* to the old present. In the second person singular the 1 has been added to a form derived from the Prakrit *uṭṭhasi,* which is also the origin of the old present *uthēs*. The remaining tenses are modern forms derived from the participles. The conjunctive participle is derived from the Apabhraṃśa form *uṭṭhiu,* to which the dative suffix *n* (old Marathi, ni, *niyā̃*) has been added.

Various tenses are formed by adding personal suffixes to the present, past or future passive participle. When the subject of the verb is in the nominative the tense so formed agrees with it in gender, number and person. In the present, the terminations are relics of the verb substantive, and in the other tenses of the personal pronouns.

The present tense is formed by compounding the present participle with the verb substantive. Further tenses are similarly made by suffixing, without compounding, various tenses of the verb substantive to the various participles.

Literature.— The modern vernacular literature of the Maratha country arose under the influence of the religious reformation inaugurated by Rāmānuja early in the 12th century. The earliest writer is Nāmdēv (13th century), whose hymns in honour of Vithoba, a personal form of Vishnu, are found in the Sikh Adi Guanth. Dnyānōbā, a younger contemporary, wrote a paraphrase of the Sanskrit *Bhagavad Gītā,* which is still much admired. Sivaji was a disciple of Rāmdās (1608–1681), who exercised great influence over him, and whose *Dāsbōdh,* a work on religious duty, is a classic. Contemporary with Rāmdās and Sivaji was Tukārām (1608–1694), a Śudra by caste, the greatest writer in the language. Being unsuccessful both in his business and in his family relations, he abandoned the world and became a wandering ascetic. His Abhangs or "unbroken" hymns are famous in the country of his birth, but do not rise to any great height as poetry. Other Marathi poets are Sridhar (1678–1728), who translated the *Bhāgavata Purāṇa,* and the learned Mayūra or Mōrōpant (1729–1793). Mahīpati (1715–1790) was an imitator of Tukārām, who collected the popular traditions about national saints.

Lāvaṇīs or erotic lyrics by various writers are popular, and by western standards hardly proper. The *Pawaḍas* or mar ballads, mostly by nameless poets, are sung everywhere throughout the country. There is a small prose literature consisting of narratives of historical events (the so-called *Rakhars),* moral maxims and popular tales.

Konkani once had a literature of its own, which is said to have been destroyed by the Inquisition at Goa. Temples and manuscripts were burned wholesale. Under Roman Catholic auspices a new literature arose, the earliest writer being an Englishman, Thomas Stephens (Thomaz Esteyão), who came to Goa in 1579, wrote the first Konkani grammar and died there in 1619. Among other works, he was the author of a Konkani paraphrase of the New Testament in metrical form. *See* also INDO-ARYAN LANGUAGES.

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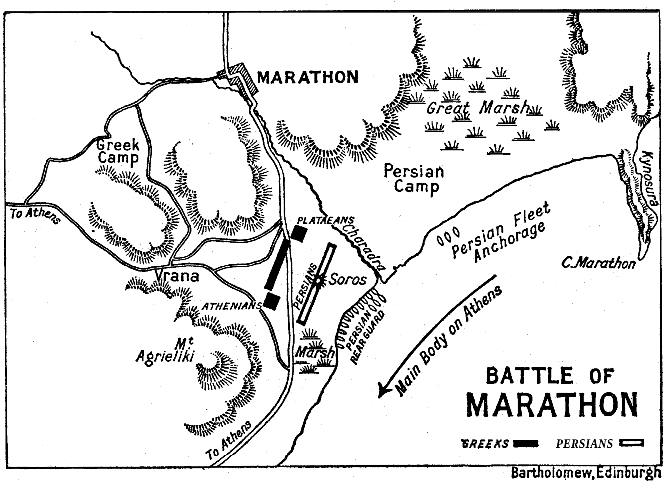
MARATHON, a plain about 5 mi. long by 2 mi. wide on the east coast of Attica 24 mi. N.E. of Athens. There is a large marsh at the northern end from which extremity the Kynosura promontory 1 mi. long ending in Cape Marathon forms an anchorage sheltered from the north and east. From the village of Marathon the Charadra brook bisects the plain and a small marsh lies at the southern end. There (490 B.C.) 9,000 Athenian and 1.000 Plataean heavy infantry defeated part of a Persian army under Datis and Artaphernes. During the Ionian revolt the Athenians and Eretrians had aided the rebels in the attack on Sardis. The Persian king, Darius, ordered his generals to "enslave Athens and Eretria and bring the slaves into his presence." *(Herodotus,* vi, 94.) Eretria, after a siege, was surrendered by treachery. The city was destroyed and the inhabitants enslaved. The Persian host, guided by Hippias, the former tyrant of Athens, landed at Marathon "thinking to do the same to the Athenians." *(Herodotus,* vi. 102.)

When news of the fall of Eretria reached Athens in 491 B.C. a



courier. Pheidippides, was sent to Sparta for aid. Miltiades, with knowledge of war and of the Persians. was selected as one of the Athenian generals under the Polemarch. Callimachus, and seems to have dominated the war council and dictated the plan of campaign. The Athenians marched on Marathon to delay the Persian advance in the passes leading to Athens and to enable the Plataeans and Spartans to join, On the march the Plataeans came up. The passes were found unoccupied and the Greeks took up a position in the Avlona valley covering the direct roads to Athens and flanking the southern road. The result was to pin down the Persians. Against the Greek position in a narrow valley with both flanks secured by hills they could not use their cavalry. To advance by the southern road would commit their column to a defile between the mountains and the sea and enable the Greeks to fall upon their rear while the main body would be unable to come up. To re-embark would expose part of their army to almost certain disaster. In spite of the Spartan delay on account of a religious festival, time fought for the Athenians.

While the Spartans were on the Isthmus of Corinth the Persians embarked their cavalry and part of their infantry to make a dash on Athens by sea. A rear guard, probably about 20.000 strong, was drawn up on the southern part of the plain parallel with the beach. Callimachus, probably on the advice of hliltiades, decided to attack—the date was probably Sept. 21. A mile from the Persian line the Greeks were marshalled, the centre thinned so as to extend the line to equal that of the Persians and to strengthen the Athenian right under Callimachus and the Plataeans on the left. Down the sloping plain moved the bronze-clad Greeks. When the ranks came within range of the Persian missiles they broke into a charge. The weak Athenian centre recoiled; but the shock of the heavy Greek wings crushed in and rolled up the Persian flanks. The victorious Persian centre was then dealt with. The hostile rear guard was destroyed losing 6.400 killed. The Greeks lost 192. The Athenians then marched back to Athens and arrived in time to forestall a landing by the Persian main body.

The failure of the Persians was the result of neglect of security measures and lack of aggressive action which resulted in failure to make use of superior numbers, and finally to a division of forces. The Greeks were prompt in action and sought to unite their strength for the decisive battle, and bring it to bear against a part of the Persian army. Tactically. the successful double envelopment of the hostile flanks foreshadowed the design of Cannae. If at Marathon the situation is unlikely to have been created intentionally, the opportunity at least was ably exploited. *See* GRAECO-PERSIAN WARS.

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MARATHON RACE, a modern road race first staged at the revival of the Olympic games at Athens. Greece, in 1896. It commemorates the legendary feat of a Greek soldier, who in 490 B.C. is supposed to have run from Marathon to Athens, a distance of 22 mi. 1.470 yd., to bring news of his countrymen's victory over the Persians.

Michel Bréal of the Sorbonne at Paris originated the idea that the commemorative race should be added to the Olympic games program and, appropriately, the first marathon winner was a Greek, Spyros Louis.

Not until 1924 was the Olympic marathon distance standardized at 26 mi. 385 yd. The distance of the first race at the 1896 Olympics was 24 mi. 1.500 yd. At Paris (1900) the distance was 40 krn. (24.85 mi.); at St. Louis. blo.. (1904), 40 km.; at the 1906 unofficial Olympic games at Athens. 26 mi.; at London (1908), 26 mi. 385 yd.; at Stockholm (1912), 24 mi. 1,725 yd.; at Antwerp (1920), 26 mi. 990 yd.; at Paris (1924), 26 mi. 38j yd. From 1924 on each succeeding Olympic marathon was run over a 26 mi. 385 yd. course. The reason for the additional 38j yd. in 1908 was that the British Olympic committee decided to start the race from the royal residence at Windsor castle and finish in front of the royal box in the stadium at London.

Because marathon courses are not standardized, the International Amateur Athletic federation does not list a world's record for the event. Except for the Olympic games championship, perhaps the most coveted honour in marathon running is victory in the Boston (Mass.) Athletic association race, held annually after 1897. Athletes from all parts of the world have participated. For a period of 11 years (1945–56) the winners were exclusively from nations other than the United States; they represented Greece. Korea. Canada. Sweden, Japan, Guatemala and Finland.

The South African Comrades' marathon is run over a 54 mi. 1,100 yd. course. One year the race is from Durban to Pietermaritzburg, the next from Pietermaritzburg to Durban. When the race starts from Durban, the course is uphill to an elevation of 3,000 ft. in the first 18 mi., and there is a rise of 500 ft. in 1 mi., near the end of the course. It was in this race that Arthur F. H. Newton, one of the most remarkable all-time distance runners, aon his first success. In 1922, at the age of 39 and with no previous athletic experience, he won this endurance run from 87 other runners. In 1925, when 42, he ran the course in 6 hr. 14 min. 30 sec. Indoors, at Hamilton, Ont., in 1931, Newton ran 152 mi. 540 yd. in 24 hr. At the age of 51, he ran 100 mi. on the Bath-to-London road in 14 hr. 7 min. 10 sec.

Another example of the fact that in the marathon road race older runners have a chance for victory was Clarence De Mar of the U.S. who won the Boston Athletic association marathon for the seventh time in 1930. He began road racing in 1909 against the advice of his physician, who predicted he would die of heart disease. but De Mar outlived the doctor. In 1951 when 63 De-h'lar started and finished in his 1,000th road race.

Because so many races of this type were won by veterans, it was believed that a younger runner would not have a chance in a major event. However, in 1951 Shigeki Tanaka. a 19-year-old Japanese boy, won the Boston Athletic association marathon in 2 hr. 27 min. 45 sec.

In the matter of preparation for a 26 mi. 385 yd. road race it is considered necessary to train over that distance. At the 1952 Olympic games. however, the Czech Emil Zatopek won easily. setting an Olympic record of 2 hr. 23 min. 3.2 sec., even though he had never run the distance before and had no special training other than that used in his preparation for his successful attempts to nin also the 5,000- and 10,000-m. races.

See also OLYMPIC GAMES.

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MARATTI (MARATTA), **CARLO** (1625–1713), Italian painter. who became one of the two leading painters of the Roman school in the later 17th century (the other being G. B. Gaulli), was born on May 13, 1625, at Cammerino in the Marches. He went early to Rome where he studied under Andrea Sacchi. His reputation was established with his first public work, the "Nativity" (1650, S. Giuseppe dei Falegnami. Rome). A few years later he was noticed by Pope Alexander VII, and thereafter he secured an almost uninterrupted series of important cornmissions for altarpieces in Italian churches. Among these are "The Mystery of the Trinity Revealed to St. Augustine" (c. 1655, Sta. Maria dei Sette Dolori), "The Appearance of the Virgin to St. Philip Neri" (*c.* 1675, Palazzo Pitti, Florence), and "The Virgin With SS. Charles Borromaeus and Ignatius" (*c.* 1685, Sta. Maria in Vallicella). He also executed a number of decorative ceiling frescoes in Roman palaces and he was the most distinguished portrait painter in Italy during this period. His portraits include "Pope Clement IX" (Hermitage, Leningrad) and several of visiting Englishmen.

Maratti's early work shows the influence of Sacchi, through whom he learned to admire chiefly the art of Annibale Caracci and Raphael. Thus he became a convinced advocate of classicism, at least in theory, in opposition to the baroque painters, Pietro da Cortona, Gaulli and Padre Pozzo. But Maratti was only partly a classicist in practice. His work shows to the full the baroque quality of magnificence. and he was wholeheartedly engaged in the task of representing with the utmost splendour the dogmas of the Counter-Reformation. Maratti died in Rome on Dec. 1j, 1713.

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MARAZION, a small seaport and seaside resort in the West Penwith rural district of Cornwall, Eng., on the shore of Mount's bay, about 11 mi. E.S.E. of Land's End by road. Pop. (1951) 1,293. A causeway of boulders and pebbles passable at low tide unites the township with St. Michael's Mount (*q.v.*). It has an ancient reputation as a market town, for a market granted to St. Michael's Mount in the 11th century appears from the first to have been held at Marazion. Three more fairs and three markets, held by the priors of St. Michael's Mount, were returned to their own land under Richard, king of the Romans! after which Ralph Bloyou procured for the town a market and a fair in 1331. One fair alone survives. A charter of incorporation was granted by Elizabeth I to Marazion in 1595 but borough privileges were lost in the time of Edward VI owing to the troubles of the religious rebellion.

Marazion owed its former prosperity to the throng of pilgrims who came to visit St. Michael's Mount. During the first half of the 16th century it was plundered by the French and by Cornish rebels, and the rise of the neighbouring borough of Penzance in the 17th century also seriously affected it.

Today it is a quiet town in surroundings of much beauty. Market gardening is extensively carried on and there is a fishing industry. The inscribed stones in the churchyard of St. Hilary, 1 mi. distant, date from the 4th century, one being in honour of Constantine the Great. It is said that St. Ives once paid a yearly sum for the whitewashing of St. Hilary's spire, to render it a better landmark.

MARBECK (MERBECK), **JOHN** (d. *c.* 158j), English theological writer and musician, was organist of St. George's Windsor, about 1540. Four years later he was convicted of heresy and sentenced to the stake, but received a pardon through the intervention of Gardiner, bishop of Winchester. In 1550 Marbeck published his *Booke* of *Common Praier noted* intended to provide musical uniformity in the use of the First Prayer Book of Edward VI. Marbeck's object was to provide a "playne tune" for daily officesof the church. His "playne tune" is defined by H. C. Colles (1879–1943), in Grove's *Dictionary* as "neither 'plain-song' in the technical sense (notes of undefined value) nor mensural music (notes of strict value), but a typically English compromise between the two, designed to guide the singer in his new problems of singing an accentual language in place of quantitative language." Other principles triumphed. but in the 19th century hlarbeck's excellent work was recognized. His *Booke* was reprinted in 1844 and the sung Eucharist in the English Church is largely based on his work. Marbeck compiled the first English concordance of the Bible, and several works of a strongly Calvanistic character. He died about 158j.

MARBECK, PILGRAM (*c.* 1490–1556), the outstanding 16th-century South German Anabaptist leader and writer (*see* ANABAPTISTS), was born at Rattenberg in the Inn valley of Tirol. By profession an engineer. he served first as a mining judge at his home town, whence he was expelled in 1528 as an Anabaptist, then as an engineer of water works for the cities of Strasbourg (1528–31, until his expulsion) and Augsburg (1544–56), where he died.

In Strasbourg he emerged as a vigorous Anabaptist leader, at first in close touch with the reformers Martin Bucer, Wolfgang Capito and Zell, with whom he had numerous theological discussions. Marbeck's three major theological works and two small pamphlets. with a total of over 2,000 pages, place him in the ranks of the top Anabaptist writers with the Dutch Menno Simons (*q.v.*) and Dirk Philips and the Hutterite Peter Riedemann. Two of these books, the *Vermahnung* (printed in 1542) and the *Verantwortung* (written in 1544–50 but never printed), both written in collaboration with Leupold Scharnschlager, arose out of his controversy with the spiritualist Kaspar Schwenckfeld. The Anabaptist group led by Marbeck, sometimes called Pilgramites, was never large and was absorbed into the Swiss Brethren about the middle of the 16th century.

See also MENNONITES.

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MARBLE, DANFORTH (1810–1849), U.S. actor, who was famous for his character roles as a New Englander, was born at East Windsor, Conn., on April 27, 1810. His formal education was limited and he worked as a silversmith in Hartford, Conn , before appearing in minor roles on the New York stage.

Noted for his humorous Yankee dialect, Marble first gained wide popularity in 1836 when he appeared as Sam Patch in a play of the same name by E. H. Thompson. Thereafter Marble's name was associated with that Yankee hero and similar characters, and he performed with great popular success in leading cities on the Mississippi river and in the east. He also won acclaim for his comedy roles in London and in Scotland and Ireland.

Marble was sometimes called the "Game Cock of the Wilderness" (the title of one of his plays dealing with the experiences of a New Englander who travels to the western frontier).

He died in Louisville, Ky., on May 13, 1849.

MARBLE, a metamorphic rock used in many classic sculptures and buildings. Technically, the term (from the Greek *marmaros*, "stone," or "boulder") is restricted to granular limestones and dolomites that have been recrystallized under the influence of heat. pressure and aqueous solutions in metamorphic environments (see METAMORPHISM); commercially, it includes all decorative calcareous rocks that can be polished, as well as certain serpentines (verd antiques).

Marbles in the petrographic sense are massive and consist of a mosaic of calcite grains which under the microscope rarely show any traces of crystalline form but are traversed by minute cracks appropriate to the rhombohedra1 cleavage of calcite. Particularly in the more severely deformed rocks, the grains show stripes indicating polysynthetic twinning and may be elongated perceptibly in a particular direction or even crushed.

These marbles occur very often interbedded with mica schists, phyllites, gneisses and granulites, and are commonest in the older Paleozoic and pre-Cambrian layers of the earth's crust which have been deeply buried in regions of extreme folding and igneous intrusion such as the Appalachian belt of the eastern United States. The passage of limestones rich in fossils into true marbles as they approach such metamorphic regions is a common phenomenon; occasionally the recrystallization of the rock has not completely obliterated the organic structures; *e.g.*, at Carrara, Italy, and at Bergen, Norway.

Most of the white and gray marbles of Alabama, Georgia and western New England and that from Yule, Colo., are recrystallized rocks, as are a number of Greek and Italian statuary marbles famous from antiquity which are still quarried. These include the Parian marble, the Pentelic marble of Attica in which Phidias, Praxiteles and other Greek sculptors executed their principal works and the snow-white Carrara marble used by Michelangelo and Antonio Canova favoured by modern sculptors. The exterior of the National Gallery of Art in Washington, D.C., is of Tennessee marble, and the Lincoln memorial contains marbles from Yule, Colo., Alabama (roof transparencies) and Georgia (Lincoln statue).

Even the purest of the metamorphic marbles, such as that from Carrara, contain some accessory minerals, and in many they form a considerable proportion of the mass. The commonest are quartz in small rounded grains, scales of colourless or pale yellow mica (muscovite and phlogopite), dark shining flakes of graphite, iron oxides and small crystals of pyrite.

Many marbles contain other minerals which ere usually silicates of lime or magnesia. Diopside is very frequent and may be white or pale green; white bladed tremolite and pale green actinolite are found; the feldspar encountered may be a potassic variety, but is more commonly a plagioclase such as albite, labradorite or anorthite. Scapolite, various kinds of garnet, vesuvianite, spinel, forsterite. periciase, brucite. talc, zoisite, wollastonite. chlorite, tourmaline, epidote, chondrodite, biotite, sphene and apatite may be mentioned as possible accessory minerals Pyrrhotite, sphalerite and chalcopyrite may also be present in small amounts.

These minerals represent impurities in the original limestone which reacted during metamorphism to form new compounds. The alumina represents an admixture of clay; the silicates derive their silica from quartz and from clay; the iron came from limonite, hematite or pyrite in the original sedimentary rock. In some cases the original bedding of the calcareous sediments can be detected by mineral banding in the marble. The silicates, if present in any considerable amount, may colour the marble; *e* g., green from green pyroxenes and amphiboles, brown from garnet and vesuvianite, yellow from epidote, chondrodite and sphene. Black and gray colours result from the presence of fine scales of graphite.

Bands of calc-silicate rock may alternate with bands of marble, or form nodules and patches, sometimes producing interesting decorative effects, but these rocks are particularly difficult to finish because of the great difference in hardness between the silicates and carbonate minerals.

Later physical deformation and chemical decomposition of the metamorphic marbles often produces attractive coloured and variegated varieties. Decomposition yields hematite, brown limonite, pale green talc and, in particular, the green or yellow serpentine derived from forsterite and diopside which is characteristic of the ophicalcites or verd antiques. Earth movements may shatter the rocks, producing fissures afterward filled with veins of calcite; in this nay the beautiful brecciated or veined marbles are produced. Sometimes the broke fragments are rolled and rounded by the flow of marble under pressure, and pseudoconglomerates result.

The so-called onyx marbles consist of concentric zones of calcite or aragonite deposited from cold-water solutions in caves and crevices and around the exits of springs. They are, strictly speaking, neither marble nor onyx for true onyx is a banded chalcedony composed largely of silicon dioxide. Onyx marble was the "alabaster" of the ancients, a source of confusion since alabaster now is defined as a calcium sulfate rock (see GYPSUM). These marbles are usually brown or yellow due to the presence of iron oxide.

Well-known examples include the giallo antico ("antique yellow marble") of the Italian antiquaries (see ROME. The Ancient City: .Materials), the reddish-mottled Siena marble from Tuscany, the large Mexican deposits at Técali near Mexico City and at El Marmol. Calif., and the Algerian onyx marble used in the buildings of Carthage and Rome and rediscovered near Oued-Abdallah in 1849.

Unmetamorphosed limestones showing interesting colour contrasts or fossil remains are used extensively for architectural purposes. The Paleozoic rocks of Great Britain for example, include "madrepore marbles" rich in fossil corals and "encrinital marble" containing crinoid stem and arm plates with characteristic circular cross sections. The shelly limestones of the Purbeck formation and the Sussex marble, of Mesozoic age, consist of masses of shells of fresh water snails embedded in blue, gray or greenish limestone. They were a favourite material of medieval architects and may be seen in Westminster Abbey and a number of English cathedrals. Black limestones containing bituminous matter, which commonly emit a fetid odor when struck, are widely used; the well known **petit** granit of Belgium is a black marble containing crinoid stem plates.

Uses.—Marbles are used principally for buildings and monuments, interior decoration, statuary, table tops and novelties. Colour and appearance are the most important qualities overall. Resistance to abrasion, which is a function of cohesion between grains as well as the hardness of the component minerals, is important for floor and stair treads. The ability to transmit light is important for statuary marble, which owes its luster to light penetrating from $\frac{1}{2}$ to $1\frac{1}{2}$ in, and being reflected at the surfaces of deeper-lying crystals. Brecciated, coloured marbles, onyx marble and verd antique are used principally for interior decoration and for novelties. Statuary marble, the most valuable variety, niust be pure nhite and uniform in grain size. For endurance in exterior use marble should be uniform and nonporous to prevent the entrance of water that might discolour the stone or cause disintegration by freezing, and it should be free from impurities such as pyrite that might lead to staining on weathering. Calcite marbles exposed to atmospheric moisture made acid by carbon dioxide and sulfurous and other gases maintain a relatively smooth surface during weathering. but dolomite limestone may weather with an irregular, sandy surface from which the dolomite crystals stand out.

The principal mineral in marbles is calcite (*q.v.*); the fact that calcite varies in hardness, light transmission and other properties in various directions has a number of practical consequences in the preparation of some marbles. Calcite crystals transmit more light in one direction than in others, so that slabs prepared for uses in which translucency is significant are cut parallel to that direction. The bending of marble slabs has been attributed to the directional thermal expansion of calcite crystals on heating. The basal faces of calcite crystals are less rapidly soluble than those at right angles; a number of marble tombstones from the 1800s, cut so as to expose the basal faces, have withstood weathering better than those not so prepared.

Quarrying. — The use of explosives in the quarrying of marble is very limited because of the danger of shattering the rock. Instead, channeling machines utilizing chisel-edged steel bars make cuts about two inches wide and several feet deep. Wherever possible, advantage is taken of natural joints already present in the rock. and cuts are made in the direction of easiest splitting ("rift" or "grain"). which is a consequence of the parallel elongation of platy or fibrous minerals. The marble blocks outlined by joints and cuts are separated by driving wedges in drill holes. Mill sawing into slabs is done with sets of parallel iron blades which move back and forth and are fed by sand and water. The marble may be machined with lathes and carborundum wheels, and is then polished with increasingly finer grades of abrasive. *(See* also QUARRYING.)

Even with the most careful quarrying and manufacturing methods, at least half of the total output of marble is waste. Some of this material is made into chips for terrazzo flooring and stucco n-all finish. It is in various localities put to most of the major uses for which high-calcium limestone is suitable *(see* LIMESTONE).

See also Index references under "Marble" in the Index volume.

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(D. L. G.)

MARBLEHEAD, a town of Essex county. Mass., U.S., is located 17 mi. N.E. of Boston. Built upon a rocky promontory. the town has narrow, twisted. hilly streets and a character of quaint charm. Among its historic buildings are the Jeremiah Lee mansion (1768). St. Michael's church (Episcopalian; 1714). the Old Brig (*c.* 1720). the Old Tavern (1680) and the Elbridge Gerry house.

Marblehead, originally part of Salem: was first settled in 1629 by a group of rugged fishermen from the Channel Islands and Cornwall, Eng. The village was known for its unruliness and disinclination to abide by many of the laws of the Puritan colony. It was incorporated as a separate town in 1649 and in the colonial period was an important commercial. fishing and shipbuilding port. After the passage of the Boston Port act (1774), it was made the port of entry in place of Boston. but its merchants invited the Boston merchants to use their wharves and warehouses. During the American Revolution many vessels set out from this port. the most famous being the "Lee." commanded by John Manley, which in Nov. 1775 captured the "Nancy," with a valuable and much needed cargo of military stores. The schooner "Hannah." manned and fitted there, was the first American warship regularly commissioned (Sept. 2. 1775. by Gen. George Washington) by authority derived from the continental congress. The port declined in importance after the War of 1812 and in the 19th century Marblehead turned to the manufacture of shoes. rope and cordage. The harbour. formed by a rocky peninsula known as Marblehead Neck, provides safe anchorage for craft of all kinds and has become a noted yachting centre. Marblehead is a suburban, residential and resort town. Manufactures include boats and marine equipment. For comparative population figures *see* table in MASSACHUSETTS: *Population.* (L. G. BA.)

MARBOT, JEAN BAPTISTE ANTOINE MARCELIN, BARON DE (1782–1854), French soldier. son of Gen. Jean Antoine de Marbot (1754–1800), who died in the defense of Genoa under Masséna, was born at La Rivière (Corrèze) on Aug. 18. 1782 He joined the republican army as a volunteer in 1799. He was aide-de-camp to Marshal Xugereau, commanding the VII corps, in the war against Prussia and Russia in 1806–07. After this he served in the Peninsular War under Lannes and Masséna, in the Russian War of 1812 and the German campaign of the following year. After a slow recovery from the wounds he had received at Leipzig and Hanau, he was promoted general of brigade by Napoleon during the Hundred Days, and took part in. and was wounded at, the battle of Waterloo. He was exiled at the second restoration and only returned to France in 1819. His intimacy with the duke of Orleans secured him important military positions. Under the July monarchy he was present at the siege of Antwerp in 1832. He was promoted lieutenant-general in 1836. From 1835 to 1840 he served in various Algerian expeditions. and in 1845 he was made a member of the Chamber of Peers.

Three years later. at the fall of Louis Philippe. Marbot retired into private life. He died at Paris on Nov. 16. 1854. Marbot's fame rests on the fascinating *Memoirs of His Life and Campaigns* (1891; Eng. trans.. 1902).

His elder brother: ANTOINE ADOLPHE MARCELIN DE MARBOT (1781–1844), served in Napoleon's campaigns of 1808 to 1812, and again in the Hundred Days. He returned to the army after 1830.

MARBURG (MARBURG AN DER LAHN), a university town in the *Land* of Hesse. Germany, on the right bank of the Lahn. 60 mi. by rail north of Frankfort-on-Main, on the main line to Cassel. Pop. (1950) 39.530. Marburg is first historically mentioned in a document of the beginning of the 13th century, and received its municipal charter from the landgrave Louis of Thuringia in 1227. By 1247 Marburg had already become the second town of Hesse. and in the 15th and 16th centuries it alternated n-ith Cassel as the seat of the landgraves. In 1529 the famous conference between Luther and Zwingli on the subject of Transubstantiation took place there in the Rittersaal of the Schloss. The hill on nhich the town lies is crowned by the Schloss, a Gothic building. the most noteworthy parts of which are the Rittersaal, dating from 1277–1312. and the little chapel. This Schloss is now the repository of the archives of Hesse. The Elizabethenkirche, in the purest Early Gothic style. was erected by the grand master of the Teutonic Order in 1235–83, to contain the tomb of St. Elizabeth of Hungary. who was the wife of the landgrave Louis. She built a hospital there. and died in 1231, worn out with works of charity. In 1235 she was canonized at the instance of the Teutonic Knights who were zealous in promoting her cult. Her rich silver-gilt sarcophagus may still be seen, but the Protestant zeal of Landgrave Philip the Generous caused him to remove the body to some unknown spot in the church.

The Lutheran church is another Gothic edifice, mainly 15th century. The town hall. built in 1512, and several houses in the Renaissance style. also deserve mention. The University of Marburg, founded in 1527, was the first university established without papal privileges, and acquired a great reputation throughout Protestant Europe.

Marburg is the seat of a district court. Marburg pottery is renowned: and soap. iron wares and surgical instruments are also manufactured there.

MARBURG, COLLOQUY OF, the name given to a conference of divines held in 1529 in the interests of the unity of Protestant Germany. The circumstances in which it mas held, the influence of the-men who conducted its deliberations, and the result of its proceedings, combine to render it of no small importance for the history of the Reformation in Germany.

The measures taken by the Catholic party to resist the progress of the Reformation. especially by resolutions at Speyer (1526 and 1529), would be met only by the united force of all the princes and states subscribing to the Evangelical teaching; and this unity was wanting. The feud which raged round the doctrine of the Lord's Supper had already broken out before the first diet of Spires, and had aroused great and immediate excitement. At a very early period. however. efforts were made to allay the dissension. Strassburg pronounced for conciliation; but the most powerful and zealous champion of peace was to be found in the landgrave Philip of Hesse, who recognized the absolute necessity—from a political standpoint—of the union of all German Protestants. It was obvious that a permanent coalition could not be expected unless some definite understanding on the debated point could be attained; and the landgrave succeeded in bringing about a conference or "colloquy" at Marburg, in October 1529.

The proceedings opened on the 1st of October with conferences between Luther and Oecolampadius, and Melanchthon and Zwingli: then on the two following days the discussion proper—confined almost entirely to Luther and Zwingli—was held before the landgrave and his guest Duke Ulrich of Württemberg, in the presence of more than fifty persons. As regards the main point of contention, *i.e.,* the doctrine of the Lord's Supper, no agreement was found practicable; and the private conversations on the 4th of October, which formed the sequel of the debate, carried matters no farther. Since the landgrave, however, was reluctant to see the colloquy brought to an absolutely fruitless close, he requested Luther to draw up a list of the most important points of doctrine on which it might yet be possible to arrive at some degree of unanimity. This was done on the 4th of October; and a few alterations were introduced to meet the wishes of the Swiss deputies. The *Articles of Marburg*, which thus came into being, contain the doctrine of the Trinity, of the personality of Christ, of faith and justification, of the Scriptures, of baptism, of good works, of confession, of government, of tradition and of infant baptism. The fifteenth article, treating of the Lord's Supper, defines the ground common to both parties even in this debatable region, recognizing the necessity of participation in both kinds, and rejecting the sacrifice of the Mass. It then proceeds to fix the point of difference in the fact that no agreement had been reached on the question "whether the true body and blood of Christ are corporeally present in the bread and wine."

See T. Kolde, *s.v.* "Marburger Religionsgespräch," in *Realencyklopädie f. protestant. Theologie,* 3rd ed. xii. 248 *seq.*

MARC, FRANZ (1880–1916), German painter, one of the leaders of the "Blue Rider" Expressionist movement, was born in Munich on Feb. 8, 1880. His father was a minor landscape and genre painter. Marc studied at the Munich academy under Wilhelm Diez. A trip to Paris in 1903 brought him into contact with Impressionism, while the Art Nouveau movement in Munich made him conscious of the problems of formal structure. Perhaps the strongest influence on his early work was Van Gogh, but he did not fulfill the potentialities of his genius until he discovered the nonobjective paintings of Wassily Kandinsky (*q.v.*) with their pure colour and form. In 1911 he and Kandinsky edited the book *Der Blaue Reiter,* one of the great documents of modern art. The almanac also gave its name to a significant movement in Expressionism: the "Blue Rider." Whereas Kandinsky renounced the objective, Marc was drawn to nature, especially the animal motif, in which he sought a pantheist empathy with the vibrations and rhythms of nature. In 1913 and 1914 he created his most important paintings, "The Tower of Blue Horses," the "Fate of the Beasts" and "The Unhappy Tyrol." Influenced by nonobjectivity, Cubism and Futurism, he worked with sonorous colours and crystalline forms which interpenetrate to create an organic harmony. He used colour and form to dismantle the material and the objective and to help create the world of the spirit. Finally, he painted a series of entirely nonobjective paintings. In 1914 Marc joined the German army; he was killed near Verdun on March 4, 1916.

See also PAINTING: *Expressionism and the German School.*

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MARCA, PIERRE DE (1594–1662), French prelate and historian, born at Gan, near Pau, on Jan. 24, 1594, attracted the notice of Richelieu by his support of the Catholic cause in the south during the wars of religion. Richelieu brought him to Paris as counsellor of state in 1640. He defended the "Gallican liberties" in the famous treatise. *De concordia sacerdotii et imperii, seu de libertatibus ecclesiae gallicanae* (1641). He was governor of Catalonia during the French occupation and, after holding various ecclesiastical preferments, was nominated archbishop of Paris in succession to De Retz in February 1662. He died on June 29 of the same year. Marca made a minute study of the archives of Béarn and of the history of Catalonia. His *Histoire de Béarn* (1640) is valuable for the number of charters and other documents which it contains. *Marca hispanica* (1688), left unfinished at his death, was completed by his friend Baluze.

MARCANTONIO (MARCANTONIO RAIMONDI): *see* RAIMONDI, MARCANTONIO.

MARCASITE, a mineral with the same chemical composition as pyrite, being iron disulfide, FeS_2, but crystallizing in the orthorhombic instead of the cubic system. Apart from crystalline form, the appearance and physical characteristics of marcasite (sometimes known as white iron pyrite) are very similar to those of pyrite, and in the absence of distinct crystals it is difficult to distinguish between the two species. The colour is pale bronze-yellow; on freshly fractured surfaces the colour is tin-white, but this rapidly tarnishes on exposure to air. The lustre is metallic and brilliant; the streak is greyish black; the hardness is 6 to 6.5; the specific gravity is 4.89. In the course of time. specimens of marcasite usually disintegrate, forming ferrous sulfate and sulfuric acid. In nature marcasite is frequently altered to hydrated iron oxide. goethite (*q.v.*) or limonite (*q.v.*). Under weathering conditions it is less stable than pyrite.

Distinctly developed single crystals of marcasite are rare; more often crystal aggregates occur twinned on a prism plane producing pentagonal stellate groups of fine crystals. This frequent twinning gives rise to characteristic forms, with many re-entrant angles, to which the names "spear pyrites" and "cockscomb pyrites" are applied. The commonest state of aggregation is that of radially arranged fibres, the external surface of the mass being globular, nodular or stalactitic in form.

Marcasite is found in metalliferous veins associated with lead and zinc ores (Joplin, Mo.; Galena, Ill.). It is frequently found in sedimentary deposits. In the chalk of the southeast of England nodules of marcasite with a fibrous radiated structure are abundant, and in the chalk marl between Dover and Folkestone fine twinned groups of "spear pyrites" are common. Marcasite is often associated with organic matter: for example, as a concretion around organic remains; or in the plastic clay of the brown coal formation at Littnitz, near Carlsbad (Karlovy Vary), Czech., where it has been extensively mined for the manufacture of sulfur and ferrous sulfate. (A. J. F.)

MARCEAU, FRANÇOIS SEVERIN DESGRAVIERS (1769–1796), French general, was born at Chartres on March 1, 1769. He studied law, but joined the army in 1785. He joined in the attack on the Bastille (July 14, 1789), and then took his discharge from the regular army. Later he joined the National Guard, and in March 1792 became lieutenant-colonel of a battalion of the Eure-et-Loire, taking part in the defence of Verdun in 1792. He was re-employed as captain in the regular service, but in 1793 was imprisoned for some time with other officers as a "suspect." On his release he fought at Saumur against the Vendéen royalists, and rescued Bourbotte (June 10, 1793) from the insurgents Marceau became general of division (Nov. 10), and with Kléber, who became his personal friend, won important victories near Le Mans (Dec. 12–13) and Savenay (Dec. 21), but after their retirement from the war they were only saved from arrest and execution by the intervention of Bourbotte. After spending the winter of 1793–94 in Paris, Marceau took command in the army under Jourdan in which Kléber also served, and distinguished himself in the campaigns of 1794 and 1795. In the campaign of 1796 Marceau's men covered Jourdan's retreat over the Rhine. He fought the desperate actions on the Lahn (Sept. 16 and 18), and at Altenkirchen on Sept. 19 received a mortal wound, of which he died on the 21st. His body was burned, and his ashes, which at the time were placed under a pyramid designed by Kléber, were transferred in 1889 to the Panthéon at Paris.

See Maze, *Le Général Marceau* (1888); Parfait, *Le Général Marceau* (1892); and T. C. Johnson, *Marceau* (London, 1896).

MARCEL, ETIENNE (d. 1358), provost of the merchants of Paris under King John II, came from a family of drapers. He is mentioned as provost of the Grande-Confrérie of Notre Dame in 1350. In 1354 or 1355 he succeeded Jean de Pacy as provost of the Parisian merchants. His political career began in 1356, when John was made prisoner after the battle of Poitiers. In conjunction with Robert le Coq, bishop of Laon, he played a leading part in the states-general called together by the dauphin Charles (later Charles V of France) on Oct. 17. A committee of 80 members, constituted on their initiative, pressed their demands with such insistence that the dauphin prorogued the states-general; but financial straits obliged him to summon them once more on Feb. 3, 1357, and the promulgation of an edict of reform was the consequence. John forbade its being put into effect, whereupon a conflict began between Marcel and the dauphin, Marcel endeavouring to set up Charles II of Navarre in opposition to him. The states-general assembled again on Jan. 13. 1358. and on Feb. 22 the populace of Paris, led by Marcel, invaded the palace and murdered the marshals of Champagne and Normandy before the prince's eyes. Thenceforward Marcel was in open hostility to the throne. After vainly hoping that the insurrection of the Jacquerie might turn to his advantage, he next supported the king of Navarre, whose armed bands infested the neighbourhood of Paris. On the night of July 31 Marcel was about to open the gates to them, but Jean Maillart prevented the execution of this design and excited the mob that killed Marcel before the Porte Saint-Antoine.

BIBLIOGRAPHY.—F. T. Perrens, *Etienne Marcel et le gouvernement de la bourgeoisie au xiv^e siècle* (Paris, 1860; 2nd ed., 1874); P. Frémaux, "La Famille d'Etienne Marcel." in the *Mémoires de la société de l'histoire de Paris et de l'Ile de France,* vol xxx (Paris, 1903); R. Delachenal, *Histoire de Charles V*, vol. i (Paris, 1908).

MARCELLINUS, ST., according to the Liberian catalogue, became bishop of Rome on June 30, 296; his predecessor was Caius or Gaius. He is not mentioned in the *Martyrologium hieronymianum,* or in the *Depositio episcoporum,* or in the *Depositio martyrum.* The *Liber pontificalis,* basing itself on the Acts of St. Marcellinus, the text of which is lost, relates that during Diocletian's persecution Marcellinus was called upon to sacrifice, and offered incense to idols, but that, repenting shortly afterward, he confessed the faith of Christ and suffered martyrdom with several companions. According to the *Liber pontificalis,* Marcellinus was buried, on April 26, 304, in the cemetery of Priscilla, on the Via Salaria, 2j days after his martyrdom; the Liberian catalogue gives as the date Oct. 2j. After a considerable interregnum he was succeeded by Marcellus, with whom he has sometimes been confounded.

See L. Duchesne, *Liber pontificalis,* I, lxxiii–lxxiv, 162–163, and II, 563.

MARCELLO, BENEDETTO (1686–1739). Italian composer, was born in Venice on Aug. 1, 1686. He was a pupil of Lotti and Gasparini, but was intended by his father for the law. In 1711 he was a member of the Council of Forty, and in 1730 went to Pola as *provveditore.* He retired after eight years to Brescia in the capacity of *camerlingo,* and died there on July 24, 1739. Being of patrician birth, he never held any official musical appointment. Marcello is best remembered for his *Estro poetico-armonico* (Venice, 1724–26), a musical setting for voices and strings of the first 50 psalms, as paraphrased in Italian by G. Giustiniani. Charles Avison and John Garth brought out an edition with English words (London, 17j7). His other compositions include the opera *Arianna,* the oratorio *Giuditta,* concertos (1701), *Canzoni madrigaleschi* (1717) and cantatas. He was also a poet, translated John Dryden's *Timotheus* as a text for one of his cantatas, wrote a libretto for Ruggieri's opera *Arato in Sparta* and a satirical pamphlet, *Il teatro alla moda* (1720) which is still one of the most important early documents in the history of opera.

A catalogue of his works is given in *Monatshefte fur Musikgeschichte,* vol. xxiii (Berlin, 1891).

MARCELLUS, the name of two popes.

MARCELLUS I, pope and saint, was elected to succeed Marcellinus, after an interval of three or four years, either in 307 or as late as May 308, during the reign of the Roman emperor Maxentius. The severe penances that he imposed on Christians who had lapsed under the recent persecution led to rioting, and he was banished from Rome early in 309. He died shortly afterward and is commemorated in the Western Church on Jan. 16.

MARCELLUS II (Marcello Cervini). born on May 6, 1501, was made cardinal priest of Sta. Croce in Gerusalemme by Paul III in 1539. As one of Paul's legates presiding at the first sessions (1545–47) of the Council of Trent, he incurred the anger of the emperor Charles V by his jealous defense of papal prerogative. Elected pope on April 9, 1555, in succession to Julius III, he died three weeks later, on April 30.

MARCELLUS, a Roman plebeian family belonging to the Claudian gens. Its most distinguished members were:

MARCUS CLAUDIUS MARCELLUS (*c.* 268–208 B.C.), one of the Roman generals during the Second Punic War and conqueror of Syracuse. He first served against Hamilcar in Sicily. In his first consulship (222) he was engaged, with Gnaeus Cornelius Scipio as colleague, in war against the Insubres and won the *spolia opima* for the third and last time in Roman history by slaying their chief Viridomarus or Virdumarus (Polybius ii, 34; Propertius v, 10, 39). In 216. after Cannae. he took command of the remnant of the army at Canusium and, although he was unable to prevent Capua's going over to Hannibal, saved Nola and southern Campania. Consul for the third time in 214 he was sent to Sicily, where he stormed Leontini and besieged Syracuse. but the skill of Archimedes repelled his attacks. He took it after a two years' siege and set the example of carrying away the art treasures of a captured city. Consul again in 210, he took Salapia in Apulia, which had revolted to Hannibal; and as proconsul, in 209, he attacked Hannibal near Venusia. In his last consulship (208), he and his colleague, while reconnoitring near Venusia, were unexpectedly attacked, and Marcellus was killed. His successes have been exaggerated by Livy, but the name often given to him, the "sword of Rome," was well deserved.

See Livy xxiii, 14–17, 41–46; xxiv, 27–32, 35–39; xxv, 5–7, 23–31; xxvi, 26, 29–32; xxvii, 1–5, 21–28; Polybius viii, 5–9, x, 32; Appian, *Hannibal,* 50; Florus ii, 6.

M. CLAUDIUS MARCELLUS, an inveterate opponent of Julius Caesar. During his consulship (51 B.C.) he proposed to remove Caesar from his army in March 49, but was outmanoeuvred by Curio. He scourged a citizen of Novum Comum in order to flout Caesar's grant of privilege to the city. In Jan. 49 he vainly tried to put off declaring war against Caesar until an army could be got ready. He followed Pompey to Greece and. after Pharsalus, retired to Mytilene, where he practised rhetoric and studied philosophy. In 46 the senate successfully appealed to Caesar to pardon him, this being the occasion of Cicero's speech *Pro Marcello.* Marcellus left for Italy, but was murdered in May by one of his own attendants, P. Magius Chilo, at the Peiraeus. Marcellus was a thorough aristocrat. He was an eloquent speaker (Cicero, *Brutus,* 71) and a man of firm character. although not free from avarice.

See Cicero, *ad Familiares,* iv, 4, 7, 10, and *ad Atticum,* v, 11; Caesar, *De Bello Gallico* i, 2; Suetonius, *Caesar,* 29; G. Boissier, *Cicero and his Friends,* Eng. trans. (London, 1897).

M CLAUDIUS MARCELLUS (*c.* 42–23 B.C), son of C. Marcellus and Octavia, sister of Augustus. In 25 he was adopted by the emperor and married to his daughter Julia. This seemed to mark him out as the heir to the throne. In 2j he accompanied the emperor to Spain; but in 23, when curule aedile, he died at Baiae. Great hopes had been built on the youth, and he was celebrated by many writers, especially by Virgil in a famous passage (*Aeneid,* vi, 860). He was buried in the Mausoleum of Augustus, and hugustus himself pronounced the funeral oration. The Theatrum Marcelli was afterward dedicated in his honour.

See Horace, *Odes,* i, 12; Propertius iii, 18; Dio Cassius liii, 28, 30; Tacitus, *Annals,* ii, 41; Suetonius, *Augustus,* 63; Velleius Paterculus ii, 93.

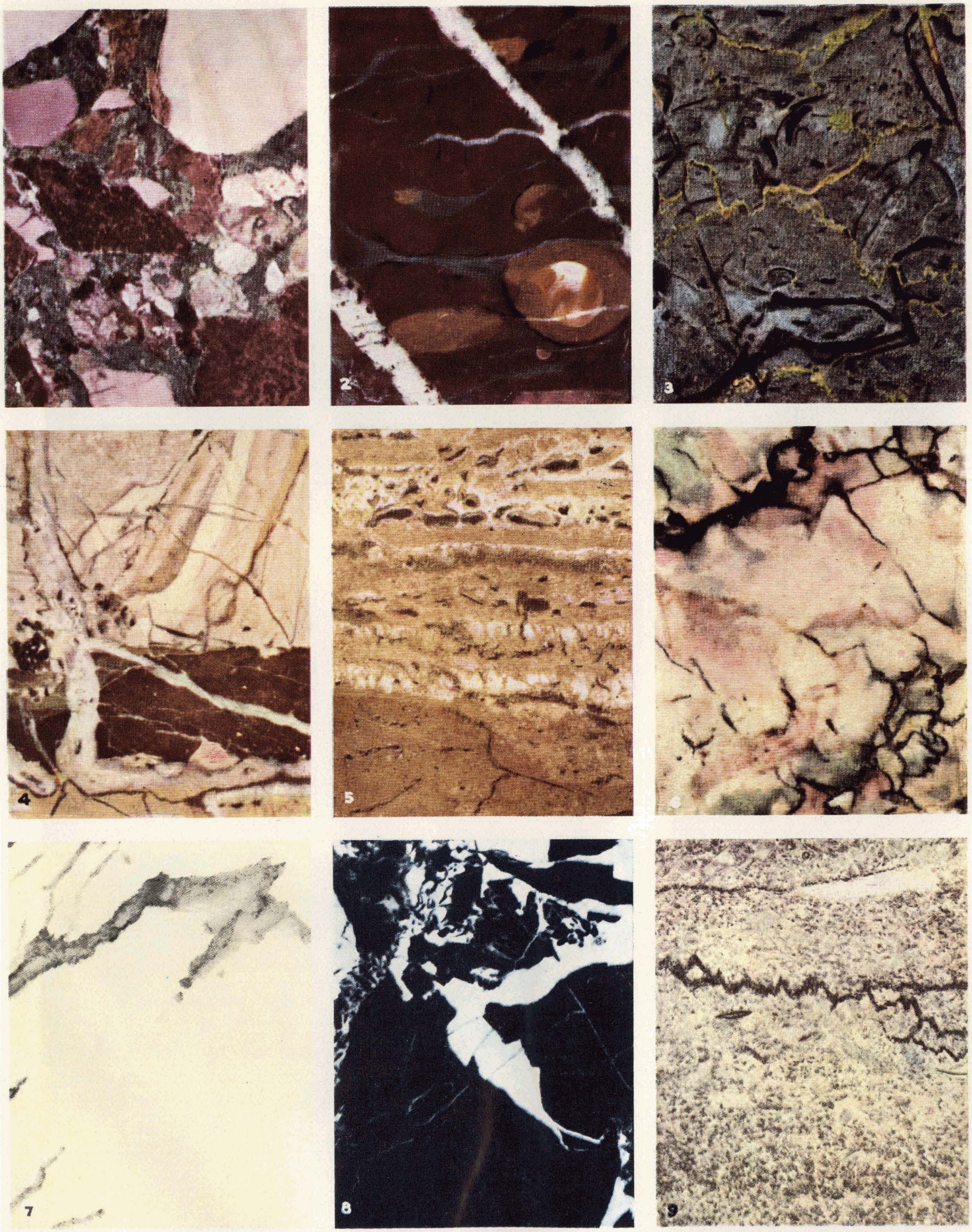
MARCH, AUSIAS (1379–1459), Catalan poet, was born at Valencia. An undisguised follower of Petrarch, he carries the imitation to such a point that he addresses his *Cants d'amor* to a lady whom he professes to have seen first in church on Good Friday; so far as the difference of language allows. he reproduces the rhythmical cadences of his model, and in the *Cants de mort* touches a note of brooding sentiment peculiar to himself. The success of his metrical innovation no doubt encouraged Boscán (*q.v.*) to introduce the Italian metres into Castilian.

BY COURTESY OF THE TOMPKINS-KIEL MARBLE COMPANY

VARIETIES OF ORNAMENTAL MARBLES

1. Forest green (serpentine), Italy
2. Campan mélange vert (sawn across the bed), France
3. Royal Jersey green (serpentine), Phillipsburg, N. J.
4. Campan mélange rouge (sawn with the bed), France
5. Morocco red flamme (sawn with the bed), Algeria
6. Roman breche, France
7. Monte skyrose, South America
8. Famosa violet "W," Germany
9. Benou jaune, France

MARBLE



BY COURTESY OF THE TOMPKINS-KIEL MARBLE COMPANY

VARIETIES OF ORNAMENTAL MARBLES

1. Breche rose, Italy
2. Campan Griotte, France
3. Lumachelle, France
4. Loredo chiaro, Italy
5. Sienna Travertine, Germany
6. Escalette, France
7. Piastracola veined, Italy
8. French grand antique, France
9. Napoleon pray, Central United States

MARCH EARLS OF, title derived from the "marches" or boundaries (1) between England and Wales, and (2) England and Scotland, and held severally by great feudal families possessed of lands in those border districts. The earls of March on the Welsh borders were descended from Roger de Mortemer (so called from his castle of Mortemer in Normandy), who was connected by marriage with the dukes of Normandy. His son Ralph (d. *c.* 1104) figures in Domesday as the holder of vast estates in Shropshire, Herefordshire and other parts of England, especially in the west; and his grandson Hugh de Mortimer, founder of the priory of Wigmore, Herefordshire, was one of the most powerful of the barons reduced to submission by Henry II. The Mortimers, however, continued to exercise almost undisputed sway, as lords of Wigmore, over the western counties and the Welsh marches.

I. Welsh Marches.—ROGER DE MORTIMER (*c.* 1286–1330), 8th baron of Wigmore and 1st earl of March, being an infant at the death of his father, Edmund, was placed by Edward I. under the guardianship of Piers Gaveston, and was knighted by Edward in 1306. Through his marriage with Joan de Joinville, or Genevill, Roger acquired increased possessions on the Welsh marches, including the important castle of Ludlow, and extensive estates in Ireland, whither he went in 1308 to enforce his authority. This brought him into conflict with the De Lacys, who turned for support to Edward Bruce, brother of Robert Bruce, king of Scotland. Mortirner was appointed lord-lieutenant of Ireland by Edward II. in 1316, and at the head of a large army drove Bruce to Carrickfergus, and the De Lacys into Connaught. About 1318 he began to interest himself in the growing opposition to Edward II. and his favourites, the Despensers; and he supported Humphrey de Bohun, eari of Hereford, in refusing to obey the king's summons to appear before him in 1321. Forced to surrender to the king at Shrewsbury in 1322, Mortirner was consigned to the Tower of London, whence he escaped to France in Aug. 1324. At the French court Queen Isabella found Roger Mortimer; she became his mistress and refused to return to England so long as the Despensers retained power as the king's favourites. Isabella's relations with Mortimer compelled them to withdraw to Flanders, where they obtained assistance for an invasion of England. Landing in England in 1326, they were joined by Henry, earl of Lancaster; London rose in support of the queen; and Edward took flight to the west, where he was captured in November, and compelled to abdicate in favour of his son. The country was now ruled by Mortimer and Isabella, who procured the murder of Edward II. in the following September. In 1328 Mortimer was created earl of March. The jealousy of Lancaster having been excited by March's arrogance, Lancaster prevailed upon the young Edward III., to throw off the yoke of his mother's paramour. March was arrested and conveyed to the Tower. Accused of assuming royal power and of various other high misdemeanours, he was condemned without trial and hanged on Nov. 29, 1330, his vast estates being forfeited to the Crown. His eldest son, Edmund. was father of Roger Mortimer (*c.* 1328–60), who was knighted by Edward III. in 1346, and restored to his grandfather's title as 2nd earl of March.

EDMUND DE MORTIMER (1351–1381), 3rd earl of March, was son of Roger, 2nd earl of March, by his wife Philippa, daughter of William Montacute, 1st earl of Salisbury. Being an infant at the death of his father, Edmund, as a ward of the Crown, was placed by Edward III. under the care of William of Wykeham and Richard Fitzalan, earl of Arundel. The young earl married in 1368 Philippa, only daughter of Lionel, duke of Clarence, and of Elizabeth, daughter and heiress of William de Burgh, 6th lord of Connaught and 3rd earl of Ulster. The earl of March, therefore, not only became the representative of one of the chief Anglo-Norman lordships in Ireland in right of his wife Philippa, but the latter, on the death of her father shortly after her marriage, stood next in succession to the crown after the Black Prince and his sickly son, afterwards King Richard II. This marriage had, therefore, far-rezching consequences in the history of England, giving rise to the claim of the house of York to the crown of England, contested in the Wars of the Roses. He died at Cork in 1381. The earl had two sons and two daughters, the elder of whom, Elizabeth, married Henry Percy (Hotspur), son of the earl of Northumberland. His eldest son Roger succeeded him as 4th earl of March and Ulster.

ROGER DE MORTIMER, 4th earl of March and Ulster (1374–98), succeeded to the titles and estates of his family when a child of seven, and a month afterwards he was appointed lord-lieutenant of Ireland. March's daughter Anne married Richard earl of Cambridge, son of Edmund duke of York, fifth son of Edward III.; their son Richard, duke of York, was father of King Edward IV., who thus derived his title to the crown and acquired the estates of the house of Mortimer.

EDMUND DE MORTIMER (1391–1425), 5th earl of March and Ulster, son of the 4th earl, succeeded to his father's claim to the crown as well as to his title and estates. When Richard II. was deposed and the crown seized by Henry of Lancaster in 1399, the young earl of March and his brother Roger were kept in custody by Henry IV., who, however, treated them honourably, until March 1405, when they were carried off by the opponents of the Lancastrian dynasty, of whom their uncle Sir Edmund Mortimer and his brother-in-law Henry Percy (Hotspur) were leaders in league with Owen Glendower. The boys were recaptured, and in 1409 were committed to the care of the prince of Wales. On the accession of the latter as Henry V., in 1413, the earl of March was restored to his estates, his brother Roger having died some years previously; and he continued to enjoy the favour of the king in spite of a conspiracy in 1415 to place him on the throne. March accompanied Henry V. throughout his wars in France, and on the king's death in 1422 became a member of the council of regency. He died in Ireland in 1425, and as he left no issue the earldom of March in the house of Mortimer became extinct, the estates passing to the last earl's nephew Richard, who in 1435 was officially styled duke of York, earl of March and Ulster, and baron of Wigmore. Richard's son Edward having ascended the throne in 1461 as Edward IV., the earldom of March became merged in the crown.

See T. Rymer, *Foedera*, etc. (1704–32); T. F. Tout, *The Political History of England*, vol. iii., ed by W. Hunt and R. L. Poole (1905); W. Dugdale, *Monasticon anglicanum* (3 vols., 1655–73); W. Stubbs, *Constitutional History of England* (1874–78), vol. ii.

II. Scottish Marches.—The Scottish earls of March were descended from Crinan, whose son Maldred married Algitha, daughter of Ughtred, earl of Northumberland, by Elgiva, daughter of the Saxon king Aethelred. Maldred's son Cospatric, or Gospatric, was made earl of Northumberland by William the Conqueror; but being soon afterwards deprived of this position he fled to Scotland, where Malcolm Canmore, king of Scotland, granted him Dunbar and adjoining lands. Two generations of Cospatrics followed in lineal succession, bearing the title of earl, but without territorial designation. Cospatric II witnessed the charter of Alexander I founding the abbey of Scone in 1115. The 3rd earl, also named Cospatric, a liberal benefactor of Melrose abbey, died in 1166, leaving two sons, the younger of whom was the ancestor of the earls of Home. The elder son, Waltheof, was the first of the family to be styled "comes de Dunbar," about 1174. He was one of the hostages for the performance of the Treaty of Falaise for the liberation of William the Lion in 1175. Waltheof's son Patrick Dunbar (the name Dunbar, derived from the family estates, now becoming an hereditary surname), styled 5th earl of Dunbar, although his father had been the first to adopt the territorial designation, was keeper of Berwick castle, and married Ada, natural daughter of William the Lion. His grandson Patrick, 7th earl, headed the party that liberated King Alexander III. in 1255 from the Comyns, and in the same year was nominated guardian of the king and queen by the Treaty of Roxburgh. He signed the Treaty of Perth (July 6, 1266) by which Magnus VI. of Norway ceded the Isle of Man and the Hebrides to Scotland. His wife was Christian, daughter of Robert Bruce.

PATRICK DUNBAR, 8th earl of Dunbar and 1st earl of March, claimed the crown of Scotland in 1291 as descendant of Ada, daughter of William the Lion. He was one of the "seven earls of Scotland," a distinct body separate from the other estates of the realm, who claimed the right to elect a king in cases of disputed succession. He was the first of the earls of Dunbar to appear in the records as "comes de Marchia," or earl of March. He was favourable to the English interest in Scottish affairs, and he did homage to Edward I. In 1298 he was appointed the English king's lieutenant in Scotland.

PATRICK DUNBAR (1285–1369), 9th earl of Dunbar and and earl of March, son of the preceding, gave refuge to Edward II. after Bannockburn, and contrived his escape by sea to England. Later, he made peace with Robert Bruce, and by him was appointed governor of Berwick castle, which he held against Edward III. until the defeat of the Scots at Halidon Hill (July 19, 1333). His countess, known in Scottish history and romance as "Black Agnes," daughter of Thomas Randolph, earl of Moray (Murray), and grandniece of Robert Bruce, is famous for her defence of Dunbar castle against the English under the earl of Salisbury in 1338. This lady succeeded to the estates and titles of her brother, John Randolph, 3rd earl of Moray. The earldom of Moray passed after her death to her second son, John Dunbar, who married Marjory, daughter of King Robert II.

GEORGE DUNBAR (d. 1420), 10th earl of Dunbar and 3rd earl of March, great-nephew of the 8th earl and warden of the marches, accompanied Douglas in his foray into England in 1388, and commanded the Scots after Otterburn. He afterwards quarrelled with the Douglases, and when his lands were seized, fled to England, where he was welcomed by Henry IV. He fought on the English side at Homildon Hill; and, having revealed to Henry the defection of the Percies, who were in league with Douglas and Owen Glendower, he fought against those allies at Shrewsbury (July 23, 1403). Becoming reconciled with Douglas, he returned to Scotland in 1409, and was restored to his earldom by the regent Albany.

GEORGE DUNBAR, 11th earl of Dunbar and 4th earl of March, was one of the negotiators for the release of James I. of Scotland in 1423 from his captivity in England, and was knighted at that king's coronation. In 1434, however, on the ground that the regent had had no power to reverse his father's forieiture for treason, March was imprisoned and his castle of Dunbar seized by the king; and the parliament at Perth declared his lands and titles forfeited to the Crown.

The earldom of March in the house of Dunbar having thus been forfeited to the Crown, James II. in 1455 conferred the title, together with that of warden of the marches, on his second son Alexander, duke of Albany; but this prince entered into treasonable correspondence with Edward IV. of England, and in 1487 the earldom of March and the barony and castle of Dunbar were again annexed to the crown of Scotland.

The title of earl of March was next held by the house of Lennox. (*See* RICHMOND, EARLS AND DUKES OF; and LENNOX.)

The title of earl of March in the peerage of Scotland, by another creation, was conferred in 1697 on William Douglas, second son of William, 1st duke of Queensberry. (*See* QUEENSBERRY, EARLS, MARQUISES AND DUKES OF.)

See Andrew Lang, *History of Scotland* (4 vols., 1900–07); Sir Bernard Burke, *A Genealogical History of Dormant and Extinct Peerages* (1866); Sir Robert Douglas, *The Peerage of Scotland* (2 vols., 1813); Lady Elizabeth Cust, *Some Account of the Stuarts of Aubigny in France* (1891).

MARCH, FRANCIS ANDREW (1825–1911), U.S. philologist, lexicographer and educator, whose special field of study was the English language, was born on Oct. 25, 1825, in Millbury, Mass. He graduated in 1845 from Amherst college, where his attention was turned to the study of Anglo-Saxon by Noah Webster After teaching in secondary schools and at Amherst, he went in 1855 as a tutor to Lafayette college, Easton, Pa., where in 1857 he became professor of English language and comparative philology—the first chair of the kind established. In 1907 he became professor emeritus.

In 186j he published *Method of Philological Study of the English Language,* and in 1870 *A Comparative Grammar of the Anglo-Saxon Language,* a monumental work, and *An Anglo-Saxon Reader,* both marking a new era in the study of English in America. To the "Douglass Series of Christian Greek and Latin Classics," which he edited, he contributed *Latin Hymns* (1874). In 1879–82 March nas director of the American readers for the Philological Society's *New English Dictionary.* His article "On Recent Discussions of Grimm's Law" in the *Transactions and Proceedings* of the American Philological association for 1873 in large part anticipated Verner's law. With his son, Francis Andrew March, (1863–1928), who was also a professor at Lafayette and a noted lexicographer, he edited *A Thesaurus Dictionary of the English Language* (1903). March died in Easton, Pa., on Sept. 9, 1911. Peyton Conway March (*q.v.*) was also his son.

MARCH, PEYTON CONWAY (1864–1955), U.S. soldier, was born at Easton, Pa., on Dec. 27, 1864. He graduated from Lafayette college, Easton, in 1884 and four years later from the U.S. Military academy, West Point, N.Y. March graduated from the artillery school in 1898, and on the outbreak of the Spanish-American War went to the Philippines, remaining there three years and rising to the grade of lieutenant colonel of volunteers. After honourable discharge from the volunteers in 1901, he was appointed captain of artillery in the regular army. From 1903 to 1907 he was a member of the general staff and in 1904, during the Russo-Japanese War, was with the Japanese army in Manchuria as observer. He was promoted to major in 1907, lieutenant colonel in 1912 and colonel in 1916. Soon after the entrance of the U.S. into World War I in 1917, he was made a brigadier general, U.S.A., and later major general of the national army and, in Sept. 1917, major general of the regular army. In 1917 he was with the A.E.F. in France in charge of the U.S. artillery forces. In March 1918 he was appointed acting chief of staff, and the following May chief of staff with the rank of general. On June 30, 1920, his rank reverted to that of major general, and at his own request he was retired irom active service Nov. 1, 1921. As chief of staff of the army, March reorganized the war department and consolidated the regular army, national guard and national army divisions into a single army—the U.S. army. March died April 13, 1955, in Washington, D.C.

MARCH, an urban district in the Isle of Ely county constituency, Cambridgeshire, Eng., 30 mi. N. of Cambridge by road. Pop. (1951) 12,996. Area 30.9 sq.mi. It lies on a ridge in the fen country and the tower of the town hall (headquarters of the Isle of Ely county council) is a landmark for miles. St. Wendreda's church, dating from *c.* 1343, has a 16th-century double hammer-beam roof; the grammar school was founded in 1696. March is an agricultural and market centre, mainly for root crops, and with a sugar-beet factory. The five railways converging at March superseded the old Nene river as a means of transport.

MARCH (Lat. *Martius),* the third month of the modern calendar, has 31 days. According to tradition the earliest Roman calendar, ascribed to Romulus, had only ten named months, March through December, the "dead season" of midwinter being left undesignated; to these ten January and February were later added by Numa Pompilius. Though the historical evidence for these early calendars is disputed, it is clear, if only from the names of the numbered months (*e.g.* December, "tenth month"), that March was originally the first month, the starting point for the annual cycle of religious festivals. It was only in or after 153 B.C., when Jan. 1 was finally fixed as the date for new magistrates to take office. that the civil calendar prevailed over the religious, and January thus came to be regarded as the first month. Since early spring was the season for renewed activity both in agriculture and in warfare, March was appropriately named for the god Mars, who seems to have been originally both a god of war and the protector of vegetation.

Memorable dates in this month include March 1j ("the Ides of March"), on which Julius Caesar was assassinated, and St. Patrick's day, March 17. Since the Council of Nicaea (A.D. 325) the date of Easter, the chief movable feast of the Christian calendar, has been calculated from the vernal equinox, reckoned as March 21. Until the passage of the 20th amendment to the Constitution, presidents of the United States were normally inaugurated on March 4. This amendment, adopted in 1933, modified the provisions of the 12th amendment and set the date for the inauguration on Jan. 20. (F. R. WN.)

MARCHAND, JEAN BAPTISTE (1863–1934), French general and African explorer, was born at Thoissey (Ain) on Nov. 22, 1863. After four years' service in the ranks. he was, in 1887, appointed a sublieutenant. In 1889 he was on active service in Senegal. was twice wounded, and made a chevalier of the Legion of Honour. In 1898 he carried out his historic occupation of Fashoda *(see* EGYPT: *Modern History)* and for this he was promoted to commander in the Legion of Honour. In 1902 he was made colonel and shortly after the outbreak of war in 1914 he was appointed to command the colonial brigade of the 14th corps, and in 1915 was promoted a temporary general of brigade. A few months later he assumed command of the 10th (colonial) division and was wounded in Sept. 1915. On April 4. 1917, he was promoted general of division. He retired in 1919, and received the grand cross of the Legion of Honour in 1920. Marchand died Jan. 14, 1934.

MARCHAND, JEAN HIPPOLYTE (1883–1941), French painter. was born in Paris on Nov. 22, 1883. He studied with Leon Bonnat and Luc Merson (1902–06), but deserted conventional styles, and exhibited at the Salon des Indépendants in 1908. He visited Russia and England on several occasions. Though Marchand came under the influence of Cubism between 1910 and 1912, his work was not greatly affected by it. His human forms are treated with power and discretion, while his landscapes and still life are tinged with an intense melancholy. He died in Paris on Oct. 10, 1941.

MARCHE, or LA MARCHE. a former province of France. Geographically it corresponds to the northern part of Limousin, from which it was detached in the 10th century by the overlords, the counts of Poitiers, to form a military march or border district against the Norman invaders coming from the Loire valley (whence its frequent name of Marche Limousine). It had no precise borders and was originally made of two different districts. Haute Marche in the east along the Creuse, around Guéret, and Basse Marche in the west, on the Vienne, around Charroux, Le Dorat and Bellac. They were nearly separated by fiefs held directly from the counts of Poitiers (Bridiers, Peyrat, Bourganeuf) and episcopal lordships (Bénévent. Le Grand-Bourg-de-Salagnac). Its neighbours, Poitou, Berry, Bourbonnais and Auvergne. encroached on its territory, annexing Combrailles. Boussac and Gouzon. Later on, in the 13th century, it was increased by the union of Ahun and the viscounty of Aubusson, after which it remained unaltered until the Revolution. It embraced the greater part of the modern department of Creuse, a considerable part of northern Haute-Vienne and a fragment of Indre.

La Marche had been given in the middle of the 10th century by William III. duke of Aquitaine. to Boso the Old. head of the house of Charroux, who took the title of count. In 1091, by the marriage of Adalmadis of Charroux with Roger of Montgommery, it passed to the house of Montgommery, which kept it until 1177, when Audibert of Montgommery sold it to Henry II. It was thenceforth under the English king until 1199, when King John gave it to Hugh IX of Lusignan, but next year John tried to take it back, having quarrelled with the Lusignans. Hugh X of Lusignan made an alliance with Henry III during the minority of Louis IX but was obliged, after the battles of Taillebourg and Saintes (1242), to submit to the French king and to recognize Alphonse of Poitiers as overlord. Hugh XIII died childless in 1303, and Philip IV of France united the county to the crown in 1308. In 1311, however, it nas made an apanage for Philip's third son, Charles (afterward King Charles IV). for whom Philip V elevated it to the rank of *comté-pairie* in 1316 and who reunited it to the crown for a few years (1322–27) and then gave it to Louis of Bourbon. The Bourbon family held it for the next two centuries, except the years from 143j to 1477, when it was owned by the family of Armagnac. In 1527, after the treason of the constable of Bourbon, Francis I confiscated it and made it part of the domain of the French crown. During the two last centuries of the monarchy. Marche lost its unity. Haute Marche becoming part of the *généralité* of Moulins, Basse Marche part of that of Limoges. But the whole province was under the jurisdiction of the *parlement* of Paris, while Limousin depended from Bordeaux. Agriculture was subsequently developed, as in Limousin (*q.v.*), but Marche has no industry except the famous manufactures of tapestry at Aubusson, which started in the 14th century. (F. CT.)

MARCHES, THE (or MARCHE), a territorial division (region) of Italy, embracing from north to south the provinces of Pesaro and Urbino, Ancona, Macerata, and Ascoli Piceno. Pop. 1,364,030 (1951). It is bounded by Emilia on the north, the Adriatic on the east, the Abruzzi on the south, and Umbria and Tuscany on the west. The chief rivers, all of which run into the Adriatic eastward and northeastward, are the Metauro (anc. *Metaurus, q.v.*) and the Tronto (anc. *Truentus),* the latter forming the southern boundary of the Marches for some distance. Except for the river valleys and the coast strip (often very narrow), the general level is more than 500 ft. above the sea. The lower hills are largely composed of loose, clayey, unstable earth, while the Apennines are of limestone. The province of Pesaro and Urbino falls within the boundaries of the ancient Umbria (*q.v.*), while the territory of the other three belonged to Picenum (*q.v.*). The railway from Bologna to Brindisi runs along the coastline of the entire territory.

At Fano there is a branch to Fermignano, on the line from Fabriano to Urbino; at Falconara, near Ancona, it is joined by the main line from Foligno and Rome; at Porto Civitanova is a branch to Macerata, San Severino and Fabriano (a station on the line from Ancona to Rome and the junction for Urbino): at Porto S. Giorgio is a branch to Fermo and Amandola, and, at Porto d'Ascoli, a branch to Ascoli Piceno.

History.—For early history of the territory of the Marches, *see* PICENUM. From the Carolingian period onward the name Marca begins to appear—first Marca Fermana for the mountainous part of Picenum, Marca Camerinese for the district farther north, including a part of Umbria, and Marca Anconitana for the former Pentapolis. In 1080 Marca Anconitana was given in investiture to Robert Guiscard by Gregory VII, to whom the countess Matilda ceded the Marches of Camerino and of Fermo. In 1105 we find the emperor Henry IV investing Werner with the whole territory of the three marches under the name of March of Ancona. It was afterward once more recovered by the church and governed by papal legates. It became part of the kingdom of Italy in 1860. Pictorial art of the Marches since the 13th century has become the object of considerable interest.

Agriculture and Industry.—Owing largely to the *métayage* system the soil is fairly highly cultivated.

Silk industries, making of strawplait and straw hats, rearing of silk worms and cocoons, with sugar refining, tobacco, terra-cotta manufacture, brickworks and ironworks, came to be the chief occupations of the people of the Marches next after agriculture and pastoral pursuits.

Another important branch of activity is the paper industry, especially at Fabriano. Limestone quarries and sulphur mines supply building stone and sulphur to the regions of central Italy; chalk and petroleum were also found. Ancona was developed as a good harbour. Fishing is carried on along the entire coast.

MARCHESI, MATHILDE (née MATHILDE GRAUMANN) (1826–1913), German singer and teacher, was born at Frankfort-on-Main on March 26. 1826. She made her debut as a singer in 1844, but in 1849 began her teaching career, speedily earning a wide reputation at the conservatories of Vienna and Cologne, as well as in London and Paris. In 1852 she married Salvatore Marchesi. Cavaliere de Castrone (d. 1908), a well-known singer and teacher. Among Madame Marchesi's pupils were Emma Calvé, Emma Eames, Melba, Emma Nevada, Gabrielle Kraus and Etelka Gerster. She published various works on the technique of singing, and in 1897 a volume of reminiscences, *Marchesi* and *Music*. She died in London on Nov. 17, 1913.

Her daughter, Blanche Marchesi (1863–1940), was also a famous singer and teacher.

MARCIAN (*c.* 390–457), emperor of the east (450–457), was born of humble parentage in Thrace, and entered the army at an early age. Eventually through the influence of Aspar and Ardaburius he became a captain of the guards, and later tribune and senator. On the death of Theodosius II he was chosen as consort by the latter's sister and successor, Pulcheria. Marcian repudiated the payment of tribute to Attila, and reformed the finances. He repelled attacks upon Syria and Egypt (452) and quelled disturbances on the Armenian frontier (456). The other notable event of his reign is the Council of Chalcedon (451).

See Gibbon, The Decline and Fall of the Roman Empire, ed. by Bury (1896), iii 384, iv 444–445; J. Bury, The Later Roman Empire (1889), i 135–136.

MARCIANUS (c. A.D. 400), Greek geographer, was born at Heraclea in Pontus. Two of his works have been preserved in a mutilated condition. In the first, the Periplus of the Outer Sea, in two books, in which he proposed to give a complete description of the coasts of the eastern and western oceans, his chief authority is Ptolemy; the distances from one point to another are given in stades, with the object of rendering the work easier for the ordinary student. The second, the Periplus of the Inner Sea (the Mediterranean), is a meagre epitome of a similar work by Menippus of Pergamum, who lived during the times of Augustus and Tiberius. It contains a description of the southern coast of the Euxine from the Thracian Bosporus to the river Iris in Pontus. A few fragments remain of an epitome by Marcianus of the 11 books of the *Geographumena* of Artemidorus of Ephesus.

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MARCION (fl. 2nd century A.D.), the leader of a vigorous heretical movement in early Christianity, the most striking tenet of which was the doctrine of two Gods: one the Creator and Judge; the other, the God whom Jesus revealed. Since nothing from Marcion's hand has survived, and any information about him must be derived from the occasional and often biased comments of such orthodox opponents as Tertullian (Against *Marcion)* and St. Epiphanius (Panarion), scant knowledge of the man himself is available. Obviously a person of considerable originality and force, he hailed from Sinope (Sinop) in Bithynia-Pontus, where his father is said to have been the Christian bishop. He appears to have become a shipowner and a man of some wealth. His early life is altogether obscure but toward the middle of the 2nd century he emerged as an influential teacher in Rome. It is likely that this activity in the Roman Church followed upon similar activity farther to the east. It has been argued that Polycarp's epistle to the Philippians (c. A.D. 130) reflects the presence and influences of Marcion in Macedonia. Having reached Rome (c. A.D. 137), he was associated for a time with Cerdo, an important Gnostic teacher, and it is possible that some of the features of his thought are to be ascribed to Cerdo's influence. But Marcion was not a true or typical Gnostic despite his dualism and docetism (*q.v.*). He thought of himself as being a devoted disciple of Paul, who, he claimed, was the only true apostle. Because he looked upon the Jewish Scriptures, which were also at that time the Scriptures of the early church, as belonging to the inferior Creator-God, he repudiated them and set up in their place for his followers a new scripture consisting of a gospel (closely resembling that of Luke) and the Epistles of Paul. He also composed the Antitheses, a work in which the law and the gospel were sharply contrasted. Marcion was a gifted organizer as well as a brilliant and persuasive teacher, and the movement he established became both widespread and powerful. The date of his death is unknown. See also MARCIONITES; GNOSTICISM.

See A. von Harnack, *Marcion:* das Evangelium vom *fremden* Gott (1921 and 1924). (J. Kx.)

MARCIONITES. Marcion (*q.v.*) exercised a major influence upon the development of Christianity in the 2nd century, an influence to be seen both in what the church took from him—especially a renewed attention to the writings of St. Paul—and in the measures adopted to oppose what was quickly perceived to be a dangerous perversion of the Gospel. Marcion was not merely an exponent of heresy or the leader of a school of thought verging on Christianity, but also a founder of churches that were at first serious rivals to orthodox Christianity and kept themselves in being for centuries.

Marcion's theology centred upon his conviction that Christianity was something wholly new. Unable to reconcile the God revealed in Jesus with the God described in the Old Testament, he severed the Christian revelation from its roots in past history and taught that Jesus had come to reveal the true God, as yet wholly unknown, a God of pure love who had now for the first time acted in the material universe by sending His Son to redeem men from it. The Old Testament was not rejected as untrue; it was revelation of a kind. But the god whom it truly revealed, the god of the Jews, the demiurge (*q.v.*) was an inferior being who had fashioned the material universe, including man, and ruled it on the principle of law and obedience. He was powerful, but not omnipotent; at best, he was just, at worst, capricious, wrathful and violent. Although not in himself the principle of evil, he was not the principle of good. The Messiah of the Old Testament was not identified with the Son of the true God. In redeeming men from sin and death, Jesus, the Son of God, was also rescuing them from the demiurge, who would eventually pass away together with his material universe. In all this Marcion was convinced that he had the support of St. Paul, indeed that he alone properly understood the apostle. In Paul he saw, above all else, the antithesis between law—the principle of the demiurge, of the Old Testament and of the Jews—and gospel—the principle of the God of love and of redemption in Jesus. With law went rewards and punishments, justification by works of obedience, while to gospel belong faith, liberty and grace. He also made the most (and more) of Paul's distinction between flesh and spirit. It cannot be doubted that Marcion was genuinely trying to interpret St. Paul; that the contemporary church was showing signs of a legalism contrary to the spirit of Paul and had an inadequate understanding of his profoundest teachings; or that Marcion was honestly facing real problems—in general, the problem of evil, and, in particular, the problem of the character of God as described in the Old Testament. He refused to adopt the method of allegorical exegesis which removed the latter difficulty for most Christians in an age which knew little of biblical criticism or "progressive revelation."

On the other hand, it is equally clear that Marcion perverted the teaching of St. Paul and that his own views had certain other sources. How Marcion's doctrine was related to gnosticism (*q.v.*) has often been a matter of controversy. He was unlike some leading gnostic teachers in that he eschewed all theories of aeons and emanations from God, had no fantastic mythology of redemption and did not so classify men by their natures that salvation was assured to one class and denied to another: for him, salvation was received by faith in Jesus Christ, indeed in Christ crucified. But it seems wrong to distinguish him from the gnostics on the ground that, while they were primarily philosophers, he was essentially religious; for the gnostic systems were normally offered as religions of redemption from evil and death. Marcion's kinship with gnosticism is inescapably evident in his attitude to matter and to the flesh; matter (at least according to his early critics) he treated as the principle of evil, and the flesh, if not intrinsically evil (as he probably believed), was for him unworthy of redemption. Hence his Christology was docetic; Christ had no true human nature (see DOCETISM). Though Marcion emphasized the place of the Cross and of suffering in redemption, it is doubtful whether he could consistently do this. Unlike Paul, he did not wrestle with the reconciliation of love and justice in one God, so that his doctrine of redemption, the core of his teaching, was after all shallow and un-Pauline. The same was probably true of his notion of faith and grace.

Marcion organized his followers into churches outwardly similar to those of the catholic church. They had an episcopal ministry, practised (illogically, his critics said) the sacraments of baptism and the eucharist and lived ascetically, renouncing marriage. Further, they possessed a Bible, the first fixed canon of Christian scriptures. Marcion accepted only St. Luke's Gospel and ten Pauline epistles (*i.e.,* he excluded the Pastorals and Hebrews); and these he mutilated, cutting out anything inconsistent with his own beliefs. Besides furnishing the epistles with prologues, Marcion gave his churches a guide to their interpretation in his

Antitheses, a book that has not survived but that can be reconstructed in part from Tertullian's *Against Marcion.*

The existence of such churches compelled the catholic church to take Marcion very seriously. After the earlier skirmishers, such as Justin Martyr, Irenaeus attacked him, among the gnostics, in his *Against the Heresies* (*c.* 185), as did Tertullian in his longest work, *Against Marcion* (*c.* 207), and elsewhere. It was easy to attack his arbitrary treatment of the text of those books which he himself accepted as Scripture, to press against him the argument from history and prophecy and to assert the necessary unity of the God of creation and redemption, the goodness of matter as God's creation and, therefore, the full reality of Christ's humanity (technically, Marcion's Christology was not only docetic but also modalist, the Son being conceived as no more than a manifestation of the Father); but also, if the church was to reject the dualism of good and evil (or imperfect) gods or of God and matter as the answer to the problem of evil, it had to develop its alternative solution. Hence the renewed emphasis upon the doctrine of the Fall evident in Irenaeus, Tertullian and Origen. Further, Marcion's misuse of St. Paul had to be countered by an even deeper interpretation of his essential message. This was largely provided by Irenaeus. Tertullian also emphasized the redemption of all creation (including the resurrection of the flesh) and brought out the continuity of sacred history: the good God had not been absent from his creation before the Incarnation. Marcion's canon produced a crystallization of the church's own, with apostolic authorship as the criterion. Paul, of course! was accepted, but so were Peter and John. Other Gospels with apostolic authority were set with St. Luke's; and further attention was drawn to the importance of the apostles by the inclusion of Acts. More generally, apostolicity was advanced as a principal mark of the true church in reply to Marcion and to other gnostics who took too little account of history and of tradition or who claimed to have secret revelations of their own. The church appealed to the apostolic writings and to the tradition preserved in churches of apostolic origin, seen in worship and in the apostolic rule of faith and guarded by the bishops in manifest succession of office in each local church — often, it was believed, from the days of the apostles themselves. Marcion did not create catholicism by causing a development, in reaction to himself, which would not otherwise have occurred: the concept of canonicity, respect for apostolic tradition, creeds and an authoritative ministry were none of them novelties. Rather he quickened the pace of the movement toward that presentation of "the catholic church" which is worked out in, for instance, Tertullian's *De praescriptione haereticorum.* That the dangers of excessive rigidity, traditionalism and institutionalism were not completely avoided is probable, and Montanism (*q.v.*) may be interpreted as in part a reaction from these aspects of catholicism. (*See* also GNOSTICISM.)

Marcionite churches spread rapidly through the empire, but the movement lost impetus in the west before the 3rd century was over. They probably merged into Manichaeism (*q.v.*). That they flourished longer in the east was shown by Cyril of Jerusalem (*c.* 350), who supposed that any city may contain a Marcionite conventicle; by Theodoret of Cyrrhus (in the middle of the 5th century), who converted many Marcionites in his diocese; and by Esnik's writings against those in Armenia. Clear traces of Marcionism proper were lost after the 7th century, but the dualism of the Marcionites, their suspicion of the flesh and their asceticism reappeared in other sects, such as the Paulicians and Bogomils, as well as in the Manichees. More modern tendencies among Christians to dismiss the Old Testament are often called Marcionism, while theologians who distrust natural theology and natural law sometimes express their understanding of the uniqueness of revelation in Christ in terms which recall those of Marcion himself.

BIBLIOGRAPHY.—The chief ancient authorities are Irenaeus and Tertullian, as cited above. Modern study is based on A. von Harnack, *Marcion: das Evangelium vom fremden Gott,* no. 45 of *Texte und Untersuchungen zur Geschichte der altchristlichen Literatur* (1921; 2nd ed. 1924), with his *Neue Studien zu Marcion* (1923) in which he replied to his chief critics. Harnack's views drew attention to Marcion's greatness and influence, but overstated them. *See* also E. C. Blackman, *Marcion and His Influence* (1948, 1950); also John Knox, *Marcion and the New Testament* (1942). (S. L. G.)

MARCOMANNI, the name of a Suevic tribe "men of the mark, or border." They were often in conflict with the Roman empire, and gave their name to the Marcomannic war, a struggle waged by the emperor Marcus Aurelius against them. The Marcomanni disappeared from history during the 4th century, being probably merged in the Baiouarii, the later Bavarians.

See SUEBI; and E. Devrient, "Hermunduren und Markomannen" in *Neues Jahrb. f. das klassische Altertum* (1901), 51.

MARCONI, MARCHESE **GUGLIELMO** (1874–1937), Italian physicist, the inventor of a practical system of communicating intelligence without the use of connecting wires between sending and receiving points, was born in Bologna on April 25, 1874, the son of an Italian country gentleman who had married the daughter of Andrew Jameson of County Wexford, Ire. Educated first in Bologna and later in Florence, Marconi then went to the technical school of Leghorn, where he studied physics under Vincenzo Rosa and had every opportunity of investigating electromagnetic (or Hertzian) wave technique, following the earlier mathematical work of Clerk Maxwell and the experiments of Heinrich Hertz, Édouard Branly, Oliver Lodge, Augusto Righi and others.

In 1894, Marconi began experimenting at his father's estate in Pontecchio, near Bologna, using comparatively crude apparatus: an induction coil with a spark discharger controlled by a Morse tapping key at the sending end and a simple filings coherer at the receiver. After preliminary experiments over a short distance, he first improved the coherer and made it self-restoring in operation; then, by systematic tests, he showed that the range of signalling was increased by using a vertical aerial with a metal plate or cylinder at the top of a pole connected through the spark gap to a similar plate on the ground. In this way, the range of signalling was increased to about $1\frac{1}{2}$ mi., and Marconi had convinced himself of the importance of this new system of communication. It was at this period also that he conducted some simple experiments with reflectors around the aerial to concentrate the radiated electrical energy into a beam instead of spreading it in all directions.

As he received little encouragement to continue his experiments in Italy, he was advised by his mother's relations to go to England; and in Feb. 1896 he arrived in London and met William Preece, engineer in chief of the post office, who offered him every assistance and encouragement. Marconi filed his first patent in England in June 1896 and, during that and the following year. he gave a series of successful demonstrations in some of which he used balloons and kites to obtain greater height for his aerials. He was able to send signals over distances up to 4 mi. on Salisbury plain and to nearly 9 mi. across the Bristol channel. These tests, together with Preece's lectures on them, attracted considerable publicity both in England and abroad; and, in June 1897, Marconi went to Spezia, where a land station was erected and communication was established with Italian warships at distances up to 12 mi.

There was, however, still a good deal of scepticism about the useful application of this means of communication and lack of interest in its exploitation. But Marconi's cousin Jameson Davis, a practising engineer, financed his patent and was instrumental in the formation of the Wireless Telegraph and Signal Co., Ltd., the name of which was changed in 1900 to Marconi's Wireless Telegraph Co., Ltd. John Ambrose Fleming, who was to patent the first two-electrode thermionic valve in 1904, became scientific adviser to the company, the efforts of which for some time were devoted to assisting Marconi in his continuous endeavour to show to the full the possibilities of this new means of communication. A further step was taken in 1899, when a wireless station was established at South Foreland for communicating with Wimereux in France, a distance of 31 mi.; and in the same year British battleships had exchanged messages at 75 mi.

In Sept. 1899, Marconi equipped two U.S. ships to report to newspapers in New York city the progress of the yacht race for the America cup. This was another great success, which aroused world-wide excitement and led to the formation of the American Marconi company. The following year the Marconi International Marine Communication Co.. Ltd., was established for the purpose of installing and operating services between ships and land stations. In 1900 also, Marconi filed the famous patent No. 7777 for "Improvements in Apparatus for Wireless Telegraphy." This was based on the earlier work of Sir Oliver Lodge in tuning wireless transmitters and receivers, which enabled several stations to operate on different wave lengths without mutual interference.

Marconi's great triumph was, however, yet to come. In spite of the opinion expressed by some distinguished mathematicians that the curvature of the earth would limit practical communication by means of electric waves to a distance of 100–200 mi., Marconi succeeded in Dec. 1901 in receiving at St. John's, Nfd., signals transmitted across the Atlantic ocean from Poldhu in Cornwall. This achievement created an immense sensation in every part of the civilized world; and, though much remained to be learned about the laws of propagation of radio waves around the earth and through the atmosphere, it was the starting point of the vast development of radio communications, broadcasting and navigation services that took place in the next 50 years, in much of which moreover Marconi himself continued to play an important part.

During a voyage on the U.S. liner "Philadelphia" in 1902, Marconi received messages from distances of 700 mi. by day and 2,000 mi. by night. He thus first discovered the fact that, because some radio waves travel by reflection from the upper regions of the atmosphere, the conditions of transmission or propagation are sometimes more favourable at night than during the hours of daylight. It was in 1902 also that Marconi patented the magnetic detector; and during the next three years he developed and patented the horizontal directional aerial. Both of these devices improved the efficiency of the communication system. In 1910, assisted by H. J. Round, he received messages at Buenos Aires, Arg., from Clifden in Ireland over a distance of about 6,000 mi., using a wave length of about 8,000 m. In 1912 he introduced the timed-spark system of generating pseudocontinuous waves in place of the damped trains of waves produced by the older spark transmitters. This effected a considerable improvement in the selectivity of transmission and reception with a further gain in efficiency. The system was used for several years at many important long-distance stations; and by its means Marconi sent the first messages ever transmitted by wireless from England to Australia, in Sept. 1918.

In spite of the rapid and widespread developments then taking place in the various aspects of wireless and its applications to communication, to navigation and to the safety of life at sea, Marconi's intuition and urge to experiment toward greater accomplishments were by no means exhausted. It was in 1916, during World War I, that he saw the possible advantages of electric waves, shorter than those used before. For example, the shorter waves permitted the use of reflectors round the aerial, which in wartime minimized the interception of the transmitted signals by the enemy and also effected an economy in signalling. After tests in Italy (20 years after his original experiments with reflectors), Marconi continued the work in Great Britain with C. S. Franklin and, on a wave length of 15 m., received signals over a range of 20–100 mi. In 1923 the experiments were continued with G. A. Mathieu on board the steam yacht "Elettra," which had been specially fitted up. From a transmitter of 1 kw. at Poldhu, signals were received at a distance of 1,400 mi., much louder than those from Caernarvon on a wave length several hundred times as great and with 100 times the power at the transmitter. Thus began the development of short-wave wireless communication which, with the use of the beam aerial system for concentrating the energy in the desired direction, constitutes the basis of nearly all modern long-distance radio communication. It was in 1924 that the Marconi company obtained a contract from the post office for the establishment of short-wave communication between England and the countries of the British Commonwealth.

A few years later Marconi returned to the study of still shorter waves and. with the aid of valve-oscillator technique, examined the range possibilities of wave lengths of about half a metre. At these very short wave lengths, a parabolic reflector of moderate size gives a considerable increase in radiated power in the desired direction, and experiments conducted off the coast of Italy in the yacht "Elettra" soon showed that useful ranges of communication could be achieved with small powers at the transmitter. In 1932, Marconi installed a very short-wave radio telephone system between the Vatican and the pope's palace at Castel Gandolfo. In later work, Marconi once more demonstrated that even radio waves as short as 5j cm. are not limited in range to the horizon or optical distance between transmitter and receiver.

Marconi received many honours and several honorary degrees: he was created a knight of Italy (1902); made a freeman of Rome (1903); awarded half the Nobel prize for physics, the Albert medal of the Royal Society of Arts and, in the United States, the Franklin and John Fritz medals (1909); appointed an honorary Grand Cross of the Victorian Order (1914); sent as plenipotentiary delegate to the peace conference in Paris (1919), in which capacity he signed the peace treaties with Austria and with Bulgaria; created marchese and nominated to the Italian senate (1929); and chosen president of the Royal Italian Academy (1930). Marconi died in Rome on July 20, 1937, and was accorded a state funeral by the Italian government. At his own wish, he was buried at his native town of Bologna. (R. L. S.-R.)

MARCUS, SAINT, pope in 336 (Jan. 18–Oct. 7) or, as other sources claim, from 337 to 340, is credited with having established the right of bishops of Ostia to consecrate new popes. He also is said to have founded the present church of S. Marco in Rome, and another over the Catacomb of Balbina, but a letter alleged to have been sent by him to Athanasius is now regarded as spurious.

His feast day is Oct. 7. (G. E. McC.)

MARCUS AURELIUS ANTONINUS (121–180), Roman emperor and Stoic philosopher, was born in Rome A.D. 121, the date of his birth being variously stated as April 6, 21 and 26. His original name was Marcus Annius Verus. His father Annius Verus (prefect of the city and thrice consul), who came of Spanish stock, had received patrician rank from Vespasian. Marcus was three months old when his father died, and was thereupon adopted by his grandfather. Hadrian adopted, as his successor, Titus Antoninus Pius (uncle of Marcus), on condition that he in turn adopt both Marcus (then 17) and Lucius Ceionius Commodus, the son of Aelius Caesar, who had originally been intended by Hadrian as his successor. but had died before him. Marcus had been, at the age of 15, betrothed to Fabia, the sister of Commodus; the engagement was broken off by Antoninus Pius, and he was betrothed to Faustina, the daughter of the latter. In 139 the title of Caesar was conferred upon him and he dropped the name of Verus. The full name he then bore was Marcus Aelius Aurelius Antoninus, Aelius coming from Hadrian's family, and Aurelius being the original name of Antoninus Pius. In 140 he was made consul. He was educated, not at school, but by tutors, Herodes Atticus and M. Cornelius Fronto (*q.v.*), in the usual curriculum of rhetoric and poetry; but Stoicism attracted him from the first, and at 25 he definitely abandoned Fronto, whose training was wholly literary. to learn philosophy under Rusticus the Stoic, and law under L. Volusius Moecianus. A Stoic he remained in practice, but retained the humanity of his disposition.

Emperor.—Antonipus Pius died in 161, having recommended as his successor Aurelius, then 40 years of age, without mentioning Commodus, his other adopted son, commonly called Lucius Verus. It is believed that the senate urged Aurelius to take the sole administration. But he admitted Verus as his partner, giving him the tribunician and proconsular powers, and the titles Caesar and Augustus. In the first year of his reign Faustina gave birth to twins, one of whom became the emperor Commodus.

Aurelius' reign was largely occupied in defending the empire against attacks from all sides. First of all the Parthians under Vologeses III broke into Syria. Verus went out in nominal command of the war against them, which was really conducted by Avidius Cassius. The war was concluded in 165, but the returning army brought a pestilence with them that spread over the whole empire. Aurelius accompanied Verus in wars in Pannonia and Noricum in 167–8, and peace was made with the Marcomanni in 168. Early in 169 Verus died, leaving Aurelius sole emperor. In the autumn of 169 war again broke out on the Rhine-Danube frontier, and Marcus Aurelius lived almost entirely at Carnuntum for three years. The Marcomanni were eventually driven out of Pannonia and almost annihilated, and in 174 Aurelius won over the Quadi the celebrated victory of the "thundering legion," commemorated on the column of Antonina.

Germany. — Aurelius next marched to Germany. There news reached him that Avidius Cassius, the commander of the Roman troops in Asia, had revolted and proclaimed himself emperor (175). But after three months Cassius was assassinated, and his head was brought to Aurelius, who with characteristic magnanimity, persuaded the senate to pardon all the family of Cassius.

During his journey of pacification, Faustina, who had borne him 11 children, died. Aurelius trusted her while she lived, and mourned her loss.

After the death of Faustina and the pacification of Syria, Aurelius proceeded, on his return to Italy, through Athens, and was initiated in the Eleusinian mysteries. He gave large sums of money for the endowment of chairs in philosophy and rhetoric, with a view to making the schools the resort of students from all parts of the empire. Along with his son Commodus he entered Rome in 176, and obtained a triumph for victories in Germany. In 177 occurred that persecution of Christians, the share of Aurelius in which has been the subject of so much controversy. Meanwhile the German War continued, and the two Quintilii, who had been left in command, begged Aurelius once more to take the field.

Death. — In this campaign Aurelius, after a series of successes, was attacked, according to some authorities, by an infectious disease, of which he died after a week's illness, either in his camp at Sirmium (Mitrovitz), on the Save, in Lower Pannonia, or at Vindobona (Vienna), on March 17, 180, in the fifty-ninth year of his age. Other accounts are: (1) that he was poisoned in the interests of Commodus (Dio. Cass. lxxi, 33, 4), (2) that he died of a chronic stomachic disease; the latter is perhaps the most likely. His ashes (according to some authorities, his body) were taken to Rome. By common consent he was deified and all those aho could afford the cost obtained his statue or bust; for a long time his statues held a place among the penates of the Romans Commodus, who was with his father when he died, erected to his memory the Antonine column (now in the Piazza Colonna at Rome), round the shaft of which are sculptures in relief commemorating the miracle of the thundering legion and the various victories of Aurelius over the Quadi and the Marcomanni. A bronze equestrian statue was set up in the Forum, now on the Capitol.

Aurelius was consistently hostile to Christianity, and persecution, unknown or forbidden under earlier reigns, was systematically pursued under his directions. His attitude was logical enough. The State religion was to him an essential part of the imperial system, and the Christians, particularly in their opposition to emperor-worship, were a danger to the established order.

In his work on the internal administration Marcus Aurelius was equally untiring. His reign is especially notable for legal reforms, and an attempt to arrest the fall in the legitimate birth-rate. His provincial administration was not made easier by the drain on the Treasury caused by the defence of the empire. Against his will he had to increase taxation, and he risked alienating his soldiers by refusing an increase of pay. Last of a line of emperors who all seemed to come little short of the Stoic ideal of the philosopher king, Marcus Aurelius was the best of them all.

Philosophy. — The book which contains the philosophy of Aurelius is known by the title of his *Reflections*, or *Meditations*, although that is not the name which he gave to it himself (Td εἰς ἑαυτόν). Of the genuineness of the work no doubts are now entertained. It is believed that he wrote also an autobiography, which has perished. The *Meditations* were written, it is evident, as occasion offered—in the midst of public business. and on the eve of battles on which the fate of the empire depended—hence their fragmentary appearance, but hence also much of their practical value and even of their charm.

Throughout his life he was a practising, but he was not strictly an orthodox, Stoic. In his hands Stoicism is a practical rule of life, not a philosophy of quietism. In the *Meditations* are no speculations on the absolute nature of the deity, and no clear expressions of opinion as to a future state. He is, above all things, a practical moralist. The goal in life to be aimed at, according to him, is not happiness, but tranquillity, or equanimity. This condition of mind can be obtained only by "living conformably to nature," that is to say, one's whole nature, and as a means to that man must cultivate the four chief virtues, each of which has its distinct sphere — wisdom, or the knowledge of good and evil; justice, or the giving to every man his due; fortitude, or the enduring of labour and pain; and temperance, or moderation in all things. It is no "fugitive and cloistered virtue" that Aurelius seeks to encourage; on the contrary, man must lead the "life of the social animal." While he held that the prime principle in man is the social, "the next in order is not to yield to the persuasions of the body, when they are not conformable to the rational principle which must govern." This divinity "within a man," this "legislating faculty," which, looked at from one point of view, is conscience, and from another is reason, must be implicitly obeyed. He who thus obeys it will attain tranquillity of mind.

What gives the sentences of Marcus Aurelius their enduring value and fascination, and renders them superior to the utterances of Epictetus and Seneca, is that they are the gospel of his life. His precepts are simply the records of his practice. To the saintliness of the cloister he added the wisdom of the man of the world; he was constant in misfortune, not elated by prosperity, never "carrying things to the sweating-point," but preserving, in a time of universal corruption, unreality and self-indulgence, a nature sweet, pure, self-denying, unaffected.

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MARCY, WILLIAM LEARNED (1786–1857), American statesman, was born in Southbridge, Mass., on Dec. 12, 1786. He graduated at Brown university in 1808, studied law, was admitted to the bar in Tray, N.Y., and began practice there in 1810. During the War of 1812 he served as a captain of volunteers and on Oct. 22, 1812, took part in the storming of the British post at St. Regis, Can. In 1816 he became recorder of Troy, but he was removed from office in 1818 by his political opponents. As editor of the Troy *Budget* he was a vigorous supporter of Martin Van Buren, and when Van Buren's followers acquired control of the legislature in 1821 Marcy was made adjutant general of the New York militia. From 1823 to 1829 Marcy was comptroller of the state, an office then especially important on account of the large expenditures for internal improvements, and during this period he became the leading member of the famous "Albany regency" (*q.v.*), a group of able Democratic politicians who exerted a powerful influence throughout the state by their control of the party patronage and machinery. He was one of the associate justices of the New York supreme court from 1829 to 1831, presiding over the trial of the alleged murderers of William Morgan and in other important cases, and was a member of the United States senate from Dec. 1831 to July 1832, when he resigned to become governor of New York. In a speech in the senate defending Van Buren against an attack by Henry Clay. Marcy made the unfortunate remark that "to the victors belong the spoils of the enemy" and thereby became widely known as a champion of the proscription of political opponents. He served as governor of New York for six years (1833–38 inclusive). As governor he secured the enactment, in 1838, of a general banking law, which abolished the monopoly features incident to the old banking system. In 1844–45 he was recognized as one of the leaders of the "Hunkers," or regular Democrats in New York, and an active opponent of the "Barnburners." He was secretary of war under Pres. James Polk from 1845 to 1849 and as such discharged with ability the especially onerous duties incident to the conduct of the Mexican War.

From 1853 to 1857 he served the term as secretary of state in the cabinet of Pres. Franklin Pierce. Few cabinet officers in time of peace have had more engrossing duties. His circular in 1853 to American diplomatic agents abroad, recommending that, whenever practicable, they should "appear in the simple dress of an American citizen," created much discussion in Europe; in 1867 his recommendation was enacted into a law of congress. In 1853 Marcy secured the negotiation of the Gadsden treaty (*see* GADSDEN, JAMES), by which the boundary dispute between Mexico and the United States was adjusted and a large area was added to the federal domain. The expedition of William Walker (*q.v.*) to Nicaragua in 1855 further complicated the Central American situation. The diplomatic relations of the United States and Spain growing out of the noted "Black Warrior Case" furnished, perhaps, the most perplexing of Marcy's problems, and it was largely due to his influence that war was averted. However, he was not averse to increasing his popularity and his chances for the presidency by obtaining Cuba in an honourable manner, and it was at his suggestion that James Buchanan, J. Y. Mason and Pierre Soulé, the ministers, respectively, to Great Britain, France and Spain, met at Ostend and Aachen in Oct. 1854 to discuss the Cuban question. But the remarkable "Ostend Manifesto" (*q.v.*), the outcome of their conference, was quite unexpected, and Marcy promptly disavowed the document. In domestic affairs Marcy was a shrewd, but honest partisan; in diplomacy he exhibited the qualities of a broadminded, patriotic statesman, endowed, however, with vigour, rather than brilliancy, of intellect. He died at Ballston Spa, N.Y., on July 4, 1857.

For his early career, consult J. S. Jenkins, *Lives of the Governors of New York* (1851); and for his work as secretary of state, *see* James Ford Rhodes, *History of the United States,* vol. i and ii (1892), and an article by Sidney Webster, "Mr. Marcy, the Cuban Question, and the Ostend Manifesto," *Political Science Quarterly,* vol. viii (1893); J. B. Moore, "A Great Secretary of State," *Pol. Sci. Quart.,* vol. xxx, pp. 377–396 (1915); "Diary and Memoranda of William L. Marcy, 1849–51," *American Hist. Rev.,* vol. xxiv, pp. 444–462, 641–653 (1919); De Alva S. Alexander, *A Political History of the State of New York* (1906–1923).

MAR DEL PLATA, Argentine coastal city, primarily important as a seaside resort and known to Argentines as the "Pearl of the Atlantic," located 250 mi. S. of Buenos Aires. in Buenos Aires province. Pop. (1960) 203,093. Settled in the 1850s as site for a meat-salting plant, Mar del Plata did not become a resort area until the early 20th century. Extensive beaches, a pleasant climate, night clubs and a government-controlled casino add to the tourist attraction. The harbour is an important port for the Argentine fishing fleet, and large canneries have been built to process the catch. (Js. R. S.)

MARDI GRAS: *see* SHROVE TUESDAY.

MARDIN, a town in the il (province) of the same name in Kurdistan, Turk.. and about 30 mi. N.W. of Nisibin, on the line of the Baghdad railway. The town is of some importance on the caravan route between the east and west. From Mardin one road leads west to Urfah and so to Aleppo or Aintab. A second runs northwest to Diarbekr. Southeast runs the road to the Tigris and so to Mosul and Baghdad. The town is the centre of a rich agricultural district, the principal products being wheat, barley and sesame. A certain amount of wool is produced, and there is a small cotton and woolen weaving industry. The population is very mixed and was (1960) 27,390 for the city and 354.112 for the province. It includes Arabs, Armenians, Jacobites, Kurds and a medley of Asiatics.

MARDONIUS (fl. 479 B.C.), Persian general, was the son of Gobryas, one of the conspirators against Smerdis the Magian. He married Artazostra, daughter of Darius Hystaspis, and in 492 was sent to succeed Artaphernes in the settlement of Ionia with a special commission to attack Athens and Eretria. Contrary to the usual Persian policy, he restored democracies in Ionia and then crossed the Hellespont and invaded Thrace and Macedonia. His fleet was wrecked off Athos with enormous loss, and Mardonius abandoned further progress and came back to Aria; he was superseded in 490. On the accession of Xerxes, Mardonius was one of the chief instigators in the invasion of Greece. After Salamis he persuaded Xerxes to return, and he himself stayed behind with a large army. He was defeated by Pausanius and killed at Plataea in Sept. 479.

See Herodotus: books vi–ix; *Diod.* xi, i, 28–31.

MARDUK, a late name for the god of the city of Babylon, uho appears regularly in the classical Sumerian liturgies under the titles *Asar-lu-dug* and *Enbilulu.* The original title is *Asaru,* which occurs in the old pantheon at Fara, *c.* 3200 B.C., and so far as known, long before the city of Babylon was founded. *Asaru, Asar-ri,* is a title of this, originally inferior. deity of the cult of Enki at Eridu, as son of the water god, a deity of lustration. His connection with Babylon, which is first mentioned as a small city by Sargon in the 28th century B C., may be original and very old. The title *Marduk* lays special emphasis upon his solar aspect. It is certain that all the older titles of this god, Asaru, Asar-alim, Asar-alim-nun-na, Asarludug, describe him as an inferior deity of the water cult of Eridu, and how he came to be transferred to Babylon is at present inexplicable. *Alim* means the mythical fish ram, symbol of his father, the water god of Eridu, and *Asaru* was the god of lustration at Habur in Eridu. Asarludug means "Asaru who restores man to happiness," and describes his original activity as agent of Enki in all magical rituals of the water cult against demons. Marduk is pre-eminently the god of the magicians in Babylonian and Assyrian religion, and this was his sole sphere in the original Sumerian pantheon.

With the rapid rise of Babylon under the 11 kings of the 1st dynasty (2169–1870 B.C.), the priests of the local cult looked for some means of increasing the respect due to the god of the great capital and a theological reason for it. Inasmuch as the Sumerian pantheon had been universally accepted by the Accadians, and had now a firm hold upon the religious beliefs of the Semites in Assyria, Cappadocia and the Amoritic western country, it was impossible to make *Asaru* one of the three heads of the trinity; these were securely held by Anu, Enlil and Enki. But the old war and sun god Ninurta, Zamama, son of Enlil, was largely drawn upon to make Asaru also a sun god, and more especially the god of the spring sun. This addition to his original character as a god of lustration and magic was brought about by rewriting the Sumerian legend of Creation in which Kinurta championed the gods against the dragon of Chaos, the storm demon Zû, and then created the world. The new Semitic version in six books attributed this victory of the gods to Marduk. The name itself was introduced at this time, *amar-udu, amar-utu,* and means "young bull, the sun," becoming. after the regular rule of Sumerian loanwords, *Marutukku, Marudukku, Má-rû-tu-*[*uk-ku*], *Maruduk, Merduku, Marduk.* (*See* S. Langdon, *Oxford Editions of Cuneiform Texts,* vol. vi. 99, 113, and *Cuneiform Texts . . .* in the British Museum, vol. xxv. 34. ii. 17.) The Hebrew transcription is Merodak, and the Greek, *Maradouchos, Mardakos, Mardokos, Maradach.*

In the Semitic version of the Epic, Marduk's birth and education are described. The old theological view, that he was the son of Enki or Ea of Eridu, is preserved, except in the Assyrian editions, where he is displaced by Ashur, son of Lahmu. The legend of how he was unanimously raised to the rank of a great god (in the convocation of the gods), because of his magical power to cause objects to vanish and reappear, and for his promise to go forth to battle with Tiamat, Kingu and the dragons of darkness, is one of the principal episodes of the epic. After Tiamat was slain and the dragons bound, Marduk created heaven and earth, the constellations and planets, and fixed their movements. Finally, he ordered man to be created on the advice of his father, Ea. Kingu was then slain and from his blood "mankind" was created. This was the Eridu legend of the creation of man, but in the rival Nippurian school his creation is said to have been by the mother goddess, Aruru, from clay. Undoubtedly the Hebrew legend of the creation of Adam from clay combines the legend of Marduk and Aruru.

Upon the epic of Creation and the myth of the conquest of light over darkness is based the Babylonian new year festival, which is described in the article BABYLONIA AND ASSYRIA. For the later identification of Marduk with Tammuz and the Resurrection of Bêl, *see* TAMMUZ. So completely did Marduk finally dominate the religion of Babylonia that he is chiefly known to Greek and Roman writers as "lord," Bêlos, *see* BĒL. A text proves that in the late period theological speculation went so far as to assimilate all the important deities to Marduk, but this advance toward real monotheism was obviously confined to priests at Babylon. (*See* Jensen, *Keilinschriftliche Bibliothek,* vi. pt. 2, p. 118.) Unlike other great and older deities, Marduk had no temples and shrines outside his own city. The Sumerian cities of the south never admitted his new rôle in the pantheon, but only his original names and character as an inferior water deity of Eridu. At Babylon his temple, Esagila, and his stage tower, Etemenanki, were the largest of the kind in Babylonia and Assyria. To Esagila, at least in the late period, all the statues of the great gods of Babylonia were brought in ships and wagons to assemble in the hall of convocation (Dukug) and fix the fates of men for the coming year at the Nisan festival.

Marduk's principal rôle in astronomy was as the planet Jupiter; as such he was known as Shulpaé, a title of a deity which originally had no connection with Asaru or Marduk. The title belongs originally to Enlil, the ancient *Bêl* of Nippur, and is found in the oldest inscriptions. The planet must have been known as *mul Shulpaé,* and identified with Enlil before the 22nd century, otherwise the name would not have been chosen for Marduk when the theologians assigned to him the largest of the planets.

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MARE, the female of any animal of the family *Equidae,* particularly of the horse. It is also used of the camel. To find a "mare's nest" is an old saying for a purely imaginary discovery. In "night-mare," an oppressive or terrifying dream, the termination is a word for a goblin, supposed to cause these dreams: *cf.* ELF.

MARE CLAUSUM and **MARE LIBERUM** (Lat. for "closed sea" and "free sea")! in international law terms associated with the historic controversy which arose out of demands on the part of different states to assert exclusive dominion over areas of the open or high sea. Thus Spain and Portugal laid claim to exclusive dominion over whole oceans, Great Britain to the narrow seas. and so on. These claims gave rise to vigorous opposition by other powers and led to the publication of Hugo Grotius' work *Mare liberum* (1608). In *Mare clausum,* written in 1617–18 and published in 1635, John Selden asserted "that the sea by the law of nature or nations is not common to all men but capable of private dominion or property as well as the land."

A formula was found, on the other hand, by Cornelius van Bynkershoek in his *De dominio maris* (1702), for the restriction of dominion over the sea to the actual distance which could be protected by cannon range; *i.e.,* three marine miles (see WATERS, TERRITORIAL; HIGH SEAS).

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MAREE, LOCH, is a fresh-water loch in the county of Ross and Cromarty, Scot. Its name commemorates St. Maelrubha, who in 671 founded a monastery at Applecross and a chapel on Isle Maree. The lake is 123 mi. long from Kinlochewe, at the head of the dam erected in the 16th century (or earlier) by the iron-smelters of the Cheardach Ruardh, or Red Smiddy, on the river Ewe, by which it drains to the sea. Its greatest breadth is just over 2 mi. at Slattadale, and the greatest depth 367 ft. There are over 30 islands, covering an area of nearly 1 sq.mi. and lying mostly north and east of Slattadale. The largest is Eilean Subhainn, or St. Swithin's Isle, which contains two small lakes. For two-thirds of its length the loch is flanked by mountains. On the northeast the principal heights are Ben Slioch (3,217 ft.), Ben Lair and Beinn Airidh Charr, and, on the southwest, the peaks of Ben Eay, four of which exceed 3,000 ft. Sea trout and salmon are taken in the loch. The National Nature reserve at Kinlochewe was the first of its kind established in Great Britain.

MARÉES, HANS VON (1837–1887), German painter, was born at Elberfeld on Dec. 24, 1837. In 1853 he went to Berlin, where he studied for two years under Steffeck. For the next eight years he worked chiefly in Munich, coming under the influence of the historical school, and in 1864 he went to Italy, where he lived for about 20 years. He also traveled in Spain and France and spent some time in Berlin. In 1873 he received his most important commission, the painting of frescoes in the library of the Zoological museum at Naples. Although ambitious, Marées lacked self-confidence, and in the latter part of his life ceased to exhibit his work. He died in Rome on June 5, 1887, a disappointed and practically unknown man. When his works were collected at the Munich exhibition in 1891, their value became apparent, as in "The Oarsmen," a subject he often painted.

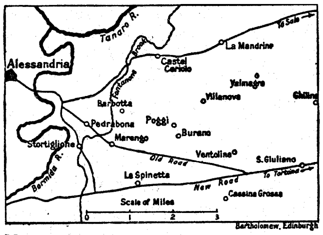
MAREMMA, a marshy region of Tuscany, Italy, from the mouth of the Cecina to Orbetello, 15 to 25 mi. broad. In Etruscan and Roman times the Maremma was a populous and fertile coast plain, with considerable towns situated on the hills—Populonia, Rusdellae, Cosa, etc.—and was drained by subterranean canals, which were brought to light when excavations were in progress for the building of railways. The decline of agriculture at the end of the Republic led to a conversion of the land to pasture, and the fall of the Empire resulted in neglect of watercourses. Leopold II. of Tuscany (1822–1844) made the first successful efforts to counteract malaria by drainage, filling up of swamps, and establishment of new farms, and since his time continuous efforts have been made with considerable success.

See C. Iiicolosi, *Il Litorale Maremmano; La Montagna* ***Maremmanu*** (Bergamo, Arti Grafiche, 1911), well illustrated.

MARENGO, a village of north Italy, on the road between Alessandria and Tortona, and $4\frac{3}{4}$m. E.S.E. of the gates of the former. It is situated on the Fontanone brook, a small affluent of the Tanaro which marks the western edge of the plain of Marengo, the scene of the great victory won by Napoleon Bonaparte over the Austrians under Baron Melas (1729–1806) on June 14, 1800. The antecedents of the battle are described under FRENCH REVOLUTIONARY WARS.

The French army, uncertain of its opponent's position, had advanced westward from the Scrivia towards Alessandria on the 12th, and its outposts had reached the Bormida on the evening of the 13th. But contact with the main Austrian army was not obtained, and on the assumption that it was moving towards either Valenza or Genoa Bonaparte weakened his army by considerable detachments sent out right and left to find the enemy and to delay his progress. Unknown, however, to Bonaparte Melas's army was still at Alessandria, and on the morning of June 14 it filed out of the fortress and began its advance into the great plain of Marengo, one of the few favourable cavalry battle-grounds in north Italy.

Gen. Victor had not carried out Bonaparte's evening order to destroy the bridges over the Bormida, and the dispersion of the French army allowed only a fragmentary, though most energetic, resistance to be offered to the Austrian onset. The latter, considerably delayed at first by the crossing of the river Bormida, broke up into two columns,[1] advanced, the right by the main road on Marengo, the left on Castel Ceriolo. The former, personally commanded by Melas, was 20,000 strong, and Gen. Victor, its immediate opponent, about 10,000, or including some 5,000 of Lannes' corps who fought on his right, about 15,000 strong; the Austrians were, moreover, greatly superior in guns (in all 192 to 14) and cavalry. The French disputed every yard of ground, holding their first line until they had by fire and counter-attack forced practically the whole of the Austrian right to deploy, and two hours passed before the Austrians managed to reach the Fontanone brook. But Victor's troops, being disorganized and short of ammunition, had then to retire more rapidly across the plain. The retreat was orderly, according to Victor's report, and made in echelon from the centre, and it is certain that at any rate the regiments held together, for the 6,000 Austrian sabres found no opportunity to charge home. Many guns and wagons were, however, abandoned.



MAP OF MARENGO, THE SCENE OF NAPOLEON'S VICTORY OVER THE AUSTRIANS, JUNE 14, 1800

On the French right, opposed to the column of Lieut.-Field-Marshal Ott, was Lannes, with some 4,000 men (excluding Watrin's division which was with Victor) against 7,500. He too was after a time forced to retire, with heavy losses. Thus, about 11 A.M., Bonaparte, who was at some distance from the field, became convinced that he had to deal with Melas's army. At once he sent out his staff officers to bring back his detachments, and pushed forward his only reserve, Monnier's division, to support Lannes and Victor. But before this help arrived Lannes had been driven out of Castel Ceriolo, and Victor and Watrin forced back almost to San Giuliano. A little after 2 P.M. Monnier's division (3,500) came into action, and its impetuous advance drove the Austrians out of Castel Ceriolo. But after an hour it was forced back in its turn, and by 3 P.M., therefore, the 20,000 French troops, disordered and exhausted, and in one line without reserves;[2] held a ragged line of battle to the right and left of San Giuliano. The best that could be expected was a prolongation of the struggle till nightfall and a fairly orderly retreat. Melas, slightly wounded and believing that the battle was won, returned to Alessandria, leaving a younger man, his chief of staff Zach, to organize the pursuit.

Then followed one of the most dramatic events in military history. Of the two detachments sent away by Napoleon in search of the enemy, one only received its orders of recall. This was Boudet's division of Desaix's corps, away to the south at Rivalta and at noon heading for Pozzolo-Formigaro on the Alessandria-Genoa road. At 1 P.M. a brief message, "Revenez, au nom de Dieu!" altered the direction of the column, and between 4 and 5, after a forced march, the division, headed by Desaix, came on to the battle-field. It was deployed as a unit and moved forward at the word of command along the main road Alessandria-Tortona, the sight of their closed line giving fresh courage to the men of Lannes and Victor. Then, while on the other side Zach was arraying a deep column of troops to pursue along the main road, Napoleon and Desaix, themselves under fire, hastily framed a plan of attack. All arms were combined. First, Marmont with eight of Boudet's guns and ten others (the rest had been abandoned in the retirement) came into action on the right of the road, replying to the fire of the Austrian guns and checking their advanced infantry; close in rear of the artillery was Desaix's infantry with the remnants of Lannes' and Victor's troops rallying on its right and left; on Lannes' right, still facing Ott's column, was Monnier, supported by the Consular Guard of horse and foot; lastly 400 sabres of Kellermann's cavalry brigade, which had already been engaged several times and had lost heavily, formed up on the right of Desaix. About 5 P.M. Desaix advanced against the head of the Austrian main column formed by Zach. He himself fell in the attack, but the onset of his intact troops drove back the leading Austrians upon their supports, and at the critical moment when the attack of Boudet's single weak division had almost spent its force, Kellermann with his 400 sabres sallied out of the French line. Marmont had brought up two guns to assist the infantry, and as he fired his last round of case-shot the cavalry raced past him to the front, wheeled inwards against the flank of the great column, and rode through and through it. Zach was taken prisoner with more than 2,000 men, and Kellermann, rallying some of his troopers, flung himself upon the astonished Austrian cavalry and with the assistance of the Consular Guard cavalry defeated it. The "will to conquer" spread along the whole French line, while the surprise of the Austrians suddenly and strangely became mere panic. Lannes, Victor and Monnier advanced afresh, pushing the Austrians back on Marengo. A few Austrian battalions made a gallant stand at that place, while Melas himself, as night came on, rallied the fugitives beyond. Next day the completely exhausted, but victorious, French army extorted from the dazed Austrians a convention by which all Italy up to the Mincio was evacuated by them. The respective losses were: French about 4,000, Austrians 9,500.

See the French official *Campagne de l'armée de rtserve*, vol. ii., *by* C. de Cugnac.

[1]A third column was sent out to the extreme right (3,000 under O'Reilly). This destroyed a small French detachment on the extreme left, but took little or no part in the main battle.

[2]The Austrians, too, fighting in "linear" formation had few reserves. About one-third only of the imperial forces in Italy was actually engaged in the battle.

MARENZIO, LUCA (before 1560–1599), Italian composer, was born probably at Coccaglia in the Bergamask before 1560. According to some accounts he was descended from a noble family of Bergamo. He was a pupil of Giovanni Contini, organist of Brescia, and began to publish books of madrigals at an early age. In 1581 he was in Venice and from 1582 to 1585 in Rome, where he was at one period chapel-master to the Cardinal d'Este. For two years he held a handsome appointment at the court of Poland, but 1595 found him back in Rome with an appointment at the Papal chapel. In Rome he became a warm friend of Cardinal Aldobrandino, the pope's nephew. He died in Rome on Aug. 22, 1599. Marenzio's most important compositions consist of the 16 books of madrigals, 5 books of vilanelles and airs, 2 books of motets and 1 mass. (The complete list is in Eitner's *Quellen-lexikon.*) The 5-part and 6-part madrigals in two books are in the British Museum. The *Musica transalpina* (1588) contains some of his works, and several motets are included in Proske's *Musica divina* (1853).

See also "Marenzio" *in* Grove *Dictionary* of *Music and Musicians.*

MAREOTIS, the most westerly of the lakes in the Delta of Egypt (Arab. *Mariut*). On the narrow strip of land separating the lake from the Mediterranean the city of Alexandria is built. (*See* EGYPT and ALEXANDRIA.) In classical times its shores were a region of great fertility, and in the middle ages the lake was practically dry. During the siege of Alexandria in 1801 the British cut the ridge of dunes at Aboukir and flooded the area with sea water. Now, by means of pumps, the water-level of the lake is kept about 8 ft. below sea-level, and cultivation has been largely restored.

MARE'S-TAIL, the popular name for an aquatic herb known botanically as *Hippuris vulgaris* (water milfoil family Hippuridaceae). Mare's-tail grows on margins of lakes, ponds and similar localities and has a submerged stout creeping rootstock, from which spring many jointed cylindrical stems bearing numerous narrow leaves close set in whorls. The minute greenish flowers are borne in the leaf axils. Like many fresh-water plants it has a wide distribution, occurring in arctic and temperate regions in the northern hemisphere. It reappears in southern South America.

MARET, HUGUES-BERNARD, Duc de Bassano (1763–1839), French statesman and publicist, was born at Dijon. After receiving a sound education, he entered the legal profession and became advocate at the King's Council at Paris. The interest aroused by the debates of the first National Assembly suggested to him the idea of publishing them, conjointly with Méjean, in the *Bulletin de l'Assemblée.* The publicist Charles Joseph Panckoucke (1736–1798), owner of the *Mercure de France* and publisher of the famous *Encyclopédie* (1781), persuaded him to merge this in a larger paper, the *Moniteur universel,* which gained a wide repute for correctness and impartiality. He was a member of the moderate club, the Feuillants; but after the overthrow of the monarchy on Aug. 10, 1792 he accepted an office in the ministry of foreign affairs, where he sometimes exercised a steadying influence. On the withdrawal of the British legation from Paris Maret went on a mission to London, where he had a favourable interview with Pitt on Dec. 2, 1792. All hope of an accommodation was, however, in vain. After the execution of Louis XVI. (Jan. 21, 1793), the chief French diplomatic agent, Chauvelin, was ordered to leave England, while the French Convention declared war (Feb. 1, 1793). These events precluded the possibility of success attending a second mission of Maret to London in January. He was sent to Naples as ambassador of the French Republic; but he was captured by the Austrians, and was only released in 1795 when the duchess of Angoulême was set free. Maret took part in the negotiations with Great Britain at Lille during the summer of 1797, until the *coup d'état* of Fructidor frustrated any peace. On the return of Bonaparte from Egypt in 1799 Maret joined the general's party which came to power with the *coup d'e'tat* of Brumaire (Nov. 9–10. 1799).

Maret now became one of the First Consul's secretaries and shortly afterwards secretary of state. The *Moniteur,* which became the official journal of the state in 1800, was placed under his control. In 1804 he became minister; in 1807 he was named count, and in 1809 he received the title of duc de Bassano. His personal devotion to the emperor was of that absolute unwavering kind which Napoleon highly valued. Maret accompanied Napoleon through most of his campaigns, including that of 1809; and in the spring of 1811 he replaced Champagny, duc de Cadore, as minister of Foreign Affairs. In this capacity he concluded the treaties between France and Austria and France and Prussia, which preceded the French invasion of Russia in 1812. He was with Napoleon through the greater part of that campaign; and after its disastrous conclusion helped to prepare the new forces with which Napoleon waged the equally disastrous campaign of 1813. But in November 1813 Napoleon replaced him by Caulaincourt, duc de Vicence.

Maret, however, as private secretary of the emperor, remained with his master through the campaign of 1814, as also during that of 1815. After the second restoration of the Bourbons he was exiled, and retired to Gratz where he occupied himself with literary work. In 1820 he was allowed to return to France, and after the Revolution of 1830, Louis Philippe, king of the French, made him a peer of France; he also held two high offices for a few days. He died at Paris in 1839. He shares with Daru the honour of being the hardest worker and most devoted supported in Napoleon's service; but it has generally been considered that he carried devotion to the length of servility, and thus often compromised the real interests of France. This view has been contested by Baron Ernouf in his work *Maret, duc de Bassano,* which is the best biography.

For Maret's mission to England in 1792 and his work at Lille in 1797, *see* Augustus W. Miles, *Letters on the French Revolution.*

MARGARET, a female proper name, which became very popular in all Christian countries as that of Saint Margaret (*q.v.*). (Fr. *Marguerite,* It. *Margherita,* Ger. *Margareta,* fr. Lat., *margarita,* Gr. μαργαρίτης, a pearl.)

MARGARET, ST. (Sancta Margarita), virgin and martyr, is celebrated by the Church of Rome on July 20. According to the legend, she was a native of Antioch, daughter of a pagan priest named Aedesius. She was scorned by her father for her Christian faith, and lived in the country with a foster mother keeping sheep. Olybrius, the "praeses orientis," offered her marriage as the price of her renunciation of Christianity. Her refusal led to her being cruelly tortured, and after various miraculous incidents, she was put to death about 275 A.D. Among the Greeks she is known as Marina, and her festival is on July 17. She has been identified with St. Pelagia (*q.v.*)—Marina being the Latin equivalent of Pelagia — who, according to a iegend, was also called Margarito. The cult of St. Margaret was very widespread in England, where more than 250 churches are dedicated to her.

See *Acta sanctorum,* July, v. 24–45; *Bibliotheca hagiographica, Latina* (Brussels, 1899), n. 5303–13; Frances Arnold-Forster, *Studies in Church Dedications* (London, 1899), i. 131–133 and iii. 19.

MARGARET, ST. (*c.* 1045–1093), queen of Malcolm III. Canmore king of Scotland, was the daughter of the English prince Edward, son of Edmund Ironside, and sister of Edgar Aetheling. In 1067 the widow and children of Edward fled from Northumberland and sought the protection of the Scottish king. The marriage of Malcolm and Margaret was followed by several invasions of Northumberland by the Scottish king, probably in support of the claims of his brother-in-law Edgar. A considerable portion of the old Northumbrian kingdom had been reduced by the Scottish kings in the previous century, but up to this time the English population had little influence upon the ruling element of the kingdom. Malcolm's marriage undoubtedly improved the condition of the English, and under Margaret's sons, Edgar, Alexander I. and David I., the Scottish court practically became Anglicized. Margaret died on Nov. 17, 1093, four days after her husband and her eldest son Edward, who were slain in an invasion of Northumberland. She rebuilt the monastery of Iona, and was canonized in 1251 on account of her benefactions to the Church.

MARGARET (1353–1412), queen of Denmark, Norway and Sweden, the daughter of Valdemar IV. of Denmark, was born in 1353 and married ten years later to King Haakon VI. of Norway. Her first act, after her father's death (1375), was to procure the election of her infant son Olaf as lung of Denmark. Olaf died in 1387, having in 1380 also succeeded his father; and in the following year Margaret, who had ruled both kingdoms in his name, was chosen regent of Norway and Denmark. She now turned to Sweden, where the nobles were in arms against their unpopular king, Albert of Mecklenburg.

At a conference held at Dalaborg castle, in March 1388, the Swedes were compelled to accept all Margaret's conditions, elected her "Sovereign Lady and Ruler," and engaged to accept from her any king she chose to appoint. On Feb. 24, 1389, Albert, who had returned from Mecklenburg with an army of mercenaries, was routed and taken prisoner at Aasle near Falkoping, and Margaret was now the omnipotent mistress of three kingdoms. Stockholm, then almost entirely a German city, still held out; fear of Margaret induced both the Mecklenburg princes and the Wendish towns to hasten to its assistance; and the Baltic and the North Sea speedily swarmed with the privateers of the *Viktualien brodre* or *Vitalianer,* so called because their professed object was to revictual Stockholm. Finally the Hansa intervened, and by the compact of Lindholm (1395) Albert was released by Margaret on promising to pay 60,000 marks within three years, the Hansa in the meantime to hold Stockholm in pawn. Albert failing to pay his ransom within the stipulated time, the Hansa surrendered Stockholm to Margaret in September 1398, in exchange for very considerable commercial privileges.

It had been understood that Margaret should, at the first convenient opportunity, provide the three kingdoms with a king who was to be her nearest kinsman, and in 1389 she proclaimed her infant cousin, Eric of Pomerania, king of Norway. In 1396 homage was rendered to him in Denmark and Sweden likewise, Margaret reserving to herself the office of regent during his minority. To weld the united kingdoms still more closely together, Margaret summoned a congress of the three councils of state to Kalmar in June 1397; and on Trinity Sunday, June 17, Eric was crowned king of Denmark, Norway and Sweden. The proposed act of union divided the three *Rigsraads,* but the actual deed embodying the terms of the union never got beyond the stage of an unratified draft. Margaret revolted at the clauses which insisted that each country should retain its own laws and customs, and be administered by its own dignitaries, as tending to prevent amalgamation, but she avoided every appearance of an open rupture.

A few years after the union of Kalmar, Eric, now in his eighteenth year, was declared of age and homage was rendered to him in all his three kingdoms, but during her lifetime Margaret was the real ruler of Scandinavia. So long as the union was insecure, Margaret had tolerated the presence near the throne of "good men" from all three realms (the *Rigsraad,* or council of state, as these councillors now began to be called); but their influence mas always insignificant. In every direction the royal authority remained supreme. The offices of high constable and earl marshal were left vacant; the *Danehoffer* or national assemblies fell into desuetude, and the great queen, an ideal despot, ruled through her court officials acting as superior clerks Margaret also recovered for the Crown all the landed property which had been alienated during the troublous days of Valdemar IV. This so-called "reduktion," or land-recovery, was carried out with the utmost rigour, and hundreds of estates fell to the Crown. Margaret also reformed the Danish currency. In foreign politics she maintained a strict system of neutrality. On the other hand she spared no pains to recover lost Danish territory. Gotland she purchased from its actual possessors, Albert of Mecklenburg and the Livonian Order, and the greater part of Schleswig was regained in the same way. Margaret died suddenly on board her ship in Flensborg harbour on Oct. 28, 1412.

See *Danmarks riges historie, den senere Middelalder,* pp. 358–412 (Copenhagen, 1897–1905); Erslev, *Danmarks historie under dronning Margrethe* (Copenhagen, 1882–1901); Hill, *Margaret of Denmark* (London, 1898) (*R*.N. B.)

MARGARET (1489–1541), queen of Scotland, eldest daughter of Henry VII., king of England, by his wife Elizabeth, daughter of Edward IV., was born at Westminster on Nov. 29, 1489. She married James IV. of Scotland on Aug. 8, 1503, but the scanty dowry given by her avaricious father embittered the relations between the two kingdoms, which the marriage, although accompanied by a treaty of perpetual peace. did nothing to heal. The whole of Margaret's life after her marriage was an unending series of intrigues, first with one political faction then with another; her conduct being mainly influenced by considerations affecting her pocket.

Margaret was crowned at Edinburgh in March 1504. Between 1507 and 1510 two sons and a daughter were born, all of whom died in infancy; in 1512 she gave birth to a son who succeeded his father as James V.; in 1514 she bore a posthumous son, Alexander, created duke of Ross, who died in the following year. A dispute with her brother Henry VIII. over a legacy was a contributory cause of the war which ended at Flodden, where James IV. was killed in Sept. 1513, having by his will appointed Margaret sole guardian of her infant son, now James V. Scotland was divided mainly into two parties, one in favour of alliance with England, and the other with France. The leader of the latter was John Stewart, duke of Albany, next heir to the crown of Scotland after Margaret's sons; Margaret herself for the most part inclined to the English faction; and when Albany returned to Scotland from France on the invitation of the Scottish parliament in the spring of 1514, the conflict grew almost to civil war. Her marriage to Archibald Douglas, earl of Angus, on Aug. 6, 1514 alienated many of the nobility, especially the earls of Arran and Home, and made her entirely dependent on the house of Douglas. It also furnished the council with a pretext for removing her from the regency and guardianship of the king in favour of Albany in July 1515. She fled to England in September, where a month later she bore to Angus a daughter, Margaret, who afterwards became countess of Lennox, mother of Lord Darnley and grandmother of James I. of England.

In 1516 Margaret went to her brother's court in London, while Angus, much to his wife's displeasure, returned to Scotland, where he made peace with Albany and was restored to his estates. The rivalry between the French and English factions in Scotland was complicated by private feuds of the Hamiltons and Douglases, the respective heads of which houses, Arran and Angus, were contending for the supreme power in the absence of Albany in France, where at the instance of Henry VIII. he was detained by Francis I. Margaret, quarrelling with her husband over money matters, sided at first with Arran and began to agitate for a divorce from Angus. In this she was probably aided by Albany, who found an unexpected ally in the queen-mother, Margaret being temporarily alienated from the English party by her brother Henry's opposition to her divorce. When Albany returned to Scotland in 1521 his association with Margaret gave rise to the accusation that it was with the intention of marrying her that he favoured her divorce from Angus. As Albany was strongly supported by the Scottish parliament, Angus found it necessary to withdraw to France till 1524. During these years there was constant warfare between the English and the Scots on the border, but in May 1524 Albany was obliged to retire to France. Henry VIII. continually aimed at securing the person of his nephew, the king of Scots, but he was proclaimed a reigning sovereign in July 1524. The queen-mother married Henry Stewart, second son of Lord Avondale, immediately after her divorce from Angus in 1527. Margaret and her new husband, who was created Lord Rlethven, now became for a time the ruling influence in the counsels of James V. But when her desire to arrange a meeting between James and Henry VIII. in 1534 was frustrated by the clergy and the council, Margaret in her disappointment revealed certain secrets to Henry which led to her being accused by her son of betraying him for money and of acting as an English spy. She died at Methven Castle on Oct. 18, 1541.

See A. Lang, *History of Scotland,* vol. i. (1900); M.A. E. Green, *Lives of the Princesses of England (6* vols., 1849–55); *The Hamilton Papers,* ed. by *J*. Bain (2 vols, Edinburgh, 1890); John Leslie, *Hzstory of Scotland,* ed. by *T*. Thompson (4 vols., Edinburgh, 1830); Sir H. Ellis, *Original Letters Illustrative of Englzsh History* (182j-46).

MARGARET (1283–1290), titular queen of Scotland, and generally known as the "maid of Norway," was the daughter of Eric II., king of Norway, and Margaret, daughter of Alexander III., king of Scotland. Her mother died soon after Margaret's birth, and in 1284 the estates of Scotland decided that if Alexander died childless the crown should pass to his granddaughter. In March 1286 Alexander was killed and Margaret became queen. The English king Edward I. was watching affairs in Scotland, and in 1289 a marriage was arranged between the infant queen and Edward's son, afterwards Edward II. Margaret sailed from Norway and reached the Orkneys, where she died in Sept. 1290. Some mystery surrounded her death, and about 1300 a woman from Leipzig declared she was Queen Margaret. The impostor, if she were such, was burned as a witch at Bergen.

See A. Lang, *History of Scotland,* vol. i. (Edinburgh, 1904); A. O. Anderson, *Early Sources of Scottish History, A.D. 500–1286,* vol. *a* (1922).

MARGARET MAULTASCH (1318–1369), countess of Tirol, nicknamed Maultasch (pocket-mouth) on account of the shape of her mouth, was the daughter and heiress of Henry, duke of Carinthia and count of Tirol. When Henry died in 1335 Carinthia passed to Albert II., duke of Austria; but Tirol was inherited by Margaret and her young husband, John Henry, son of John, king of Bohemia, whom she had married in 1330. This union was not a happy one, and the Tirolese disliked the government of Charles, afterwards the emperor Charles IV., who ruled the county for his brother. Margaret combined with the Estates and expelled her husband, being supported by the Emperor Louis IV., who, declaring her marriage null and void, married her in 1342 to his own son Louis, margrave of Brandenburg, whom Margaret then pronounced Count of Tirol. The local nobles were, however, soon discontented with their new rulers. Supported by the Pope, who placed the Emperor and his son under the ban, they attacked Margaret, who defended herself bravely until her husband put down the rebellion. Louis died in 1361 and Margaret's only son, Meinhard, in 1363 On Sept. 29, 1363, Margaret handed over Tirol to Rudolph IV., duke of Austria, and retired to Vienna, where she died on Oct. 3, 1369. She lived long in the memory of the people of Carinthia, who regarded her as an amazon, and called her the *Wicked Gretl.*

See A. Huber, *Geschichte der Vereinigung Tirols mit Oesterreich* (Innsbruck, 1864). Her story is the subject of Lion Feuchtwanger's novel *The Ugly Duchess.*

MARGARET OF ANJOU (1430–1482), queen of England, daughter of René of Anjou, titular king of Naples and Jerusalem, was born on March 23, 1430. She married Henry VI. king of England on April 23, 1445. Her marriage had been negotiated by William de la Pole, duke of Suffolk, and when she came to England, Suffolk and his wife were her only friends. Naturally she fell under his influence, and supported his policy. This, added to her French origin and sympathies, made her unpopular. Her active share in politics began after Suffolk's fall in 1450. She not only supported Edmund Beaufort, duke of Somerset, in his opposition to Richard of York, but concerned herself also in the details of government, seeking pecuniary benefits for herself and her friends. As a childless queen her influence was limited; and when her only son, Edward, was born on Oct. 13, 1453, her husband was stricken with insanity. From this time she was the ardent champion of her husband's and son's rights; to her energy the cause of Lancaster owed its endurance, but her implacable spirit contributed to its failure.

When York's protectorate was ended by Henry's recovery in January 1455, Margaret, not content with the restoration of Somerset and her other friends to liberty and office, pushed her politics to extremes. The result was the defeat of the Lancastrians at St. Albans, and for a year Margaret had to acquiesce in York's power. Ultimately, in October 1456 at Coventry, she procured some change in the government. Though formally reconciled to York in March 1458, she continued to intrigue with her partisans in England. and even with friends in France. After the Yorkist failure at Ludlow in 1459, Margaret embittered the struggle by a wholesale proscription of her opponents in the parliament at Coventry. She was not present with her husband at Northampton on July 10, 1460. She made her way to Scotland, and from Mary of Gelderland, the queen regent, purchased the promise of help at the price of surrendering Berwick. Margaret was still in Scotland at the date of Wakefield, so was not, as alleged by hostile writers, responsible for the barbarous treatment of York's body. But she was with the northern army which defeated Warwick at St. Albans on Feb. 17, 1461; for the executions which followed she must bear the blame. After Towton Margaret with her husband and son once more took refuge in Scotland.

A year later she went to France, and with help from her father and Louis XI. equipped an expedition which landed in Northumberland in October, and achieved some slight success; but on the way to seek further help from Scotland the fleet was overwhelmed in a storm. In the spring she was again trying to raid Northumberland. In August 1463 she crossed to Sluys in Flanders. She was almost destitute, but was courteously treated by Charles the Bold, then count of Charolais, and joined her father in France. Margaret never lost her hopes of her son's restoration. But when at last the quarrel between Warwick and Edward IV. brought her the opportunity, it was with difficulty that she could consent to be reconciled to so bitter an enemy. After Warwick's success and Henry's restoration Margaret still remained in France. On the day of Warwick's defeat at Barnet (April 14) Margaret and Edward landed at Weymouth. Three weeks later the Lancastrians were defeated at Tewkesbury, and Edward was killed. Margaret was captured a few days after, and brought to London where for five years she remained a prisoner. Finally Louis XI. ransomed her under the Treaty of Pecquigny, and she returned to France in January 1476. Margaret lived for six years in Bar and Anjou, in poverty and dependent for a pension on Louis, who made her surrender in return her claims to her father's inheritance. She died on April 25, 1482 and was buried at Angers cathedral.

BIBLIOGRAPHY.—For contemporary English authorities *see* under HENRY VI. French authorities and especially the *Chroniques* of George de Chastellain, and the *Mémoires* of Philippes de Comines contain much that is of value. The *Letters of Margaret of Anjou* (Camden Soc., 1863) have small historical importance. There have been numerous biographies, the chief is Mrs. Hookham's *Life of Margaret of Anjou* (1872).

MARGARET OF AUSTRIA (1522–1586), duchess of Parma and regent of the Netherlands from 1559 to 1567, was a natural daughter of Charles V. Her mother, Margaret van Ghent, was a Fleming. She was brought up by her aunts Margaret of Austria and Maria of Hungary, who were successively regents of the Netherlands from 1507 to 1530 and from 1530 to 1555. In 1533 she was married to Alexander de' Medici, duke of Florence, who was assassinated in 1537, after which she became the wife of Ottavio Farnese, duke of Parma, in 1542. The union proved an unhappy one. Like her aunts, who had trained her, she was a woman of masculine abilities, and Philip II., when he left the Netherlands in 1559 for Spain, acted wisely in appointing her regent. In ordinary times she would probably have proved as successful a ruler as her two predecessors in that post, but her task was very different from theirs. She had to face the rising storm of discontent against the Inquisition and Spanish despotism, and Philip left her but nominal authority. He was determined to pursue his own arbitrary course, and the issue was the revolt of the Netherlands. In 1567 Margaret resigned her post into the hands of the duke of Alva and retired to Italy. She died at Ortona in 1586.

See L. P. Gachard, *Correspondance de Marguérite d'Autriche avec Phillippe II. 1554–1568* (Brussels, 1867–87); R. Fruin, *Het voorspel van den tachtig jarigen vorlog* (Amsterdam, 1856); E. Rachfahl, *Margaretha von Parma, Statthalterin der Niederlande, 1559–1567* (Munich, 1895); also bibliography in *Cambridge Modern History,* iii. 795–809 (1904).

MARGARET OF AUSTRIA (1480–1530), duchess of Savoy and regent of the Netherlands from 1507 to 1530, daughter of the archduke Maximilian of Austria, afterwards the emperor Maximilian I., was born at Brussels on Jan. 10, 1480. In April 1497 she was married at Burgos to the Infant John, heir to the throne of Castile and Aragon. She was left a wido , however, a few months later. In 1501 Margaret became the wife of Philibert II., duke of Savoy, who only survived until 1504. The sudden death of her brother the archduke, Philip the Handsome (Sept. 25, 1506), opened out to her a new career. In 1507 she was appointed by her father regent of the Netherlands and guardian of her nephew Charles, afterwards the emperor Charles V. Charles came of age in 1515, but he entrusted Margaret with the regency, and she held the post until her death in 1530. She was a wise and prudent ruler, of masculine temper and intrepidity, and capable in affairs of state. She is noted for her part in conducting preliminary negotiations with Louise of Savoy, mother of Francis I of France, leading toward the treaty of Cambrai (1529) between Francis and Charles V. Under that treaty, known as la *paix des dames* ("ladies' peace"), Francis renounced his claims on Milan and Naples but retained Burgundy.

See Th. Juste, *Charles-Quint et Marguérite d'dutriche* (Brussels, 1858); A. Le Glay, *Maximilien I. et Marguérite d'dutriche* (with correspondence, Paris, 1839); De Quinsonas, *Matériaux pour servir & l'histoire de Marguérite d'Autriche* (Paris, 1855); E E Tremayne, *The First Governors of the Netherlands: Margaret of Austria* (1908); Jane de Iongh, *Margaret of Austria, Regent of the Netherlands,* Eng. trans. *by* M. D Herter Norton (New York, 1953; London, 1954).

MARGARET OF NAVARRE: *see* MARGUERITE D'ANGOULEME.

MARGARET OF VALOIS: *see* MARGCERITE (MARGOT) DE VALOIS.

MARGARINE, or OLEOMARGARINE, has been variously defined during its history. In the U.S. it is defined in the standard of identity promulgated under the federal Food, Drug and Cosmetic act as a plastic food prepared from one or more vegetable and animal fats intimately mixed with one or more variations of cow's milk together with table salt and several other permitted optional ingredients in small quantities. It may also be defined as a plastic, solid, fat food consisting of 80% (U.S. legal minimum) edible fat, which carries dispersed in it the balance of the product, namely, an aqueous portion consisting primarily of skim milk and salt.

The ingredients in margarine, then, are those found in its edible fat portion and in its milk portion. The edible fats used have varied widely since the 1870s when the manufacture of margarine began, the trend having been from the animal fats predominantly in use earlier, to the vegetable fats predominantly in use in the mid-20th century in the C.S. In European countries whale oil has been and is widely used, but it was never commonly used in the U.S. Animal fats used in the U.S. included lard, oleo oil and tallow; a wide variety of the vegetable fats have been used, principally cottonseed, soybean. peanut and corn oils in the 1950s; and nut oils, such as coconut, palm and palm kernel oils before 1935.

Usually there are such ingredients as vitamins A and D, vegetable lecithin. emulsifiers and similar materials dissolved in the liquid fats used in making margarine, while in the milk portion there are dissolved the salt and other ingredients readily mixable with milk. These two portions are then thoroughly mixed to produce an emulsion which is chilled to a solid, kneaded to a suitable mass and packaged.

Margarine was developed in the late 1860s by the French chemist Hippolyte Mège-Mouriès, who not only received recognition for his achievement in France and other European countries, but was also granted a U.S. patent in 1873. Out of Mège-Mouriès' early experience and process, uhich was unduly complicated. there grew the generally simple process in the 1870s and 1880s in the U.S. of churning the melted margarine fat blend with milk and salt, solidifying the churned mixture by chilling with cold water, working mechanically (kneading) the chilled mass to a plastic consistency and packaging, all by means of typical butter-working equipment of the time.

Primarily as a result of the efforts of competitive industries, margarine was subjected in the United States and elsewhere to severe restrictive legislation. The Oleomargarine act of 1886 was the earliest significant U.S legislation on the subject. This law, together with subsequent amendments to it (1902, 1930), imposed a prohibitive tax on yellow margarine, levied high licence fees on all manufacturers, wholesalers and retailers of the product, and in other respects subjected the manufacture and sale of this food to numerous restrictions. The result was not only to prevent margarine from reaching its normal consumption level but for a very long time to prevent the sale of any yellow margarine. There was also a wave of similar state legislation, in which practically every state took part.

An important development in margarine processing occurred in the mid-1930s. Before that time, most vegetable fat margarine was made from imported oils, such as coconut, palm and palm kernel oils. While these oils were perfectly wholesome. the anti-margarine groups used this situation to support the continued restrictions on margarine and even to advocate additional ones on the basis that such use of foreign oils was inimical to the best interests of the C.S. farmer. After considerable research, manufacturers of margarine in the U.S. finally found in the mid-1930s how to make a satisfactory margarine from domestic vegetable oils. The resultant increase in the use of cottonseed and soybean oils stimulated the interest of cottonseed and soybean farmers and processing groups in the elimination of discriminatory restrictions on margarine; in the 1940s consumer groups in the U.S. also became interested in the elimination of this legislation.

The efforts of domestic, agricultural and consumer groups to have margarine freed from what they considered unfair legislation culminated in success in 1950, when congress repealed all the federal taxes and licence fees on margarine made in the U.S. This action was followed by similar action of state legislatures, and within a relatively short time thereafter, most of the state prohibitions against yellow margarine were repealed.

In addition to the development of the use of domestic vegetable fats in margarine, other improvements by modern scientific methods were made. In 1923 it was first fortified with vitamins A and D. In 1941, following extensive public hearings, the United States Food and Drug administration established a definition and standard of identity for margarine which, in turn, were revised and brought up to date in 1952. This standard prescribed the mandatory and the optional ingredients to be used in the manufacture of margarine, and served not only as government recognition of the wholesomeness of the product, but also as a protection to the consumer. As a result of these developments and other scientific advances, margarine has been accepted by the U.S. public to an extent comparable with its acceptance in many European countries.

Nutritionally, the value of margarine as a food fat is primarily as a source of food fuel (calories) and of other nutritional factors. From the early 1950s, all margarine manufactured in the U.S. was fortified with at least 15,000 U.S.P. units of vitamin A to the pound. The caloric value of margarine is derived from food fats widely used and accepted by many people in forms other than margarine. See also Index references under "Margarine" in vol. 24.

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MARGARITA ISLAND (ISLA DE MARGARITA), also known as the Isle of Pearls, is the largest of 70 islands making up the state of Nueva Esparta (*q.v.*) in Venezuela, and is about 12 mi. N. of the peninsula of Araya. Of the 75.899 persons in the state in 1950, 72,229 were concentrated on the island. Margarita is about 40 mi. long from east to west, has an area of 414 sq.mi. and a coast line of 198 mi., with many natural harbours. It is in reality two islands joined by a low, narrow isthmus. The highest elevation on the island is the peak of Macanao, 2,493 ft. After 1950 the government enlarged its road-building program, and in 1957 the official claim was that the island had 200 mi. of improved roads. There is an airport at Porlamar. Water is a fundamental problem of the island population; drinking water is brought from the mainland. Farming and grazing is carried on but the island is a net importer of foodstuffs.

La Asunción (pop. [1950] 4,510), on the eastern end of the island, is the capital of the state. It was founded in 1524 by Marcelo Villalobos. Porlamar (pop. [1950] 14,769), is the most important city. It is the centre of a pearl fishing industry that dates back to the early 16th century and which is closely controlled by the government in order to guarantee its continuance. Pampatur (pop. [1950] 2,506), the leading port, is located on a protected bay. Juangriego (pop. [1950] 3,928), located on the north side of the island, is a major fishing centre; its canned products are sold throughout the nation.

Tile and ceramics are manufactured on the island. Shoes and hats made from sisal, produced locally, have a national market. The building of fishing boats is an established industry, as is the manufacture of salt. After World War II Margarita won favour as a tourist area.

The island of Margarita was discovered by Columbus in 1498 on his third voyage. The pearl industry of Margarita and the surrounding islands sprang up soon thereafter. The life span of the Indian divers was short and the raiding of the mainland for replacements led to bloody reprisals by the natives. In 1j61 the crazed Lope de Aguirre ravaged the island before menacing the mainland. Fifteen years later (1576) it was visited by British pirates. In 1662 Pampatar was razed by the Dutch. For a long time Margarita was attached to Cumaná, but in the 18th century it was made administratively independent. Its traders rendered invaluable assistance to the revolutionists in the wars of independence; Simon Bolivar used the island as a base of operation in 1816, and the Spanish general Pablo Morillo was driven from its shores in 1817. In recognition of its contribution to the independence movement Margarita, with the surrounding smaller islands, was renamed Nueva Esparta ("New Sparta").

The population of Margarita is predominantly indigenous; the Spanish ancestry is traceable chiefly to the Canary Islands. Since 1920 the island has attracted immigrants from abroad, but at the same time many islanders have migrated to the mainland in search of favourable employment. There are on the island a liceo (high school) and three institutions which provide commercial instruction. (J. J. J.)

MARGATE, a municipal borough and seaside resort in the Isle of Thanet parliamentary division of Kent, Eng., 16 mi. N.E. of Canterbury by road. Pop. (1961) 45,708. Area 10.9 sq.mi. During the summer it is served by pleasure steamers from London. The municipality owns 9 mi. of sea front, with promenades along almost the whole distance. and has provided concert pavilions, winter gardens, bathing pools and other amenities for the summer visitors, which are the town's chief industry. There are some light industries south of the town. Margate suffered considerably from air raids in World War II, and in 1951 new government offices were built.

Margate was originally known as St. John's. Thanet, and the church of St. John the Baptist, founded in 1050, contains some portions of Norman architecture and many brasses. The port was an ancient and senior noncorporate member of Dover, and at the time of the siege of Calais it contributed 15 ships of small tonnage. A pier existed before 1500 but, the amount of corn shipped being small, the *droits* were insufficient to keep it in repair. In 17jo Margate became known as a bathing place with beautiful sands and in 1777 the pier was rebuilt. The present stone pier was badly damaged in the storms of 1952 when the lighthouse (1829) was destroyed. In 1835 the town was still a liberty of Dover and no right of citizenship could be acquired. In 1857 it was incorporated and in 1935 the borough was extended to include the resorts of Westgate-on-Sea, Birchington, Cliftonville and the parish of Garlinge. The early 15th-century gateway of the manor house of Daundelyon, or Dent de Lion, remains between Margate and Westgate. The foundation of a Roman villa was discovered at Tivoli, south of Margate, in 1924.

MARGAY (*Felis wiedii),* an American cat found from far southwestern Texas to Paraguay, east of the Andes. It is 2 ft. long, with tail 18 in., resembling the larger ocelot in colour, but with more elongate spots and a longer tail. The head is more rounded. The name tiger cat is applied loosely to the margay and several other American wildcats. (J. E. HL.; X.)

MARGGRAF, ANDREAS SIGISMUND (1709–1782), German chemist whose name is especially associated with the discovery of sugar in beetroot, was born at Berlin, March 3, 1709. He studied chemistry at Berlin and Strasbourg, medicine at Halle, and mineralogy and metallurgy at Freiberg, and returned to his native city in 1735 as assistant to his father, who was chief apothecary at the court. In 1738 he was elected to the Berlin Academy of Sciences, which in 1754 put him in charge of its chemical laboratory and in 1760 appointed him director of its physics class. He died in Berlin, Aug. 7, 1782. Marggraf's discovery of beet sugar in 1747 led to development of the beet sugar industry. He introduced the microscope as an aid to chemical inquiry and used this instrument to detect the presence of minute sugar crystals. In another research dealing with the nature of alum, he showed that one of the constituents of that substance, alumina, is contained in comtnon clay, and that it is quite distinct from lime. He explained and simplified the process of obtaining phosphorus from urine, and made some observations on phosphoric acid; but though he noted the increase in weight that attends the oxidation of phosphorus he remained an adherent of the phlogistic doctrine. For his time he was a skilful chemical analyst.

His papers were presented to the Berlin academy, and with the exception of a few of the latest were collected in two volumes of *Chynzische Schriften* in 1761–67.

MARGHILOMAN, ALEXANDRE (1854–1925), Rumanian statesman, was born at Buzeu on July 4, 1854. In 1884 he was elected a deputy as a member of the Conservative party, of which he became leader in 1914. Marghiloman was convinced that economic reasons demanded close relations between Rumania and Germany and Austria-Hungary. At the beginning of World War I, he advocated Rumania's neutrality and when in 1916 Bratianu offered him a portfolio in his cabinet, Marghiloman refused on the ground that he could not assume the responsibility of an insufficient military preparation. He remained in Bucharest under the German occupation, where he organized relief work, but rejected the proposals of the German commander to form a government for the purpose of concluding a separate peace. In March, 1918, Marghiloman went to Jassy and formed a government which signed the separate peace with the Central Powers. This treaty was never ratified.

When the war ended Marghiloman ceased to play any part in Rumanian politics and died in Buzeu on May 10, 1925.

MARGIN, a term in finance meaning the amount by which the value of collateral provided as security for a loan exceeds the amount of the loan. This excess represents the borrower's equity contribution in a transaction that is partly financed by borrowed funds; thus it provides a "margin" of safety to the lender over and above the collateral that is pledged. The size of the margin which is required varies with the type of collateral, the stability of its market price, expectations with regard to its future price and the credit standing of the borrower.

The term margin is used especially in connection with transactions in securities and commodity futures. When securities are purchased "on margin" the buyer supplies only a percentage, or margin, of the purchase price and borrows the remainder from his broker. pledging the security as collateral for the loan. A fall in the price of the security subsequent to the purchase reduces the margin available to the lender and the customer may be called upon to restore his margin to a prearranged level. This level is determined by the lending broker, but may not be below minimum levels stipulated by the organized exchange in which the transaction takes place.

In addition, minimum initial margin requirements on loans made for the purpose of purchasing securities are required by the federal reserve, board under authority granted by the Securities Exchange act of 1934. Since 1934 the board's requirement has varied between 25% and 100%. (EA. S.)

MARGOLIOUTH, DAVID SAMUEL (18j8–1940), British Arabic scholar, was born in London on Oct. 17, 1858, the son of a missionary. Educated at Winchester and New College, Oxford, he devoted himself to Arabic studies, in which he obtained a European reputation. In 1889 he became Laudian professor of Arabic at Oxford. He took an active part in the Royal Asiatic society. was awarded its triennial gold medal in 1928 and was its president 1934–37. He held many other honours. In addition to several works on the history of Mohammedanism he edited and translated many important Arabic texts, including the *Letters of Abu'l-'Ala* (Oxford, 1898), Yakut's *Dictionary of Learned Men, 6* vol. (Leyden and London, 1907–27), and (with H. F. Amedroz) *The Eclipse of the 'Abbasid Caliphate,* 7 vol. (Oxford, 1920–21j.

See the *Proceedings of the British* ***Academy,*** vol. xxvi (London, 1940).

MARGRAVE (Ger. *Markgraf*), A German title meaning "count of the March." The margraves had their origin in the counts established by Charlemagne and his successors to guard the frontier districts of the empire. and for centuries the title was always associated with this function. In the 12th century the margraves of Brandenburg and Austria (the north and east marks) asserted their position as tenants in chief of the empire; with the breakup of the great duchies the others did the same; and the margraves henceforward took rank with the great German princes.

The title of margrave very early lost its original significance, and was borne by princes whose territories were in no sense frontier districts; *e.g.,* by Hermsnn. a son of Hermann, margrave of Verona, who assumed in 1112 the title of margrave of Baden.

MARGUERITE, the popular name for the plant known botanically as *Chrysanthentum frutescens* (family Compositae), a shrubby perennial with smooth leaves cut pinnately into narrow segments and flower heads two or three inches across produced singly in summer and autumn on slender erect stalks. The white ray-florets surround a yellow disk. It is a native of the Canary isles, and a favourite for decoration and for greenhouse cultivation, window boxes and open ground in the summer. The yellow marguerite has somewhat larger pale yellow flowers and glaucous leaves. The plant is propagated from cuttings taken in autumn from old plants and placed in sandy loamy soil in cold frames. By pruning the shoots in autumn the plants rnay be grown into very large specimens in the course of a few seasons.

The African subshrub, *Felicia amelloides* (family Compositae) known in cultivation as blue daisy, is also called blue marguerite.

MARGUERITE D'ANGOULÊME (1492–1549), queen of Navarre, was the daughter of Charles d'Orléans, count d'Angoulême and was born in Angoulême on April 11, 1492. She was two years older than her brother Francis I. She was betrothed early to Charles, duke d'Alençon, and married him in 1509 She was not very fortunate in this first marriage, but her brother's accession to the throne made her, next to their mother, Louise of Savoy, the most powerful woman of the kingdom. She became a widow in 1525, and married in 1527 Henri d'Albret, titular king of Navarre. Navarre was not reconquered for the couple as Francis had promised, but ample apanages were assigned to Marguerite, and at Nérac and Pau miniature courts were kept up, which yielded to none in Europe in the intellectual brilliancy of their frequenters. hfarguerite was at once one of the chief patronesses of letters that France possessed, and the chief refuge and defender of advocates of the Reformed doctrines. Round her gathered C. Marot, Bonaventure Des Périers, N. Denisot, J. Peletier, V. Brodeau, Boaistuau. Le Maçon and many other men of letters, while she protected Rabelais, E. Dolet and others. For a time her influence with her brother prevailed. but latterly political rather than religious considerations led him to uage a fierce persecution against both Protestants and freethinkers, a persecution which drove Des Périers to suicide and brought Dolet to the stake. Marguerite's own inclinations seem to have been rather towards a mystical pietism than towards dogmatic Protestant sentiments. Marguerite died in Odot-en-Bigorre on Sept. 21, 1549. By her first husband she had no children, by her second a son who died in infancy, and a daughter, Jeanne d'Albret, who became the mother of Henry IV. She does not, from the portraits which exist, appear to have been regularly beautiful, but as to her sweetness of disposition and strength of mind there is universal consent.

Her literary work consists of the *Heptame'ron,* of poems entitled *Les Marguerites de la marguerite des princesses,* and of *Letters.* The *Heptame'ron,* constructed, as its name indicates, on the lines of the *Decameron* of Boccaccio, consists of 72 short stories told to each other by a company of ladies and gentlemen who are stopped in the journey homewards from Cauterets by the swelling of a river. It was not printed till 1558, ten years after the author's death, and then under the title of *Les Amants fortunés.* Internal evidence is strongly in favour of its having been a joint work, in which more than one of the men of letters who composed Marguerite's household took part. It is a delightful book, and strongly characteristic of the French Renaissance. The *Letters* are interesting and good. The *Marguerites* consist of a very miscellaneous collection of poems, mysteries, farces, devotional poems of considerable length, spiritual and miscellaneous songs, etc. The *Dernières poésies,* not printed till 1896 (by M. A. Lefranc), are interesting and characteristic, consisting of verse-epistles, *comédies* (pieces in dramatic form on the death of Francis I., etc.), *Les Prisons,* a long allegorical poem of amorous-religious-historical tenor; some miscellaneous verse chiefly in dizains, and a later and remarkable piece, *Le Navire,* expressing her despair at her brother's death.

BIBLIOGRAPHY.—Of the other works, never yet completely edited, the best editions are, for the *Heptaméron,* Leroux de Lincy (1855); for the *Lettres,* F. Genin (1841); and for the *Marguerites,* F. Frank (1873). English translation of the *Heptame'ron;* A. Machen (1887), with introduction by A. M. F. Robinson (Mme. Darmesteter), and an anonymous translation (1894) with introduction by G. Saintsbury. The religious poem, *Le Miroir de L'Âme Pécheresse,* was translated *by* Queen Elizabeth. *See* also V. Durand, *Marguerite de Valois et la Cour de François Ier* (1848); F. Lotheissen, *Königin Margarethe von Navarra* (188;); *H.* de la Ferrière, *Marguerite d'Angoulême* (1891); Edith Sichel, *Women and Men of the French Renaissance* (1901); *P.* Courtault, *Marguerite de Navarre* (1904); **A.** Lefranc, *Grands écrivains de la renaissance* (1914).

MARGUERITE (MARGOT) DE VALOIS (1553–1615), queen of Navarre, was born on May 14, 1553, daughter of Henry II. by Catherine de' Medici. Famous for her beauty, her learning, and the looseness of her conduct, she was married, after a liaison with the duke of Guise, to Henry of Navarre, afterwards Henry IV., on the eve of St. Bartholomew's day. There were no children of the marriage. Marguerite was established in the castle of Usson in Auvergne, and after the accession of Henry the marriage was dissolved by the pope. But Henry and Marguerite still continued friends; she still bore the title of queen; she visited Marie de' Medici on equal terms; and the king frequently consulted her on important affairs, though his somewhat parsimonious spirit was grieved by her extravagance. Marguerite died in Paris on March 27, 1615. She left letters and memoirs the latter of which are admirably written, and rank among the best of the 16th century. She was the idol of Brantôme, and is the "Reine Margot" of anecdotic history and romance.

BIBLIOGRAPHY.—The *Mémoires, Poésies et Lettres* were edited *by* F. Guessard (1842), L. Lalanne (1858), C. Caboche (1860). The chief of many lampoons against her was the famous *Divorce satirique,* variously attributed to Agrippa d'Aubigné, Palma Cayet and others. *See* L. de Saint Poncy, *Histoire de Marguerite de Valois* (1887); C. Merki, *La Reine Margot et la fin des Valois* (1905); *A.* Savine, *La Vraie Reine Margot* (1908); *H.* N. Williams, *Queen Margot* (1907, 2nd ed. 1911); J. H. Mariéjol, *La Vie de M. de Valois* (1928).

MARGUERITTE, PAUL (1860–1918) **AND VICTOR** (1866–1942), French novelists, both born in Algeria, were the sons of General Jean Xuguste Margueritte (1823–70). Paul Margueritte, born Feb. 1, 1860, who has given a picture of his home in Algiers in *Le Jardin du passe'* (1895), was sent to the military school of La Flèche for the sons of officers, and became in 1880 clerk to the minister of public instruction. His earlier novels include: *Amants* (1890), *La Force des choses* (1891), *Sur le retour* (1892), *La Tourmente* (1893), *Ma grande* (1892), *Âme d'enfant* (1894) and *L'Eau qui dort* (1896). From the time of his collaboration with his younger brother Victor Paul Margueritte's work gained in colour and force.

Among the books written in common by the brothers, the most famous is the series known under the collective title, *Une Époque,* dealing with the events of 1870–71, and including the novels *Le De'sastre* (1898), *Les Tronçons du glaive* (1900), *Les Braves gens* (1901), *La Commune* (1904). They also collaborated in an *Histoire de la guerre de 1870–1871* (1903). These books were founded on documentary and verbal information, amassed with great care and arranged with admirable art; the authors were, in this case, historians rather than novelists. La *Commune* is a bold indictment of the methods adopted by the victorious party. The novelists also attacked the laws governing marriage and divorce and the abuses entailed by the dowry demanded from the bride, in pamphlets and in the novels, *Femmes nouvelles* (1899), *Les Deux vies* (1902), and *Le Prisme* (1905). One of the best is the child story Poum (1898). Their literary partnership was dissolved in 1907. Paul Margueritte was one of the original members of the Académie de Goncourt. He died on Dec. 30, 1918.

After World War I Victor Margueritte wrote other novels, the most famous of which is *La Garçonne* (1922), and entered political controversy with two books on the question of responsibility for the war; *Les Coupables* and *Appel Aux Consciences,* both written in 1925. He died March 23, 1942.

MARÍA CRISTINA, the name of two queens of Spain.

MARÍA CRISTINA I (1806-1878). queen consort of Ferdinand VII from 1829 to 1833 and queen regent from 1833 to 1810. was born at Naples on April 27, 1806. the daughter of Francis I. king of the Two Sicilies. Spanish liberals hoped that her marriage to Ferdinand would moderate the persecution to which they were subject, and this hope was in fact realized whenever the queen exercised political power. In 1830. the queen being pregnant, Ferdinand VII confirmed the *pragmática* issued in 1789. which re-established the right of females to succeed to the throne in default of male heirs. This was opposed by supporters of the claims to the succession of the king's brother. Don Carlos (1788–1855). Within a few days of the death of Ferdinand VII (1833). when Maria Cristina mas named regent during the minority of her daughter Isabella. the first Carlist War began. The war was only terminated by the convention of Vergara in 1839 and by this time Maria Cristina had lost much support because of her morganatic marriage with Fernando Muñoz. She resigned her regency in 1840 and went to Marseilles, but returned to Spain in 1843, after Gen. Ramón Narváez's *coup d'état*. Isabella II was then declared of age and María Cristina again took part in political life, but she was forced to go into exile again in 1854, She died at Saint-Adresse in France on Aug. 23, 1878. (R. S. Ll.)

María Cristina II (1858–1929), queen consort of Alfonso XII from 1879 to 1885 and queen regent from 1885 to 1902, was born at Gross Seelowitz on July 21, 1858, the daughter of the archduke Charles Ferdinand of Austria. She married Alfonso XII on Nov. 29, 1879. He died on Nov. 26, 1885, leaving her two daughters and a posthumous son, born on May 17, 1886, who immediately succeeded to the throne as Alfonso XIII, under the regency of his mother. Maria Cristina discharged her long and difficult regency with a tact and dignity that won general respect, even though the war of 1898 against the United States was a disaster for Spain. She contributed greatly to the strengthening of the monarchy, to the appeasement of political struggles and to the steady, though slow progress of Spain from the lowest point of its decadence. After Alfonso XIII's coming of age (May 17, 1902), Maria Cristina devoted the remainder of her life to social and charitable work. She died in Madrid on Feb. 6, 1929. (R. M. N.)

MARIANA, JUAN DE (1536–1624), Spanish historian and Jesuit, was born at Talavera. In 1561 he went to teach theology in Rome, reckoning among his pupils Robert Bellarmine, afterwards cardinal; then passed into Sicily, and in 1569 was sent to Paris, where his expositions of the writings of Thomas Aquinas attracted large audiences. He returned to Spain in 1574.

Mariana's great work, *Historiae de rebus Hispaniae,* first appeared in 25 books at Toledo in 1592; ten books were subsequently added (160j), bringing the work down to the accession of Charles V in 1519, and in a still later abstract of events the author completed it to the accession of Philip IV in 1621. It was so well received that Mariana was induced to translate it into Spanish 1601–23. Though in many parts uncritical, the work is justly esteemed for its research, accuracy, sagacity and style. Of his other writings the most interesting is the treatise *De rege et regis institutione* (1599; English translation by G. A. Moore, *The King and The Education oj The King,* 1948).

The question whether it is lawful to overthrow a tyrant is answered in the affirmative, a circumstance which brought much odium upon the Jesuits, especially after the assassination of Henry IV of France, in 1610.

See Cirot, *Etudes sur les historiographes espagnols: Mariana, historien* (Bordeaux, 1905); John Laures, *The Political Economy of Juan de Mariana* (1928).

MARIANA or LADRONE ISLANDS: *see* Pacific Islands.

MARIANAO, a suburb of Havana, Cuba, about 1,500 ft. above the sea; it is a separate municipality. It possesses a pleasant climate. The population in 1953 was 219,278. On the coast below is Marianao beach, a popular watering place.

MARIANAS or MARANHAS, a tribe of South American Indians on the river Jutahy, north-western Brazil. They wear small pieces of wood in their ears and lips, but are not tattooed. Marianas were found on the upper reaches of the Putumayo across to the Yapurá.

MARIANUS SCOTUS (1028–1082 or 1083), chronicler (who must be distinguished from his namesake Marianus Scotus [d. 1088], abbot of St. Peter's, Regensburg), was an Irishman by birth, and called Moelbrigte, or servant of Bridget. He was educated by a certain Tigernach, and having become a monk he crossed over to the continent of Europe in 1056, and his subsequent life was passed in the abbeys of St. Martin at Cologne and of Fulda, and at Mainz. He died Dec. 22, 1082 or 1083.

Marianus wrote a *Chronicon,* which purports to be a universal history from the creation of the world to 1082. The *Chronicon* was very popular during the middle ages, and in England was extensively used by Florence of Worcester and other writers. It was first printed at Basle in 1559, and has been edited with an introduction by G. Waitz for the *Monumenta Germaniae historica. Scriptores* (Bd. v.).

MARIA STELLA, the self-styled legitimate daughter of Philip, duke of Orleans. According to her, Louis Philippe was not the son of Philip duke of Orleans, but a supposititious child, his father being one Lorenzo Chiappini, constable at the village of Modigliana in Tuscany. The story is that the duke and duchess of Orleans, travelling under the incognito of Comte and Comtesse de Joinville, were at this village in April 1773, when the duchess gave birth to a daughter; and that the duke, desiring a son in order to prevent the rich Penthièvre inheritance from reverting to his wife's relations in the event of her death, bribed the Chiappinis to substitute their newly-born male child for his own.

Maria Stella, the supposed daughter of Chiappini, went on the stage at Florence and married, at thirteen, the first Lord Newborough, after whose death she married the Russian Count Ungern-Sternberg. In 1830 she published *Maria Stella ou un échange d'une demoiselle du plus haut rang contre un garçon de plus vile condition* (reprinted 1839 and 1849). This coincided with the advent of Louis Philippe to the throne, and her claim became a weapon for those who wished to throw discredit and ridicule on the "bourgeois monarch." She died in poverty in Paris on Dec. 23, 1843.

See R. P. Gallwey, *Mystery of Maria Stella, Lady Newborough* (1907); M. Vitrac, *Philippe-Égalité et M. Chiappini* (1907), which is based on unpublished material in the *Archives nationales,* and destroys Maria Stella's case.

MARIA THERESA (1717–1780), archduchess of Austria, queen of Hungary and Bohemia, and wife of the Holy Roman emperor Francis I., was born at Vienna on May 13, 1717, eldest daughter of the Emperor Charles VI. (*q.v.*) and Elizabeth of Brunswick-Wolfenbüttel. On Feb. 12, 1736 she married her cousin Francis of Lorraine (*q.v.*), then grand duke of Tuscany, and afterwards emperor. Five sons and eleven daughters were born of this marriage. From the date of her father's death on Oct. 20, 1740, till her own death in 1780, Maria Theresa was one of the central figures in the wars and politics of Europe. But unlike some sovereigns, whose reigns have been agitated, but whose personal character has left little trace, Maria Theresa had a strong and in the main a noble individuality. There was no affectation in her assumption of a becoming bearing or in her picturesque words. The common story, that she appeared before the Hungarian magnates in the diet at Pressburg in 1741 with her infant son, afterwards Joseph II., in her arms, and so worked on their feelings that they shouted *Moriamur pro regina nostra Maria Theresia,* is only mythically true. But during the delicate negotiations to secure the support of the Hungarian nobles she undoubtedly did appeal to them with passionate eloquence, and with a pardonable sense of the advantage she obtained from her youth, her beauty and her sex. Maria Theresa was especially preoccupied with her position as heiress of the rights of the house of Austria. Therefore, when her inheritance was assailed by Frederick of Prussia, she fought for it with the utmost determination, and for years cherished the hope of recovering the lost province of Silesia. Her practical sense showed her the necessity of submitting to spoliation when she was overpowered. She accepted the peace of Berlin in 1742 in order to have a free hand against her Bavarian enemy, the emperor Charles VII. (*q.v.*). When Frederick renewed the war she accepted the struggle cheerfully, because she hoped to recover her own. Down to the peace of Aix-la-Chapelle in 1748 she went on fighting for Silesia or its equivalent. In the years following the peace she applied herself to finding allies in France and Russia who would help her to recover Silesia. Here, as later in the case of Poland, she subordinated her feelings to her duty to the state. Though she denied that she had ever written directly to Madame de Pompadour, it is certain that she allowed her ministers to make use of the favourite's influence over the French king. When fate decided against her in the Seven Years' War she bowed to the inevitable, and was thenceforward a resolute advocate of peace.

In internal government she worked to promote the prosperity of her people, and to give more unity to an administration made up by the juxtaposition of many states and races with different characters and constitutions. Her instincts, like those of her enemy Frederick and her son Joseph II., were emphatically absolutist. She suspended the meetings of the estates in most parts of her dominions. She was able to do so because the mass of her subjects found her hand much lighter than that of the privileged classes who composed these bodies. Education, trade, religious toleration, the emancipation of the agricultural population from feudal burdens—all had her approval up to a certain point. She would favour them, but on the distinct condition that nothing was to be done to weaken the bonds of authority. She took part in the suppression of the Jesuits, and she resisted the pope in the interest of the state. Her methods were those of her cautious younger son, Leopold II, and not of her eldest son'and immediate successor, Joseph II. She did not give her consent even to the suppression of torture in legal procedure without hesitation, lest the authority of the law should be weakened. Her caution had its reward, for whatever she did was permanently gained, whereas her successor in his boundless zeal for reform brought his empire to the verge of a general rebellion.

In her private life Maria Theresa was equally the servant of the state and the sovereign of all about her. She was an affectionate wife to her husband Francis I.; but she was always the queen of Hungary and Bohemia and archduchess of Austria, like her ancestress, Isabella the Catholic, who never forgot, nor allowed her husband to forget, that she was "proprietary queen" of Castile and Leon. She married her daughters in the interest of Austria, and taught them *not* to forget their people and their father's house. In the case of Marie Antoinette (*q.v.*), who married the dauphin, afterwards Louis XVI., she gave an extraordinary proof of her readiness to subordinate everything to the reason of state. She instructed her daughter to show a proper respect to her husband's grandfather, Louis XV., by behaving with politeness to his mistresses, in order that the alliance between the two courts might run no risk. The signing of the peace of Teschen, which averted a great war with Prussia, on May 13, 1779, was the last great act of her reign, and so Maria Theresa judged it to be in a letter to Prince Kaunitz; she said that she had now finished her life's journey and could sing a Te Deum, for she had secured the repose of her people at whatever cost to herself. The rest, she said, would not last long. Her fatal illness developed in the autumn of the following year, and she died on Nov. 28, 1780. When she lay painfully on her deathbed her son Joseph said to her, "You are not at ease," and her last words were the answer, "I am sufficiently at my ease to die."

See A. von Arneth, *Geschichte Maria Theresas* (Vienna, 1863–79) and J. F. Bright, *Maria Theresa* (1897); *M.* Gael, *Maria Theresa* (1900); also AUSTRIA, EMPIRE OF.

MARIAZELL, a town in Styria, Austria, situated in the valley of the Salza, near Lake Erlauf and surrounded by peaks of the north Styrian Alps, grows in importance as a summer resort and as a centre for winter sports. It possesses a 12th century miracle-working image of the Virgin enshrined in a special chapel of the 14th century church, which is visited by over 150,000 pilgrims each year. Population (1961) 2,134; annexed to Germany from 1938 to 1945.

See O. Eigner, *Geschichte des aufgehobenen Benedictinerstijtes Mariazell* (Vienna, 1900).

MARIBOR, a town of Slovenia, Yugoslavia, the German *Marburg*. Pop. (1961) 82,387, mainly Slovenes. It is a popular summer resort and tourist centre, picturesquely situated on the Drave, here spanned by a magnificent iron bridge. There was a settlement at Maribor in Roman times, but the present town arose in the 10th century; in the 12th and 13th centuries the town ruled a vast district. The principal buildings are the Cathedral, dating from the 12th century, but with many later additions, among them a 17th century tower 136 ft. high; and the 15th century castle, famous for its sculptures. Maribor, served both by rail and first class roads, and in the midst of a fertile fruit and wine-growing district, has a large trade in wine and grain, and especially in timber from the surrounding forests. Its industrial products are leather, boots and shoes, iron and tinware, liqueurs and sparkling wine, oil refining and milling and it has a weekly market for pork, poultry and eggs. Near by is the village of hlariast, the church of which is a popular place of pilgrimage. Maribor became part of Yugoslavia in 1918, but was occupied by Hungary in 1941, after Yugoslavia's dismemberment.

MARICOPA, a Yuman tribe living near the Pima on Gila river, Arizona; originally no doubt driven out from the lower Colorado by intertribal warfare, like the Halchidhoma and Kohuana whom they absorbed in the 19th century. The date of the hfaricopa removal is not known.

MARIE, queen of Rumania (1875–1938), was born at Eastwell Park, Kent, on Oct. 29, 1875, the eldest daughter of Alfred, duke of Edinburgh, second son of Queen Victoria. On Jan. 10, 1893 she married Prince Ferdinand, afterwards king of Rumania. From this marriage six children were born: Prince Charles, who married Princess Helen of Greece, Princess Elizabeth, married to the ex-king George of Greece, Princess Marie, later queen of Yugoslavia, the princes Nicolas and Mircea (d. 1916) and Princess Ileana. The queen was a Protestant, but the children, in accordance with the Rumanian constitution, were brought up in the Orthodox faith. Queen Marie took a great interest in the development of her adopted country. Red Cross and charity organizations were formed at her initiative, and during World War I she saw active service as a Red Cross nurse. She devoted much of her time to writing, and her published works include *The Lily of Life* (1913), *My Country* (1916), and *Ilderim* (1925). With King Ferdinand, Marie was crowned at Alba Julia on Oct. 15, 1922. She visited America in 1926. The following year King Ferdinand died, and she retired from active politics. Queen Marie died at the royal summer residence in Sinaia, July 18, 1938, and was buried at Kurtea de Argesch.

MARIE AMELIE THERESE (1782–1866), queen of Louis Philippe, king of the French, was the daughter of Ferdinand IV., king of Naples, and the archduchess Maria Carolina. She was born at Caserta, on April 26, 1782, and received a pious education. Her girlhood was spent in exile. She married Louis Philippe in November 1809. Returning to France in 1814, the duke and duchess of Orleans had barely established themselves in the Palais Royal in Paris when the Hundred Days drove them into exile. Marie Amélie took refuge with her four children in England, where she spent two years at Orleans House, Twickenham. Again in France in 1817, her life at Neuilly until 1828 was the happiest period of her existence. Her attention was absorbed by the care and education of her numerous family, even after the revolution of 1830 had made her queen of the French, a position accepted with forebodings of disaster justified by her early experience of revolutions. During her second exile, from 1848 to her death on March 24, 1866, she lived at Claremont.

See A. L. Baron Imbert de St. Amand, *La Jeunesse de Marie Amélie* (1891), *Marie Amélie au Palais Royal* (1892), *Marie Amdlie et la cow de Palerme* (1891), *Marie Amdlie et la cour des Tuileries* (1892), *Marie Amélie et l'apogée de règne de Louis Philippe* (1893), *Marie Amélie et la société française en 1847* (1894), and *Marie Amélie et la duchesse d'Orleans* (1893).

MARIE ANTOINETTE (1755–1793), queen of France, ninth child of Maria Theresa and the emperor Francis I., was born at Vienna, on Nov. 2, 1755. She was brought up under an austere régime and educated with a view to the French marriage arranged by Maria Theresa, the abbé Vermond being appointed as her tutor in 1769. Her marriage with the dauphin, which took place at Versailles on May 16, 1770, was intended to crown the policy of Choiseul and confirm the alliance between Austria and France. This fact, combined with her youth and the extreme corruption of the French court, made her position very difficult. Madame du Barry, whose influence over Louis XV. was supreme, formed the centre of a powerful anti-Choiseul cabal, which succeeded in less than a year after the dauphin's marriage in bringing about the fall of Choiseul and seriously threatening the Austrian alliance. Thus the young princess was surrounded by enemies both at court and in the dauphin's household, and came to rely almost entirely upon the Austrian ambassador, the comte de Mercy-Argenteau, whom Maria Theresa had instructed to act as her mentor, at the same time arranging that she herself should be kept informed of all that concerned her daughter, so that she might at once advise her and safeguard the alliance. Hence arose the secret correspondence of Mercy-Argenteau, an invaluable record of all the details of Marie Antoinette's life from her marriage in 1770 till the death of Maria Theresa in 1780.

Marie Antoinette soon won the affection and confidence of the dauphin and endeared herself to the king, but her position was precarious, and both Mercy and Maria Theresa had continually to urge her to conquer her violent dislike for Madame du Barry.

The accession of the young king and queen on the death of Louis XV (May 10, 1774), was hailed with great popular enthusiasm. But her first steps brought Marie Antoinette into open hostility with the anti-Austrian party. She was urgent in obtaining the dismissal of d'Aiguillon, and did all in her power to secure the recall of Choiseul, though without success. Her impatience of the cumbrous court etiquette shocked many people, and her taste for pleasure led her to seek the society of the comte d'Artois and his young and dissolute circle. But the greatest weakness in her position lay in her unsatisfactory relations with her husband. The king, though affectionate, was cold and apathetic, and it was not until seven years after her marriage that there was any possibility of her bearing him an heir.

The end of the period of mourning for the late king was the signal for a succession of gaieties, during which the queen displayed a passion for amusement and excitement which led to unfortunate results. Being childless, and with a husband whom she could not respect, her longing for affection led her to form various intimate friendships, above all with the princesse de Lamballe and the comtesse Jules de Polignac, who soon obtained such an empire over her affections that no favour was too great for them to ask, and often to obtain. In frequenting the salons of her friends the queen not only came in contact with a number of the younger and more dissipated courtiers, but also fell under the influence of various ambitious intriguers whose interested manoeuvres she was induced to further by her affection for her favourites. Thus she was often led to interfere for frivolous reasons in public affairs, sometimes with serious results, as in the case of the trial of the comte de Guines (1776), when her interference led to the fall of Turgot. At the same time her extravagance in dress, jewellery and amusements (including the gardens and theatricals at Trianon which was opened in May 1780 and of the cost of which exaggerated reports were spread), and her presence at horse races and masked balls in Paris without the king gave rise to scandal. At this critical period her brother, the emperor Joseph II, decided to visit France. As the result of his visit he left with the queen a memorandum in which he pointed out to her in plain terms the dangers of her conduct. For a time the emperor's remonstrances had some effect, and after the birth of her daughter, Marie Thérèse Charlotte (afterwards duchesse d'Angoulême), in Dec. 1778, the queen lived a quieter life. The death of Maria Theresa (Nov. 29, 1780) deprived her of a wise friend, and by removing all restraint on the rashness of Joseph II was bound to increase the dislike of the Austrian alliance and cause embarrassment to Marie Antoinette. Her position was much strengthened by the birth (Oct. 22, 1781) of a dauphin, Louis Joseph Xavier François; and on the death of Maurepas, which left the king without a chief minister, she might have exerted great influence in public affairs. But personal motives alone would lead her to interfere in public affairs, especially when it was a question of obtaining places or favours for her favourites and their friends. The influence of the Polignacs was now at its height, and they obtained large sums of money, a dukedom, and many nominations to places. But, in response to Mercy's and Joseph II's urgent representations. Marie Antoinette exerted herself on behalf of Austria in the affairs of the opening of the Scheldt (1783–1784) and the exchange of Bavaria (1785), in which, though she failed to provoke active interference on the part of France, she succeeded in obtaining the payment of considerable indemnities to Austria.

Two more children were born to her: Louis Charles, duke of Normandy, afterward dauphin, on March 27, 1785, and Sophie Hélène Beatrix (d. June, 19, 1787), on July 9, 1786. In 1785–1786 the affair of the Diamond Necklace (*q.v.*) revealed the depth of the hatred which her own follies and the calumnies of her enemies had aroused against her. The public held her responsible for the bankrupt state of the country which was the immediate cause of the revolution.

The year 1789 was one of disaster for Marie Antoinette; on March 10 her brother Joseph II died and on June 4 her eldest son. The same year saw the assembling of the states-general, the taking of the Bastille, and the events leading to the terrible days of Oct. 5 and 6 at Versailles and the removal of the royal family to Paris. Then began the negotiations with Mirabeau, whose high estimate of the queen is well-known. But the queen was violently prejudiced against him and he never gained her full confidence. She was naturally incapable of seeing the full import of the revolution. She dreaded the thought of civil war; and even when she had realized the necessity for decisive action the king's apathy and indecision made it impossible. for her to persuade him to carry into effect Mirabeau's plan of leaving Paris and appealing to the provinces. Her difficulties were increased by the departure of Mercy for The Hague in Sept. 1790, for Montmorin, who now took his place in the negotiations with Mirabeau, had not her confidence to the same extent. Feeling herself helpless and almost isolated in Paris, she now relied chiefly on her friends outside France — Mercy, Count Axel Fersen and the baron de Breteuil; and it was by their help and that of Bouillé that after the death of Mirabeau, on April 8, 1791, the plan was arranged of escaping to Montmkdy, which ended in the flight to Varennes (June 21, 1791).

After the return from Varennes the royal family were closely guarded, but they still found channels of communication with the outside world. The king being sunk in apathy, the task of negotiation devolved upon the queen; but in her inexperience of affairs and the uncertainty of information from abroad, it was hard for her to follow any clear policy. Her courageous bearing during the return from Varennes had greatly impressed Barnave, and he now approached her on behalf of the constitutional party. For about a year she continued to negotiate with them, forwarding to Mercy and the emperor Leopold II letters and memoranda dictated by them, while at the same time secretly warning them not to accept these letters as her own opinions, but to realize that she was dependent on the Constitutionals. She agreed with their plan of an armed congress, and Fersen left Brussels on a mission to the emperor to try to gain his support and checkmate the *émigrés,* whose rashness threatened the queen's plans.

As for the constitution (Sept. 1791), "tissue of absurdities" though the queen thought it, she considered that in the circumstances the king was bound to accept it in order to inspire confidence. Mercy was also in correspondence with the Constitutionals, and in letter after letter to him and the emperor, the queen, strongly supported by Fersen, insisted that the congress should meet as soon as possible, her appeals increasing in urgency as she saw that Barnave's party would soon be powerless against the extremists. But the congress was continually postponed. On March 7, 1792, Leopold II died and was succeeded by the young Francis II. Marie Antoinette's actions were now directed entirely by Fersen, for she suspected Mercy and the emperor of sacrificing her to the interests of Austria. The declaration of war which the king was forced to make (April 20) threw her definitely into opposition to the revolution and she betrayed to Mercy and Fersen the plans of the French generals. She was now certain that the life of the king was threatened, and the events of June 20 added to her terrors. She considered their only hope to lie in the armed intervention of the powers, and endorsed the suggestion of a threatening manifesto which should hold the national assembly and Paris responsible for the safety of the king and royal family. Immediately after Brunswick's manifesto followed the storming of the Tuileries and the removal of the royal family to the temple (Aug. 10). During all these events and the captivity in the temple Marie Antoinette showed an unvarying courage and dignity, in spite of her failing health and the illness of her son. After the execution of the king (Jan. 21, 1793) several unsuccessful attempts were made to rescue her and her children, and negotiations for her release or exchange were even opened with Danton; but as the allied armies approached. her trial and condemnation became a certainty. She had already been separated from her son, the sight of whose ill-treatment added to her sufferings;

she was now parted from her daughter and Madame Elizabeth, and removed on Aug. 1, 1793 to the Conciergerie, where she was under the closest guard and subjected to the most offensive espionage.

On Oct. 14 began her trial. Her noble attitude, even in the face of the atrocious accusations of Fouquier-Tinville, commanded the admiration even of her enemies, and her answers during her long examination were clear and skilful. The following were the questions finally put to the jury:—

(1) Is it established that manoeuvres and communications have existed with foreign powers and other external enemies of the republic, the said manoeuvres, etc., tending to furnish them with assistance in money, give them an entry into French territory, and facilitate the progress of their armies?

(2) Is Marie Antoinette of Austria, the widow Capet, convicted of having co-operated in these manoeuvres and maintained these communications?

(3) Is it established that a plot and conspiracy has existed tending to kindle civil war within the republic, by arming the citizens against one another?

(4) Is Marie Antoinette, the widow Capet, convicted of having participated in this plot and conspiracy?

The jury decided unanimously in the affirmative, and on Oct. 16, 1793 Marie Antoinette was led to the guillotine, leaving behind her a touching letter to Madame Elizabeth, known as her "Testament."

As to the justice of these charges, we have seen how the queen was actually guilty of betraying her country, though it was only natural for her to identify the cause of the monarchy with that of France. To civil war she was consistently opposed, and never ceased to dissociate herself from the plans of the *émigrés,* but here again her very position made her an enemy of the republic. All her actions had as their aim—firstly, the safeguarding of the monarchy and later, when she saw this to be impossible, that of securing the safety of her husband and her son.

BIBLIOGRAPHY.—M. Tourneux, *Marie Antoinette devont l'histoire. Essai bibliographique* (2nd ed., Paris, 1901); id. *Bibliogr. de la ville de Paris . . .* (vol. iv, 1906), nos. 20980–21338; also *Bibliogr. de femmes célèbres* (Turin and Paris, 1892, etc.). The most important material for her life is to be found in her letters and in the correspondence of Mercy-Argenteau, but a large number of forgeries have found their may into certain of the collections, such as those of Count Paul Vogt d'Hunolstein and F. Feuillet de Conches, while most of the works on Marie Antoinette published before the appearance of Arneth's publications (1865, etc.) are based partly on these forgeries. For a detailed examination of the question of the authenticity of the letters *see* the introduction to *Lettres de Marie Antoinette. Recueil des lettres authentiques de la reine, publié pour la société d'histoire contemporaine, par M. de la Rochetérie et le marquis de Beaucourt* (2 vols., Paris, 1895–1896). Of the highest importance are the letters from the archives of Vienna published by Alfred von Arneth and others: A. von Arneth, *Maria Theresia und Marie Antoinette. ihr Briefwechsel 1770–1780* (Paris and Vienna, 1865); *Marie Antoinette, Joseph II und Leopold II ihr Briefwechsel* (Leipzig, Paris and Vienna, 1866); id. and A. Geffroy, *Correspondance secrète entre Marie-Thérèse et le comte de Mercy-Argenteau* (3 vols., Paris, 1874–75); id. and J. Flammermont, *Correspondance secrète du comte de Mercy-Argenteau avec Joseph II et le prince de Kaunitz* (2 vols., Paris, 1889–1891); for further letters *see* Comte de Reiset, *Lettres de la reine Marie Antoinette à la landgrave Louise de Hesse-Darmstadt* (1865); id. *Lettres inédites de Marie Antoinette et de Marie-Clotilde, reine de Sardaigne* (1877). *See* also *Correspondance entre le comte de Mirabeau et le comte de la Marck, 1789–1791, recueillie . . . par F. de Bacourt* (3 vols., Paris, 1857), and R. M. de Klinckowström, *Le Comte de Fersen et la cour de France* (2 vols., Paris, 1877–1878). The chief memoirs are: Mme. Campan, *Mémoires sur la vie privée de Marie Antoinette* (5th ed., 2 vols., Paris, 1823, Eng. trans., 1824), the inaccuracy of which is demonstrated by J. Flammermont in *Etudes critiques sur les sources de l'histoire du xviii^e siècle: Les Mémoires de Mme. Campan,* in the *Bulletin de la Faculté des lettres de Poitiers* (4th year, 1886, pp. 56, 109); J. Weber, *Mémoires concernant Marie Antoinette* (3 vols., London, 1804–1809); Eng. trans., 3 vols., London, 1805–1806); *Mémoires de M. le baron de Besenval* (3 vols., Paris, 1805); *Mémoires de M. le duc de Lauzun* (2nd ed., 2 vols., Paris, 1822); E. Bavoux, *Mtms. secrets de J. M. Augeard, secrétaire des commandements de la reine M. Antoinette* (Paris, 1866); Mme. Vigée-Le-Brun, *Mes souvenirs* (2 vols., Paris, 1867); *Mémoires de Mme. la duchesse de Tourzel,* ed. by the duc de Cars (2 vols., Paris, 1883); *Mémoires de la baronne d'Oberkirch* (2 vols., Paris, 1853). M. Tourneux *(op. cit.)* discusses the authenticity of many of the memoirs.

GENERAL WORKS:—A. Sorel, *L'Europe et la Rév. fr.* vol. ii (1885–1904), contains a good estimate of Marie Antoinette. *See* also P. de Nolhac, *Marie Antoinette* (Paris 1936); which gives good descriptions of Versailles, Trianon, etc.; M. de la Rocheterie, *Histoire de Marie Antoinette* (2 vols., Paris, 1890); G. Desjardins, *Le Petit-Trianon* (Versailles, 1885). For her trial and death, *see* E. Campardon, *Marie Antoinette à la Conciergerie* (1863). *See* also A. Vuaflart and H. Bourin, *Les Portraits de Marie Antoinette* (1909); A. Cabanès. *La Princesse de Lamballe intinze* (1922); P. M. de Ségur, *Marie Antoinette* (1921; Eng. trans., 1927); John G. Palache, *Marie Antoinette* (1929); Emile Baumann, *Marie Antoinette et Axel Fersen* (Paris, 1931); Katharine Anthony, *Marie Antoinette* (1933); Marjorie Coryn, *Marie Antoinette and Axel de Fersen* (London, 1938); J. Daniel Chaucier, *The Dubious Tale of the Diamond Necklace* (London, 1939); Charles Kunstler, *The Personal Life of Marie Antoinette,* trans. by Margot Robert Adamson (London, 1940). (C. B. PH.; X.)

MARIE DE FRANCE (*fl.* c. 1175–1190), French poet and fabulist. In spite of her own statement in the epilogue to her fables: "Marie ai num, si suis de France," generally interpreted to mean that Marie was a native of the Île de France, she seems to have been of Norman origin, and certainly spent most of her life in England. Her language, however, shows little trace of Anglo-Norman provincialism. Like Wace, she used a literary dialect which probably differed very widely from common Norman speech. The manuscripts in which Marie's poems are preserved date from the late 13th or even from the 14th century, but the language fixes the date of the poems in the second half of the 12th century.

The *lais* are dedicated to an unknown king, who is identified as Henry II. of England; and the fables, her *Ysopet,* were written according to the *Epilogus* for a Count William, generally recognized to be William Longsword, earl of Salisbury. Marie lived and wrote at the court of Henry II., which was very literary and purely French. Queen Eleanor was a Provençal, and belonged to a family in which the patronage of poetry was a tradition. There is no evidence to show whether Marie was of noble origin or simply pursued the profession of a *trouvère* for her living.

The origin of the *lais* has been the subject of much discussion. Marie herself says that she had heard them sung by Breton minstrels. Gaston Paris (*Romania,* vol. xv.) maintained that Marie had heard the stories from English minstrels, who had assimilated the Celtic legends. In any case the Breton lays offer abundant evidence of borrowing from Scandinavian and oriental sources.

The *lais* which may be definitely attributed to Marie are *Guigemar, Equitan, Le Frêne, Le Bisclavret* (the werewolf), *Les Deux amants, Laustic, Chaitivel, Lanval, Le Chèvrefeuille, Milon, Yonec* and *Eliduc.* The other similar lays are anonymous except the *Lai d'Ignaure* by Renant and the *Lai du cor* of Robert Biket, two authors otherwise unknown. They vary in length from some 12,000 lines to about 100.

Marie's *Ysopet* is a collection of fables translated from an English original which she erroneously attributed to Alfred the Great, who had, she said, translated it from the Latin. Another poem attributed to her is *L'Espurgatoire Seint Patriz,* a translation from the *Tractatus de purgatorio S Patricii* (c. 1185) of Henri de Salterey, which brings her activity down almost to the close of the century.

See *Die Fabeln der Marie de France* (1898), ed. by Karl Warnke with the help of materials left by Eduard Mall; and *Die Lais der Marie de France* (2nd ed., 1900), ed. by Karl Warnke, with comparative notes by Reinhold Kohler; the two works being vols. vi. and iii. of the *Bibliotheca Normannica* of Hermann Suchier; also J. Bédier in *Revue des drux mondes* (Oct. 1891); Alice Kemp-Welch in *Nineteenth Century* (Dec. 1907); and Winkler, "Marie de France" in *Sitzengber. d. Wiener Akad,* vol. 183, 1918. For an analysis of the *Lais* see *Revue de philologie française,* viii. 161 *seq.;* Karl Warnke, *Die Quellen der Esope der Marie de France* (1900). The *Lais* were first published in 1819 by B. de Roouefort. *L'Espurgatoire Seint Patriz* was edited by T. A. Jenkins (Philadelphia, 1894). Some of the *Lays* were paraphrased by Arthur O'Shaughnessy in his *Lays of France* (1872).

MARIE DE' MEDICI (1573–1642), queen consort and queen regent of France. daughter of Francis de' Medici, grand duke of Tuscany, and Joanna, an Austrian archduchess, was born in Florence on April 26, 1573. She married Henry IV of France in October 1600. Her eldest son, the future Louis XIII, was born at Fontainebleau in September of the next year; the other children who survived were Gaston duke of Orleans; Elizabeth queen of Spain; Christine duchess of Savoy; and Henrietta Maria queen of England. During her husband's lifetime Marie de' Medici showed little sign of political taste or ability; but after his murder in 1610 when she became regent, she devoted herself to affairs with unfailing regularity and developed an inherited passion for power. She gave her confidence chiefly to Concini, afterwards maréchal d'Ancre, the husband of Leonora Galigaï, a friend of her childhood. Under the regent's lax and capricious rule the princes of the blood and the great nobles of the kingdom revolted; and the queen, too weak to assert her authority, consented at Sainte Menehould (May 15, 1614) to buy off the discontented princes. In 1616 Richelieu entered her councils. Louis XIII., who was now 16 years old, threw off the tutelage of his mother and Concini. By his orders Concini was murdered, Leonora Galigai' was tried for sorcery and beheaded, Richelieu was banished to his bishopric, and the queen was exiled to Blois.

After two years of virtual imprisonment she escaped in 1619 and became the centre of a new revolt. Louis XIII. easily dispersed the rebels, but through the mediation of Richelieu was reconciled with his mother, who was allowed to hold a small court at Angers, and resumed her place in the royal council in 1621. For a single day, the *journée des* dupes, Nov. 12, 1630, she seemed to have succeeded against the minister; but the triumph of Richelieu was followed by her exile to Compikgne, whence she escaped in 1631 to Brussels. From that time till her death at Cologne on July 3, 1642 she intrigued in vain against the cardinal

See A. P. Lord, *The Regency of Marie de Médicis* (1904); L. Batiffol, *La Vie intime d'une reine de France au XVIIe siècle: Marie de Médicis* (1931; Eng. trans., 1908).

MARIE FEODOROVNA (MARIE SOPHIA FREDERIKA DAGMAR) (1847–1928), empress of Russia, second daughter and fourth child of King Christian IX. of Denmark, was born Nov. 26, 1847. Originally betrothed to Nicholas, eldest son of Alexander II., tsar of Russia, on his death she married, on Nov. 9, 1866, the Grand Duke Alexander Alexandrovitch, his younger brother, heir-apparent to the Russian throne, and was known thenceforward as Marie Feodorovna. The grand duke succeeded to the Russian throne as Alexander III., in 1881, on the assassination of his father by revolutionaries. The empress's home life was a happy one, and she took no part in politics. Her husband was for many years in danger of his life and every precaution was taken for his safety. There was on his accession a tendency to reaction, and on the advice of Pobiedonoszeff, Alexander III. refused to accept the Constitution prepared by his father. As his accession to the throne had never been expected, he had been trained as a soldier, and had little political knowledge or ability. The empress interested herself particularly in philanthropy and education, and as head of the "department of the institution of the empress Marie" greatly extended the work of the institution, establishing new schools, hospitals and relief centres of various kinds. She endeared herself to the people of Russia by her personal interest as well as by her wide philanthropic activities. She was trained as a nurse during the Russo-Turkish war, and greatly developed the Russian Red Cross organization, of which she was the head. From the death of Alexander III., in 1894, she lived in retirement in the Anitchkov palace in St. Petersburg (Leningrad), visiting Denmark and England where she was staying on the outbreak of the World War. She returned to Russia, in spite of an attempt in Berlin to send her back to England, and worked actively for the Russian Red Cross. Her attempts to warn her son, Nicholas II., against the influence of Rasputin were unsuccessful. Three months after Rasputin's murder the revolution broke out and the emperor abdicated. The empress Marie, who was at Kiev, met him for the last time at Mohilev. She was permitted, with other members of the royal family, to live in the Crimea, under close guard. When the Crimea came under German occupation she was given the opportunity of returning to Denmark through Germany, but refused, and only left for England after the armistice in April 1919. During her later years she lived at Hvidore, in Denmark; she died at Copenhagen on Oct. 13, 1928.

The empress had five children, Nicholas, who became emperor as Nicholas II.; George, who died at the age of 23; Xenia, who married the Grand Duke Alexander Mikhailovitch; Michael, who was tsarevich from 1881 until the birth of a direct heir to the throne in 1904; and Olga, whose marriage with Prince Peter Oldenburgsky was dissolved during the war.

MARIE GALANTE, an island in the French West Indies. Pop. (1940) 23,124. It lies in 15° 55′ N. and 61° 17′ W., 16 mi. S.E. of Guadeloupe, of which it is a dependency. It is nearly circular in shape and 58 sq mi. in area A rocky limestone plateau 675 ft. high occupies the centre of the island, and from it the land descends in a series of well-wooded terraces to the sea. The shores are rocky, there are no harbours, and the roadstead off Grand Bourg is difficult of access, owing to the surrounding reefs. The climate is healthy and the soil rich; sugar, coffee and cotton being the chief products. The largest town is Grand Bourg (pop. 13,833) on the southwest coast. The island was discovered by Columbus in 1493, and received its name from the vessel on which he was sailing. The French who settled here in 1648 suffered numerous attacks both from the Dutch and the British, but since 1766, except for a short period of British rule in the early part of the 19th century, they have held undisturbed possession.

MARIE LESZCZYNSKA (1703–1768), queen consort of France, was born at Breslau on June 23, 1703, being the daughter of Stanislas Leszczynski (who in 1704 became king of Poland) and of Catherine Opalinska. During a temporary flight from Warsaw the child was lost, and eventually discovered in a stable; on another occasion she was for safety's sake hidden in an oven. In his exile Stanislas found his chief consolation in superintending the education of his daughter. Her marriage with Louis XV. took place at Fontainebleau on Sept. 5, 1725. Marie's one attempt to interfere in politics, an effort to prevent the disgrace of the duke of Bourbon, was the beginning of her husband's alienation from her; and after the birth of her seventh child, Louise, Marie was practically deserted by Louis, who openly avowed a series of liaisons. She died at Versailles on June 24. 1768.

See H. Gauthier Villars, *Le Mariage de Louis XV. d'après des documents nouveaux* (1900), P. de Nolhac, *La Reine Marie Leczinska* (1900) and *Louis XV. et Marie Leczynska* (1900); P Boyé, *Lettres du roi Stanislas à Marie Leszczynska 1754–66* (Paris and Nancy, 1901); and C Stryienski's book on Marie Joséphs de Saxe (*La Mère des trois derniers Bourbons,* 1902).

MARIE LOUISE (1791–1847), second wife of Napoleon I., was the daughter of Francis I., emperor of Austria, and of the princess Theresa of Naples, and was born on Dec 12, 1791. It is probable, though not quite certain, that the first suggestions of a marriage between Napoleon and Marie Louise emanated secretly from the Austrian chancellor, Metternich. The prince de Ligne claimed to have been instrumental in arranging it., In any case the proposal was well received at Paris both by Napoleon and by his ministers; and the difficulties respecting the divorce of Josephine, were surmounted. The marriage took place by proxy in the church of St. Augustine, Vienna, on March 11, 1810. The new empress was escorted into France by Queen Caroline Murat, for whom she soon conceived a feeling of distrust. The civil and religious contracts took place at Paris early in April, and during the honeymoon, spent at the palace of Compikgne, the emperor showed the greatest regard for his wife "He is so evidently in love with her," wrote Metternich, "that he cannot conceal his feelings, and all his customary ways of life are subordinate to her wishes" His joy was complete when on March 20, 1811, she bore him a son who was destined to bear the empty titles of "king of Rome" and "Napoleon II." Before the campaign of 1812 she accompanied the emperor to Dresden; but after that scene of splendour misfortunes crowded upon Napoleon In January 1814 he appointed her to act as regent of France (with Joseph Bonaparte as lieutenant-general) during his absence in the field.

At the time of Napoleon's first abdication (April 11, 1814), she succeeded in spite of the efforts of Joseph and Jerome Bonaparte in reaching her father, the emperor Francis, while Napoleon was on his way to Elba. She, along with her son, was escorted into Austria by Count von Neipperg, and refused to comply with the entreaties of Napoleon to proceed to Elba; and her alienation from him was completed when he ventured to threaten her with a forcible abduction. During the Hundred Days she remained in Austria, and manifested no desire for the success of Napoleon in France. At the Congress of Vienna the Powers awarded to her and her son the duchies of Parma, Piacenza and Guastalla, in conformity with the terms of the treaty of Fontainebleau (March, 1814); in spite of the determined opposition of Louis XVIII. she gained this right for herself owing largely to the support of the emperor Alexander, but she failed to make good the claims of her son to the inheritance. (*See* REICHSTADT, NAPOLEON FRANCIS JOSEPH CHARLES.) She proceeded alone to Parma, and had to acquiesce in the title "duke of Reichstadt" accorded to her son.

Long before the news of Napoleon's death reached her she was living in intimate relations with Neipperg at Parma, and bore a son to him not long after that event. Napoleon on the other hand spoke of her in his will with marked tenderness, and both excused and forgave her infidelity. Neipperg became her morganatic husband; and they had other children. In 1832 she visited the duke of Reichstadt at Vienna when he was dying. Her rule in Parma, conjointly with Neipperg, was characterized by a clemency and moderation which were lacking in the other Italian states in that time of reaction. She preserved some of the Napoleonic laws and institutions; in 1817 she established the equality of women in heritage, and ordered the compilation of a civil code which was promulgated in January 1820. On the death of Neipperg in 1829 his place was taken by Baron Werklein, whose influence was hostile to popular liberty. In 1831 Marie Louise had to take refuge with the Austrian garrison at Piacenza; on the restoration of her rule by the Austrians its character deteriorated, Parma becoming an outwork of the Austrian empire. She died at Vienna on Dec. 18, 1847.

See *Correspondence de Marie Louise 1799–1847* (Vienna, 1887); J. A. Baron von Helfert, *Marie Louise* (Vienna, 1873); E. Wertheimer, *Die Heirath der Erzherzogin Marie Louise mit Napoléon I.* (Vienna, 1882); and *The Duke of Reichstadt* (Eng. ed., 1905). *See* also the *Memoirs* of Bausset, Mme. Durand Méneval and Metternich; and Max Billard, *The Marriage Ventures of Marie Louise*, English version by Evelyn, duchess of Wellington (1910); D. Masson, *L'impératrice Marie Louise* (1902); Cuthell, *An Imperial Victim* (1912); Gachot, *Marie Louise intime* (1912); C. de Clary-et-Aldringen, *Souvenirs* (1914).

MARIENBAD (Czech *Marianské Lázně*), a watering-place in the region of Karlovy Vary, Czech., on the southeastern outskirts of the Císařský Les at an altitude of 2,093 ft., enclosed on all sides except the south by gently sloping hills clad with pine forests intersected by lovely walks. Pop. (1950) 9,178. Although its mineral springs have been known for centuries and are mentioned in a document dated 1341 as belonging to the abbey of Tepl, they attracted few people until Josef Nehr, the doctor of the abbey, demonstrated their curative properties during the period 1779–1820, and the town did not receive a charter until 1868.

After this date it grew in popularity and became one of the most frequented spas in Europe. The waters are cold and varied in composition, some, like those of Carlsbad, being alkaline-saline but of greater strength, others being rich in iron, and are used in the treatment of liver troubles, gout, diabetes and obesity. Most are used for bottling and drinking but the cure also involves a carefully regulated diet; the water is also bottled and exported in large quantities. In addition to the springs there are peat baths very rich in iron. The town is small and well-built, most of its hospitals, bathing establishments and other public buildings being quite modern.

In the vicinity lie many places of interest, *e.g.,* the rock of Podhorn (2,776 ft.), about 3 mi. E., with extensive views of the Böhmer Wald and Erz Gebirge, and, about 7 mi. E., the old abbey of Tepl, founded in 1193, though the present building dates from the 17th–18th centuries and has a fine library and collection of rare manuscripts; and, to the northeast, the small spa of Königswart. In 1938 Marienbad, as part of the Sudetenland, came under German rule. The area again became part of Czechoslovakia after World War II.

MARIENBURG (Polish, MALBORK), a town in former East Prussia, province of Gdansk, Pol., 30 mi. by rail to Danzig, on the right bank of the Nogat, a channel of the Vistula, here spanned by bridges. Pop. (1950) 16,500. The castle of the Teutonic order here was originally founded in 1274 as the seat of a simple commandery against the pagan Prussians, but in 1309 the headquarters of the grand master were transferred hither from Venice, and the "Marienburger Schloss" soon became one of the largest and most strongly fortified buildings in Germany. In the middle of the 15th century the castle passed into the hands of the Poles, by whom it was allowed to fall into neglect and decay. It came into the possession of Prussia in 1772 and was carefully restored at the beginning of the 19th century. It consists of three parts, the Alt- or Hochschloss, the Mittelschloss and the Vorburg, and is built of brick, in a style of architecture peculiar to the Baltic provinces. Marienburg manufactures agricultural machinery and sugar and has saw-mills. It carries on a considerable trade in grain, wood and flax and is the seat of cattle and horse markets. In the old market place, many of the houses of which are built with arcades, stands a Gothic town hall dating from the end of the 14th century.

MARIE THÉRÈSE OF AUSTRIA (1638–1683), queen consort of France, was born on Sept. 10, 1638, at the Escorial, the daughter of Philip IV of Spain and Elizabeth of France. The treaty of the Pyrenees in 1659 stipulated for her marriage with Louis XIV, Marie renouncing any claim to the Spanish succession. Marie Thérèse was married in June 1660, when Philip IV with his whole court accompanied the bride to the Isle of Pheasants in the Bidassoa, where she was met by Louis. She died on July 30, 1683, at Versailles, not without suspicion of foul play on the part of her doctors. Of her six children only one survived her, the dauphin Louis, who died in 1711.

See the funeral oration of Bossuet (1684); E. Ducéré, *Le Mariage de Louis XIV d'après les contemporains et des documents inédits* (1905); Dr. Cabanès, *Les Morts mystérieuses de l'histoire* (1923); M. Duclos, *Madame de La Vallière et Marie Thérèse d'Austriche* (1904); and the literature dealing with her rivals Louise de la Vallière, Madame de Montespan and Madame de Maintenon.

MARIETTA, a city of Georgia, U.S., the seat of Cobb county, is located 20 mi. N.W. of Atlanta, in the Blue Ridge foothills at an altitude of 1,118 ft. Founded in 1833, when Cobb county was formed from Cherokee land, it was chartered as a city in 1852.

The state-owned Western and Atlantic railroad, completed from Atlanta to Marietta in 1845, and subsequent railroad connections stimulated the town's growth.

In 1942 an aircraft-manufacturing plant was located 3 mi. S., where B-29s (the Superfortresses of World War II) were fabricated; the plant was reopened in 1951. As many as 15,000 workers have been employed there in the manufacture of jet aircraft.

Adjacent are the Atlanta naval air station and Dobbins air force base, centre for U.S. southeastern air defenses. A variety of small industries including furniture, textiles and stone antedated aircraft.

The Kennesaw Monument National Battlefield park, 2½ mi. N.W., which marks the site of an important American Civil War battle, is situated at Kennesaw mountain (1,809 ft.). On June 27, 1864, entrenched Confederate forces under Gen. Joseph Eggleston Johnston repulsed a frontal assault by invading Federal troops under Gen. William Tecumseh Sherman. Federal losses exceeded 2,500. A flanking movement finally forced a Confederate retreat across the Chattahoochee river into the environs of Atlanta. More than 10,000 Federal soldiers are buried in the Marietta National cemetery.

For comparative population figures *see* table in GEORGIA: *Population.* (J. C. WA.)

MARIETTA, a city of southeastern Ohio, U.S., the seat of Washington county, is located on the Ohio river, at the mouth of the Muskingum, 45 mi. S.E. of Zanesville. Its history dates from 1785, when Ft. Harmar was constructed there. Permanent settlement, the first in Ohio, began April 7, 1788, with the arrival of Gen. Rufus Putnam (*q.v.*) and his pioneer group, the Ohio Company of Associates, and was named in honour of Queen Marie Antoinette of France. On July 15, 1788, Arthur St. Clair was installed there as first governor of the Northwest territory. The first years were difficult, because of the Indian War of 1791–95. For many years thereafter Marietta was noteworthy in the flatboat trade in agricultural produce down river to New Orleans. During the steamboat era it was a typical river town. For a generation after the American Civil War it was the centre of an important oil and gas area.

There was still a considerable production in the 1960s, mostly on a secondary-recovery basis. Certain favourable peculiarities of soil and climate contributed to the growth of truck farming in the surrounding countryside, but much of the best land has been taken over for industry or housing. The chief products of the local and nearby factories are chemicals (especially plastics), metal alloys and office equipment.

Marietta is the seat of Marietta college (related to the Congregational Christian Church and chartered in 1835), the library of which has the original records of the Ohio company and the 20.000-volume Rodney M. Stimson collection relating chiefly to the Ohio and Mississippi valleys. Worthy of note are Conus, a large and perfect Indian mound in the Mound cemetery; "The Start Westward of the United States," a memorial in Muskingum park, dedicated by Pres. Franklin D. Roosevelt in 1938; and the Campus Blartius museum. operated by the Ohio Historical society The museum houses the land office of the Ohio company, the home of Rufus Putnam, a "river museum," and the Charles Goddard Slack collection of prints and autographs. A great tourist attraction, the "W. P. Snyder, Jr.." a river towboat of a type long obsolete, which is moored in the Muskingum river, also belongs to the museum

For comparative population figures *see* table in OHIO: *Population*. (R L. J.)

MARIETTE, AUGUSTE FERDINAND FRANÇOIS (1821–1881), French Egyptologist, was born on Feb. 11, 1821, at Boulogne. where his father was town clerk. Entrusted with a government mission for the purpose of seeking and purchasing Coptic. Syriac, Arabic and Ethiopic manuscripts for the national collection. he started for Egypt in 1850; and soon after his arrival he discovered the ruins of the Serapeum and the subterranean catacombs of the Apis bulls. His original mission being abandoned, funds were non advanced for the prosecution of his researches, and he remained in Egypt for four years, excavating, discovering and dispatching archaeological treasures to the Louvre, of ahich he was on his return appointed an assistant conservator. In 1858 he accepted the position of conservator of Egyptian monuments to the former khedive Ismail Pasha, and moved with his family to Cairo

The museum at Bula was founded immediately. The pyramid fields of Memphis and Sakkara and the necropolis of Meydum. and those of Abydos and Thebes, were examined; the great temples of Dendera and Edfu were disinterred; important excavations were carried out at Karnak, Medinet-Habu and Deir el-Bahri; Tanis (the Zoan of the Bible) was partially explored in the Delta; and even Gebel Barkal in the Sudan The Sphinx was bared to the rock level, and the famous granite and alabaster monument miscalled the "Temple of the Sphinx" was discovered Mariette was raised successively to the rank of bey and pasha. He died at Cairo on Jan. 19, 1881.

His chief published works are: *Le Sérapéum de Memphis* (1857 *et seq.); Dendérah,* 5 folios and 1 quarto (1873–75); *Abydos,* 2 folios and 1 quarto (1870–80); *Karnak,* folio and quarto (1875); *Deir el-Bahari,* folio and quarto (1877); *Listes géographiques des pylônes de 'Karnak,* folio (1875); *Catalogue du Musée de Boulaq (6* ed., 1864–76); *Aperçu de l'histoire d'Égypte (4* ed., 1864–74, etc.); *Les Mastabas de l'ancien empire* (ed. by Maspero) (1883).

See EGYPT: *Archaeology.*

See also "Notice biographique," by Maspero in ***Auguste Mariette; Oeuvres diverses***, tome *1* (1904).

MARIGNAN, BATTLE OF, fought on Sept. 13 and 14, 1515, between the French army under Francis I and the Swiss. The scene of the battle—which was also that of a hard-fought engagement in 1859 *(see* ITALIAN WARS)—was the northern outskirts of the village of Melegnano (in French, *Marignan*), on the river Lambro, 10 mi. S.E. of Milan, It. The young king of France had gathered an army about Lyons, wherewith to overrun the Milanese; his allies were the republics of Venice and Genoa. The duke of Milan, Maximilian Sforza, had secured the support of the emperor, the king of Spain and the pope and also that of the Swiss cantons, which then supplied the best mercenary soldiers in Europe. *(See* SWITZERLAND: *History.)* The practicable passes of the Alps and the Apennines were held by Swiss and papal troops. Francis boldly crossed the Col de l'Argentière (Aug. 1515) by paths that no army had hitherto used, and Marshal de la Palisse surprised and captured a papal corps at Villafranca near Pinerolo, whereupon the whole of the enemy's troops fell back on Milan. The king, then marching by Vercelli, Novara and Pavia, joined hands with Bartolomeo Alviano, the Venetian commander, and secured a foothold among the Milanese. But in order to avoid the necessity of besieging Milan itself, he offered the Swiss a large sum to retire into their own country. They were about to accept his offer, not having received their subsidies from the pope and the king of Spain, when a fresh corps of mercenaries descended into Italy, desirous both of gaining booty and of showing their prowess against their new rivals, the French and Lower Rhine lansquenets *(landsknechts),* and against the French *gendarmerie.* The French took up a position at Melegnano, facing about 30,000 Swiss, who had only ten small guns to oppose the 72 big ones under the command of Galiot de Genouillac. But the marshy ground was unfavourable to movement by the French cavalry.

The king's army was grouped in front of the village, facing in the direction of Milan, with a small stream separating it from the oncoming Swiss. On either side of the Milan road was a large body of *landsknechts,* a third being in reserve. The French and Gascon infantry (largely armed with arquebuses) was on the extreme right; the various bodies of *gendarmerie,* in the centre. In front of all was the French artillery. The battle opened on the afternoon of Sept. 13. As the Swiss advanced in three huge columns, the French guns fired into them with terrible effect, but the assailants reached the intersected ground bordering the stream and, thus protected from the rush of the French *gendarmerie,* debouched on the other side and fell upon the *landsknechts.* The crowd of combatants, the gathering darkness and the dust prevented any general direction's being given to the battle by the leaders of either side. Francis himself at the head of 200 gendarmes charged and drove back two large bodies of Swiss, which were pressing the *landsknechts* hard. The battle went on by moonlight till almost midnight, when the Swiss retired a short distance. Both sides spent the rest of the night on the battlefield, reorganizing their broken corps. Francis and his gendarmes were the outpost line of the French army and remained mounted all night, lance in hand and helmet on head. Next morning at sunrise the battle was renewed. The Swiss now left their centre inactive opposite the king and with two strong corps attempted to work round his flanks. The one on the left made for the French baggage but found it strongly guarded by *landsknechts,* who drove them back. The nearest French *gendarmerie* joined in the pursuit, but a detachment from the Swiss centre fell upon these and destroyed them. This detachment in turn followed up its advantage until as Francis himself expressed it, "the whole camp turned out" to aid the *landsknechts* and "hunted out" the Swiss. Meantime, the Swiss left attack had closed with the French infantry bands and the *aventuriers* (afterward the famous corps of Picardy and Piedmont), who were commanded by the famous engineer Pedro Navarro. It was in the main a struggle of arquebus against pike, but it was not the arquebus alone, or even principally, that gave the victory to the French. When the Swiss ranks had been disordered, the short pike and the sword came into play; and, aided by the constable de Bourbon with a handful of the *gendarmerie,* the French right more than held its own until Alviano with the cavalry from Lodi rode on to the field and completed the rout of the Swiss. In the centre, meanwhile, the two infantries stood fast for eight hours, separated by the brook, while the artillery on both sides fired into it at short range. But the *landsknechts,* animated by the king, endured it as well as the Swiss; and at the last, Francis, leading a final advance of his exhausted troops, forced the Swiss to give way and flee. Only 3,000 Swiss escaped out of about 25,000 who fought. On the French side probably 8,000 were killed or died of wounds. The battle lasted 28 hr. Its tactical lesson was the efficacy of combining two arms against one. The French *gendarmerie*, burning to avenge the insult of "hares in armour," made more than 30 charges by squadrons; and they were admirably supported by their light artillery, which played havoc with the Swiss pikemen, whom the mounted charges had brought to a halt. Marignan was thus a landmark in the power of the new arm and at the same time the last and greatest triumph of the armoured lancer.

MARIGNOELI, GIOVANNI DE' (*fl.* 1338–1357), a Franciscan. one of four ecclesiastics appointed by Pope Benedict XII as his legates to the court of the great Khan, was born, probably before 1290. in Florence. His family is long extinct, but a street near the cathedral (Via de' Cerretani) formerly bore the family name.

The Catholic mission left Avignon in Dec. 1338 and joined the Tatar envoys at Naples. The combined embassies traveled via Constantinople and the Black sea to the court of Mohammed Uzbeg, khan of the Golden Horde, at Sarai on the Volga. He entertained them during the winter of 1339–40 and sent them across the steppes to Armalec, Almalig or Almaligh (*i.e.*, Kuldja, 44° 00′ N., 81° 00′ E.), the northern seat of the house of Chaghatai. There the legates built a church and baptized several persons. Leaving Armalec in 1341 they reached Peking in May or June 1342. They were well received by the reigning khan, the last of the Mongol dynasty in China. There Marignolli stayed for three or four years, leaving via Zayton or Amoy in Dec. 1347. He reached Columbum (Kollam or Quilon in Malabar) in Easter week, 1348, and found there a Catholic church (probably founded by Jordanus of Severac). He visited the shrine of St. Thomas (near Madras), the kingdom of Saba (which he identified with the Sheba of the Bible, but which seems to have been Java) and Ceylon where he was detained. From Ceylon, his route appears to have been by Ormuz, Baghdad, Mosul, Aleppo, Damascus and Jerusalem. In 1353 he reached Avignon and delivered a letter from the great khan to Pope Innocent IV. In 1354, the emperor Charles IV made Marignolli one of his chaplains. Shortly afterward he became bishop of Bisignano. In 1356 he was an envoy to the pope from Florence, and in 1357 he was at Bologna. The date and place of his death are unknown.

Marignolli inserted notes of his Asian travels in his *Annals of Bohemia,* compiled for Charles IV. These fragments were not noticed until they were included by Father G. Drobner in *Monumenta historia Bohentiae nunquam antehac edita* (1768). *Fontes rerum bohemicarum,* ii, 49–604 (1882) contains'the best text.

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MARIGNY, ENGUERRAND DE (1260–1315), French statesman, was born at Lyons-la-Forkt in Normandy. Equerry to Hugues de Bonville, he became in 1298 chief bread bearer to the queen, who helped him attain higher positions. After the death, of Pierre Flotte and Hugues de Bonville at the battle of Courtrai in 1302, he became Philip IV's grand chamberlain. In 1306 he was sent to preside over the exchequer of Normandy. He received numerous gifts of land and money from Philip as well as a pension from Edward II of England. He was an able instrument of Philip's policy, and shared the popular odium which Philip incurred by debasing the coinage. He obtained rich appointments for many of his relatives and secured increased revenue for the king. His power was at its highest in 1313–14, when he was prime minister, supervising the whole of the royal finances and controlling the *chambre des comptes*. His peace with the Flemings in 1314 disappointed the princes of the blood. He was accused of receiving bribes, and Charles of Valois denounced him to the king himself; but Philip stood by him. After the death of Philip IV on Nov. 30, 1314, the feudal party turned on his ministers and chiefly on his chamberlain. Enguerrand was arrested. and 28 articles of accusation, including charges of receiving bribes, were brought against him. He was refused a hearing; but his accounts were correct, and Louis was inclined to spare him anything more than banishment to the island of Cyprus. Charles of Valois then brought forward a charge of sorcery. Enguerrand was condemned at once and hanged on the public gallows at Montfaucon, France.

MARIGOLD, a common name given to several plants, of which the following are the best known: *Tagetes erecta,* the African marigold; T. *patula,* the French marigold; *Calendula officinalis,* the pot marigold; and *Chrysanthemum segetum,* the corn marigold. These all belong to the family Compositae, but the marsh marigold (*q.v.*), *Caltha palustris,* belongs to the Ranunculaceae (buttercup family). (*See* also ICE PLANT, often called the fig marigold.)

To the gardener the name marigold most commonly indicates species of the genus *Tagetes* and especially the developed varieties of T. *erecta* and *T. patula.* Contrary to the origins indicated by their common names, these are native to America, from Mexico to the Argentine. These hardy annuals. from the tiny (one to one and one-half foot) French types to the giant (three to four feet) Africans, have finely cut strong-scented foliage. except for a few later-developed unscented varieties. Besides the above species, T. *lucida,* sweet-scented marigold, and T. *tenuifolia,* striped marigold, are grown. The flowers of yellow, orange and red to red-brown are popular in the garden in beds, borders and massed groups, and are excellent as cut flowers. Seed sown in the spring in any garden soil—poor to average. met or dry—in sun or partial shade will give a profusion of blooms from midsummer to frost. The plants require little attention and transplant readily.

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POT MARIGOLD (CALENDULA OFFICINALIS)

The pot marigold, *Calendula officinalis*, a familiar garden plant up to two feet in height, with unscented foliage and orange-coloured blossoms is probably not known in the wild state. Single and double varieties have been in cultivation for at least 300 years; John Gerard in his *Herball* (1597) mentions a proliferous form, the "fruitful marigolde," in which small flower heads proceed from beneath the circumference of the flower. He remarks that it is called *Calendula* "as it is to be seene to flower in the calends [first] of almost everie moneth." *Calendula officinalis* is one of the easiest of annuals to grow; seed sown in spring in any average soil in full or partial sun will produce flourishing plants which bloom from late spring to frost. Smaller plants, cut back in fall and potted, will bear flowers indoors for several weeks.

The Eurasian *Chrysanthemum segetum,* the corn marigold. is a weed common in fields in England and throughout the eastern part of North America. The cape marigold (*Dimorphotheca aurantiaca*) is a South African perennial, much cultivated for ornament.

MARII (officially MARI), an Autonomous Soviet Socialist republic in the Russian Soviet Federated Socialist republic, U.S.S.R., created Dec. 5, 1936, with Ioshkar-Ola (Joshkarol) (formerly Krasnokokshaisk and Tsarevokokshisk) as its main town. Area 8,958 sq.mi. Pop. (1959) 647,630. The surface consists of a plain sloping south to the Volga river. with higher ground in the east forming the watershed between the tributaries of the Volga and the Vyatka. The chief rivers are the Volga. which flows through part of the southwest, and after passing through the north of the Chuvash A.S.S.R. forms the southeastern boundary of the Marii region, the Greater and Lesser Kokshaga and the Vetluga, tributaries of the Volga. The area lies in the taiga forest zone and about 64% of it is covered with coniferous forest, pine and fir predominating. Timber and wooden wares provide a large source of income. the nearness of the Volga being a great asset for export. A railway was constructed in 1923 from Kazan to Ioshkar-Ola (pop. 88,000, 1959), the administrative centre. Kozmodemiansk, on the Volga, became a great timber centre. The soils are not favourable for agriculture, consisting mainly of sands, clays and forest earths. Chalk was worked in the north and there are extensive peat beds. Small glass and flour-milling enterprises were established. Facilities for the production of resin and turpentine were also established. and industries based on lumber, such as paper and cellulose manufacturing, sawmilling, furniture and prefabricated houses, were introduced.

The population consisted in 1947 of Marii 51%, Russians 44%, with some Tatars and Chuvashes. The Marii were called by the Russians Cheremis. They speak a Finnish dialect akin to Mordvinian and Permian, but are much more dolichocephalic and it has been suggested that they are connected with the neolithic dolichocephalic population of the shores of Lake Ladoga. They inhabited a region farther to the west than their present habitat up to the 11th century, but moved eastward into the marsh and forest region when Slav colonization began, and were settled in their present home in the 14th century. Moscow annexed the region in the 16th century but the Marii remained separate from the Russian colonists and retained their language and customs.

See also FINNO-UGRIAN.

MARIJUANA (MARIHUANA). Marijuana, an intoxicating excitant drug, used illegally in the United States and elsewhere usually in cigarette form, is obtained from the top leaves and flowers of the Indian hemp plant. Cannabis *sativa*, which grows in most parts of the world. Since ancient times people have used its products for stimulation and intoxication. (See HASHISH and HEMP.) Abusive use of it is a serious medical and social problem in various countries. Many emotionally unstable persons known to be associated with major crimes prove to be marijuana users. Marijuana intoxication may be accompanied by such physical and psychic manifestations as thirst, hunger. craving for sweet foods. nausea. dizziness, abdominal pain, droasiness, irritability. delusions of grandeur or persecution, uncontrollable hilarity, talkativeness, apprehension, mental confusion, prostration, depression, inarticulate speech and delirium. Mental dullness ordinarily increases with continued use of marijuana and psychoses may develop. Some persons have suffered most disagreeable effects a short time after smoking one marijuana cigarette.

Withdrawal of marijuana causes no such physical abstinence symptoms as opiate withdrawal does. Addiction to heroin or morphine (*qq.v.*) commonly follows use of marijuana, especially among young persons.

Marijuana, considered to have no medical value, was removed from the United States pharmacopoeia. The federal Marihuana Tax act of 1937 prohibited its use. It was placed under international control because of its increased abuse throughout the world. The World Health organization undertook a project to develop a strain of the hemp plant devoid of intoxicating resins.

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MARILLAC, SAINT LOUISE DE (1591–1660), cofounder with St. Vincent de Paul (*q.v.*) of the Daughters of Charity, better known as Sisters of Charity of St. Vincent de Paul, was born either in Paris or Ferrières on Aug. 12, 1591, and educated by Dominican nuns at Poissy and in a lay boarding school in Paris. Her delicate health, which proved lifelong, prevented her from joining the strict order of Poor Clares, and in 1613 she married Antoine le Gras, secretary to Queen Marie de Medicis, by whom she had a son before his death in 1625. Vincent de Paul, whom she had chosen as her spiritual guide, moderated her zeal and encouraged her to undertake charitable works. Receiving into her home a few country girls sent by him, she trained them in the spiritual life and taught them to assist the Ladies of Charity in visiting, feeding and nursing sick poor. Their number increased, and in 1633 Vincent founded the Daughters of Charity with Louise as their superior. He would not have them called nuns or have them enclosed. He thus pioneered in bringing religious women into the service of God and man outside the cloister. The rest of Louise's life was uneventful. She died in Paris on March 15, 1660. She was canonized in 1934, and her feast day is March 15.

See biographies by Alice Lady Lovat (1916) and Sister Bertrande Meyers (1956). (J. LD.)

MARIMBA, a musical instrument which consists of a series of sticks of wood, cut and shaped so that each stick when struck produces a musical tone of definite pitch. As used in modern orchestras, it is placed on a base and played by striking with a variety of sticks or mallets to produce different effects. It usually has a range of five octaves. A liquid tone is secured by the use of metal tubes as resonators, or even by gourds.

The marimba is of ancient origin, known in South Africa and Central America. It is commonly used in popular, especially Spanish-American, dance music, but has occasionally been used by classical composers. *See* also XYLOPHONE.

MARIN, JOHN (1872–1953), U.S. painter, whose great contribution was a dynamic expression of vivid perceptions, best known for his water colours, was born in Rutherford, N.J., on Dec. 23, 1872. (His full name, never used, was John Cheri Marin III.) His mother died a few days after he was born, and he was brought up by her relatives. After some practice of architecture, Marin studied painting at the Pennsylvania academy in Philadelphia and the Art Students league in New York. In 1905 he went to Europe for six years and returned permanently to the United States in 1911. In Europe he was influenced by Whistler in both etching and water colour; there, too, commenced his association with Alfred Stieglitz, so important to them both. Marin's technical experimentation found direction after seeing European work at Stieglitz's "291" gallery and at the New York Armory show (1913). In 1914 he married Mary H. Hughes, who died in 1945. Their permanent home was at Cliffside, N.J.

Marin's financial success was achieved through Stieglitz's handling of his output; his artistic stature was established for the general public by the retrospective exhibition at the Museum of Modern Art, New York, in 1936. His technique in water colour by 1920 was brilliant, as in "Lower Manhattan" (privately owned). Eventually he attained an equivalent intensity in oil. In 1948 he received the Fine Arts medal of the American Institute of Architects. He died at Addison, Me., on Oct. 1, 1953.

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MARINDUQUE, an island and, together with several offshore islets, a province of the Philippines, located south of central Luzon and east of Mindoro. Area 355 sq.mi. Pop. (1959) 105,140. Over 30% of the total land is in farms. Coconuts, for copra production, and rice are the leading crops. The provincial capital is Boac (pop. [1959 est.] 24,117). An iron mine at Mogpog, 3 mi. north of Boac, provides employment for about 500 persons and is the leading nonagricultural industry.

(R. E. HE.)

MARINE BIOLOGY is the science that deals with organisms that live in the sea. It also deals with certain air-borne and terrestrial forms that depend directly upon the sea for food and other necessities of life. In the broadest sense it attempts to describe all vital phenomena pertaining to the myriads of living things that dwell in the vast oceans of the world. Some of its specialized branches concern natural history, taxonomy, embryology, morphology, physiology, ecology and geographical distribution. Marine biology is closely related to the science of oceanography because of the relationship of the physical features of the oceans to the living organisms that dwell in them. It aids in the understanding of marine geology through the study of those organisms which contribute their skeletal remains to the floors of the oceans, or elaborate the vast coral reefs of the tropic seas.

Knowledge of marine biology is essential to certain aspects of human welfare. Intelligent regulation of the commercial marine fisheries would be impossible without a thorough understanding of the biology of commercial fishes. The prevention of fouling of ships depends on the knowledge of factors that interfere with biological processes of fouling organisms. Survival at sea by means of life rafts and lifeboats often depends on the utilization of various kinds of marine life for both food and water. The rapid increase in the human populations of the world has indicated a need for greater use of the marine products. which may be made more easily available through contributions of the knowledge gained in the study of marine biology.

The Marine Environment. — The great oceans and adjacent seas comprise approximately 70% of the surface of the earth, with a volume of more than 1,000,000,000 cu.km. The greater part of this vast marine environment is suitable for the existence of large numbers of living organisms; and no part has been discovered completely devoid of life. The upper layers of the oceans are effectively illuminated with sunlight to depths as great as 200 m., so as to permit the existence of pigmented plants which elaborate primary food materials by photosynthesis. Mineral salts are available for the use of living material during growth, the relative concentration of these salts approximating those of the body fluids of most marine organisms. Oxygen is present in concentrations sufficient for respiration in all but a few zones of the oceans; and even these oxygen-deficient zones are inhabited by organisms that exist by anaerobic respiration.

The temperature ranges of —2° C. to 30° C. are well within the limits required by living organisms. In addition the density and viscosity of sea water are such that it affords an ideal floatation medium for the myriads of organisms, large and small, that dwell within it.

Kinds of Organisms in the Sea.—The sea contains a vast assortment of living things including the smallest and the largest that inhabit the world. Submicroscopic bacteriophages have been isolated from the coastal waters: and at the other end of the scale, the great blue whale has been recorded, which attains a length of 34 m., and a weight of 294,000 lb. The invertebrate animals range from tiny protozoa, just visible under the highest powers of the microscope, to the giant deep sea squid. Architeuthis, which has a total length of 11 m. The smallest living vertebrate is the tiny fish, Schzndlerta, found in the South Pacific seas, which matures when 1 j mm. long and weighs less than 5 mg.

Bacteria. — There are many bacteria in the sea which perform the important function of decomposing the dead bodies of larger organisms to release their elementary substances as primary nutrients for plant growth. These bacteria are generally scant in the open waters, but become numerous near the coast lines where organic matter is abundant, and also on the surface of the sea bottoms where detritus accumulates. Terrestrial bacteria, especially those of human origin, often become abundant in bays and estuaries. These bacteria are not marine in the strict sense because they are unable to grow and reproduce in the marine environment. However, since they are able to survive in the sea for long periods of time, and are continually replenished in large supply from the land, they are given an important place in the marine community.

Marine Plants. — Most of the marine plants belong to the primitive group, Thallophyta, which is characterized by the absence of a vascular system, and by a reproductive mechanism which does not require the formation of flowers and seeds. The largest and most diverse group of plants consists of microscopic unicellular forms which abound everywhere in the illuminated upper waters of the oceans where they synthesize the greater part of the primary food supporting marine life. Reproduction is accomplished by simple cell division. When conditions are unfavourable, resting spores are formed which germinate when the situation improves. The rate of reproduction of this group of plants depends to a large extent on the availability of nutrient salts of nitrogen and phosphorus which, however, are found in most abundance in the deep unlighted waters where they cannot be utilized. Consequently, the greatest production of unicellular plants occurs where hydrographic factors cause upwelling of the deep nutrient-rich water; and therefore the primary food synthesized in these localities often provides the basic supply for prosperous commercial fisheries.

The macroscopic marine plants are represented by the red, green and brown algae, with flowering plants being represented by the eelgrasses and the saltmarsh grasses. The three groups of algae are generally anchored to the bottom or some solid structure by rootlike holdfasts which perform the sole function of attachment and do not extract nutrients from the soil as do the roots of the higher plants. Representatives of red, green and brown algae often form dense accumulations in shallow water; but their restricted zonation along the margins of the seas where the depth is 50 m. or less detracts from their importance as primary food producers.

One group of red algae, the Corallinacae, performs an important function in the formation of coral reefs. Members of this group form resistant encrustations on the seaward surfaces of reef corals, and inhibit mechanical wear by cementing loose corals with their skeletons of calcium and magnesium carbonate. A green alga, Halimeda, also contributes to the formation of coral atolls by depositing its platelike calcareous skeleton on the floors of lagoons.

The eelgrasses and saltmarsh grasses, marine representatives of the angiosperms, have true roots, and obtain their nutrients from the mud and sand in which they grow. Both groups reproduce by forming true flowers which are pollinated and produce seeds. These grasses have an important effect on the formations of geological structures in bays and estuaries where they entrap waterborn sediments, forming mud flats, sand bars and marsh banks. Marsh grasses, growing at or near the high water level on coasts where the sea level is constantly rising, build up layers of peat, some of which are several metres thick.

It is curious that few animals browse directly upon the larger marine plants. However the sea hare, *Tethys,* some other gastropods, and a few kinds of fishes, feed on macroscopic algae, while the manatees or sea cows eat other large plants. In general the importance of the larger plants in the marine communities depends upon their providing hiding places and means of attachment for sessile organisms during life. After death their contribution to the organic content of the sea is measured as detritus.

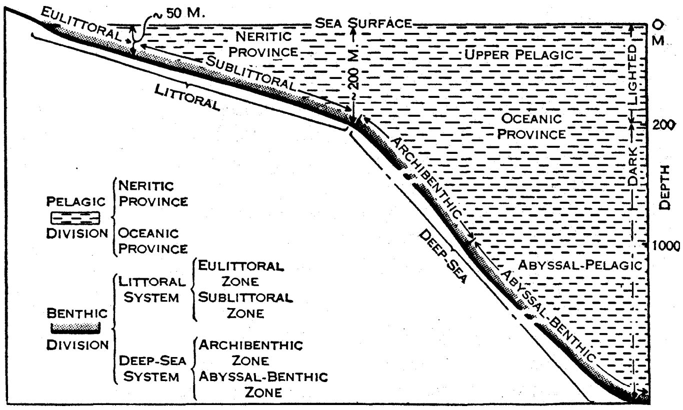
Animal Kingdom. — The animal kingdom presents a spectacular array of forms and sizes in the sea. It is represented by all the major divisions (phyla) of which five are exclusively marine; *i.e.,* the Ctenophora (comb jellies), the Echinodermata (starfish, urchins and sea cucumbers), the Chaetognatha (arrow worms), the Brachiopoda (lamp shells) and the Phoronida (tufted tube worms).

Approximately 44% of the recognized classes of animals are limited to the marine habitat and representatives of about 94% of all known classes occur somewhere in the sea. All classes of vertebrates except the Amphibia are represented. The marine fishes are numerous and diverse. The reptiles include the true sea snakes and turtles. Certain birds such as the penguins have no power of flight and spend the major part of their lives swimming in or waddling near the sea. Others, such as the albatross, soar over the oceans for long periods of time and only return to land to nest. The fish-eating cormorants are powerful underwater swimmers that pursue their prey to considerable depths below the surface of the sea. The principal mammals which are exclusively marine are the whales, porpoises and sea cows. These are so specialized for the aquatic environment that they cannot leave the sea at any time. Others, including the seals, sea lions, and sea otters, normally live in the sea, but are able to move on land for breeding purposes.

The forms and modes of life of the marine invertebrates are so diverse as to defy brief description. The mud and sand of the ocean's bottom teem with burrowing worms, molluscs and crustaceans. The surface of the sand may be covered with starfish, brittle stars, sea urchins and sand dollars where conditions are favourable. Certain groups including the Coelenterates and the Bryozoa contain members that form vast colonies which attach to solid surfaces or are free-floating. Extreme specialization occurs in the siphonophores with individual members of the colony modified for such diverse tasks as swimming, floatation, food catching, ingestion and reproduction. The gigantic coral reefs of the tropical seas are, to a large degree, formed from the skeletal secretions of colonial coelenterates.

The Crustacea are probably the most numerous and diverse group in the marine habitat. The vast majority swim freely in the upper waters feeding on phytoplankton and organic detritus; and form the primary source of food for such pelagic fishes as the herrings and mackerels. One group, comprised of crabs, lobsters and crayfish, inhabit the bottom as scavengers, feeding on dead organisms. Another group, the barnacles, has adopted a completely sedentary mode of life in the adult condition and has become firmly cemented to solid surfaces. Their legs are modified as food-gathering organs which sweep the adjacent waters for organic detritus and small organisms.

Zonation of Marine Life.—The marine environment is divided into arbitrary zones for means of convenience (see diagram); and the organisms are classified into categories determined by habitat and locomotory behaviour. The two main divisions of the sea are the benthic and the pelagic, the former comprising the entire sea bottom and the latter, all the overlying water. All organisms that burrow through the mud, attach to solid surfaces, or crawl on the bottom are classified as living in the benthos. Organisms inhabiting the pelagic division are classified as nekton if they are strong, active swimmers and as plankton if weak swimmers or passive drifters. Planktonic plants such as diatoms, photosynthetic dinoflagellates and other floating algae are known as phytoplankton. Planktonic animals which include a host of drifting forms comprise the zooplankton.



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THE MAIN DIVISIONS OF THE MARINE ENVIRONMENT

The benthic division is divided into a littoral system that extends from the shore to a depth of 200 m. and a deep sea system extending down to the greatest depths. The littoral system is further subdivided into a eulittoral zone extending from the high tide mark to the 50-m. contour; and a sublittoral zone, to seaward. The 50-m. depth is chosen because it represents approximately the greatest depth at which attached plants can grow. The kinds of things that grow in the littoral system depend to a considerable extent on the type of bottom and on the degree of exposure to wave action. Exposed sandy coasts generally develop sparse populations, especially between the tide lines. Also the few organisms inhabiting wave-swept rocky shores are generally firmly cemented to the substratum. Protected bays and inlets often develop rich populations. Protected rocky shores are generally covered with seaweeds, mussels, barnacles, etc., with various kinds of crabs and worms crawling among them. Sandy and muddy bottoms teem with burrowing molluscs, worms and echinoderms in localities where headlands and projections protect the environment from violent wave action. The sublittoral zone, which receives a considerable amount of organic matter from the shoreward area and from the waters above, is particularly rich in animal life, and therefore it is there that the important ground fisheries are located.

More than 90% of the ocean bottom is included in the deep-sea system. A detectable amount of light penetrates the shallower (archibenthic) zone, but it is in such reduced amounts that no plant growth can occur. Beyond the 1,000-m. contour the abyssal benthic zone remains in perpetual darkness. The entire deep-sea system depends on food produced in the upper lighted zones, which drifts downward in limited quantities, restricting the numbers and kinds of animals depending upon it for existence. Most deep sea animals are small and inconspicuous although a large sea spider (Pycnogonida) has been photographed at a depth of 1,800 m.

The pelagic division is divided into the neritic province that overlies the littoral benthic area, and the oceanic province which occurs over the deep sea benthic system. The entire neritic province receives solar radiation and may develop rich blooms of phytoplankton, aided by contributions of nutrient salts from the nearby land and the shallow bottom beneath. The zooplankton which feeds on the phytoplankton is characterized by the presence of a number of temporary forms including the larval stages of benthic animals derived from the populations inhabiting the bottom beneath. These are scarce in the oceanic province because of their distance from adult populations in the littoral benthos and because of the scarcity of such animals in the deep-sea system.

The upper illuminated section of the oceanic province is termed the upper pelagic. There the phytoplankton may develop in abundance in places where oceanographic features bring up nutrient salts from the deeper waters below. Animal life may become so abundant that important tuna and other pelagic fisheries may be profitably pursued. In the unlighted abyssal pelagic section, the animal populations become sparse. The fishes of this region are generally small, dark in colour and often equipped with light-producing organs.

Life Histories of Marine Organisms.—In the plant kingdom the marine bacteria and microscopic algae reproduce by simple cell division. Favourable conditions may increase the rate of reproductions to such an extent that dense local accumulations known as blooms may occur. Abnormal blooms of certain poisonous dinoflagellates are not uncommon in the warmer seas where vast quantities of fish are killed by their toxic secretions These substances are of such virulence that shore resorts are made uninhabitable since respiratory irritations result when these poisonous substances are transferred on the air by breaking waves. The macroscopic algae typically reproduce by spores which germinate into inconspicuous male and female plants, called the gametophyte generation. Fertilization then takes place and the new sporophyte generation is produced.

Marine Animals.—The life histories of marine animals are remarkably varied. Most sedentary forms reproduce sexually by liberating eggs and sperm into the water where fertilization takes place. Typically this is followed by a larval stage with the swimming larva quite unlike the adult. After a free swimming existence which extends over a period of days or weeks, the larva undergoes metamorphosis and assumes the adult form. Fertilization is internal among the majority of the crustaceans. The young grow by moulting or shedding their shells, and pass through a number of successive larval stages before the adult form is attained.

As a rule, the reproductive and developmental patterns of marine animals fall into one of three general categories: (1) internal fertilization with parental protection of the early stages of development, the offspring numbering in the hundreds or less; (2) internal or external fertilization with some provision for the early helpless stages, the offspring numbering in the thousands; and (3) external fertilization with no provision for protection during the early stages, the offspring numbering in the millions. The particular category determines to a considerable degree the way in which populations of any animal may fluctuate from time to time. Certain snails lay small numbers of eggs in resistant capsules which protect the embryos until they become well enough developed to cope with their environment. Populations of such snails tend to remain relatively constant with only gradual fluctuations over long periods of time. Many of the bottom-dwelling crustaceans fertilize the eggs internally and attach the fertilized eggs to special appendages. The eggs are then carried on the mother through the early stages of development and are finally hatched as free swimming larvae in an advanced stage. To insure some survival in the subsequent precarious free-swimming existence, the eggs usually number in the hundreds to tens of thousands. Populations of animals with this kind of life history fluctuate to a considerable extent, depending on how the conditions of the environment favour survival during the free-swimming period. Most molluscs. echinoderms and many commercial species of fish produce millions of eggs per female. These are fertilized externally and then are abandoned to fend for themselves, through a prolonged period of helpless developmental stages. Survival during this period depends on the presence or absence of predators, the strength and direction of currents. and the suitability of the physical and chemical factors of the environment. So many factors or combinations of factors may influence the survival of each generation that populations of organisms with this mode of reproduction tend to exhibit extreme variations from one year to the next. Occasionally circumstances may permit such a high degree of survival of a single generation that its constituents may outnumber all other members of the population for several years. Such a generation is known as a dominant year class and is of considerable importance in the commercial fisheries.

Physiology of Marine Organisms. — The principles of general physiology of marine organisms are essentially the same as those that apply to fresh water and terrestrial organisms. All living things extract substances from their surroundings to provide materials for growth and for energy to maintain the living processes. In the majority of cases the food consists of compounds of carbon,.the energy being derived from oxidation of these compounds. In addition, the composition of living matter must be maintained within narrow limits with respect to the water content and to the concentration of various mineral salts. The problems of maintaining the required composition is accomplished by marine organisms in a number of ways.

Most naked or thinly-covered marine organisms have little difficulty in coping with their environment because the composition of their blood approximates that of sea water with respect to the major salts. They are thus able to carry out their living processes without expending large amounts of energy in concentrating or eliminating water and mineral substances. The blood of many of the fishes, however, is less concentrated (hypotonic) than sea water, and special mechanisms are necessary to prevent loss of water through the body membranes by osmosis. In most fishes the walls of the digestive tract are permeable to solutions of mineral salts so that sea water with its salts ingested by these species may pass into the blood stream. Special organs on the gills extract the excess mineral salts from the blood and excrete them into the waters outside the body. The salt concentration of the blood is thus reduced to an optimal level. Certain species of elasmobranchs (sharks, skates and rays) accomplish the task of regulating their salt concentrations in a different fashion. Instead of expending energy in secreting salts against the osmotic gradient, they conserve their nitrogenous wastes in the form of urea which is retained in the blood in concentrations sufficient to make it the osmotic equivalent of sea water. A number of crustaceans that invade the variable dilute waters of the estuaries are faced with the problem of surviving in a medium that is less concentrated than their blood. Consequently water flows into their bodies by osmosis. These forms are generally protected over most of the body surface by impermeable shells; and the excess water entering through the reduced permeable area is eliminated with considerable expenditure of energy by means of special kidney-like organs.

The cellular fluids of many marine plants differ considerably from the surrounding sea water in their relative concentrations of sodium and potassium. In effect, these plants appear to concentrate potassium, and in doing so must eliminate sodium in order to maintain the total salt concentration of the cellular fluid at a level equal to that of sea water. The elimination of excess sodium is accomplished by means of a "sodium pump" that operates in some unknown manner but which may be stopped by substances that inhibit the organism's utiiization of energy-supplying substances.

Organisms that live between the tide lines, such as clams and oysters, are periodically deprived of oxygen-bearing water at each low tide. The end products of metabolism, formed during this period of anaerobiosis, are acidic. These are temporarily prevented from injuring the organism by being neutralized by the calcium carbonate of the shell at which time the organism incurs an "oxygen debt." This temporary condition is paid off by an increase in oxygen consumption when the oxygen-rich waters flow over the organism at high tide, the accumulation of metabolic products thus being eliminated by oxidation.

Certain tidal organisms exhibit rhythms in behaviour, or rates of metabolism, which correspond to tidal periods. These peculiarities persist even when the organisms are transferred to situations where there is no tide. The oxygen consumption of some molluscs varies as much as tenfold with the phases of the tide. This variation continues in a rhythmic manner even when the organisms are maintained under constant conditions in laboratory aquariums. Such organisms collected from separate localities where the phases of the tide differ will maintain their intrinsic rhythm in correspondence with those of the tides at their original habitats. Fiddler crabs which live in the intertidal zone and alter their colour patterns as the tides rise and fall, for example, continue to exhibit the same rhythmic colour variations under constant conditions in the laboratory.

Brittle stars, sea cucumbers and other voracious animals dwell on the sea bottom in dense accumulations. They require such enormous quantities of food that each generation of immature food organism would be entirely exhausted if eaten immediately after settling to the bottom. To make efficient use of their food supply, the brittle stars and cucumbers enter a quiescent stage during the period when the food organisms are settling, and maintain their metabdic activities at a low rate until the food organisms have increased in volume through growth. In this way the food supply is extended, eliminating the starvation.

A number of fishes are equipped with gas-containing organs called swim bladders that aid in maintaining the hydrostatic balance. Several of these fishes inhabit the depths of the oceans where the gas must be secreted into the swim bladders against a pressure of several atmospheres. The swim bladders are equipped with vascular organs which are presumed to perform the function of gas secretion. However, no physiological mechanism had been described by the 1950s that explained how free gasses could be secreted against the enormous pressure that occurs at the great depths of the oceans.

Geographical Distribution of Marine Organisms. — The flora and fauna of the oceans and adjacent seas differ from place to place because few organisms can tolerate the entire range of physical features that exist in the marine habitat. (See DISTRIBUTION OF ANIMALS.) Temperature has been found to be the principal factor governing the distribution of organisms but other physical qualities are known to be influential, particularly in the shallow water zones. For convenience, the marine habitat has been divided into a number of provinces, each with a characteristic fauna and flora. The main divisions are the arctic, boreal (north temperate), tropic, antiboreal (south temperate) and antarctic. Each of these is subdivided into a number of provinces with characteristic endemic floras and faunas.

The distribution of shallow-water sedentary forms has been analyzed exhaustively because of the great importance of these forms in connection with the fouling of ships, dockyard installations and aids to navigation. The edible mussel, many species of barnacles, and other troublesome fouling organisms occur on both coasts of the Atlantic and Pacific oceans. The north-south distributional pattern of each species is determined by combinations of seasonal extremes in temperature which affect either survival or the ability to reproduce.

The four types of combinations of extremes in the northern hemisphere are as follows:

Type of Distribution	Northern Limit	Southern Limit
1	too cold in winter	too warm in summer
2	too cold in summer	too warm in winter
3	too cold in summer	too warm in summer
4	too cold in winter	too warm in winter

Organisms whose ranges are determined by the first type of distribution are generally susceptible to extremes of temperature in the adult condition. Winter-killing occurs north of the ranges and the highest summer temperatures are lethal south of the ranges.

In the second type of distribution seasonal extremes affect both survival and propagation. No organisms can survive north of the zone where the highest summer temperatures are too cold.

On the other hand, winter temperatures south of the range never fall low enough to permit reproduction. Similarly organisms that fall in the third type of distribution find the warm summer temperatures too high for survival beyond their southern extreme, with the northern boundary determined by the lowest summer maximum that will stimulate spawning. The fourth category includes organisms that are resistant to all but the coldest winter temperatures at the northern boundary of the range, the southern boundary being limited by winter temperatures that are too warm for reproduction.

The Cycle of Life in the Sea.—The marine environment is essentially a closed system in which life proceeds in a cycle determined by the nutritional requirements of the various kinds of organisms. The primary foods are produced by the photosynthetic pigmented plants which have the ability of absorbing energy from solar radiation and of utilizing this energy to combine carbon dioxide with water to form carbohydrates. The carbohydrates synthesized in this manner are the organic frameworks from which all other living substances are derived, This is accomplished by rearrangement of the molecular structure and by the addition of nitrogen, phosphorus, sulphur and certain trace elements. The plants undergo continual grazing by hordes of herbivorous animals. Since the bulk of the plant material produced in the sea is included in the phytoplankton. the majority of the herbivorous animals are filter feeders. endowed with special structures for straining the tiny plants out of the water. The planktonic Crustacea possess filter nets of closely spaced setae on the appendages adjacent to the mouth. Clams, oysters and mussels strain their food out of the water by means of their gills. Some worms employ mucus nets which are capable of extracting particles of extremely minute size from the water. These herbivorous animals, which perform the important function of converting plant materials into animal substance. are in turn subject to predation by the primary carnivores. This group includes a vast array of forms from the tiny arrow worms which snap at individual organisms with their formidable jaws to the great baleen whales which filter their food en masse by means of their whalebone plates.

Beyond the primary carnivores, there are successive levels of carnivorous forms ending with the top predators. When those die they are decomposed by bacteria, thus releasing the elementary substances for the use of the photosynthetic plants, and completing the food cycle.

Within this general cycle of life there are a number of events which make the system complex. Death and decomposition occur at every phase of the cycle. Phytoplankton drifting down into the deep. unlighted zones of the oceans may die and decompose. Their elementary substances are then beyond the reach of their photosynthetic relatives until such time as turbulence or upwelling may return the nutrients to the illuminated water. Shrimp, fishes and other forms dying from causes other than direct predation may sink to the bottom to be eaten by scavengers such as crabs and worms before bacterial decomposition is completed. Incomplete decomposition of any dead organism may result in the production of organic detritus, which is particulate matter of indeterminate nature, included in the diet of many filter-feeding species. Lastly. the general system is made complex by the fact that the metabolic activities of all organisms continue to release elementary substances through respiration and excretion, thus helping to maintain the supply of basic nutrients for the photosynthetic plants.

The great demands for energy made by living organisms, in order to maintain the fundamental living processes, necessarily limit the amount that is available to be transferred from one step to the next in the food cycle. In general every organism uses 90% or more of its food intake to sustain its metabolic activities and transfers less than 10% into its own substance during growth. Thus the rate of production of marine life depends upon the position of a particular species in the cycle with respect to the primary source of supply which is provided by the photosynthetic plants. In the pelagic division, the herbivorous copepods and euphausid shrimps are produced at a rate fast enough to support the feeding requirements of the baleen whales.

Mussels, clams and oysters, which are also herbivorous, have proved to be a dependable source of food for coastal peoples throughout the ages.

In the field of commercial fisheries, the bulk of the world's catch consists of certain pelagic species, including the herrings, mackerels, and menhaden, all primary carnivores, which subsist on small crustaceans and other similar organisms. At the other extreme, the very large fishes and other top predators seldom reproduce and grow at a rate fast enough to permit catches of such a size as to approach those of the herrings and mackerels.

Marine Sources of Human Food.—Man has depended on the sea for part of his food supply since prehistoric times. Human preferences have tended toward the larger fishes because they are relatively easy to capture by means of both primitive and advanced types of fishing gear. However, these larger fishes are generally one or more levels removed from the primary source of food and are therefore produced at a reduced rate. As a typical example, it has been shown that the yield of a singie population of haddock to the commercial fisheries represents less than one-thousandth of the total quantity of living material synthesized by the plants growing in the waters over the fishing grounds.

The increasing need for human food has stimulated interest in making more efficient use of the productivity of the oceans. Preliminary estimates showed that the yearly production of primary food materials approximated three tons per acre when measured as dry plankton. However, two major difficulties prevented extensive use of this enormous production for human food. The vast majority of the photosynthetic plants and the herbivorous zooplankton which subsist on them are exceedingly minute—seldom more than of microscopic size. The problem of separating, such organisms from the waters is vastly more complicated than that of netting even such small fishes as sardines or anchovies. In addition, the cycle of life in the sea proceeds at such a rapid rate that the phytoplankton are consumed by the zooplankton about as fast as they grow. The herbivorous zooplankton in turn are limited constantly by the continual predation by larger forms. The final result of this rapid turnover is a low standing abundance of the groups of organisms that are produced at the highest rate. It thus appears that man must continue to depend on the larger carnivorous fishes even though they represent an infinitesimal fraction of the total amount of food produced in the sea.

Some progress was made during World War II in the use of zooplankton as an emergency source of food for survivors on lifeboats and rafts. Various kinds of zooplankton were tested as to their nutritive value and palatability. The results of these tests indicated that the commonest forms would sustain life for some time and that the taste and consistency is generally acceptable.

Considerable attention has been given to the possibility of increasing the production of such herbivorous molluscs as mussels, clams and oysters, by modifying local conditions to favour the desired species. These species are so close to the primary source of food that their production, in limited localities, surpasses that of any other kind of edible animal material. Oysters and mussels have been farmed for centuries by providing suitable surfaces for attachment and by eliminating predators and competitors. (See also Food Supply of the World.)

In a few instances it has been possible to apply principles of marine biology to the deep sea fisheries in order to locate new supplies and to regulate the degree of exploitation which would maintain the optimal sustained yield. Knowledge of the hydrographic features along the borders of the equatorial currents of the Pacific ocean has made it possible to discover productive tuna populations. An understanding of the population dynamics of Pacific halibut has made it possible for the interested nations to regulate the total catch by international agreement and thus to prevent the wide fluctuations in the availability of this species that result from overfishing. Similarly, a number of nations whose fishermen depend on the haddock resources of the northwest Atlantic agreed to regulate the size of the mesh of the trawls employed in this fishery. In this way the young haddock are allowed to escape so that they may grow to marketable size in greater numbers. This regulation was enacted after years of study of the biology of the haddock, the extent of the resource and the effect of fishing methods.

Marine Biological Methods.—During the last half of the 19th century, when emphasis was placed mainly on the collecting and cataloguing of marine organisms, the methods employed in marine biology were directed toward the capture and preservation of specimens for study. Various kinds of dredges and trawls were used to collect specimens from the bottom; and hoop nets of different sizes were employed in securing pelagic specimens. The vast multitude of marine species has made it necessary to continue to employ such methods up to modern times. The first half of the 20th century, however, saw a shifting of the emphasis toward quantitative and dynamic aspects of the science, for which refined methods and the use of more complex tools were required.

Equipment to determine the physical features of the marine environment was developed with a considerable degree of precision. Reversing thermometers were devised to determine the temperature at any desired depth, and containers which close automatically enabled investigators to bring water samples to the surface for analysis. New volumetric and colorimetric methods made possible immediate analyses for salinity, oxygen, nutrient salts, and plant pigments on shipboard. The penetration of light may be accurately determined by means of photoelectric devices that are lowered into the water; and a variety of coring instruments are available for collecting bottom sediments to a considerable depth.

Even the collecting apparatus underwent a high degree of refinement. Qualitative hoop nets gave way to quantitative samplers that may be lowered in a closed position to any desired depth, opened, towed and closed again. The exact amount of water filtered through the fine silk netting is accurately determined by propellers and counters. Continuous sampling is accomplished by a filtering device whereby a band of fine netting is moved across an opening, and then is rolled up in a tank of preservative. Such samplers may be towed long distances behind commercial vessels and re'quire only a small amount of attendance by unskilled personnel.

Direct observation of marine organisms in their natural habitats has been made possible by underwater cameras, television and improved diving equipment. Cameras have been devised that function in the greatest depths by means of light produced by commercial photographic flash bulbs or xenon gas discharge tubes. Underwater television provides the observer with a continuous picture of events that occur within the field of his submerged camera. The development of simple diving apparatus in the form of the aqualung by Jacques Yves Cousteau made it possible for the investigator to inspect personally marine organisms in their natural habitat in depths as great as 70 m.

The rate of production of primary foods by the photosynthetic plants is determined by dark and light bottle experiments and by the use of radioactive isotopes of various elements. Dark and light bottles filled with sea water of known oxygen concentration and containing a normal population of organisms are suspended in the sea for a given time. Photosynthesis which occurs in the light bottles is determined by the increase in oxygen. A comparison is made between the oxygen concentration in the water in the light bottle, determined after a finite time, with that of the water at the time of filling; the result gives an indication of the amount of food produced. Corrections for losses of oxygen by respiration are determined from the oxygen content of the dark bottle. More direct determinations of this primary productivity are made with the aid of radioactive isotopes. Light bottles filled with water containing normal populations are supplied with small quantities of salts of radioactive carbon and suspended in the sea. After a period of photosynthesis, the organisms are filtered off and the amount of carbon fixed in their bodies is determined by Geiger-Miiller counters.

The properties of isotopes have also been used to determine climatic conditions in paleoecology. It was discovered that the ratio of oxygen-16 to oxygen-18 in the calcium carbonate of shell-forming organisms is influenced by the surrounding temperature at the time of the formation of the shell. Therefore the climate in which a number of prehistoric organisms lived has been determined by the analysis of their fossil remains.

Morphological and taxonomic studies of marine organisms are generally performed on preserved materials in connection with the work in museums and universities. Physiological and embryological investigations requiring the use of living material are generally pursued at biological stations. These are situated on the sea coast, thus facilitating the rapid transfer of specimens to the laboratory where they may be maintained in seawater provided by special circulating systems.

(See also DISTRIBUTION OF ANIMALS; OCEAN AND OCEANOGRAPHY; ZOOGEOGRAPHY; ZOOLOGICAL COLLECTING; and ALGAE; CRUSTACEA; PLANKTON; etc.)

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MARINE ENGINEERING, the branch of engineering that is concerned with the design, construction and administration of machinery installations afloat. The title marine engineer usually designates the men ashore who are occupied with such installations in technical or administrative capacities. It does not normally refer to the activities of the officers and crew who are responsible for the daily operation of their vessel's machinery; they are usually called engineer officers and engineers to distinguish them from deck officers and deck hands.

Marine engineering and naval architecture are often used together to comprehend the entire engineering function involved in design and construction of ships. The demarcation between the responsibilities of the naval architect and the marine engineer is not rigid, but in general the primary responsibility of the marine engineer is the propulsion machinery of the ship, while her form and structure are in the hands of the naval architect. Auxiliary machinery of various kinds may be assigned to either one or the other, and in some shipyards and design offices the electrical installations are the province of an electrical engineer who is not responsible directly to either the marine engineer or the naval architect.

As in other disciplines of engineering, those who practise the profession of marine engineering may have prepared themselves either by formal university-level training or by practice and experience. The number of those who have been formally educated as marine engineers in the English-speaking countries is not large. In Great Britain, marine-engineering education has been mainly a branch of mechanical engineering. In the United States it has usually been administered as part of a program called naval architecture and marine engineering in the few institutions that offer courses in this field.

In any case, the core of the professional area of the specialty is the main propulsion machinery of the ship. Most installations in large ocean-going vessels transform the energy delivered by the power plant to thrust by means of one or more screw propellers at the stern of the ship. The propellers may be connected with the driving engine by direct lines of shafting, by mechanical gearing or, less commonly, by electrical transformation. The number of shafts is usually determined primarily on the basis of maximum unit engine power which can be produced and handled. In general, the smaller the number of screws the higher the propulsive efficiency.

Propulsive efficiency is the efficiency with which power delivered by the shafting (shaft horsepower, s.h.p.) is transformed into the power absorbed by the ship in uniform forward motion alone under towed conditions; *i.e.,* without the disturbances caused by the propellers (effective horsepower, e.h.p.). Single-screw propulsion may give propulsive efficiencies of 70%–80%, while quadruple-screw propulsion may show only 55%–60%. Operating costs will generally be lower with single-screw installations largely because fewer man-hours are required for operation at sea and for upkeep. However, conditions other than efficiency may favour multiple-screw propulsion. Even when the total power required for propulsion could be delivered by a single unit, the corresponding propeller diameter may be too large for the geometry of the stern. Vulnerability to damage of a single-engine shaft and screw favours the multiple-screw installation. A lesser consideration, except in special circumstances, is the feature of maneuverability, which clearly favours multiple screws.

TYPES OF POWER PLANTS

For large ocean-going vessels the two principal types of conventional power plants are the diesel engine and the steam turbine. Each type has a variety of forms and applications. The diesel installation may be connected directly to the propellers, or it may transmit power through mechanical gears or electrical transmission; the steam turbine, because of its high inherent speed, is always connected to the propellers through mechanical or electrical speed reduction. Nuclear propulsion has proved entirely feasible from the engineering standpoint and has displaced the conventional power plant in some special types of ships. The gas turbine, operated either with a conventional combustion system or with free-piston gasifiers, has also attracted considerable attention as a marine power plant.

The choice of power plant for a specific ship depends on many factors. Because of the obvious conditions of use, the factor of reliability is always paramount. Other factors, some or all of which may be governing in any particular design, are: power requirements and the availability and first cost of a power plant of proven form and size to meet these requirements; weight and space characteristics; fuel economy; maintenance costs; noise, vibration, personnel requirements, auxiliary compatibility and other special features.

First cost is seldom a deciding consideration. Both the older conventional types have survived in active competition with each other, and their costs do not differ greatly. But availability of a proven plant may often decide the issue. After the decision to build a ship has been made, there is seldom time to develop completely new designs of machinery to fit her. In large vessels, bulkhead arrangements dictated by other considerations usually make space requirements a secondary matter, except in very fast, high-powered ships.

Weight characteristics, expressed usually in pounds of machinery weight per shaft horsepower, vary widely. In smaller powers the diesel usually has the advantage; in large powers, such as are needed for high-speed liners or most naval vessels, the geared turbine usually offers weight advantage. Fuel economy is related to fueling ports on the proposed itinerary of the vessel, to the proportion of time at which full power will be used and to the proportion of time spent in stand-by condition. Most merchant vessels operate normally at or near full power; naval ships cruise normally at only a fraction of full power. For continued operation at or near full power the diesel usually offers fuel-economy advantages in all sizes. Maintenance costs are determined by the estimated reliability of the plant and the cost of labour for maintenance work. The latter factor has sometimes placed the diesel at a disadvantage in American vessels, where labour costs have been much higher than elsewhere, because the diesel usually requires more maintenance than a steam plant.

Numberless other factors may influence the choice of a particular type of power plant. The experience of the proposed owners, tradition and past practice exert powerful influences. European owners have shown preferences for diesel installations in circumstances where American owners have chosen steam turbines, and the proportion of diesel installations in ocean-going vessels has accordingly been higher in European practice than in American.

DIESEL-ENGINE DRIVE

Engine Types.—Diesel engines for marine use are divided into two general types, the four-stroke and the two-stroke, sometimes called the four-cycle and the two-cycle. In the four-stroke engine the cycle of events required for operation is completed in four strokes of the piston or in two revolutions of the crankshaft. The events are: compression on the first upstroke; combustion and expansion on the first downstroke; exhaust on the next upstroke; and aspiration or induction of air on the last downstroke.

The two-stroke cycle, as its name implies, is completed in one revolution of the crank, and, usually, the revolution is divisible into three approximately equal periods, *viz.,* compression, combustion and expansion, and exhaust and scavenge. Fig. 1 shows the sequence of events diagrammatically. Only insignificant fractions of the expansion and compression strokes are lost, because the exhaust and scavenge periods occur and are completed as the piston is approaching and leaving the bottom dead centre. Every downstroke of the main piston is a power stroke. Scavenging air is supplied by a blower, mechanically or independently driven; and the cylinder may be scavenged longitudinally, transversely or in a looped direction.

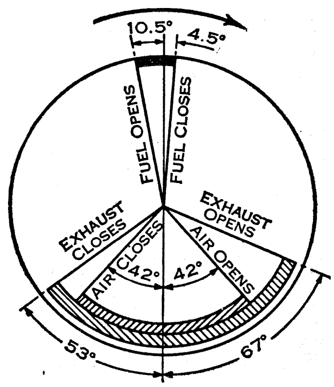


FIG. 1.—SEQUENCE OF EVENTS IN TWO-STROKE CYCLE ENGINE

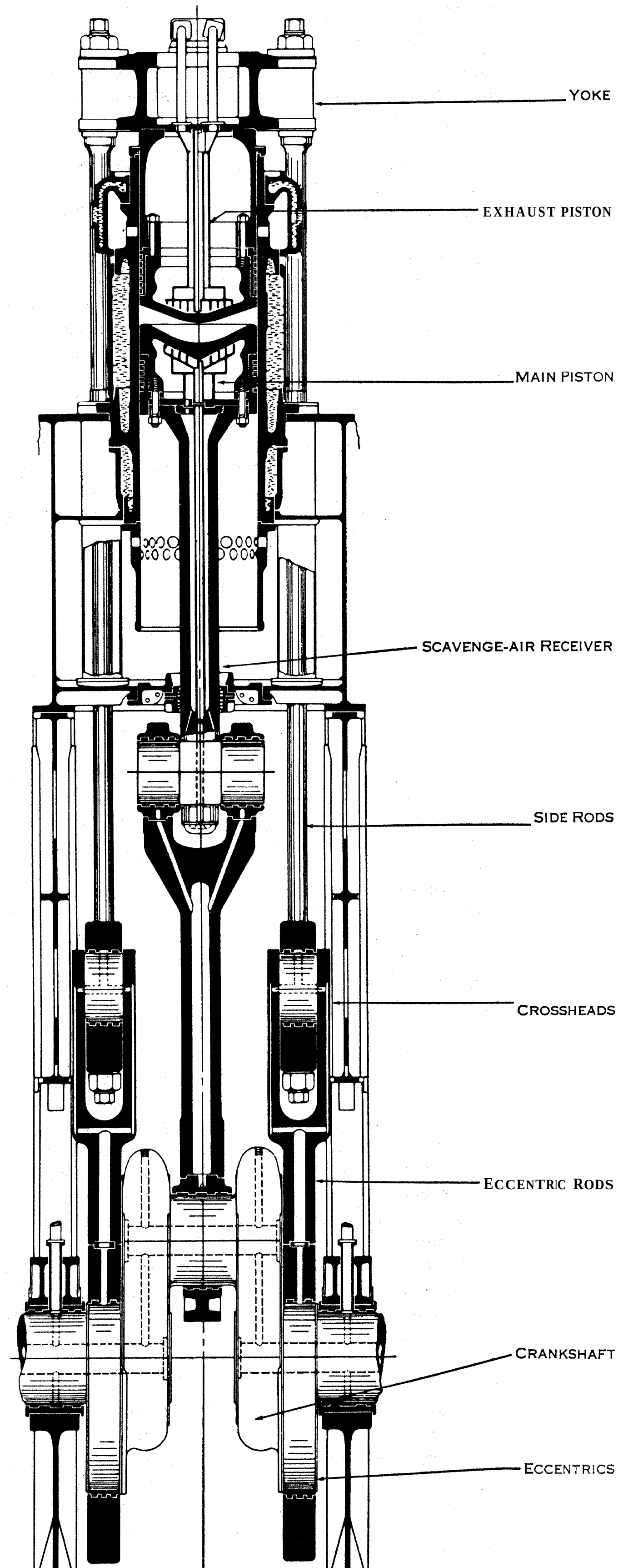
Engines are of the trunk-piston or crosshead types. In the first the crank is connected to the piston directly through the connecting rod, so that reaction to the horizontal force component of the rod results in side pressure against the cylinder wall. To reduce unit value of this side pressure the piston is elongated, or trunked, and from this derives the name trunk-piston type. Alternatively a piston rod connects the piston to a crosshead, which in turn is connected to the crank by a connecting rod, so that the horizontal force component is resisted by the crosshead pressure on its guide, which is connected to the engine frame.

Engines are characterized as single-acting or double-acting, depending on whether a pressure cycle is operative on only one end of the piston or on both ends alternately. A further distinction arises when the exhaust valves are arranged as pistons returning energy to the crankshaft. Such an arrangement is called an opposed-piston engine. When air is forced into the cylinder under pressure instead of being aspirated in at atmospheric pressure, the engine is referred to as being pressure-charged or supercharged.

During the first 15 years of marine application, the most successful engine type was the four-stroke, single-acting, crosshead design. The transverse-scavenged, two-stroke single-acting engine was next in popularity. As a pressure-charged unit the four-stroke single-acting engine persisted for many years more. In the mid-1920s the double-acting four-stroke engine was introduced for higher-powered vessels, but, after a few years, it was discarded as being too complicated for ready overhaul. At this time the double-acting, two-stroke uniflow-scavenged engine followed. The design was very successful in service, but the time and labour needed in port for overhaul precluded its wide acceptance.

Out of this long period of evolutionary activity in several countries and as the result of the independent experience of many builders, the pressure-charged, longitudinally scavenged, single-acting two-stroke engine has emerged as a widely favoured type.

Fig. 2 shows a section through a cylinder of such an engine, made by Harland and Wolff in powers from 3,000 to 8,000 brake horsepower. The bore and stroke of the cylinders are fixed in conjunction with the number of cylinders, ranging from four to eight per engine. The crankcase is isolated from the cylinder, a feature which is important when burning heavy fuels of high sulfur content. There are two pistons in each cylinder, and the scavenging



HARLAND & WOLFF LTD., BELFAST

FIG. 2.— LONGITUDINAL SECTION THROUGH ONE CYLINDER OF A HARLAND AND WOLFF SINGLE-ACTING TWO-STROKE ENGINE

is longitudinal; *i.e.,* on the so-called uniflow principle. The lower, or main, piston controls the admission of the scavenging air through tangential ports arranged near the bottom of the cylinder liner; the upper, or exhaust, piston controls the egress of the combustion gases through radial ports located near the top of the cylinder liner.

Each exhaust piston is operated by a pair of eccentrics, located one on each side of the associated crank. Each eccentric is connected to a crosshead through an eccentric strap and rod, and each crosshead is connected by two rods to a cast-steel yoke bolted to the skirt of the exhaust piston. Although, as its primary function, the exhaust piston controls the exhaust periods, it also contributes to the engine output; the working stroke is, in fact, the crank stroke plus the eccentric stroke. Scavenge air is supplied to the cylinders, in a normally aspirated engine, by two rotary blowers that are chain-driven from the crankshaft. The advantages of the eccentric-type engine are its compactness and simplicity. The crankshaft is short and stiff; there are no "criticals" to be avoided in the running range.

For certain types of ship, crosshead engines are not suitable, chiefly for reasons of height and weight, and trunk-type engines are installed. The first cost of a trunk engine is less than that of an equivalent crosshead engine, but a telling factor against the trunk engine is its higher consumption of lubricating oil.

Geared Diesel Engines.—The claims made for the geared drive are as follows: (1) It is more reliable because it has more than one engine per screw. (2) One or more engines can be shut down when the ship is running light, the others being operated at their most efficient rating. (3) Maintenance is easier because the engines are of more manageable size. (4) Engines can be overhauled. one after the other, at sea. (5) The machinery of a fleet of vessels of different powers can be standardized upon a single cylinder size.

For the geared diesel engine to be in a strong competitive position the engines should run at four times the propeller revolutions; they should be of crosshead design and be able to burn heavy fuel oil successfully.

Elastic Couplings.—An elastic coupling is provided between engine and gearing to serve as a cushion that will prevent the transmission of detrimental torque pulsations from engine to gearing; to function as a quick-disconnecting clutch, when maneuvering; and to limit the transmissible torque to about 1.5 to 2.5 times its normal value, thus obtaining a measure of protection if there should be a seizure in one of the engines. Such a coupling may be mechanical, electrical, hydraulic or pneumatic.

The electromagnetic coupling in wide use resembles an electric motor in construction and operation. It consists of two rotating members, axially aligned, with one inside the other, one connected to the engine, the other to the pinion shaft of the gear system. The outer member consists of a spider connected to the pinion shaft, with salient field poles projecting inwardly from the rim. Direct current from the ship auxiliary supply activates the field windings of these pole pieces, consuming about 1% of the transmitted power. Inside the field is the inner member, with squirrel-cage winding comparable to the rotor of an induction motor, connected to the engine crankshaft. The air gap between the two parts may be from 0.2 to 0.4 in. The field when actuated causes the two members to rotate together! with only a small slip between the two. The r.p.m. of the pinion shaft is always the same as that of the engine shaft less the slip, which normally should not be more than 1% for large powers, or 2% for smaller powers.

Reduction Gearing.—The gearing is always single reduction and usually double helical. The ratio of reduction is frequently 2.5:1 or 2:1; occasionally it is as low as 1.5:1. The efficiency of the energy transmission from diesel engine to propeller hub is approximately 92% for a geared installation; for direct-coupled engines it is about 97%. Between the crankshaft and the tunnel shafting there is a loss both in revolutions and in torque. The slip in revolutions between engine and pinion must be taken into account when determining the gear ratio, and the loss of torque at the gearing in computing the powers.

Fig. 3 shows a typical two-engine geared arrangement. Sometimes four engines are coupled to one gear-wheel shaft, with two units forward of the gearbox and two abaft of it.

Diesel-Electric Drive. — The claims for the diesel-electric drive are similar to those for the geared diesel drive: (1) Reliability is increased by having several engines. (2) Maintenance is easier, the engines being of relatively small size, with interchangeable parts. (3) One or more engines can be shut down at sea for overhaul. (4) With the ship running slowly or in ballast, the necessary units can generate power at their most efficient load. (5) The total installation weight is less, and the engine-room height is much reduced. (6) The propeller and engine revolutions can be made to suit the respective requirements. (7) By varying the number of cylinders per engine and engines per ship, one or two cylinder sizes can cover the range of likely powers.

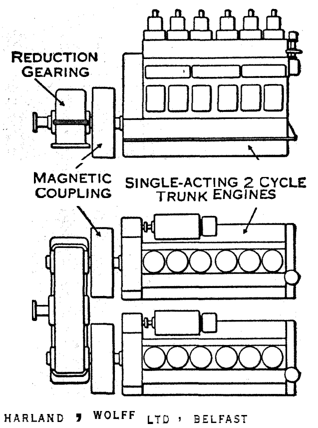


FIG. 3.—GEARED DIESEL ENGINE ARRANGEMENT

Certain additional claims are made for alternating-current drive: (1) Power distribution is flexible, because any number of engines per shaft can be installed. (2) The engines can be located anywhere, the motors being arranged aft. (3) The engines are nonreversible. (4) Complete bridge control can be obtained. (5) A quicker turn-round in port can be arranged, based upon a system of running overhauling.

The operating excellence of a diesel-electric drive utilizing direct current cannot be gainsaid. Notwithstanding the varying requirements of ship speed and power, the engines rotate steadily under the most favourable conditions; maneuvering and reversing affect only the propulsion motor; being nonreversible, the engines are spared the wear and tear which normally occur during maneuvering. But, except for small powers, direct-current machinery is too heavy and expensive to compete with other types. Alternating current and high voltages, however, are accompanied by certain problems. The diesel engines must always run in synchronism. For steady running this is not difficult to achieve, as speed governing within close limits is possible; also the alternators, being electrically linked, can drag the engines into synchronism. But, when maneuvering, the engine revolutions must rise and fall with those of the propeller, and at the same time synchronism must be maintained among the engines. In reversing, the engine revolutions are reduced to their minimum and then, immediately before reversing the propulsion motor, the load is completely taken off the engines. Immediately afterward, when the load is restored, the back torque transmitted from the propeller to the propulsion motor—caused by the way on the ship—may much exceed what the engines are capable of at the low speed at which they may be running at the moment.

STEAM TURBINES AND BOILERS

There is much more scope for variation in design with steam installations than there is with internal-combustion engines. The variables include: levels of steam pressure and temperature; capacity, number and type of steam generator; superheater arrangements; number and kind of turbines; reduction gear ratios and assembly; arrangements for economizers, air preheaters, feed heating, water distillation; and so on. The economics of a steam plant are relatively more in evidence and receive more attention because, at all points, decisions must be based on careful equating of thermal gains against monetary outlay.

Pressures and Temperatures — During World War II, steam conditions in most merchant vessels were in the range of 450–600 lb. per square inch (p.s.i.) and 750°–825° F.; a few vessels operated with more advanced conditions of 850 p.s.i. and 910° F. In the years following World War II there was a general tendency to increase both pressures and temperatures, and there were many installations in the 600 p.s.i., 800° F.; 600 p.s.i., 850° F.; and 850 p.s.i., 850° F. ranges, as well as some in the 650 p.s.i., 1,025° F. and 925 p.s.i., 1,000° F. categories. The bulk-cargo steamship "Hugo Stinnes," delivered in 1957 by the Nordseewerke, Emden, Ger., was equipped with a notable post-World War II turbine installation, employing steam at 1,200 p.s.i. and 950° F.

Steam Generators. — From about 1860 to the early 1900s the Scotch boiler was in common marine use and represented the optimum development of the fire-tube boiler. In this type, the water space was pierced by many tubes through which the combustion gases passed, transferring their heat to the water. For marine propulsion such boilers were almost entirely superseded by the watertube boiler, though the Scotch boiler persisted in some auxiliary boilers for special marine use. In the watertube boiler, water circulated within the tubes; combustion gases were outside. Two general types of such boilers were in common use in the marine field, the sectional-header and the drum (express) type.

The sectional-header boiler had certain fundamental advantages. The tubes were straight and of only a few sizes. Each tube was accessible for inspection and replacement independently of any other tube. Maintenance costs were inherently less than with the drum-type boiler, and inspection procedures were easier. However, the headers, the elements of the boiler into which the tubes fitted, limited design pressures to about 850 p.s.i., since the increased thickness required for higher pressures increased the spacing between tubes in adjacent headers.

Compared with the header type, the drum type offered the important advantage of reduction in weight and space requirements. Such a boiler is shown in fig. 4. The drum type was particularly suitable for high-powered naval vessels and fast merchant ships, where power plants of large horsepower had to be installed in minimum space and where weight was of special importance. Its design pressure was not generally subject to practical limitations with welded drums and radial tube holes. However, the tubes were usually bent and were of many different lengths. The tubes

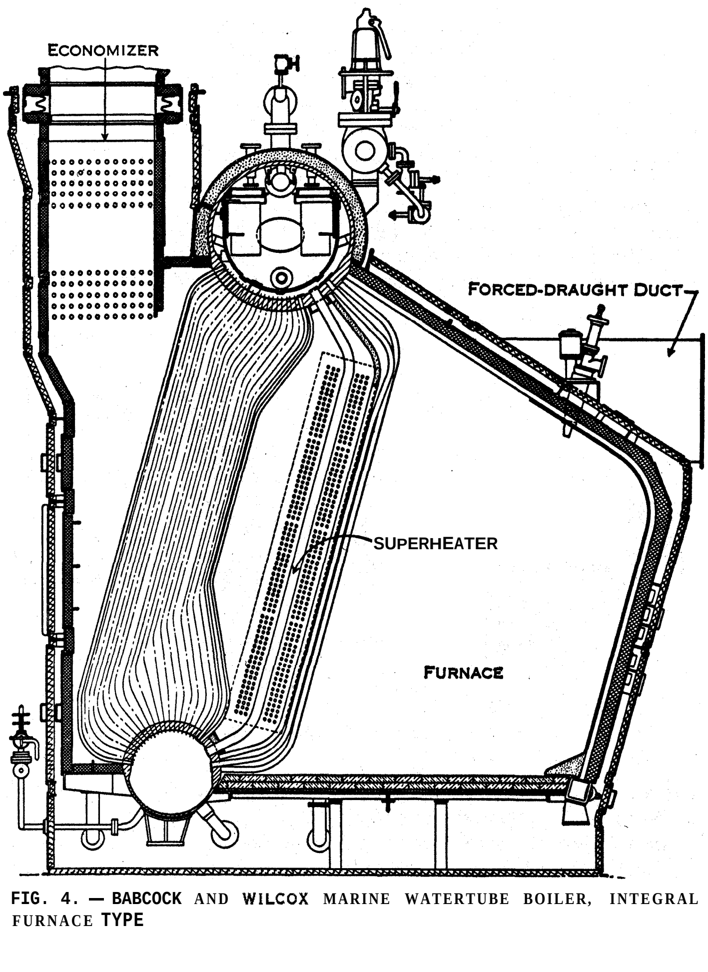


FIG. 4. — BABCOCK AND WILCOX MARINE WATERTUBE BOILER, INTEGRAL FURNACE TYPE

could not be independently removed nor easily inspected. Drum-type boilers could not be located with the longitudinal axis of the drums athwartship because of possible tube failure during a roll; header-type boilers did not suffer from this limitation.

Steam Turbines. — The earliest geared turbines were of all-reaction design. Later the high-pressure turbine embodied an impulse wheel, reducing its length. For powers of about 6,000 s.h.p. per screw and above, the standard unit became a three-turbine arrangement, in which the high-pressure turbine was impulse reaction, with end-tightened blading; the intermediate-pressure and low-pressure turbines were all-reaction; the high-pressure and low-pressure astern turbines of impulse design were respectively fitted to the intermediate-pressure and low-pressure ahead turbines; the gearing was single reduction. The astern power was nominally 60%–65% of the ahead power.

In due course, higher turbine revolutions and double-reduction gearing brought about a further improvement in the steam-consumption rate. Under the influence of land practice, all-impulse high-pressure turbines superseded impulse-reaction designs. The standard arrangement became a two-turbine set, with an all-impulse high-pressure turbine and an all-reaction low-pressure turbine; the preferred form for the latter became a double-flow design, wherein the steam entered the turbine at mid-length and flowed toward each end, reducing the low-pressure blade lengths. The high-pressure astern turbine was overhung on the high-pressure ahead turbine, and a low-pressure astern turbine was incorporated in the low-pressure ahead turbine. Many single-screw designs had only one astern turbine, which was arranged on the low-pressure ahead turbine, the astern power being nominally 40%–50% of the ahead power.

The next evolutionary step was the introduction of the single-cylinder impulse turbine. For powers between about 1,000 s.h.p. and 10,000 s.h.p. per shaft this single-casing turbine was very satisfactory, being simple and reliable. The ahead and astern turbines were arranged on a common rotor, using a single pressure casing for both turbines, with steam entering near the middle of the casing and exhausting outward.

Gearing. — Double-reduction gearing arrangements are classified as articulated, interleaved or locked train. Fig. 5 shows the principle of the articulated gear. The high-pressure and low-pressure turbines drive separate pinions, which mesh respectively with separate primary wheels, driving the secondary pinions through quill shafts. The secondary pinions mesh with the main wheel, driving the propeller. Articulated gearing has advantages over the interleaved type, which is shown in Fig. 6. A much stiffer gear case is obtained; the flexible quills between the first and second reduction trains reduce the inertia forces on the secondary pinion teeth, which arise from inaccuracies in gear cutting; and

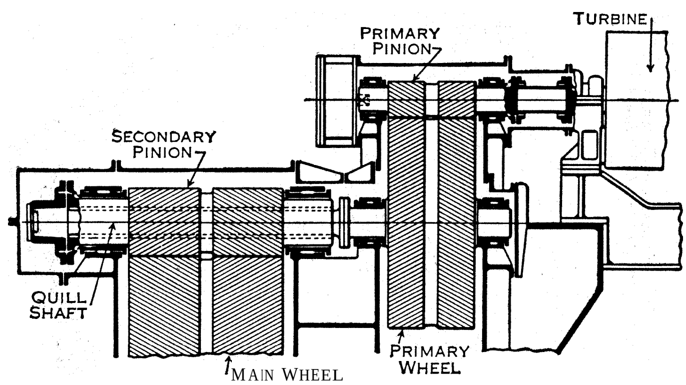


FIG. 5.—DOUBLE REDUCTION GEARING; ARTICULATED TYPE

the accurate mutual alignment required by all gearing is confined to pairs.

In the locked-train arrangement the pinion meshes with two primary wheels which are bolted at their aft ends to quill shafts; the quills pass through the secondary pinions and drive them through fine-tooth couplings. The power is transmitted from the

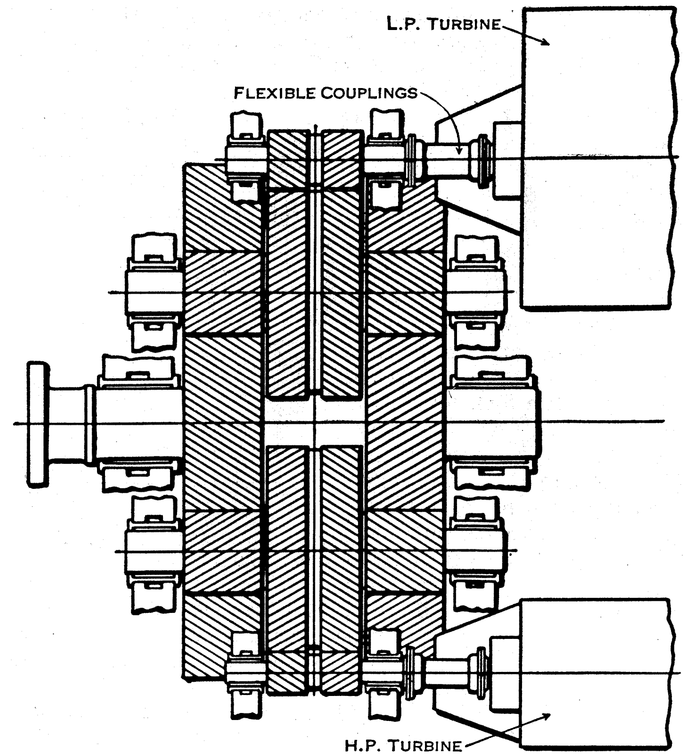


FIG. 6.—DOUBLE-REDUCTION GEARING: INTERLEAVED TYPE

secondary pinions to the main wheel. Great care is necessary in setting up locked-train gearing, to ensure the proper sharing of tooth loads.

In the single-reduction geared turbine the ratio of reduction may be from 12:1 to 20:1, if the best over-all results are to be obtained; *i.e.,* if there is to be an efficient, slow-moving propeller at one end of the line and an economical, fast-moving turbine at the other end.

For double-reduction gearing the usual ratio of reduction for the high-pressure turbine may be approximately 40:1 and, for the low-pressure turbine, 30:1; but the high-pressure turbine ratio can be as high as 60:1. All gearing teeth are of involute form. For primary pinions and primary wheels the teeth are 6/10 in., and for secondary pinions and main wheels they are 8/10 in. The propeller revolves usually about 110–120 r.p.m. for twin-screw ships and 95–100 r.p.m. for single-screw vessels.

Turbo-Electric Drive. — The turbo-electric drive presents fewer problems than the corresponding diesel-electric arrangement. The greatest power required for one propeller is obtainable from a single turbo-alternator. For a twin-screw installation each propeller motor is driven by its turbo-alternator normally, but at reduced power only one turbo-alternator need be used, the current being divided between the motors. Turbo-alternators can be run at much higher rotational speeds than geared turbines; being non-reversible, they can be simpler.

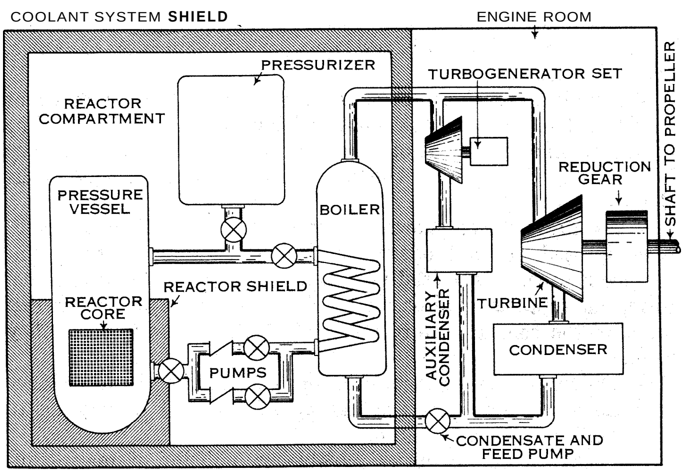
NUCLEAR POWER

From the standpoint of the marine engineer, nuclear power means utilizing the process of nuclear fission in a reactor as the source of heat, with nuclear fuel replacing conventional fuel. The differences in fuel weight are enormous. One pound of U^{235} produces as much heat as 2,300 tons of coal or 300.000 gal. of fuel oil. The weight of the nuclear fuel itself is an almost inconsequential part of the weight of a nuclear power plant. The amount of energy that may be released within a reactor is almost unlimited, and thus the power produced is approximately independent of the size of the reactor. Any amount of power within very wide limits may be produced from any size reactor if the energy can be removed from it. The limitations on the power of the reactor are, consequently, those imposed by the engineering problems in the heat-removal process.

A large number of reactor types have been studied and analyzed from the standpoint of suitability for mobile marine use. The installation in the first nuclear submarine, the U S.S. "Nautilus," and the plant developed and engineered for the first commercial nuclear merchant ship, the N.S. "Savannah," were both based on the pressurized water, heterogeneous, enriched fuel, thermal reactor type. These terms are used to identify the principal features of the system. Pressurized water describes the type of coolant-moderator material. Other coolants proposed or used include boiling nater, organic liquid, gas and sodium. Heterogeneous indicates the physical separation of fuel, coolant and moderator elements, in contrast to the homogeneous type in which they are mixed. Enriched fuel means that the natural uranium, which contains only o 7% U^{235}, the remainder being U^{238}, is enriched in the U^{235} isotope for use in the plant. In a thermal reactor the neutrons are greatly sloned from their initial high energy by a moderator, while if no moderator is used the reactor is called fast.

The submarine thermal reactor plant installed in the U.S.S. "Nautilus" consisted of a reactor in which U^{235} fissioned as a result of the absorption of thermal neutrons into the nucleus. Heat was transferred from the reactor into the steam generator or boiler by ordinary water (primary coolant) under pressure high enough to prevent boiling. This primary coolant water was circulated through the reactor and boiler in a closed loop by canned-rotor-type pumps. The boiler, essentially a shell and tube heat exchanger, utilized ordinary boiler feed water on the shell side at considerably lower pressures, producing steam delivered to a conventional marine-turbine condensing propulsion system. (See fig. 7.)

In the N.S. "Savannah," as designed under the auspices of the U.S. Maritime administration and the U.S. Atomic Energy commission, the primary system consisted of two loops with one steam generator and two main circulating pumps in each loop. The steam generators were of the natural circulation type, with bent-tube U-shell-type boilers that could supply both the main turbines and the auxiliary turbogenerator units simultaneously or independently. The main circulating pumps were driven by canned-rotor constant-speed motors with two-speed windings. The major portion of the reactor system was enclosed within a sealed and shielded containment capable of containing the products of any possible rupture in the reactor system during operation.



FROM SYAME TRANSACTIONS (1957); REPRODUCED BY PERMISSION OF THE SOCIETY OF NAVAL ARCHITECTS AN3 MARINE ENGINEERS

FIG. 7.— SCHEMATIC DIAGRAM OF A TYPICAL PRESSURIZED NUCLEAR-PROPULSION PLANT. RELATIVE SIZES NOT INDICATED

The power plant of the "Savannah" was designed to operate at a steam pressure of 480 lb. per square inch absolute (p.s.i.a.) with $\frac{1}{2}$ in. Hg vacuum, delivering 22.000 s h.p. to a single propeller. It comprised high- and low-pressure main turbines and reduction gear, main and auxiliary condensers, feed water system, turbine generators and the usual auxiliaries. The estimated gross weight of the complete plant was as follows:

Propulsion system	1,150 long tons
Reactor system	600 " "
Containment and shielding	1,900 " "

A conventionally powered ship of the same dimensions would carry about 2,500 tons of fuel oil instead of the reactor system and containment, would deliver the same s.h.p., could carry about 500 tons less cargo and would be limited to 13,000 mi. without refueling. The nuclear-powered ship would have a corresponding radius of 350,000 mi. before renewal of fuel became necessary.

GAS TURBINE PROPULSION

The gas turbine system, eliminating steam as a transfer medium and leading the exhaust products from a combustion system direct to a turbine, obviously has interesting possibilities for marine propulsion. The gas-turbine ship "John Sergeant," converted from a Liberty ship in 1956, was the first ocean-going vessel to be propelled by a single-unit, mechanical-drive gas turbine. The gas turbine installed was an open-cycle, two-shaft regenerative machine with a 14-stage axial-flow compressor, a combustion system, a single-stage high-pressure turbine driving the compressor, and a single-stage low-pressure turbine driving a controllable-pitch propeller through a reduction gear. Maximum rating was 6,600 s.h.p. at a propeller r.p.m. of 114. The vessel on trial easily developed 7,500 s.h.p. A fuel rate of 0.523 lb./s.h.p.-hour at normal power was attained.

In the free-piston, gas-turbine type of propulsion, a bank of free-piston engines constitutes both the combustion system and the compressor system for a gas-turbine drive. The free-piston engine, or gassifier, is essentially an opposed-piston, two-stroke, uniflow diesel engine. Each piston is composed of a power piston and a compressor piston. Firing is by compression ignition. There is no crankshaft, the pistons being free to oscillate except for a connecting linkage to maintain phase relationship.

A free-piston engine was conceived and built in the early 1920s, but it was not until World War II when the German navy employed free-piston air compressors in submarines that the type achieved operating success. By 1957 over 100 free-piston gassifiers of approximately 1,000 brake horsepower (b.h.p.) each were in service throughout the world in various applications. Two small French coasters, the "Cantenac" and "Merignac", each employing two such units, went into service in 1953 between Bordeaux and Hamburg. They achieved a high degree of reliability and economy. The first British ship designed with free-piston machinery was the ore carrier of the Ormsary class. The conversion of the Liberty ship "William Patterson" to free-piston, gas-turbine drive was completed under the auspices of the U.S. Maritime administration in 1957 and the vessel placed in trans-Atlantic service. The plant consisted of six free-piston gassifiers connected in parallel to two turbines which were connected to a single propeller shaft through reduction gearing. See NAVAL ARCHITECTURE; SHIPBUILDING (MERCHANT AND NAVAL).

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(C. C. P.; H. A. SE.)

MARINE INSURANCE. Marine insurance is the insurance of interests—property and earnings—that may be imperilled in a maritime adventure. These two groups of interest include such as (1) ship and goods, (z) freight and passage money. Marine insurance is also a protection against certain liabilities such as shipowner's liability for collision damages, and carriers' responsibility for goods, and against losses occasioned by sacrifices for the general safety of an adventure. (See AVERAGE.) It is transacted in all nations having trade which necessitates transport, even those which have no seaports, and is the safeguard of the shipowner, merchant, banker, mortgagee, and of any who risk their property, money, or credit in commercial or financial enterprise and of those who have occasion to send valuable objects from one place to another. Primarily marine insurance is concerned with sea transport, but it is adapted to the insurance of transport of any kind, and frequently policies concerning goods for overseas transport include a certain amount of risk on shore. *See* also LLOYDS.

Practice. — In practice marine insurance is a complicated business transacted for the most part through the medium of brokers who, by their expert knowledge, can select the best market in which to place their clients' risks, and obtain the terms most suitable for the adventure to be insured. So far as the hulls of ships are concerned, sailing vessels are generally insured for each voyage, while steamers are insured for periods of time, generally 12 months. The risks against which the hulls of ships are insured by the full (with average) policy. are the perils of the seas, and similar perils covered by the traditional marine policy in common use, including sacrifices made in "general average" *(see* AVERAGE).

It is also customary to add, by the use of clauses, insurance against liability for damage done by collision and certain other liabilities and perils. It is also customary in Great Britain to exclude war risks from the marine policy, these being insured separately, or covered on a mutual basis by associations formed for that purpose among shipowners. During World War I the amount to be covered on both ships and cargo against war risks was so great that the British government instituted a war risk bureau which functioned simultaneously with the open market, and this system of a national war risk insurance office was also adopted by other countries, including some of those which remained neutral. So far as marine perils are concerned, the hulls of ships are also insured under policies which do not include the risk of particular average, and also under policies which cover total loss, general average (other than damage to ships), salvage charges and collision liabilities, these being known as "free of damage absolutely" insurances. Another form of insurance is the "free of particular average" policy which does not pay particular average unless the vessel has been stranded, sunk, on fire, or in collision. "Particular average" is partial loss caused by a peril insured against, and which is not general average. In connection with hull insurances, shipowners also insure their freight, their insurance premiums, and an indefinite interest known as "disbursements," the amount of which represents the financial loss over and above the actual value of the vessel which a shipowner incurs when his vessel is totally lost.

Goods and merchandise, valuables, securities and other concrete transportable interests are insured under the traditional marine form of policy, risks being added by means of clauses, of which the principal are the "with average" and "free of particular average" clauses of the Institute of London Underwriters. The "with average" clauses cover practically every fortuitous accident which may occur during transit, while the "free of particular average" clauses cover total loss, general average and certain other liabilities, but do not cover particular average unless the vessel has been stranded, sunk, on fire or in collision. These clauses also extend the risk of sea transit to cover the goods from the time they leave the warehouse at the port of shipment, until delivery at the consignee's or other warehouse at the destination named in the policy, or until the expiry of fifteen days from midnight of the day on which the discharge of goods from the overseas vessel is completed, whichever may first occur. Extension of the risk to 30 days from the completion of discharge is made when the destination to which the goods are insured is without the limits of the port of discharge.

Legislation. — In Great Britain, marine insurance was the subject of sporadic legislation up to the end of the 19th century. In the reign of Elizabeth an Act was passed (43 *Eliz. c. 12)* setting up a Court of Policies of Insurance to arbitrate in cases of dispute. The Act of 1720 incorporating the Royal Exchange Assurance and London Assurance, has already been mentioned. In 1745 an Act (*19 Geo. 2. c.* 37) prohibited the issue of wagering policies, and also policies of re-insurance, and although this Act was not finally repealed until the passing of the Act of 1906, its provisions with regard to re-insurance became obsolete. From the passing of this Act, until the Act of 1906 there appears to have been no legislation of importance dealing with marine insurance, other than certain finance acts dealing with policy duties, but during that period case law, mainly owing to the efforts of Lord Mansfield, had created precedents on practically every point likely to be raised on marine policy, and the Act of 1906 (6 *Edw.* 7 *c. 41*) was largely a codification of this case law, although certain provisions with regard to the prohibition of gambling policies were embodied in it. These provisions were amplified by the Marine Insurance (Gambling Policies) Act of 1909.

The Act of 1906, while codifying the existing law, did not, however, do away with litigation over points not previously decided. It is by no means as comprehensive as some of the continental codes, and while its provisions have proved singularly free from ambiguity since they have seldom been the subject of litigation, there still arise questions outside its scope which have to be decided in courts of law. It is, nevertheless, to the Marine Insurance Act of 1906 that reference may best be made on points arising out of marine insurance questions, especially where matters of principle and not of detail are concerned.

The Policy. — Reference has already been made to the marine policy, which, in Great Britain, is invariably based upon the traditional form which has been evolved from the early policies mentioned in the historical review. The Marine Insurance Act gives a form of policy which may be used, but which is not compulsory. This form is based on the traditional policy, and is, in fact, almost identical with the form adopted by Lloyd's underwriters in 1779 *(see* LLOYD'S). The custom is, however, to supplement the policy by a clause excluding war risks, while since 1919, as a result of the case of *British and Foreign Marine Insurance Co.* v. *Sanday (Times L.R. 266 and* 374) it has become customary to add the *frustration clause* which prevents underwriters from being held liable for loss due to loss of market caused by the frustration of a voyage owing to arrests, restraints or detainments of kings, princes or peoples.

This policy, archaic in form, and described by Justice Buller as an "absurd and incoherent document," has been so explored in the course of time, by means of legal action, that there remains very little, if any doubt as to the legal interpretation of any of its clauses.

It has already been shown, however, that the policy, by itself, is rarely used, and in modern practice the contract of marine insurance is usually expressed in a policy based upon the traditional form, but supplemented or modified by clauses in which the real terms of the contract are to be sought, rather than in the policy itself.

All policies of marine insurance must be stamped in accordance with the Stamp Act 1891 (54 *and* 55 *Vict. c.* 39) if they are to have validity in Great Britain.

The scale of stamp duties payable on policies of marine insurance is that of the Finance Act, the current scale in 1928 being that of the Act of 1920 (*10 and 11 Geo. 5* c. 18 *s. 41*).

The provisions of the Act, together with those of the schedule, prevent any insurance being effected for more than twelve months, but to meet the cases of vessels insured for time which are at sea or in distress at the time the policy expires, the Act of 1901 provides that a policy of sea insurance may contain a continuation clause, and shall not be invalid on the ground only that by reason of the clause it may become available for a period of more than twelve months. A policy with a clause of this nature is chargeable with a stamp duty of sixpence in addition to that otherwise chargeable, and the "Institute time clauses" under which the majority of British vessels are insured, contain a continuation clause which is in conformity with the provisions of the Finance Act of 1901.

The Revenue Act 1903 (3 *Edw.* 7 *c. 16)* allows marine policies on building risks to run for periods longer than twelve months, and to be stamped as voyage policies.

The Contract. — From the Marine Insurance Act it is learnt that a contract of marine insurance is one whereby the insurer undertakes to indemnify the assured in a manner and to the extent thereby agreed, against marine losses. It may, by express terms, or by usage of trade, be extended so as to protect the assured against losses on inland waters or on any land risk which may be incidental to any sea voyage. It is to be noted, however, that subsequent litigation, Muller v. *l'Union* Maritime (*Ll.L.* Rep. *KB.17. 90.CA.18.* 339. *HL.* 20.90) throws doubt on whether the contract is identical, with regard to the risk on land, to that with regard to the risk on sea.

The Act defines "maritime perils" as "perils consequent on or incidental to, the navigation of the sea, that is to say, perils of the seas, fire, war perils, pirates, rovers, thieves, captures, seizures, restraints and detainments of princes and peoples, jettison, barratry and any other perils either of the like kind or which may be designated by the policy." Before the Act was passed, case law had decided that "all other perils" meant only perils *ejusdem generis* with those of the sea, but even now it cannot be said that the end of dispute as to what is, or what is not covered by the policy has been reached, although precedents exist on all the main points. In practice, however, the marine cargo policy is frequently extended by clauses (the express terms of the Act) to cover perils not strictly those of the seas, such as, for instance, theft, the risk of "thieves" in the policy meaning "robbery with violence, or breaking in." Insurances on the hulls of vessels are also extended by clauses, the principal addenda being the indemnification of the assured against liability for collision done to any other ship or vessel; loss or damage due to accident in loading or discharging, or through the negligence of the master, mariners, engineers or pilots, and loss or damage due to the bursting of boilers, or through latent defects in the machinery or hull.

These clauses are, so far as Great Britain is concerned, mostly those issued by the "Institute of London Underwriters," a body composed of representatives of the marine insurance companies.

Insurable Interest. — The Act, after stating that every contract of marine insurance by way of gaming or wagering, is void, proceeds to define what an insurable interest is. A person has an insurable interest when he stands in any legal or equitable relation to the adventure, or to any insurable property at risk therein in consequence of which he may benefit by the safety or due arrival of the insurable property, or may be prejudiced by its loss, or by damage thereto, or by the detention thereof, or may incur liability in respect thereof. He must, however, be interested in the subject matter insured at the time of loss, though he need not be when the insurance is effected. An example of the application of this is when goods are sold in transit, and the insurance is transferred to the purchaser. An assured cannot, however, acquire interest subsequent to a loss by any act or election after he is aware of the loss.

Insurable Value. — Subject to the express provisions or valuation of the policy, the insurable value of ship, freight goods, and other subject matter is laid down by the Act. Broadly speaking, this is the value of the interest at the inception of the risk plus incidental charges, including insurance. It is now the almost invariable practice to insert the value in the policy, in which case that value becomes the basis of all claims and adjustments.

Disclosure and Representation. — The Marine Insurance Act states that "a contract of marine insurance is a contract based upon the utmost good faith, and, if the utmost good faith be not observed by either party, the contract may be avoided by the other party." This is the basis of the whole of the business of marine insurance, which, in Great Britain, is largely transacted by means of verbal representations by the assured or his broker to the underwriter, and this being so, the importance of the observance of the principle of good faith is apparent. According to the Act, the assured must disclose to the insurer, before the contract is concluded, every material circumstance which is known to the assured, who is deemed to know every circumstance which, in the ordinary course of business, ought to be known by him. Failure to make such disclosure voids the contract. The Act also states that every circumstance which would influence the judgment of a prudent insurer in fixing the premium, or determining whether he will take the risk, is material, but no circumstance need be disclosed which is known or presumed to be known to the insurer. Every material representation made by the assured or his agent to the insurer during the negotiations for the contract, and before the contract is concluded, must be true, or the insurer may void the contract. Representations as to matters of expectation or belief must be made in good faith, but representations may be corrected or withdrawn before the contract is concluded. The contract of marine insurance is deemed to be concluded when the proposal of the assured is accepted by the insurer, whether the policy be then issued or not: and for the purpose of showing when the proposal was accepted, reference may be made to the slip, or covering note, or other customary memorandum of the contract, although it be unstamped. To appreciate the meaning of this provision it is necessary to explain that in Great Britain marine insurance is generally transacted by making a brief memorandum of the essential details of a risk on a slip, upon which the insurer writes the amount he will accept on that risk, appending his initials. The contract thus expressed cannot be legally enforced, but when a stamped policy is prepared embodying its terms, the slip may be produced as evidence of the intentions of the parties to the contract. A covering note is a memorandum issued by the insurer, or by a broker, to the assured, stating that the risk is covered, the terms on which the insurance has been effected, and the premium to be paid.

Measure of Indemnity. — According to the Act, the sum which the assured can recover in respect of a loss is, in the case of an unvalued policy, the full extent of the insurable value, or in the case of a valued policy, the full extent of the value fixed by the policy; this, however, is subject to any express provisions of the policy. In the event of total loss the measure of indemnity is the sum fixed by the policy, in the case of a valued policy, or in an unvalued policy, the insurable value of the subject matter insured. In the case of partial loss of a ship, the measure of indemnity is the reasonable cost of repairs, less the customary deductions, but not exceeding the sum insured in respect of any one casualty. The customary deductions are for depreciation, *i.e.,* since new material is substituted for old when repairs are effected, but in the case of steamships it is generally expressly agreed that no deductions shall be made. In the case of freight, the measure of indemnity is such proportion of the sum fixed by the policy, in the case of a valued policy, or the insurable value in the case of an unvalued policy, as the proportion of the freight lost by the assured bears to the whole freight at the risk of the assured under the policy.

In the case of partial loss of goods, the measure of indemnity, in the case of a valued policy, is such proportion of the sum fixed by the policy as the insurable value of the part lost bears to the insurable value of the whole, ascertained as in the case of an unvalued policy. In the case of an unvalued policy, the measure of indemnity for partial loss is ascertained as in the case of total loss, *i.e.,* the insurable value of the subject matter insured. In the case of goods arriving damaged by a peril insured against, the measure of indemnity is such proportion of the sum fixed by the policy in the case of a valued policy, or of the insurable value in the case of an unvalued policy, as the difference between the gross sound and damaged values at the place of arrival, bears to the gross sound value. In the case of general average and salvage charges, the measure of indemnity (subject to the provisions of the policy) is the full amount of the contribution, if the subject matter liable for contribution is insured for its full contributory value, but if it is not so insured, or if only part be insured, the indemnity payable by the insurer must be reduced in proportion to the under-insurance, and where there has been a particular average loss which constitutes a deduction from the contributory value and for which the insurer is liable, the amount must be deducted from the insured value in order to ascertain what the insurer is liable to contribute. Where the assured has effected an insurance in express terms against any liability to a third party the measure of indemnity, subject to any express provision in the policy, is the amount paid or payable by him to such third party in respect of such liability. An instance of this is insurance against collision liability, where it is customary for the insurer to cover only three-fourths of the risk, leaving one-fourth to be borne by the assured. The practice has arisen, however, of covering the assured's one-fourth mutually in associations of shipowners formed for that purpose.

In cases not specifically provided for in the Act, the principle enunciated in the provisions of the Act is to be applied.

Warranties. — In marine insurance a "warranty" is some particular thing that the assured undertakes shall, or shall not be done—an undertaking that some condition shall be fulfilled; or the affirmation or negation of the existence of a particular state of fact. Warranties must be complied with exactly, whether they be material to the risk or not; or the insurer is discharged from liability as from the date of the breach of warranty.

Examples of warranties are where the assured warrants that a vessel is in good safety on a certain date; where he warrants that a vessel shall not proceed on certain voyages; or where he warrants that he is uninsured for a specified proportion of the amount at risk.

These are "express warranties," and must be included in, or written upon, the policy, or must be contained in some document incorporated by reference into the policy.

There are also "implied warranties" as, for instance, that the vessel shall be seaworthy at the commencement of the voyage, but there is no implied warranty of seaworthiness in a policy for a period of time; nor, in the case of goods, that the goods are seaworthy. Breach of warranty is excused, under the Marine Insurance Act, when, by change of circumstance, the warranty ceases to be applicable to the circumstances of the contract, or where compliance with the warranty is rendered unlawful by any subsequent law. A breach of warranty may be waived by the insurer; and in practice it is customary, in the case of some warranties, to make provision in the policy to the effect that in the event of breach, the risk is "held covered" either at a specific premium, or at a premium "to be arranged." According to the Act, when an additional premium is to be arranged in a given event, but no arrangement is made, then a reasonable additional premium is payable.

Where a warranty is broken, the assured cannot avail himself of the defence that the breach has been remedied, and the warranty complied with, before loss.

Double Insurance. — Where two or more policies are effected by or on behalf of the assured on the same adventure and interest, or any part thereof, and the sums insured exceed the indemnity allowed by the Marine Insurance Act, the assured is said to be over-insured by double insurance. In such circumstances he may according to the Act, claim payment from the insurers in such order as he may think fit, unless the policy otherwise provides, but he is not entitled to receive any sum in excess of the indemnity allowed by the Act. Where, however, the policy is a valued policy, the assured must give credit as against the valuation for any sum received by him under any other policy without regard to the actual value of the subject matter insured. Where the policy is unvalued, he must give credit, as against the full insurable value, for any sum received by him under any other policy, and where the assured receives a sum in excess of the indemnity allowed by the Act, he is deemed to hold such sum in trust for the insurers, according to their right of contribution amongst themselves.

The insurers, on their part, are bound, by the Act, to contribute rateably to the loss in proportion to the amount for which they are liable under their contracts, and if any insurer pays more than his proportion of a loss, he is entitled to maintain an action for contribution against the other insurers. Where the assured has over-insured under an unvalued policy, a proportionate part of the premium is returnable, but if the policies have been effected at different times, and the earlier policy has, at any time, borne the entire risk, or if a claim has been paid on the policy in respect of the full sum insured, no premium is returnable in respect of that policy; nor is any premium returnable when a double insurance is effected knowingly by the assured.

Subrogation. — Where there is a loss either partial or total, the insurer becomes entitled to the advantage of every right of the assured in respect of the subject matter of the loss. A good example of this is where there has been a total wreck, and the underwriter has paid a total loss, since he then becomes entitled to the proceeds of the sale of the wreck. On broad lines, the assured must account to the insurer for any diminution of the loss. A very general application of this right of subrogation is where the insurer pays a loss and then proceeds against a third party to recover; for his own benefit, but in the name of the assured; in respect of a liability that third party may have incurred.

Re-Insurance. — Re-insurance is the indemnification of one insurer by another in respect of liabilities that the former has incurred in the course of business, and the Marine Insurance Act of 1906 gives the re-insured an insurable interest in his risks, but stipulates that unless the policy provides, the original assured has no right or interest in respect of such re-insurance. Re-insurance may be either facultative, which is the re-insurance of specified individual risks, or by treaty. A treaty of re-insurance is an agreement by one insurer to accept a stated proportion of the whole, or any specified part of, the business accepted by another, it being customary to place limits as to the maximum amount that may be given off under the treaty. In connection with these treaties an anomalous situation has arisen concerning their validity under British law, for while they are undoubtedly contracts of marine insurance, the fact that they cover no specified amount makes it impossible to pay duty on them in accordance with the provisions of the Stamp Act so that it would seem that they are unenforceable in law. The leading legal decision on this point is that of the House of Lords *In re National Benefit Assurance Co., Ltd.* (31 *Ll. L. Rep.* 321). In practice, however, legal difficulties are not likely often to arise, since most treaties provide that stamped policies shall be issued in respect of the risks accepted under the contract, and in the event of dispute arising, legal action can be taken on these policies.

Institutions. — In marine insurance, the institutions which exist for the purpose of furthering and protecting the interests of underwriters play a very prominent part. In Great Britain the oldest of these institutions is the Liverpool Underwriters Association, founded in 1802, but the leading body is the Institute of London Underwriters, founded in 1884, and composed of the majority of the companies transacting marine business in London, including the London branches of companies in Liverpool and other provincial cities. This body formulates and issues the clauses to which reference has already been made, and a special feature of its work in this connection is the drafting of special sets of clauses for the insurance of trades. These clauses are drafted after consultation with the Trade Associations interested in the commodities to be insured, and are therefore acceptable to both parties to the contract of insurance. Examples of these clauses are the "London Jute Associations Clauses" and the "London Corn Trade Associations Clauses." The institute has established various sub-committees, of which the most important is the "Technical and Clauses Committee," the title of which explains its functions, and which keeps in close touch with various trade associations with a view to maintaining clauses in accordance with the requirements of the trades those associations represent. An important committee which sits under the auspices of the institute, is the "Joint Hull Committee," on which Lloyd's Underwriters and the Liverpool market are represented, and which deals with such matters as the framing of agreements with regard to hull rates and values, the drafting of "warranties," governing voyages and seasons, and similar matters.

Lloyd's Underwriters Association is another important market institution, to which practically all the active underwriting members of Lloyd's belong, and which works in close collaboration with the Institute of London Underwriters on matters of principle, and sometimes on matters of practice. Lloyd's Brokers Association is a body representative of the brokerage side of the business at Lloyd's while the Corporation of Insurance Brokers represents brokers in all parts of Great Britain. The Chartered Insurance Institute, largely educational in function, holds examinations in marine insurance, and there are local institutes in connection with the Chartered Institute.

Market Institutions in Other Countries.—Elsewhere there are, in most markets, local or national institutions concerned with the regulation and government of business, such as the Central Underwriters Association of Norway, the Association for the Improvement of Marine Insurance in Holland, the "Verband" or Union of Underwriters in Germany, and the "Union des Syndicats" in Paris. These are similar, in many respects to the Institute of London Underwriters, and are in constant communication with that body and each other. There is also the "International Marine Insurance Union" with headquarters in Berlin, in which the majority of national markets are represented by the leading companies. This institution holds an annual conference at which matters of common interest are discussed, and has been the means of promoting a number of international agreements, the principal of which is the "dangerous drugs" agreement, by which underwriters are pledged to incorporate in all policies on drugs a clause making it imperative that all claims shall be accompanied by a certificate from the government of the country of origin authorizing the shipment in respect of which the claim is made. This agreement made in the first place at the instance of the British Foreign Office, has proved effective in checking the trade in opium, cocaine, and other drugs scheduled in the International Opium Convention.

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UNITED STATES

Marine insurance business in America as in Great Britain, is transacted for the most part through the medium of brokers. Sailing vessels are generally insured for each voyage, and steamers are insured for periods of time, generally 12 months. The risks against which the hulls of ships are insured are about the same in the United States as in Great Britain. Goods and merchandise are insured against various risks and on various terms and conditions dependent on the nature of goods, voyage, trade customs, etc.

The various States all have their insurance laws for the licensing and regulation of the companies and the activities of agents and brokers, and all the states also have a so-called insurance department as a branch of the state administration. For many years, there was no uniformity in the laws of the various states dealing with marine insurance. There was some effort to bring about uniformity and the District of Columbia, New York, Pennsylvania and New Jersey passed laws bringing about uniformity as to regulation and taxation. There is no federal act similar to the Marine Insurance act of 1906 which codified the laws of England, and most of the states have no such code.

The law and practice governing the contract, and regarding insurable interest, insurable value, disclosure and representation, measure of indemnity, warranties, double insurance and reinsurance are substantially the same as in Great Britain. There are some variations and among them is the rule of law as to what constitutes a constructive total loss and the extent of the insurers' liability in the case of general average and salvage charges where the contributory value of the interest is in excess of the insured value. As regards an implied warranty of seaworthiness in a policy for a period of time the law of the United States is not as broad and as favourable to the assured as the English act. In the United States many, if not most, double insurance policies provide how losses and premiums shall be dealt with in such cases. The most common clause provides that resort shall first be had to the policy of earlier date for collection of a loss or a claim, and that only the excess of the whole loss or claim over the amount recoverable under the policy of earlier date shall be recovered under the policy of later date, and that the premium attaching to the excess of the amount insured over the insurable interest in the policy of later date shall be refunded.

Regarding subrogation, in the United States, on payment of a loss the insurers acquire the rights of the owners in respect of and to the extent of the amount paid.

The American Institute of Marine Underwriters suggests policy forms and acts on behalf of underwriters in matters affecting the general welfare of the business but does not deal with rates. Practically all the U.S. and various foreign companies admitted to do business in the United States are members of this organization. The United States Salvage association, participated in by most U.S. companies, supplies services for the survey and inspection of hulls. The American Marine Insurance syndicate, composed of most U.S. and a large percentage of the foreign admitted companies, issues joint policies on the hull, disbursements and earnings of steamers. It has become the chief market for the insurance of these risks on U.S. steamers.

The Board of Underwriters of New York, formed in 1820, is composed of the principal U.S. and foreign admitted companies. Its principal functions are the reporting of casualties, handling of losses, surveying of cargo, handling of proceeds, stowage of cargo, inspection of the loading and discharging of vessels, arbitrations, salvage awards, examination of adjustments, reports on maritime inventions and the appointment of commissioners of pilots. (W. N. D.)

See S. B. hckerman, *Insurance* (1939).

MARINE RAILWAY: see SLIPWAY.

MARINES are troops specially recruited, trained and organized for service at sea and in land operations incident to naval campaigns. The use of marines goes far back in history. Herodotus and Thycydides refer to *Epibatai*, or "heavy-armed sea soldiers" in the Greek fleets. while Polybius describes *milites classiarii* ("soldiers of the fleet"), a category of Roman soldier organized and specially armed for duty aboard warships, usually the quinqueremes. During the middle ages, ordinary soldiers were frequently embarked aboard ship to provide a fighting backbone, but it was not until the naval wars of the 17th century that the distinct and organized role of marines was almost simultaneously rediscovered by the British and Dutch, who raised the first two modern corps of marines, in 1664 and 1665. The U.S. marine corps, organized in 1775, was originally patterned on the British model. It has retained many of its inherited characteristics but has evolved along independent lines to become the most famous organization of its kind.

U.S. MARINE CORPS

The U.S. marine corps is a military service within the department of the navy. Side by side with the navy, the marine corps comes directly under the secretary of the navy. Its commaridant, a four-star general, is responsible to the secretary of the navy for the readiness, administration and performance of the corps as a whole. The commandant also sits as a member of the joint chiefs of staff (*q.v.*) when matters of concern to the marine corps are under consideration.

The primary missions of the marine corps are to provide fleet marine forces of combined arms, including aviation, for seizure and defense of advanced bases; to conduct land operations incident to naval campaigns; and to develop the doctrines, tactics, techniques and equipment for U.S. landing forces in amphibious operations. In addition, the marine corps is responsible for providing detachments for service aboard battleships, large aircraft carriers, cruisers and certain amphibious ships (including assault helicopter carriers), as well as security forces for naval shore stations and for United States embassies and consulates. Finally, the corps is required by law to be instantly ready to perform such other duties as the president may direct.

The two fleet marine forces are the expeditionary part of the corps, and are required by law to be maintained at a minimum strength of three combat divisions, three air wings and supporting units. One fleet marine force is assigned to the Atlantic fleet and the other to the Pacific fleet. To provide and support the marine operating forces. the marine corps supporting establishment includes on each coast of the United States. one recruit depot. one major ground base, one supply centre and one or more air stations. Officer training, and all marine development activities, are centralized at marine corps schools. Quantico, Va. Marine corps headquarters is in Washington, D.C. The marine corps reserve, upon which the corps draws to augment its strength in time of large-scale emergency, embraces units and individuals in more than 150 cities. The peacetime strength of the regular marine corps does not usually exceed 200.000.

Marine aviation is primarily trained and equipped to render close air support and to conduct expeditionary operations. In addition, it reinforces naval carrier-based aviation. Since marine assault concepts demand the closest air-ground teamwork, marine aviation is integrated in every possible way with the corps as a whole.

Ranks of marine officers are the same as those of the U.S. army, but certain of the noncommissioned officer titles have varied traditionally and are distinctive to the marine corps. (See INSIGNIA, MILITARY.) Young men between the ages of 17 and 28 who are physically and mentally qualified may enlist in the marine corps for three, four or six years. Although the corps was compelled to accept draftees during the two World Wars and the Korean war, it is traditionally made up only of volunteers. Every marine recruit undergoes 12 weeks of rigorous but carefully supervised recruit training at Parris Island, S.C., or San Diego, Calif., followed by 4 more weeks of advanced training in infantry weapons and tactics at Camp Lejeune, N.C., or Camp Pendleton, Calif. The corps obtains officers from a wide variety of sources, including the naval academy, military academy, civilian colleges, the marine aviation cadet program and meritorious noncommissioned officers. With a few special exceptions, newly commissioned marine officers, regardless of source or previous training, are sent through the marine corps basic school, Quantico. Va.

The marine corps includes women marines, both regular and reserve. In peacetime approximately 2.000 women—2% of the authorized strength of the corps—serve as U.S. marines at posts in continental United States and the Hawaiian Islands, as well as in Europe. Women marines perform such duties as personnel administration, communications, aerology, food services, photography and disbursing. The director of women marines, a colonel, supervises the women marines and is on the commandant's staff at marine corps headquarters.

Single young women of good character who are physically and mentally qualified and between the ages of 18 and 30 are eligible for the marine corps. Women recruits undergo ten weeks' training at Parris Island, while women officer candidates (who must be college graduates or equivalent) train for 18 weeks at marine corps schools, Quantico, Va. Although women were not authorized as a permanent regular component of the corps until 1948, they were first enlisted for war service in World War I as "Marinettes," and in World War II as women reservists.

History and Traditions.— On Nov. 10, 1775, the date usually given for the origin of the U.S. marine corps, the Continental Congress ordered that two battalions of marines be raised for service as landing forces with the fleet. For an infant maritime power this was a natural requirement which has continued to exist. In addition to projecting naval power ashore, however, it has also been a recognized function of the marine corps to provide mobile, immediately ready, professional military units to serve as national forces-in-readiness. The first commandant of the corps was Capt. Samuel Nicholas of Philadelphia.

Marines have participated in all wars of the United States, being in most instances first, or among the first, to fight. In addition, marines have executed more than 300 landings on foreign shores and served in every major U.S. naval action since 1775.

The marines' first battle was the expedition against Nassau, in the Bahamas, in 1776. After the American Revolution, the marines, together with the navy, were inactivated; on July 11, 1798, congress re-established the marines as a separate corps. During the following century marines fought in the naval war with France (1798–1801), Tripolitan War (1801–05), War of 1812, Creek and Seminole wars (1836–42), Mexican War (1846–48) and the Civil War (1861–65). During the Civil War, marines fought at Bull Run, on the Mississippi and in all amphibious landings of the U.S. navy along the Confederate coast. The Confederacy organized its own marine corps on March 16. 1861; this was a smaller but virtually identical copy of the U.S. marines, and the Confederate marines—largely officered by a few former C.S. marine officers of southern birth—performed similar duties throughout the nar.

Between wars in the 19th century, marines landed in the South seas, China, Japan. Korea, Panama, Uruguay, Paraguay, Egypt, Mexico, Cuba, the arctic, Formosa, Argentina, Chile, Greenland, Haiti. Nicaragua and Samoa.

Following the Spanish-American War (1899) the corps entered an era of professional development and expansion. It saw active service in the Philippine insurrection (1899–1902), Boxer uprising (1900), Cuba (1906–09), Nicaragua (1912), Vera Cruz (1914), Haiti (1915–34) and Santo Domingo (1916–24). After the United States entered World War I, the marine brigade in France fought at Belleau wood, Soissons, St. Mihiel, Blanc Mont and the Meuse-Argonne. Meanwhile, the corps carried on expeditionary duties in Haiti, Santo Domingo, Cuba, the Azores and the Mexican border.

In 1921, foreseeing the eventuality of a naval war in the Pacific, the marine corps began its development of modern amphibious warfare. For the next two decades, uith a strength that never exceeded 18.000, it worked closely with the navy to evolve the amphibious assault doctrines ultimately used by the United States in World War II. These doctrines were proven by marines on Guadalcanal (first American offensive in World War II), Bougainville, Tarawa, Roi-Namur, Eninetok, New Britain, Saipan, Tinian, Guam, Peleliu, Iwo Jima, and Okinawa. By 1945 the marine corps included six divisions, four air wings and supporting troops. Its top strength in World War II was 485,113, of whom more than 90% served overseas in combat.

Immediately after the war, the marine corps became convinced that the challenge of modern weapons, especially the atom bomb, required a far more flexible, widely dispersed and rapid landing attack than had been possible in the past. Between 1946 and 1950, the marine corps therefore developed an amphibious "vertical envelopment" concept using assault helicopters—pioneered by the corps—as landing craft, and aircraft carriers as transports. This was subsequently adopted, like the earlier marine concepts of the 1920s and 1930s, as standard U S. navy and marine doctrine.

After outbreak of war in Korea (1950), marines were the first reinforcements dispatched from the United States to the aid of the U.S. forces retreating on Pusan. Here the corps flew helicopters in combat for the first time in history. Subsequently marines executed the Inchon landing and carried out the epic winter withdrawal from Chosin reservoir down to the sea. From 1951 to 1953, marine ground and aviation units played a major part in the hard-fought but indecisive battles along the 38th parallel. (See KOREAN WAR).

The marine corps emblem is the western hemisphere superimposed on a fouled anchor and surmounted by a spread eagle. The corps motto is *Semper Fidelis* ("Always Faithful"). which is also the title of the corps march, composed by John Philip Sousa when he was leader of the U S. marine band. Perhaps even more familiar is "The Marines' Hymn" beginning with the words, "From the Halls of Montezuma to the shores of Tripoli . . ." The marine band, the oldest musical organization in the C.S. armed forces, is known as "The President's Own" because of its privilege of performing at all state functions at the White House. The official colours of the corps are scarlet and gold, but forest green enjoys semiofficial recognition. The distinctive dress blue uniform of marines, with its standing collar, is well known, whereas the forest green service uniform bespeaks the original status of the corps as light infantry (see UNIFORMS). From the standing collar—descended from the tall leather neckpiece of the 18th- and 19th-century uniform—comes the traditional nickname for marines of "leathernecks"; the equivalent slang term for British marines, from the same origin, is "boot-necks." In naval formations, marines have the privilege of forming on the right of line or at the head of column, the traditional places of honour and seniority.

ROYAL MARINES (GREAT BRITAIN)

The Royal Marines were founded by an order in council on Oct. 26. 1664, as the duke of York and Albany's maritime regiment of foot—1.200 "land Souldgers prepared for sea service." administered by the admiralty. The modern Royal Marines remain under the admiralty, and the commandant general, Royal Marines, a lieutenant general, reports to the board of admiralty. His headquarters, the Royal Marine office, is in London. A member of the royal family serves as captain general of the corps.

The missions of the Royal Marines are to: (1) supply detachments for her majesty's ships; (2) provide bands for the navy: (3) man minor landing craft; (4) provide commando (amphibious raiding) units; (5) serve as a link between the navy and the army during landing operations. Since World War II, the peacetime strength of the Royal Marines has approximated 10.000.

The marine establishment in the U.K. is divided into the Portsmouth and Plymouth groups. each under a major general. Portsmouth group, with headquarters at Royal Marine barracks, Eastney. directs the seagoing training of the corps, as well as the amphibious school at Poole, Dorset, which operates in conjunction with the Joint Services School of Amphibious Warfare at the same place. Plymouth group. with headquarters at Stonehouse barracks, Plymouth, co-ordinates the military training of Royal Marines. Plymouth group's two most important subordinate activities are the commando school, Bickleigh, Devon, and the infantry training centre. Lympstone, Devon. The latter also includes the Officers' School Royal Marines, where subalterns receive basic instruction. Recruits are trained at Deal, Kent. While women serve with the Royal Marines. they are assigned from the Women's Royal Naval service (WRENS).

Aside from ships' detachments, the commando brigade—Britain's permanent commando force—is the principal operating unit of the corps. After World War II, when marines assumed the commando role, the brigade served in Hong Kong, Palestine, Malaya and Cyprus. At Suez (1956) the brigade formed the amphibious spearhead; one unit conducted its assault on Port Said by helicopters landed from an aircraft carrier in accordance with the U.S. marine helicopter concept.

History and Traditions.—From 1664 until 1755 the various marine regiments went through reorganizations! disbandments and fluctuations between army and admiralty control. The most distinguished episode of the period was the capture and subsequent defense of Gibraltar by marines in 1704–05, for which the corps still bears on its colours the single battle honour, *Gibraltar*. In 1755 the corps of marines was reorganized into 50 independent companies under complete admiralty control, and grouped into three "divisions" at Portsmouth, Plymouth and Chatham, an organization which, with slight changes, lasted until 1947.

Marines served in the Seven Years' War (1756–63), American Revolution (1775–81). and Napoleonic Wars (1792–181j), winning the designation. "royal." in 1802. Three years later a fourth division was established at Woolwich, and an artillery company was added to each existing division. In 1855, the infantry companies were designated "Royal Marines, light infantry." and, in 1862, the artillery companies were grouped as "Royal Marine artillery." This separation continued until 1923, when the corps was reconstituted as the Royal Marines.

In World War I, marines saw service widely at sea. as infantry, and as artillery. The most notahle action of the corps was its raid on Zeebrugge in 1918. In World War II, the corps initially organized one marine division and two mobile naval base defense organizations, and attained a top strength of 78,000. A reorganization in 1944 converted most of the Royal Marines into commandos and landing craft detachments. Outstanding among many feats of the corps in the war were the defense of Crete (1941) and assault on Walcheren (1945). One commando was sent to Korea in 1950 and served with the U.S. 1st marine division thoughout the Changjin reservoir campaign.

The Royal Marines' badge is the globe (conferred in 1827 by King George IV), surrounded by a laurel wreath won in 1761 for the storming of Belle Isle. surmounted by the lion and crown of a royal regiment, and an anchor. *Per Mare, Per Terram* ("By Sea and by Land") is the corps motto, and the corps colours are yellow, scarlet, green and blue. The uniforms of Royal Marines are not unlike those of the U.S. marine corps.

OTHER MARINES

In addition to the United States and Great Britain, 19 other nations maintain marines or units which perform similar duties. Oldest of these is the Royal Netherlands *korps mariniers*, established on Dec. 10, 1665, as part of the Netherlands navy. The *korps mariniers* saw immediate action against England, France and Spain, and played a conspicuous part in the Dutch amphibious raid up the Medway (1667). Subsequently the corps was mainly employed to police and protect the Dutch empire. During World War II it was reorganized and trained by the U.S. marine corps. The motto of the corps is *Qua Patet Orbis* ("To the Ends of the World").

Other countries having marines or some type of "naval infantry" are: Argentina. Brazil, Cambodia, Chile, Colombia, France, Indonesia. Iran, Mexico, Nationalist China. Philippine Republic, Republic of Korea, Spain, Thailand, U.S.S.R., Venezuela, Vietnam and Yugoslavia.

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MARINETTI, FILIPPO TOMMASO (1876–1944), Italian writer, the founder. of the literary Futurist movement, was born at Alexandria. Egy., Dec. 22. 1876, and educated in Paris. He published the original Futurist manifesto in the Paris *Figaro* on Feb. 20, 1909. His most characteristic work was the *Mafarka le futuriste* (1910). In 1914 he wrote the extraordinary *Zang-tumb-tuum* on the Balkan War. His *Guerra sola igiene del mondo* (191j) advocated Italian intervention in World War I. In *Futurismo e fascismo* (1924) he expressed support of Fascism, under which he enjoyed official backing.

Marinetti described himself as a "mystic of action"; but his technical devices (*e.g.*, "words in their freedom") and noisy agitations were essentially sterile. His war against all forms and patterns of ideas of the past. though expressive of a revulsion against literary tradition, created a rhetoric of its own. His Futurism also numbered Italian painters among its followers, with some success. Marinetti died at Bellagio, Dec. 2. 1944. (U. L.)

MARINO (MARINI), **GIAMBATTISTA** (1569–1625), Italian poet, the foremost of the *secentisti* (*see* ITALIAN LITERATURE). was born at Naples on Oct. 18. 1569. After a riotous youth, he secured the powerful patronage of Cardinal Piero Aldobrandini. whom he accompanied from Rome to Ravenna and to Turin. His early poems, *Le rime,* were published in 1602, and under the title *La lira,* in 1608 and 1614. At Turin (1608–1j) he enjoyed the duke of Savoy's protection, but Marino eventually had to leave Italy because of resentment at his satirical writing and at his disorderly life. He then took refuge in Paris (1615–23) where he was favourably recognized by Marie de' Medici and by Louis XIII.

Marino died at Naples on March 25, 1625.

Marino's *Adone* (1623; new ed. by R. Balsamo-Crivelli, 1922) tells the story of Venus and Adonis, with many digressions, in 45,000 lines. The poem contains many passages that still impress by their brilliance and shows a consummate mastery of technique; but it remains episodic, failing to come to life as a whole.

Marino's avowed purpose as a stylist was novelty at all costs. in order to dazzle the reader; and his licence. extravagances and conceits impressed his contemporaries and led many to imitate him. "Marinism" was the Italian manifestation of that cult of artifice and ornament which characterized western European literature in the 17th century.

Other publications by Marino include *La strage degli Innocenti* (1632; Eng. trans., by R. T., *The Slaughter of the Innocents*, 1675); *Lettere* (1627; critical ed. by A. Borzelli and F. Nicolini *Epistolario;* 1912). Selections of his works were published in *Poesie varie*, ed. by B. Croce (1913), *Le più belle pagine di Giambattista Marino*, ed. by R. Balsamo Crivelli (1925) and *Prose e poesie*, ed. by C. Culcasi (1930).

See G. F. Damiani, *Sopra la poesia del cavalier Marino* (1899) ; C. Culcasi, G. B. *Marino* (1932). (U. L.)

MARINUS, the name of two popes.

MARINUS I, (d. 884), pope from 882 to 884, a Tuscan, succeeded John VIII in Dec. 882. He had been deacon and treasurer of the Roman church and bishop of Caere and had been sent on missions to Constantinople by Nicholas I, Adrian II and John VIII. Marinus carried on the discussions with Photius begun under Nicholas. Owing to the researches of F. Dvornik it is now widely doubted that Marinus ever condemned Photius.

Marinus died on May 15, 884. He is sometimes mistakenly called Martin II.

MARINUS II, (d. 946). pope from 942 to 946, a worthy man of whom little is known except that he was ruled by Alberic, prince and senator of the Romans. He died in April or May 946. (C. P. L.)

MARINUS, Neoplatonist philosopher, came from Neopolis (Shechem) in Samaria and was a convert from Samaritan Judism to the old Greek religion. He succeeded Proclus as head of the Neoplatonic school at Athens in A.D. 485. His thought like that of his predecessor and teacher, was a strange mixture of sober scholarship, acute reasoning (he was keenly interested in mathematics) and fantastic superstition.

Marinus' chief surviving work is a biography of Proclus. ed. by J. F. Boissonade (1814), Eng. trans. in L. J. Rosan, *The Philosophy of Proclus* (1949). (A. H. AG.)

MARIO, GIOVANNI, COUNT OF CANDIA (1810–1883), Italian singer, the most famous tenor of the 19th century, son of General di Candia. was born at Cagliari on Oct. 17, 1810. While serving as an officer in the Sardinian army he was imprisoned at Cagliari and on his release fled to Paris. There his success as an amateur vocalist produced an offer of an engagement at the Opéra. He studied singing for two years under L. A. Ponchard and G. M. Bordogni, and made his debut in 1838 in Meyerbeer's *Robert le Diable*. In 1840 he joined the company of the Théâtre Italien, which then included Maria Felicita Malibran, Henriette Sontag, Fanny Persiani and Giulia Grisi. Giovanni Rubini, Antonio Tamburini and Luigi Lablache. In a short time he won a European reputation in Italian opera, and sang regularly in Paris and London. His voice; though less powerful than that of Rubini or that of Enrico Tamberlik, had an unrivalled softness and richness. On the stage he retained the grace and charm of youth long after his voice had begun to show signs of decay. He created very few new parts, that of Ernesto in *Don Pasquale* (1843) being perhaps the only one deserving of mention. Among his best parts were Otello in Rossini's opera of that name. Gennaro in *Lucrezia Borgia*, Almaviva in *Il Barbiere di Siviglia*, Fernando in *La Favorita* and Manrico in *Il Trovatore*. In 1856 he married Giulia Grisi, the famous soprano, by whom he had three daughters, Mario left the stage in 1871. He died in Rome in reduced circumstances on Dec. 11, 1883.

MARION, FRANCIS (1732–1795), American soldier. was born in 1732 at Winyah, near Georgetown. S.C., of Huguenot ancestry. In 1761 he served in a campaign against the Cherokees. In 1775 he was a member of the South Carolina provincial congress. Commissioned a captain, Marion took an active part in the defense of Ft. Moultrie in Charleston harbour (1776) and in the unsuccessful siege of Savannah (1779). In 1780 the British captured Charleston and overran the state. Made a brigadier general by Gov. John Rutledge, Marion showed his genius in organizing a band of guerrilla volunteers; he gained recruits and trained them to be fearless riders and good marksmen, and "Marion's brigade" became known far and wide for its successful exploits against the British.

His sudden attacks often resulted in the capture of superior numbers and intimidated the Tories. Col. Banastre Tarleton was sent to capture him, but soon despaired of finding "the old swamp fox." who eluded him by following swamp paths. His men united with Gen. Nathanael Greene's forces for important engagements at Georgetown, Ft. Watson, Ft. Motte and Eutaw Springs. For a skilful rescue of Colonel Harden's men, hemmed in by a superior British force which he defeated at Parker's Ferry, he received the thanks of congress.

In 1782 his brigade deteriorated during his absence; and there was a conspiracy to hand him over to the British. From 1782 to 1790 Marion served in the state senate where he opposed harsh treatment of the Tories. He was made commander of Ft. Johnson with a salary of £500 per annum, in recognition of his services. He died on his estate in Berkeley county on Feb. 27. 1795. As a soldier he was quick, resourceful and calm, a great partisan leader.

See W. D. James, *Life of Francis Marion* (1821); M. L. Wiems, *Life of Francis Marion* (1833) ; W. G. Simms, *Life of Francis Marion* (1844) ; E. McCrady, *History of South Carolina in the Revolution* (1901–02).

MARION, city and seat of Grant county, Ind., U.S., is located 65 mi. N.E. of Indianapolis on the Mississinewa river.

In the 1880s and 1890s it experienced booms in gas and oil, supplies of which failed after the turn of the century. Its industry, rapidly expanding by mid-20th century, is diversified but tends toward automotive parts domination. Other products include plastics, glassware: castings, television tubes, paper products, wire and cable. electrical parts and dairy products. Corn, oats and pigs are important in the local economy. Wheat and beef and dairy cattle are also produced and the county ranks high in soybean and tomato production.

A veterans administration hospital cares for about 1,650 psychiatric patients in more than 60 buildings. Taylor university (1846) is at nearby Upland. Matter park includes a zoo and historical museum. U.S. troops fought Miami Indians nearby at the battle of Mississinewa in 1812. The community was founded in 1831 as the county seat, chartered in 1889, and named for Gen. Francis Marion (*q.v.*). For comparative population figures *see* table in INDIANA: *Population.* (R. S. SI.)

MARION, a city of Ohio, U.S., and seat of Marion county, is located 44 mi. N. of Columbus in the midst of fertile farming and grazing lands. Laid out in 1821 (or 1820) on a natural travel route between Columbus and Lake Erie, the site first was called Jacob's Well after Jacob Foos, who had dug for water just south of the original plat (now within the city limits). The settlement was officially named for Gen. Francis Marion (*q.v.*) of Revolutionary War fame, in 1822; it was incorporated as a village in 1830 and became a city in 1890.

The city's location and transportation facilities contributed to its prosperity, and its pre-eminence in the manufacture of excavating machinery earned for it the sobriquet "Shovel City." Other major industries include road-construction machinery, home laundry dryers, metal products, refrigeration equipment, racing sulkies, brass bushings, burial vaults and oyerhead garage doors.

At Marion are the Harding house and museum and the Harding memorial, honouring the nation's 29th president, Warren G. Harding (*q.v.*). The city is also the location of a U.S. army engineer storage depot. For comparative population figures *see* table in OHIO: *Population.* (J. S. ST.)

MARIONETTES: *see* PUPPETS AND MARIONETTES.

MARIOTTE, EDME (*c.* 1620–1684), French physicist, codiscoverer of Boyle's lam, (*q.v.*), which is known by Mariotte's name in France, spent most of his life at Dijon, where he was prior of St. Martin-sous-Beaune. He was one of the first members of the Academy of Sciences founded at Paris in 1666. He died at Paris on May 12, 1684. The first volume of the *Histoire et mémoires de l'Académie* (1733) contains many original papers by him upon a great variety of physical subjects, such as the motion of fluids, the nature of colour, the notes of the trumpet, the barometer, the fall of bodies, the recoil of guns and the freezing of water.

His *Essais de physique,* four in number, of which the first three were published at Paris between 1676 and 1679, are his most important works, and form, together with a *Traité de la percussion des corps,* the first volume of the *Oeuvres de Mariotte* (2 vol., 1717). The second of these essays (*De la nature de l'air*) contains a statement of Boyle's law, which Mariotte discovered independently.

MARIPOSA LILY (*Calochortus*), the name given to a genus of beautiful plants of the lily family (Liliaceae), comprising about 40 species native to western North America, about 25 of which are found in California. They are tuliplike perennials. with simple or somewhat branched stems, one-half foot to four feet tall, rising from coated corms and bearing a few narrow leaves and showy white, yellow, lilac or bluish flowers, often spotted or marked in the centre. The three large broad petals, one to two inches long, usually bear a conspicuous basal gland. Several species are in cultivation.

See SEGO LILY.

MARIS, JACOB (1837–1899), Dutch landscape painter,. the eldest of three brothers all of whom became artists. was born at The Hague on Aug. 25, 1837 He first studied at the Antwerp academy, and subsequently in Antoine Hébert's studio in Paris from 1865 till 1871. He is best known for his scenes from the Netherlands countryside, of bridges and windmills, old quays, massive towers and level banks. against misty skies or chasing clouds. In all his works, whether in water or oil colour, and in his etchings, the subject is always subordinate to the atmospheric effect.as in the "Grey Tower, Old Amsterdam," "Landscape Near Dordrecht," "Sea-weed Carts, Scheveningen," "A Village Scene" and numerous other pictures.

Jacob Maris died at Karlsbad on Aug. 7, 1899.

MATTHEW MARIS (1839–1917), younger brother of Jacob, was bdrn at The Hague on Aug. 1;. 1839. He received a royal subsidy and for some time lived and worked with his brother Jacob, on whom his more spiritual and mystical nature had a refining influence. There is a touch of medievalism in many of his figures. "Souvenir of Amsterdam," "Bride of the Church," "The Four Mills" and "Girl Feeding Chickens" are among his most successful works. In 1885 he went to London to design windows.

Matthew Maris died there Aug. 1;, 1917.

WILLIAM (WILLEM) MARIS (1844–1910), youngest of the brothers, was born at The Hague, Feb. 18, 1844. He developed under the influence of Jacob and Matthew and lived for the greater part of his life in London. His paintings of cattle grazing, the most famous of which is "Cows Beside a Ditch," are modern in treatment and have charm of colour and feeling.

William Maris died in London in 1910.

MARITIME ADMINISTRATION, U.S., an agency of the federal government established in May 1950, along with the federal maritime board, to replace the United States maritime commission. The Maritime administration was made a part of the department of commerce. Both the board and the administration were established to foster the growth of a U.S. merchant marine sufficient to meet the needs of national defense and of foreign and domestic commerce. The guiding principles for their operation remained those set forth in the Merchant Marine act of 1936.

The Maritime administration is responsible for administering shipbuilding, shipping, port development and related programs authorized by law. It determines the ocean services, routes and lines needed for the nation's foreign and domestic commerce. and the types of ships required to provide adequate service. It recommends the terms of subsidy contracts to be awarded by the federal maritime board to U.S. shipping companies and shipyards. The Maritime administration provides insurance on private loans and mortgages for ship construction, arranges for war risk insurance and pays the cost of national defense features added to ships. It conducts a research and development program to improve the efficiency and economy of operations of the U.S. merchant marine, including study of nuclear-powered ships such as the U.S.S. "Savannah." It maintains a national defense reserve fleet of some 2,000 government-owned ships. maintains four shipyards in inactive condition for use in a national emergency, and operates five warehouses for the storage of marine equipment that might be required in an emergency. It also operates three radar training schools and the C.S. Merchant Marine academy at Kings Point, N.Y.

The federal maritime board is composed of three members appointed by the president by and with the advice and consent of the senate. One of the three members is designated as chairman of the board and also ser-ves as head of the Maritime administration. The board is a regulatory agency and as such is independent of the secretary of commerce. Its functions include the regulation of rates, services, practices and agreements of common carriers by water. It may enter into subsidy contracts relating to construction and operating costs to help U.S. shipyards and shipping companies meet the competition of foreign countries. It makes its determinations with regard to such contracts in accord with the provisions of the Merchant Marine act of 1936.

By 1960, 15 U.S. shipping companies operating on 31 world trade routes that were considered essential to the nation's commerce and defense held subsidy contracts with the government. These lines were engaged in the nation's largest peacetime shipbuilding effort to replace, at a cost of $4,600,000,000, more than 300 passenger and dry-cargo ships, representing the nucleus of the U.S. maritime fleet.

The history of efforts by the federal government to develop and maintain a strong merchant marine and to regulate water carriers in foreign and interstate commerce goes back many years. In 1916 the U.S. shipping board was established with these goals in mind. It played an important role in World War I but during the postwar years the U.S. merchant fleet was in a far from healthy state. The Shipping board was abolished in 1933 and in 1936 new legislation created the U.S. maritime commission. The 1936 act authorized new types of subsidies to help U.S. shipping firms meet competition from low-wage countries which also offered subsidies to their merchant marines.

See also SHIPPING INDUSTRY: *World Merchant Fleets.*

(M. S. BL.)

MARITIME LAW, or admiralty law, is the body of legal rules, partly substantive, partly procedural, which has grown up around the shipping industry. As transportation of goods and passengers by water on some kind of floating structure is one of the earliest forms of commercial activity of which there is record, references to the law of the sea abound in the sources which have come down from antiquity and, after the revival of a commercial society in Europe, from the middle ages. It is easy to exaggerate both the completeness of the ancient and medieval sea codes and their relevance to modern law. The 6th-century Byzantine compilation known as the Digest of Justinian includes a mass of references which are often confused and contradictory, obscure in meaning and of uncertain date, authority and integrity. The largely mythical body of law attributed to the Rhodian mariners has been constructed from a few scattered references in the Digest. A number of medieval collections of local maritime customs have survived. the earliest extant editions or copies going back to the 13th and 14th centuries; the best known of these are the *Consolat de Mar* or "Consulate of the Sea!' (Barcelona, 1494), the Laws of Oléron and the Laws of Visby (or Wisby), which are of uncertain date. Many of these medieval sea codes, so-called, were reproduced in the influential 17th-century French treatise by Cleirac. *Les Us ef Coutumes de la mer* (1647). The great 19th-century collections were made by Pardessus, *Collection des lois maritimes antérieures au XVIIIe siècle* (6 vol., 1828–45) and by Sir Travers Twiss in his edition of the *Black Book* of *the Admiralty* (4 vol., 1871–76).

Development of English Admiralty Jurisdiction. — All of this material is of great historical interest but is irrelevant to a discussion of modern maritime law. The law in any field renews itself generation by generation; as the conditions of life and commerce change, so, of necessity, do the legal rules which do not so much regulate as reflect them. Each major change in the technology which underlies the shipping industry has meant a major change in the inarticulate bases of maritime law. Furthermore, in England. the United States and the other English-speaking countries whose legal systems derive from the English common law, a peculiar event in the history of the English court system contributed to a decisive break with the medieval tradition.

It appears that, by the end of the 16th century. the English courts of admiralty had come to exercise an extremely wide jurisdiction. reaching far beyond salt-water transportation into many areas of commercial law. These courts were closely allied with the import and export trade that was so vital to English industrial development and enjoyed the full confidence of the mercantile community. But during the first half of the 17th century the judges of the common-law courts succeeded in divesting their competitors in the admiralty of their commercial jurisdiction and in restricting them to the adjudication of "things done upon the sea." This transfer of jurisdiction was accomplished through writs of prohibition issued by the common-law courts under the vague authority of a series of long-ignored statutes, the earliest of which was dated in the reign of Richard II (13 Rich. II c.5 [1389]). The common-law courts do not seem to have had, or to have won, the confidence of the merchants; there ensued a hiatus of nearly 200 years in the development of English commercial law during which mercantile disputes were rarely settled in court. During the second half of the 18th century, under the vigorous leadership of Lord Mansfield. the common-law courts, stimulated, no doubt, by the novel needs of a society in full course of industrialization, proceeded to fashion a new series of legal rules for dealing with mercantile disputes. Meanwhile, the courts of admiralty, cut off from the main streams of commercial activity and of legal thought, eked out a precarious and obscure existence. Pepys, writing as early as 1662, left a vivid description of the admiralty judges contriving, with much solemnity, to make a little business go a long way. Not until the 19th-century reorganization of the English court system was there re-established by statute (3 & 4 Vict. c.65 [1840]; 13 & 14 Vict. c 26 [1850]; 23 Vict. c.10 [1861]) a court of admiralty with extensive jurisdiction over the problems peculiar to the shipping industry. It is only from the time of this restoration of jurisdiction that modern English admiralty law can be said to date. In the organization of the English court system that prevailed by the middle of the 20th century the admiralty court was a part of the high court of justice, forming with probate and divorce a division of that court; certain county and other inferior courts were also to some degree invested with admiralty powers.

American Developments.— The development in the American colonies followed a different line. During the pre-Revolutionary period vice-admiralty courts exercised, without successful challenge, a jurisdiction much wider than that left to the English admiralty courts. The judges of the vice-admiralty courts were appointed by the crown and, following the tradition of the royal or prerogative courts, sat without juries; for these reasons, and perhaps because of their unsympathetic attitude toward smuggling offenses, the vice-admiralty courts were not popular during the period of ferment which preceded the American Revolution.

Article III of the federal constitution, which defines the "judicial power of the United States," provides in Sec. 2 that "the judicial power shall extend . . . to all Cases of admiralty and maritime Jurisdiction. . . ." Little is known of the genesis of this notably obscure provision, whose meaning was left to be supplied by congress and the courts. In the Judiciary act of 1789 congress translated the constitutional ambiguity into an equally glaring statutory ambiguity by providing that "the [federal] district courts . . . shall also have exclusive original jurisdiction of all civil causes of admiralty and maritime jurisdiction . . . saving to suitors, in all cases, the right to a common law remedy, where the common law is competent to give it. . . ." Several times amended, most recently in connection with the revision of the Judicial code in 1948, the substance of the act of 1789 now appears, in slightly different language but with, apparently, no change in meaning, as Sec. 1333 of Title 28 of the United States code.

At the outset, the congressional enactment, far from clarifying the situation, served merely to introduce an additional element of confusion; the riddling words of the second branch of the jurisdictional provision came to be known as "the saving-to-suitors clause." The courts, and particularly the U.S. supreme court, were therefore charged with the task of determining the scope of the jurisdictional grant ("all civil causes of admiralty and maritime jurisdiction") as well as that of figuring out a meaning for the saving-to-suitors clause.

The resolution of the saving-to-suitors clause question furnished one of the distinctive features of U.S. admiralty practice. The judicially determined meaning of the clause was this: although a cause of action is within the "admiralty and maritime jurisdiction" and thus (under the first branch of the statutory provision) within the "exclusive original jurisdiction" of the federal courts (sitting "in admiralty"), the same cause of action may be sued on in a nonadmiralty court (that is, a state court or a federal court sitting, not "in admiralty." but as a civil court of law and equity). What developed therefore was not a body of law, federally created and administered exclusively by the federal courts, but a body of law administered and to some degree inspired by both state and federal sources. State courts developed systems of admiralty law which were quite independent of general or federal maritime law and the legislatures of many states enacted comprehensive maritime codes. This process was brought to a halt by the supreme court's decision in the case of The Moses Taylor (71 U.S. [4 Wall.] 411 [1867]), holding unconstitutional a state statute which authorized an in *rem* proceeding against a vessel in a state court. Such a proceeding, it was held, could be brought only in the federal court in admiralty and was not a "common-law remedy" under the saving-to-suitors clause. The *Moses* Taylor decision made it clear that to some extent admiralty was an exclusively federal domain, but it continued to be thought that in actions brought outside the admiralty court under the saving-to-suitors clause, state courts would apply their own rules of substantive law (for example, that plaintiff's contributory negligence bars an action in tort) even where those rules were inconsistent with the "general maritime law" (under which plaintiff's contributory negligence may cause damages to be divided or apportioned but is not a bar to the action). Considerable doubt was cast on the principle that state courts apply their own law in maritime causes of action by Southern Pacific Co. v. Jensen (244 U.S. 205 [1917]), in which the supreme court, holding a state workmen's compensation statute unconstitutional as applied to a longshoreman engaged in work aboard ship, included in its opinion language which suggested that state law is invalid if it "works material prejudice to the characteristic features of the general maritime law or interferes with the proper harmony and uniformity of that law in its international and interstate relations." Thereafter, in a series of cases decided during the 1940s and 1950s the supreme court seemed to be elaborating what might be called a theory of maritime-law supremacy. The supremacy theory was expressed principally in cases involving actions by seamen and other maritime workers for death or personal injuries. The court was closely divided on these issues and shifts in its membership in the late 1950s led to a series of decisions (*e.g.,* The Tungus v. *Skovgaard,* 358 U.S. 588 [1959]) which indicated that the supremacy theory might be confined within its present limits if not curtailed.

Jurisdiction of Admiralty Courts.—In addition to their civil jurisdiction, admiralty courts in England and the United States have long exercised a jurisdiction over crimes committed on shipboard The general theory is that a national court has jurisdiction to try crimes committed in its own territorial waters as well as crimes committed by its own nationals or citizens or on ships flying the national flag on the high seas or within the territorial waters of another nation. (United States v. *Flores,* 289 U.S. 137 [1933].) Applicable principles of international law and comity will determine the extent to which a national court is entitled to assert, or will assert, jurisdiction over crimes committed on foreign ships within its territorial waters.

For several centuries the law of prize was a distinctive feature of the practice of admiralty courts. An enemy ship captured in time of war could be brought into port and, if adjudicated as lawful prize by the local admiralty court, mould be sold by the court with the proceeds being divided among the lucky captors. The hope of fat profits in prize money no doubt stimulated the patriotic efforts of the daring privateers who in earlier days sailed as semiofficial adjuncts to the regular naval fleets and who seem to have had with those fleets the same sort of uneasy relationship which the "private eye" is said to have with the official police force in contemporary detective novels. As, during the 19th century, battleships became bigger, more expensive and more destructive, the opportunity for amateurs to turn a state of war into a profitable commercial venture on the high seas was lost and naval warfare became a grim, professional business. With the change of style in warfare at sea, the institution of prize gradually fell into disuse and in the 20th century disappeared.

In both Great Britain and the United States the admiralty courts exercise a limited jurisdiction over maritime causes of action. Only admiralty courts have power to entertain a proceeding ***in rem*** against a ship and to execute maritime liens. The admiralty courts sit in civil cases without juries, except that in the United States a special statute confers a right of jury trial in Great Lakes cases; they have traditionally followed a simple: flexible and nontechnical procedure. Since access to these specialized courts, with their special powers, depends on the existence of a maritime cause of action, much attention has been given to the dividing line between what is, in a legal sense, maritime and what is nonmaritime. In general, British and U.S. lam are in substantial agreement on the demarcation; indeed, to a considerable degree this body of law is supranational and world-wide.

One basis of admiralty jurisdiction is territorial: the occurrence on navigable waters of some event of a maritime nature which relates to a vessel or to her cargo. Under this branch of the jurisdiction fall crimes (including piracy) and torts such as collisions, injuries to crew members and passengers, and damage to cargo. In England the jurisdiction was territorially restricted to the high seas and tidal waters. In the United States, no doubt because of the great economic importance of the inland waterway system, the English limitation was eventually abandoned (The *Genesee Chief* v. *Fitzhugh,* 53 U.S. [12 How.] 443 [1851]); all inland waterways, whether they be lakes, rivers or canals, which are in fact navigable in interstate or foreign commerce, are within the jurisdiction. The requirement that some kind of floating structure which constitutes a "vessel" be involved leads to occasional litigation about odd objects which, by accident or design, find their way into navigable waters. The older cases, both English and American, took the vessel limitation seriously with the result that such things as navigation beacons and dry docks which had broken loose from their moorings were held not to be subject to the maritime rules of salvage (*q.v.*). Recent cases have taken a less restrictive approach.

The other principal basis of admiralty jurisdiction is contractual: a dispute arising out of a contract which is considered to be maritime in nature. It was this branch of the jurisdiction which was withdrawn from the English admiralty courts during the 17th century, as noted above, and restored by statute toward the middle of the 19th century.

In the United States a broad contractual jurisdiction was at all times maintained, following the precedents of the colonial vice-admiralty courts. Justice Joseph Story, who was at all times an apostle of federalism. was the most influential exponent of the concept of a broad admiralty jurisdiction; his learned opinion in *De Lovio* v. *Boit* (7 Fed. Cas. 418 [C.C.D. Mass. 1815]), holding a contract of marine insurance within the jurisdiction, became the classic statement of that approach.

The line between maritime and nonmaritime contracts was eventually drawn to include within the admiralty jurisdiction most contracts which would be popularly thought of as closely connected with the business of shipping: contracts for transporting passengers or cargo, for chartering ships, for services and materials furnished to a ship (supplies, repairs, towage, pilotage, wharfage, etc.), for maritime employment, for marine insurance, and so on. There were, however, some strange exclusions: contracts to build or sell ships are nonmaritime and. apart from statute: so are mortgages of ships. In lieu of mortgages, maritime law recognized two security interests known as bottomry bonds and respondentia bonds. Bottomry was a loan on the security of a ship, respondentia on the security of a cargo. The peculiar and, from a lender's point of view, unattractive feature of both bottomry and respondentia was that if the ship or the cargo failed to complete the voyage (having been, for example, lost at sea) the lender lost not merely his security but his right to repayment of the loan. Any attempt to give the lender a claim which would survive the loss of the ship or cargo was held to convert the bond into a nonmaritime mortgage. Bottomry and respondentia have long since passed out of use and in both Great Britain and the Gnited States statutes have conferred maritime status on ship mortgages which comply with the rather complex requirements which the statutes impose.

Liens.—Most types of maritime claims, whether based on contract or arising from tort, give rise to maritime liens against the ship or its cargo. In admiralty terminology, the pleading which initiates a proceeding is known as a libel. A libel may be brought either in personam, against the shipowner. or ***in rem,*** against the ship or cargo. Under an in personam libel the decree, if the libelant is successful, is a money judgment against the shipowner. When a ship is libeled *in rem* the ship is arrested and kept in the custody of the court unless the owner secures her release by posting a bond for indemnity. If judgment goes for the libelant in an *in rem* action, the ship will be sold by order of the court or there will be recovery on the bond. The sale of a ship by an admiralty court acting ***in rent*** is said to divest or "execute" all liens against the ship—not merely those liens which may have come into the proceeding in which the ship was sold but all liens everywhere in the world. (By way of contrast, the holder of an in personam judgment against a shipowner can. like any judgment creditor, have the ship sold on execution. But such a sale, unlike the admiralty sale *in rem,* does not execute existing liens; the ship, in the hands of the purchaser at the execution sale, remains subject to all existing liens.) Thus, the libel in *rem* has decisive advantages over the libel in personam and these advantages become even more striking when the shipowner is insolvent or when, typically following some maritime disaster, the aggregate of claims far exceeds the value of the offending ship. Possession of a claim with maritime lien status has a taofold importance: (1) with some statutory exceptions in Great Britain, only the holder of a maritime lien may bring an action ***in rem;*** (2) when funds are distributed following judgment in an *in rem* action in which several parties have filed libels or have been allowed to intervene, maritime lien claims are paid in full, with priority over claims which are maritime but do not have lien status as well as over-all nonmaritime claims.

All maritime torts for which a ship is responsible give rise to liens. Examples of such torts are collisions due to negligent navigation, and injuries to persons or damage to property caused by the negligence of the ship's personnel or by the ship's unseaworthiness. The breach of most types of maritime contracts also gives rise to liens: contracts of affreightment or passage; charter parties; employment contracts of officers and crew; contracts for repairs, supplies and various types of maritime services such as towage, pilotage and wharfage. Breach of a contract, however, gives a lien only when at the time of breach the contract has been to some degree executed or performed—as by delivery of cargo on board ship or by delivery of a ship under a charter party. Breach of a contract while it is wholly executory—for example, the refusal of a ship to accept cargo which it has agreed to carry or to receive a passenger to whom a ticket has been sold, or the failure to deliver a ship under a charter—creates a maritime claim, but such a claim does not enjoy lien status. A few types of concededly maritime claims have at one time or another, usually for no discernible reason, been denied lien status; examples are the claim of an insurance company for unpaid premiums on a marine insurance policy and the claim of a general agent for advances.

Maritime liens are also given for several types of peculiarly maritime transactions or services. Among these are the liens which arise from bottomry and respondentia bonds, liens for salvage and for contributions made to a general average ***(see*** AVERAGE).

The ship may have a lien against the cargo. Typically the lien against cargo is asserted for nonpayment of freight, but it could support a claim for damage caused the ship by the cargo. For enforcement of such a lien the cargo may be libeled *in rem* and sold by the admiralty court, just as in cases of *in rem* actions against ships. The peculiarity of the lien against cargo is said to be that it depends on possession and is lost by a voluntary delivery of goods to the consignee.

Under general maritime law there is a complex hierarchy of maritime liens; that is to say, in a proceeding which involves distribution of an inadequate fund to a number of lien claimants, liens of a higher rank will be paid in full in priority over liens of a lower rank. Liens are ranked according to two quite different criteria: the time when they arise and the nature of the transaction or event which gives rise to the lien.

With respect to the time of accrual the general rule is that liens rank in inverse order of creation; that is, existing liens are subordinated to liens subsequently created. Various theories have been advanced to explain this rule which, at first blush, seems to fly in the face of reason. The priority given to the most recent contract lien has been said to rest on the fact that the lienor's services presumably benefited the ship and enabled her to get on with the voyage. Reasonable as that may be, it does nothing to explain the priority given to the most recent tort lien, and the inverse order rule appears to be even more rigorously applied to tort liens than to contract liens. An alternative theory, which does little more than describe the result, suggests that all existing lienors become in a sense "co-owners" of a ship and, by allowing it to proceed on a voyage, voluntarily subordinate their claims to the contingencies of the voyage. The practical result of the inverse order rule is that the lienor must assert his claim promptly or take the risk of subordination to later claims.

The strict inverse order rule is usually qualified to the extent that liens are ranked not hour by hour or day by day but voyage by voyage; that is, liens of the same class which accrued on the most recent voyage all share equally and all enjoy priority over the liens which accrued on the preceding voyage, and so on back. In the United States, in the case of coastal shipping, liens are ranked by the calendar year and, in the case of Great Lakes shipping, by the season (on the Great Lakes ice makes navigation impracticable during approximately four months of each year). Furthermore, a few special rules are applied to harbour shipping: in New York harbour, for example, liens which accrue within 40 days from the date of the initiating libel outrank all prior liens, which share equally. It has been suggested that the several rules reflect the normal periods of credit which are extended by suppliers; from this it has been argued that the voyage rule, which was developed during the 19th century when a transoceanic voyage was a matter of weeks or months instead of days, should be replaced by a calendar year or season rule which would allow lienors to delay enforcing their claims for a reasonable credit period without running the risk of subordination. This argument has not, however, as yet prevailed (*The City* of *Athens*, 83 *F.* Supp. 67 [D.Md. 1949]).

Liens are ranked not only by time of accrual but by class. With respect to ranking by class, it is safe to say that the highest priority goes to seamen's claims for wages: these are, it was once colourfully said, "sacred liens, and, so long as a plank of the ship remains, the sailor is entitled, against all other persons, to the proceeds as a security for his wages." (*The John* G. *Stevens*, 170 U.S. 113 [1898]). Not far behind come claims for salvage, and there is even some authority for the proposition that a salvage lien will outrank liens for wages earned before the salvage. Apart from wages and salvage, the general rule is that tort liens outrank contract liens; a perhaps desirable flexibility is introduced into the structure by the fact that it has never been clear whether liens for damage to cargo are on the tort side (because of negligence in stowing or caring for the goods) or on the contract side (under the contract of carriage).

Since liens are ranked according to two quite different criteria—time and class—it is obvious that clarity and predictability in the law are, even theoretically, impossible of achievement. Indeed, for a hundred years past commentators have regularly bemoaned the extraordinary degree of confusion which marks the question of lien priorities. From the fact that the confusion has been allowed to persist, it may be concluded that clarity and predictability have not been found to be essential and that a certain vagueness or formlessness in the legal categories, which leaves ample room for judicial maneuver, meets the needs of the situation. Without much exaggeration, it can be said that a trial judge, in decreeing the distribution of an inadequate fund among competing lien claimants, can find authority and precedent for almost any distribution which appears to him to be reasonable. Furthermore, appeals from decrees of distribution are rarely taken, so that. in the absence of authoritative statements by appellate courts, the law becomes progressively more unsettled and parochial. This phenomenon is by no means unexampled in the law, although it is offensive to the purist, the black-letter man and, most of all, to the nonlawyer. Evidently the industry most immediately concerned has found it possible to live with the confusion and there is no sign in the case law that any progress will be made toward a neat, tidy and rigid formulation of priorities.

Limitation **of** Liability.—A distinctive feature of maritime law is the privilege accorded to a shipowner under certain circumstances to limit his liability, in respect to both tort and contract claims. to the value of his investment; *i.e.*, the value of the ship. The basic condition of the shipowner's privilege is that he must be free from "privity or knowledge"; this formula (which is common to the limitation law of all maritime countries) means, roughly, that the shipowner is not liable for losses caused by faulty navigation but may be liable for losses caused by the ship's unseaworthiness which could have been corrected before it broke ground for the voyage. In a sense the limited liability of shipowners may be compared to the limited liability which any investor may now achieve by incorporating his enterprise. However, the limited-liability idea in maritime law long antedates the emergence or invention of the modern corporation or limited company; its early appearance in maritime law may be taken as a recognition of the extraordinary hazards of sea-borne commerce and the need to protect the adventurous shipowner, before even the most primitive forms of insurance became available, from a crushing burden of liability. Modern commentators have often suggested that the peculiar features of maritime limitation of liability have outlived their usefulness; the development of insurance has radically altered the conditions out of which the shipowner's privilege originally grew. Although no maritime country has yet gone to the length of abolishing limitation of liability, shipowning interests appear to have become concerned about the possibility of such a development. The Brussels convention of 1957 on the Limitation of Shipowners' Liability proposes a limitation fund substantially larger than that previously available in many countries. The convention was promptly adopted in Great Britain by the Shipping act of 1958, and it has been suggested that British sponsorship of the convention was motivated by fears on the part of shipowners that parliament was in any case disposed to proceed unilaterally to revise the law in a manner adverse to their interests. In the United States it has been suggested that it would be unwise to submit any kind of limitation legislation to congress on the ground that, once the subject was opened, the result might quite possibly be the abolition of limitation entirely.

In most maritime countries the principle of limitation of liability was considered to be a part of the general maritime law. As it developed in continental Europe the idea, generally stated, was that a shipowner entitled to limitation could satisfy his liability by abandoning the ship (and its pending freight) to claimants. Since the privilege of limitation was, and is, typically invoked following a large-scale maritime disaster, the abandonment theory meant that claimants got the value of the ship as it was following the disaster. If the ship had sunk or was a total loss with no freight pending, the claimants got nothing. This theory was carried over into the law of many South American countries.

A number of the principal European countries, as well as Brazil, adopted a modification of the abandonment theory proposed by the Brussels convention of 1922. Under the convention the owner retains the privilege of abandoning his ship in full satisfaction of claims but may, as an alternative, retain the ship and limit his liability to £8 per ton of the ship's registered tonnage (plus an amount for freight) in respect of property claims, with additional provision being made for death and personal injury claims. The convention was described as a happy compromise between British and continental theories of limitation but was. in fact, more favourable to the shipowner than either the British system or the previous continental system.

Great Britain and the United States were the only maritime countries that refused to admit the principle of limitation as part of the general maritime law. In both countries, however, the competitive needs of the shipping industry compelled its reintroduction by statute.

The first British limitation act was passed in 1734 (7 Geo. 2 c. 15) and was thereafter many times amended. Until after the middle of the 19th century, English limitation law, much less favourable to shipowners than the continental abandonment theory, set the limitation figure at the value of the ship at the beginning of the relevant voyage—i.e , before the disaster—plus pending freight. In 1854 (17 & 18 Vict. c. 184) it was provided that in case of death and personal injury claims the value of the ship should be taken as not less than £15 per ton. Thereafter in 1862 the actual value of the ship was abandoned as a measure of liability, and limitation was fixed in all cases at £15 per ton in cases of death and personal injury and £8 per ton in cases of property damage alone. These provisions were incorporated in the Merchant Shipping act of 1894 (57 & 58 Vict. c. 60) and remained in force until displaced by the Shipping act of 1958. The £8 per ton figure was no doubt a rough average of ship values in 1862 when it was adopted; in the 20th century, particularly after the end of World War II, soaring costs deprived the £8 figure (or even the £15 figure) of any relation to reality.

U.S. shipowners apparently did not become concerned about the question of limitation of liability until the middle of the 19th century. The Limitation of Liability act of 1851 was closely modeled on the British statute then in force and was supported in congress as a measure designed to restore U.S. shipowners to a position of competitive equality with British shipowners. The act fixed the maximum liability of a shipowner entitled to limitation at the value of the ship plus pending freight, but gave no indication whether that value was to be calculated after the disaster (the European "abandonment" theory) or before (the English theory under the statute then in force). The legislative history of the act suggested that it should be construed according to British law but the U.S. supreme court eventually decided (Norwich *&* N.Y. *Transportation* v. Wright, 80 U.S. [13 Wall.] 104 [1871]) that the principle of limitation was a part of the general maritime law, which the act had merely restored to vitality, and elected to follow the European theory. Thereafter the court decided that a shipowner entitled to limitation could keep for his own benefit any insurance recovery and did not have to put that money into the limitation fund (Tlze Czty of Norwich, 118 U.S. 468 [1886]). These holdings left U.S. limitation law at the end of the 19th century in a state much more favourable to the shipowning interests than was the corresponding British law. However, as ship values continued to increase, the U.S. formula, in cases where the ship was not a total loss, opened the way to recoveries substantially larger than were available under the British formula, tied to the increasingly unrealistic £8 per ton figure of 1862.

The U.S. act of 1851, consistent with its purpose to restore the U.S. mercantile fleet to a position of equality with the British fleet, had excluded from its coverage vessels used on the inland waterways; in 1886, however, the act was extended to "all vessels used on lakes or rivers or in inland navigation."

Until 1935 the U.S. Limitation act made no special provision for death and personal-injury claims. Public indignation was aroused in 1934 when the owners of the steamship "Morro Castle," which burned off the New Jersey coast with large loss of life, petitioned to limit their liability to $20,000. The following year congress added to the Limitation act provisions, modeled on those of the British act, requiring that a special fund in the amount of $60 per ton be set up to satisfy death and personal-injury claims. The loss of life provisions apply only to "seagoing vessels."

The Brussels convention of 1957 on Limitation of Shipowners' Liability adopts the structure of British limitation law, setting the limitation fund at an amount closer to actual ship values than the obsolete figures of £8 and £15 which had prevailed in Britain since 1862. The convention figures are stated in terms of the gold content of Poincaré francs and convert into U.S. dollars (1958) at $140 per ton for death and personal-injury claims exclusively with another $67 per ton to be shared ratably by such claims and property claims.

In general, the limitation law of any country will be applied by its own courts in favour of foreign shipowners as well as of citizens. From the point of view of shipowning interests, however, a major weakness of limitation law has been the fact that decrees of limitation (unlike in *rem* decrees of admiralty courts) are not given international recognition (The Titanic, 233 U.S. 718 [1914]). That has meant that a shipowner whose ships move in international trade could find himself sued in several countries, as a result of one disaster, and forced to set up limitation funds in each country (although in Britain an owner who paid claims in foreign proceedings was allo ed to credit those amounts against the British limitation fund). The Brussels convention of 1957 purports to make limitation decrees delivered by admiralty courts in ratifying countries internationally effective; that is, a shipowner could be required to set up only one limitation fund, out of which all claims would be paid, no matter in how many countries proceedings might be instituted against him. Thus the convention, which increases the liability of shipowners in most countries, does offer in return this considerable advantage to the small group of shipowners whom the present rule affects adversely.

Marine Insurance.—An appreciation of the part played by marine insurance (*q.v.*) is essential to an understanding of the shipping industry and the special law which governs it. With the exception of claims for death and personal injury and claims of seamen for wages, substantially all claimants are themselves insured. The shipowner carries hull insurance on his own ship and protects himself against claims by third parties under a variety of arrangements. Water-borne cargo is almost universally insured against the perils of the seas. It is impossible in a brief outline such as this to go into any of the special intricacies, which are many. of marine insurance law. The point to be borne in mind is that any case of property damage, to a ship or its cargo or to ships in collision, resolves itself into a settlement between insurance carriers. Proposals for reform of the maritime law must always be evaluated against this background of universal insurance coverage. Abolition of the shipowner's privilege to limit his liability or of the peculiar maritime rules of general average or an increase in ship's liability to cargo would all mean not much more than that insurance now taken out and paid for by A would be taken out and paid for by B, who would pass on the additional cost of his insurance in the rates or prices charged to his customers. Since the same insurance carriers write both hull and cargo insurance, the end result of such reforms would be merely a redistribution of business among their several departments. Except for litigation involving death and injury claims, there appears to have been during the 20th century a notable decrease in maritime litigation of all sorts. It is reasonable to suppose that this decrease is related to the increasing availability of all-risk insurance; insurance carriers notoriously, and commendably, prefer settlement or arbitration to litigation, even when a given carrier does not find itself in the position of having insured both parties.

Marine insurance is the oldest form of insurance that is known. Indeed, the institution of general average, under which the participants in a maritime venture contribute to losses incurred by some for the benefit of all, may itself be looked on as a primitive form of self-insurance. Marine insurance in a discernibly modern form made its appearance in the middle ages; many of the medieval sea codes contained regulatory provisions, and a special court for trying marine insurance cases was established in England in 1601 (43 Eliz. c. 12). Modern hull-msurance policies still reproduce the language, which has come to seem quaint and archaic, of the so-called Tiger policy, written in London in 1613. Marine insurance seems to have grown up in the interstices, so to say, of existing maritime law and to have adapted itself to that framework. Until the 20th century it was a characteristic of marine insurance that a substantial number of risks could not be covered, and this remains to some degree true in cargo policies customarily written to exclude losses under stated percentages (the so-called F.P.A. or "free of particular average" clauses — "average" meaning a loss and a "particular average" meaning a loss not made good in a general average contribution). The theoretical basis for exclusion of certain risks is often said to be the furnishing of an inducement to the owner of property to look after it himself. as in the case of the "deductible!' feature in the familiar automobile collision-insurance policy. However that may be, the pressures from shipowners for comprehensive insurance coverage have gradually led to the inclusion of almost all risks: "collision and running down" clauses, war risk riders, so-called "disbursements" policies and "P. and I." (protection and indemnity) insurance.

The British Marine Insurance act of 1906 (6 Edw. 7, c. 4) codified British law and was of great influence in the development of U.S. marine-insurance law. The U.S. supreme court has consistently insisted on the need for international uniformity in this field. with the result that both the British codification and British cases have been recognized as authoritative. (*E.g., Queen* Insurance Co. of America v. Globe *& Rugers* Fire Insurance Co., 263 C.S. 487 [1924].) Nevertheless, certain differences have grown up between British and U.S. practice; for example, in cargo policies variant clauses are in use in the two countries with respect to the risk covered in cases of stranding or collision (the clauses are referred to as F.P.A.E.C. and F.P.A.A.C.—Free of Particular Average, English Conditions; Free of Particular Average, American Conditions). The case of *Wilburn* Boat Co. v. Fireman's Fund *Insurance* Co. (348 U.S. 310 [1955]), which held that a state statute controlled the decision whether a policy on a houseboat kept on an inland lake was void for breach of warranty, led some commentators to speculate that the supreme court had abandoned its long-held policy of uniformity in the marine-insurance field.

Nature **of** Maritime Law. — Maritime law is often thought of as being a species of private international law—ius *gentium*—rather than a branch of domestic or municipal law. It should not be denied that the international aspect of maritime law gives it a distinctive flavour; in doubtful cases courts of one country will often look to the precedents or statutes of another country for inspiration or guidance, and a relaxed attitude toward the principles of the law of conflict of laws is customary on the ground that the rules of maritime law are world-wide in scope. The supranational nature of maritime law was emphasized in an opinion written by Justice Robert H. Jackson of the U.S. supreme court in 1953: "[C]ourts of this and other commercial nations have generally deferred to a non-national or international [maritime] law of impressive maturity and universality. It has the force of law, not from extraterritorial reach of national laws, nor from abdication of its sovereign powers by any nation, but from acceptance by common consent of civilized communities of rules designed to foster amicable and workable commercial relations." (Lauritzen v. Larsen, 345 U.S. 571 [1953].) Traditionally the interplay between British and U.S. courts in this field has been close and continuous.

It is, however, very easy to overstate the degree to which maritime law is a branch of the law of nations. Justice Oliver Wendell Holmes pointed out long ago: "The maritime law is not a corpus *juris*—it is a very limited body of customs and ordinances of the sea." (Southern Pacific Co. v. Jensen, 244 C.S. 205 [1917].) In all countries there is discernible a progressive tendency to codify maritime law, and the nature of national statutes is such as to preclude reference to outside sources of law. It is undoubtedly true that maritime law in mid-20th century was much more a creature of nationalism than it had been 100 years earlier.

Countervailing pressures of an internationalist kind have not been without influence. Since the late 19th century the Comité Maritime International has produced a series of international conventions. While many of these conventions have failed of widespread ratification, others have been highly successful: the Salvage convention of 1912, the Safety of Life at Sea convention of 1929, the convention on the Carriage of Goods by Sea of 1922 have all been adopted, either by ratification or by the passage of parallel legislation, by the principal maritime countries of the world, including Great Britain and the United States. The international rules of navigation. most recently revised as the result of recommendations of the Safety conference held at London in 1948 and adopted by statute in many countries including Great Britain and the United States, are in effect an international code of navigation on the high seas; these rules of the road are of the greatest importance in determining fault in ship collision. (*See* RULE OF THE ROAD AT SEA.)

In other fields much has been accomplished to ensure international uniformity through private agreements voluntarily adhered to by affected interests; the York-Antwerp Rules of General Average. first promulgated in 1890 and most recently amended in 1950, are the best-known example of such agreements which, although they do not technically have the force of lam. nevertheless, by incorporation in charter parties and bills of lading, determine the shape of the law as effectively as any statute. It may also be that the widespread submission of international maritime disputes to arbitration, where the informality of the procedure facilitates escape from aberrant national rules, reflects the stubbornly international bias which has characterized the shipping industry from earliest times.

See also ADMIRALTY, HIGH COURT OF; AFFREIGHTMENT; MARINE INSURANCE; NAVIGATION LAWS; SALVAGE; WRECK.

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(G. GI.)

MARITIME PROVINCE, a former province of Russia, in east Siberia; see FAR EASTERN AREA.

MARIUPOL (ZHDANOV), a seaport of the Ukrainian Soviet Socialist Republic, U.S.S.R.. at the mouth of the Kalmius river, in 47° 6' N. lat. and 37° 35' E. long. The population was 284.000 in 1959. The harbour is 4 mi. S.W. of the city. Known as Mariupol until 1948, the city was renamed Zhdanov in honour of a Soviet politician, Andrei Zhdanov. The place is said to have been inhabited in remote times under the name of Adamakha. The modern town was built only in 1779, by Greek emigrants from the Crimea. Zhdanov became an industrial centre and a metallurgical institute was founded there. Manufactures include steel pipes, machinery and chemicals. Fishing and shipbuilding industries were also established. It was linked by rail with the north.

MARIUS, GAIUS (155–86 B.C.), Roman general, of plebeian descent, the son of a small farmer of Cereatae (mod. *Casamare,* "home of Marius") near Arpinum. He served first in Spain under Scipio Africanus, and rose from the ranks to be an officer. In 119 as tribune he proposed a law intended to limit the influence of the nobles at elections. This brought him into conflict with the aristocratic party, who prevented him from obtaining the aedileship. When about forty years of age he married a lady of patrician rank. Julia, the aunt of Julius Caesar. Praetor in 115, he subdued Further Spain. In the war with Jugurtha (109–106) he came to the front as lieutenant of the consul Quintus Caecilius Metellus Numidicus. He came home in 108 to stand for the consulship, was elected, and proceeded to upset all precedent by over-ruling the Senate on the question of his command, and getting the war with Jugurtha assigned to him by the Assembly. He then raised a large army by another unconstitutional departure, enrolling the classes without property (capiti censi), probably the most momentous step he ever took. He superseded his old commander Metellus, and took with him as quaestor L. Sulla. who commanded the cavalry. Between them they brought the war to a triumphant issue, and Marius passed two years in his province of Numidia, which he thoroughly subdued and annexed. The surrender of the person of Jugurtha to Sulla gave rise to the view that he, not Marius, had really ended the war, and so laid the foundation of the subsequent enmity between the two leaders.

Marius was next appointed to the command against the Cimbri and Teutones, who had destroyed two Roman armies near the lake of Geneva. Marius, out of unpromising materials and a demoralized soldiery, organized a well-disciplined army, with which he inflicted on the invaders two decisive defeats, the first in 102 at Aquae Sextiae (Aix), 18 m. north of Marseilles, and the second in the following year near Vercellae *(Vercelli),* about midway between Turin and Milan. In 101 Marius was elected consul a fifth time (previously in 107, 104, 103, 102), hailed as the "saviour of his country," and honoured with a triumph.

The glorious part of his career was now over. A very able soldier, as a politician he on the whole failed, though he retained the confidence of the popular party almost to the last. But he unfortunately associated himself with the demagogues Saturninus (*q.v.*) and Glaucia, in order to secure the consulship for the sixth time (100). Later their excesses forced him to turn against them, and this cost him his popularity. So he left Rome for Asia, where he endeavoured to provoke Mithridates to hostilities. On his return he served as legate in the Social War (90), and defeated the Marsi on two occasions. In 88 war broke out with Mithridates, and Sulla was appointed by the senate to the chief command. While Sulla was at Nola with the army, the tribune Sulpicius Rufus started a program of revolutionary legislation which included the transfer of the command to Marius. Sulla marched on Rome, crushed the revolution, and outlawed Marius, who fled with a price on his head. After a picturesque series of incidents which included a frustrated attempt to land at Carthage, he settled for the time in Cercina. No sooner had Sulla left for the east, than Cinna's revolution started. Marius joined Cinna, forced his way into Rome and entered on a reign of terror in which senators and nobles were slaughtered wholesale. He had himself elected consul for the seventh time, in fulfilment of a prophecy given to him in early manhood. Less than three weeks afterward he died of fever, on Jan. 13, 86.

He carried out to their logical conclusion the processes begun by Rufus, and under the new organization the soldier was a man who had no trade but war. He did not himself use the army as a political weapon, but under the new order the great general was bound to become the ruler of the State.

For Marius the original sources are numerous passages in Cicero's works, Sallust's *Jugurtha,* the epitomes of the lost books of Livy, Plutarch's *Lives* of Sulla and Marius, Velleius Paterculus, Florus and Appian's *Bellum civile. See* F. D. Gerlach, *Marius und Sulla* (Basel, 1856); I. Gilles, *Campagne de Marius dans la Gaule* (1870); W. Votsch, *Marius als Reformator des romischen Heerwesens* (with notes and references to ancient authorities) 1886; A. H. J. Greenidge, *History of Rome,* vol. i. (1904); also ROME: *Ancient History: The Republic.*

MARIVAUX, PIERRE CARLET DE CHAMBLAIN DE (1688–1763), French novelist and dramatist, was born at Paris on Feb. 4, 1688. His father became director of the mint at Riom in Auvergne, and Pierre was brought up there and at Limoges. Marivaux began his literary career by writing plays, admirable and graceful comedies, of which the most famous are *Le jeu de l'amour et de l'hasard* (1730), *Les Fausses Confidences* (1736), *Le Legs* (1736) and *L'Epreuve* (1740). If they lacked something in depth and characterization, they were full of witty dialogue, much of it about trifles, but exquisite in its way. This dialogue gave a new word to the French language, *marivaudage;* the style perfectly reflects the gallantry and the *sensibilité* which is the subject matter. Simultaneously Marivaux conducted two or three short-lived periodicals, in the *Spectator* style: *Le Spectateur français* (1722–23), *L'indigent Philosophe* (1727), and *Le Cabinet du philosophe* (1732).

In 1731 Marivaux published the first two parts of his best and greatest work, *Marianne,* a novel of a new and remarkable kind. The eleven parts appeared in batches at intervals during a period of exactly the same number of years, and, after all, it was left unfinished. In 1735, another novel, *Le Paysan parvenu,* was begun, but this also was left unfinished. *Marianne* is an extremely important step in the legitimate development of the French novel — legitimate, that is, in opposition to the brilliant but episodic productions of Le Sage. Its connection, and that of *Le Paysan parvenu,* with the work not only of Richardson but of Fielding is also an interesting though a difficult subject. The subject matter of Marivaux's peculiar style has been generally, and with tolerable exactness, described as the metaphysics of love-making. His characters, in a happy phrase of Crébillon's, not only tell each other and the reader everything they have thought, but everything that they would like to persuade themselves that they have thought. He was elected a member of the Academy in 1742. He survived for more than 20 years, contributing occasionally to the *Mercure* and writing plays. He died on Feb. 12, 1763, aged 75 years.

Marivaux was, though a great cultivator of *sensibilité*, on the whole decent and moral in his writings, and was unsparing in his criticism of the rising *Philosophes.* This last circumstance, and perhaps jealousy as well, made him a dangerous enemy in Voltaire. He had good friends, not merely in the rich, generous and amiable Helvétius, but in Mme. de Tencin, in Fontenelle, and even in Mme. de Pompadour, who gave him, it is said, a considerable pension, of the source of which he was ignorant.

The best and most complete edition of Marivaux is that of 1781 in 12 vol. reprinted with additions 1825–30. The plays had been published during the author's lifetime in 1740 and 1748. There are modern editions by Paul de Saint Heylli Victor (1863), by G. d'Heylli (1876) and by E. Fournier (1878), while issues of selections and separate plays and novels are numerous. Of works concerning him J. Fleury's *Marivaux et le Marivaudage* (Paris. 1881). G. Larroumet's *Marivaux, sa vie et ses oeuvres* (1882; new ed, 1894), the standard work on the subject, and G. Deschamps's *Marivaux* (1897), in the *Grands écrivains français,* are the most important.

MARJORAM, aromatic herbs or undershrubs, belonging to the genera *Origanum* and *Majorana* (family Labiatae). Wild marjoram (*O. vulgare*), a perennial native to Europe and Asia, is common in dry copses and on hedgebanks in England and is naturalized in the eastern United States. It has many stout stems 1 to 3 ft. high, bearing short-stalked somewhat ovate leaves and clusters of purple flowers. Sweet marjoram, M. *hortensis,* and pot marjoram, M. *onites,* are cultivated for the use of their aromatic leaves, either green or dry, for culinary purposes; the tops are cut as the plants begin to flower and are dried slowly in the shade. *See* FLAVOURINGS.

MARK, SAINT, evangelist, an apostle of first-generation Christianity and the traditional author of the second Gospel (*see* MARK, GOSPEL ACCORDING TO SAINT). His symbol, therefore. has become the lion. the second animal at the throne of God (Ezek. i. 10: *see* Rev. iv.' 7). In the New Testament. Mark is mentioned several times, but even an uncritical combination of this information produces only a very fragmentary picture. Furthermore, critical investigation has raised serious doubts about the historicity of most of the given data.

The only unquestionably reliable information is to be found in Philem. 24, where a certain Mark is mentioned as one of Paul's fellow workers who sends greetings from Rome to the Christians at Colossae. But there is no indication there as to the identity of this person. The information in Col. iv, 10, that the Mark of Paul's company was a cousin of Barnabas, may also be authentic, although the Pauline authorship of Colossians is not beyond doubt.

Acts xii, 12, 25; xv, 37 speaks about "John whose other name was Mark," and xiii, 5, 13 simply says "John;" but elsewhere in the New Testament he is known by his Latin surname Mark (a name related to that of the god Mars). Acts also relates that his mother's house in Jerusalem was a centre of Christian life (xii, 12), and that Barnabas and Paul took him along to Antioch (xii, 25) whence he became their assistant on a mission journey (xiii, 5). When they arrived at Perga in Pamphylia, however, Mark left them and returned to Jerusalem (xiii, 13). According to Acts, this was the reason why Barnabas and Paul later separated, because Barnabas insisted on giving Mark another chance, while Paul declined (xv, 37–39). Subsequently, Mark sailed to Cyprus with Barnabas, never to be mentioned again in Acts.

The dependability of the Acts account is highly questionable. The writer of Acts is particularly interested in finding a reason for the breach between Paul and Barnabas, and probably introduces the rather colourless figure of John Mark for this very reason; but in so doing, he contradicts Paul's own account (Gal. ii, 11–14). What did the author of Acts actually know about Mark?

Apparently he had only the information contained in the Pauline Epistles; *i.e.*, he knew about a Mark who was mentioned among Paul's company as a relative of Barnabas.

II Tim. iv. 11, which pictures a forsaken Paul requesting Timothy to bring Mark "for he is very useful in serving me," is almost certainly a pseudepigraphic synthesis of data from Acts and Colossians. Greetings from "my son Mark" are included in I Pet. v, 13, which was written from Rome ("Babylon"), and a close relationship between Mark and Peter also is suggested by Papias' presbyter tradition, which identifies Mark as the interpreter of Peter and thus the author of the Petrine Gospel. But this seems to be a wishful identification aimed at giving the Gospel greater authority. If I Peter is spurious, as many scholars are convinced. its mention of Mark is a part of the device of pseudonymity which only proves that the tradition connecting Mark with Peter and Rome goes back to the end of the 1st century A.D.

Later tradition assumes that Mark mas one of the Seventy (Luke x, 1), and identifies him with the young man fleeing naked at Jesus' arrest (Mark xiv. 51 f.). The tradition first mentioned in Hippolytus (Refutation, vii. 30, 1) metaphorically calls Mark "shortfingered," since his Gospel is the shortest of all Gospels. Mark also was claimed by the Egyptian church as its founder, and from the 4th century A.D. the Alexandrian see has been called cathedva Marci. Dependent on the tradition that connected Mark with Peter and Rome, the church of the once important city of Aquileia (north Italy) traced its origin back to Mark. After the destruction of Aquileia by Attila in A.D. 452, its refugees founded Venice. of which Mark became the patron saint (a fantastic legend tells how Venetian merchants stole Mark's remains from Alexandria), and Venice's glory and predominance gave Mark's winged lion widespread fame throughout the middle ages. St. Mark's feast day is April 25.

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(H. H. KO.)

MARK, a word of which the principal meanings are in their probable order of development—boundary, an object set up to indicate a boundary or position; hence a sign or token, impression or trace. (See MARK SYSTEM.) Mark, in the monetary sense, was formerly the name of a German silver coin. and as such is probably a distinct word and not of Teutonic origin; it is found in all Teutonic and Romanic languages. Latinized as *marca* or *marcus*. The mark was originally a measure of weight (varying during the middle ages, but *c.* 8 oz.) for gold and silver only and was common throughout western Europe. In England the "mark" was money of account only, and apparently came into use in the 10th century through the Danes. (See MONEY, MEDIAEVAL.)

The modern German mark was adopted in 1873, and first issued in 1875, as the standard of value and the money of account. It was of the value of 6.146 grains of gold, 900 fine, and was equal to English standard gold of the value of 11.747*d.* (in New York 23.821 cents). After the collapse of the mark (see BANKING; GERMANY) the mark was replaced in 1923 by the rentenmark, issued by the newly founded Rentenbank, and in 1924 by the reichsmark, issued by the Reichsbank. After World War II the reichsmark collapsed and was replaced by the deutschemark.

MARK, GOSPEL ACCORDING TO SAINT, in canonical order the second of the four Gospels of the New Testament. As the earliest of the three so-called Synoptic Gospels it was used as a source by the others, Matthew and Luke (see GOSPEL). Since Mark also was probably the first Gospel ever written, its outline of the life and ministry of Jesus can be considered as the first attempt to present the whole tradition of Jesus in a continuous "story."

Composition.—The core of Mark's Gospel is the Passion narrative, which Christian tradition already had formulated on the basis of the actual order of events in Jesus' trial, Passion and death. This comprises about 40% of Mark (in Luke, it is only 20%). To this core, the author of Mark added other traditional materials (mainly narratives), thereby extending the Passion narrative backward into a life of Jesus. The term Gospel, which originally meant the oral preaching about Jesus' death and resurrection, was used for the first time in Mark as the leading motif for a literary composition concerning the entire story of Jesus. Since in Mark this term occurs exclusively in editorial sentences, it was clearly the author of Mark himself who applied the word Gospel to tradition that previously had not been so designated. Therefore, the author of Mark may justly be called the creator of the early Christian literary form, Gospel.

The outline of the Gospel of Mark is certainly more primitive than that of Matthew and Luke, but it is nevertheless largely the result of the author's own editorial work and reflects his own theological understanding of Jesus. The framework of the Gospel contains very little reliable historical information. Only a few geographical references and personal names already were associated with the narratives used by Mark; *e.g.*, Capernaum (i, 21; ii, 1), the Sea of Galilee (i, 16, etc.), Dalmanutha (viii, 10), Caesarea Philippi (viii, 27), John the Baptist (i, 4–11; vi, 14–29, which also includes Herod) and Peter (viii, 27–29). Especially in the Passion narrative, persons and places are original elements of the tradition.

But beyond these few instances, the framework of Mark is an artificial device by which originally isolated stories are combined and some kind of chronological sequence is established (see, for example. the common phrase "from there he went to . . ."). Some scenery is always at Mark's disposal to give life to the picture, as "the sea" (ii, 13, etc.), "the other side of the sea" (v, 1, 21), a "lonely place" (i, 35; vi, 32), "hills" (iii, 13, etc.) or the "synagogue" (i, 21 ff., etc.). Seldom is a direct chronological connection made except during the Passion week narrative. The persons pictured in the Gospel are partly the author's own editorial work, partly already presented in the tradition. The "crowd" (ii, 13 ff., etc.) serves as the background for Jesus' acts and preaching, and is artificially introduced and quickly forgotten; the opponents appear abruptly whenever they are necessary for a controversy; the disciples frequently are nothing more than a foil for Jesus' miraculous power, belonging to Jesus' company as a matter of course, but scarcely anywhere acting as independent personalities.

Mark is not, however, simply a mechanical compilation by means of such technical devices, but both in its essential structure and in its details it is thoroughly governed by theological principles. These are most evident first in the arrangement of the traditional material, second in the short comprehensive summaries of Jesus' activity inserted by the author himself (i, 32–34; iii, 7–12; vi, 53–56), and finally in the introductions and conclusions he has added to many traditional stories.

Outline.—Mark's Gospel deals with the following:

i, 1–13:	"Beginning of the Gospel" (the Baptist)
i, 14–viii, 26:	the Galilean ministry
i, 14–iii, 35:	first disciples, healings and controversies
i, 14–ii, 12:	activity around Capernaum
ii, 13–iii, 12:	first conflicts
iii, 13–35:	first crisis and separation (calling of the Twelve, Beelzebul controversy, true brethren)
iv, 1–viii, 26:	around the Sea of Galilee
iv, 1–34:	mystery of the parables
iv, 35–v, 43:	the great miracles (tempest, Gadarene [Gerasenesl demoniac, Jairus' daughter)
vi, 1–56:	the great events (Nazareth, death of John the Baptist, sending of the Twelve, feeding of 5,000)
vii, 1–viii, 26:	the great controversy (clean and unclean, healings and feeding of 4,000, discourse on signs and leaven)
viii, 27–x, 52:	from Galilee toward the Passion in Jerusalem
viii, 27–30:	confession of Peter
viii, 31–ix, 29:	the right understanding of discipleship (transfiguration)
ix, 30–x, 31:	problems of discipleship (discussions about greatness, offense, marriage, the rich young man)
x, 32–52:	Christ and the disciples on their way to Jerusalem (the sons of Zebedee)
xi, 1–xv, 41:	the Jerusalem ministry and the Passion
xi, 1–xiii, 37:	the closing ministry
xi, 1–11:	first day: entry into Jerusalem
xi, 12–19:	second day: cleansing of the Temple

xi, 20–xii, 44: third day: Jesus' authority—the wicked husbandmen; controversy with Jerusalem's leaders (tribute to Caesar, great commandment, David's son)
xiii, 1–37: mystery of the future ("the Little Apocalypse")
xiv, 1–xv, 41: Passion of Jesus
xiv, 1–42: the preparation (anointing, betrayal, Last Supper, Gethsemane)
xiv, 43–xv, 20: the trial of Jesus
xv, 21–41: crucifixion and death
xv, 42–xvi, 8: conclusion (burial and empty tomb)
(xvi, 9–20: spurious ending: the appearance of the Risen Lord)

Themes.—The introduction makes it clear that the "Gospel" means not only Passion and Resurrection but the entire Jesus event. The story of Jesus' temptation (i, 12–13) shows symbolically the meaning of Jesus' activity. It is the eschatological battle between God and Satan in history.

The first main section of the Gospel depicts this struggle in a strange way. Jesus' ministry is limited to Galilee, nhich He leaves only occasionally (Decapolis, Tyre), but never for Jerusalem. Almost all of the Marcan miracle stories are found in these first eight chapters, and except for the parable chapter (iv) this section contains almost no sayings and few discourses. Thus the "Galilean ministry" is concerned with the revelation of Jesus' messiahship in His mighty works. But this is at conflict with another motif found in Mark's editorial comments—the "Messiah secret": (1) Jesus repeatedly forbids public announcement of His messiahship (i, 34. 44. etc.); (2) he speaks in parables in order to prevent the crowd from understanding the message (iv, 10–12. 33–34); (3) even the disciples appear to be completely blind and without understanding of Jesus' messiahship (vi, 52; viii, 14–21). Without any doubt such a description of Jesus' ministry contradicts both the historical reality and the tendency of the already messianized narrative traditions used by Mark. But in extending the primitive Gospe' (that the Messiah has paradoxically overcome the Satanic powers in His suffering and death) to include Jesus' life. Mark is primarily interested in the theological comprehension of that life. Accordingly, the Marcan edition of Jesus' life emphasizes His *mysterious* struggle for power with Satan in history. For Llark. the fact that the Messiah had to suffer necessarily implies that Jesus' ministry had to be described as concealed revelation.

Peter's confession (viii. 27–30) is an exemplary description of one acknowledging Jesus as the Christ. but it is rebuked since it does not also include the recognition that the Messiah has to win His battle through suffering and death. This becomes the theme of the central part of the Gospel. where both Jesus' messiahship and the anticipation of suffering are disclosed to the disciples. Miracle stories are incidental to this section (only ix, 14–29 and x, 46–52). Instead, Mark assembles stories and discourses that are concerned with the disciples' facing suffering. Predictions of the Passion run through these chapters like an unbroken thread (viii, 31; ix, 31; x, 32–34), not as a recollection of the actual psychological preparation of the disciples for the Passion. but as a presentation of those traditions which Mark considers to be the very centre of Jesus' message for the church. In contradistinction to the other Gospels (Matthew and Luke) Mark does not portray Jesus primarily as preaching the coming of the Kingdom, but as calling His "disciples" (i e., the church) to participate in His own eschatological struggle with Satan.

The last part of the Gospel presents Jesus's ministry in a strikingly different way. The location is restricted to Jerusalem; miracle stories are totally lacking; Jesus' action is now pictured as attack and victory much more than before (see especially the great discussion with Jerusalem's leaders in xii, 13–44); and the motif of concealment is missing. The entry into Jerusalem and cleansing of the Temple present Jesus in the open display of His messiahship. The so-called Synoptic Apocalypse (xiii). a purposeful arrangement and interpretation of (partly Jewish) apocalyptic traditions, stresses that the church will have to continue Jesus' fight in history until the Second Coming and the final consummation. The first fruits of the victory are Jesus' Passion and death, and the church can only follow her master with fear and trembling into the ongoing battle (x, 32; xvi, 8). Despite the fact that the disciples were aware that. paradoxically, suffering was the victory, their behaviour during Jesus' Passion was complete failure (xiv, 27–31, 32–42, 50–52. 66–72). Thus Mark depicts Jesus' Passion and death as a continuing "scandal" for those to whom the secret of the Messiah already has been disclosed in the Resurrection (ix, 9; xvi, 1–8).

Literary History.—The last verse of the authentic text of Mark is xvi, 8. The verses that follow (9–20) in many Greek manuscripts and in almost all Bible translations are missing in some of the best manuscripts and are clearly a summary compiled later. Their originality already mas doubted in the ancient church (Eusebius, Jerome). A shorter alternative ending contained in certain manuscripts is likewise spurious. Scholars are divided about whether the peculiar last sentence of the authentic text ("for they were afraid") was intended to be the original ending, whether Mark was perhaps prevented from completing the Gospel, or whether he wrote another ending that is now lost.

The related question, whether Mark is preserved in its original form at all, has led to several attempts either to reconstruct a Proto-Mark (*Urmarkus*) or to discover extensive written sources that provided the pattern and most of the material for the present Mark. Although none of these attempts has found wide acceptance, the problem of the "original Mark" admits to no facile solution. The hypothesis that the present Gospel is a Greek translation of an Aramaic original is to be rejected. Certainly it contains some Semitisms, often caused by the originally Aramaic traditions used by Mark; nor is its Greek style that of a well-educated Hellene, since it contains many colloquialisms; but it cannot be doubted that its original language was Greek. It is equally sure that Matthew and Luke used a Greek text of Mark. although there is some evidence that their edition of Mark was not identical with ours. Neither Matthew nor Luke contains anything to correspond nith Mark iv, 26–29; viii. 22–26; xiv, 51–52. and there are a few minor "common omissions' (e g., Mark xi. 10a) Matthew and Luke also seem to preserve a more original wording in certain common synoptic pericopes. But if such instances suggest the existence of an "original Mark," it is also clear that it was only slightly different from the present text.

The questions of authorship, date and place of the Gospel are still debated. The use of Mark by Matthew and Luke establishes a date earlier than about A.D 80. All attempts have failed to establish a close connection betneen the Neronian persecution (A.D. 64) or the Jeuish War (A.D. 66–70) and the writing of Mark. A time shortly before A.D 70. but certainly after Paul, would be possible, unless Mark xiii, 2, 14 is to be taken as "prophecy arising from the event" (i e., formulated after the destruction of the Temple in Jerusalem); if this is true, the years A.D. 70–80 would fit best. The earliest information about Mark is a presbyter tradition in Papias, bishop of Hierapolis (about A.D. 140, quoted by Eusebius in his *Church* History):

> Mark, who had become the interpreter of Peter, wrote accurately the things said or done by the Lord, though not in the right order. For he had neither heard the Lord, nor had he been his follower, but later, as I said, he had followed Peter, who composed the teachings for his needs, but not as if making a composition of the sayings of the Lord. Therefore Mark committed no sin in writing certain things just as he remembered. For he had only one concern: to leave out nothing of what he had heard nor to include anything false.

Some consider this tradition to be a trustworthy indication of the Petrine basis (and perhaps also Roman origin) for the Gospel. But the picture of Peter traveling with an interpreter for his "courses of instruction" is as questionable as the suggestion that the "recollection of the Apostles" and their followers was the connecting link between Jesus and the written Gospels. Furthermore the statement about the disorder of Mark's Gospel is plainly wrong, and the role of Peter in the Gospel does not suggest the specifically Petrine origin of its material; nor does its character in general indicate that the Gospel was written by someone like Mark. who is mentioned in the New Testament as a personal companion of the Apostles (see MARK, SAINT). Papias' statement springs from a desire to establish the authorship of an

Apostle, or at least of a direct follower, for certain writings used by the church, and is therefore not reliable. This leaves us almost completely in the dark about the author of Mark, and about the place of origin as well. That the *Shepherd* of Hermas (Rome A.D. 100–150) used Mark cannot be substantiated. It is not impossible that Justin knew it. But until Tatian, who composed a harmony of the four Gospels in Syriac (about A.D. 170), and Irenaeus, who values Mark as one of the four canonical Gospels, there is virtually no trace of Mark's being used, except in other Gospels (Matthew, Luke and the apocryphal Gospel of Peter). Later evidence comes from Rome, but this does not imply anything about the place of Mark's origin a century earlier (nor do Mark's Latinisms strengthen the argument for its Roman origin). It is just as reasonable to hold that Mark was written somewhere in the Greek-speaking church in the east (Syria or Asia Minor), where Matthew and Luke found and used it.

See also BIBLE.

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MARKET. The word "market" or some similar one derived from the Latin *mercatus* appears in most European languages, and always refers to the place or method of contact between buyer and sellcr. The contact may be relatively simple, direct and personal: as in a market place, meat market, or farmer's roadside market. It may be a highly organized institution such as those for securities, cotton, or grain; or it may be almost an abstraction, such as the "labour market."

Historically the word usually meant a place at which a number of buyers and of sellers met at fairly frequent recurrent fixed times to do business, under certain rules and regulations, in one or at most a few kinds of goods. Meetings at such long intervals as three, six, or twelve months were called fairs; while business conducted by peddlers or in private retail stores or warehouses or by personal orders was not regarded as taking place in the market proper.

In ages when the volume of trade was small and transportation difficult it was good for sellers to know that if they took their wares to a certain spot on an appointed day they would find buyers gathered there. This knowledge centralized supply and demand, saved time and stimulated production for sale. Produce which became available only at certain seasons—wool, grain, cotton, furs, young livestock, etc.—could be disposed of at the end of the productive period in an annual fair. Commodities which were being produced the year round—butter, cheese, eggs, fish, handicraft wares, cloth, etc.—would need to be sold meekly at a market. Further, while a producer of seasonal commodities would not mind a long trip to a remote fair once a year, the seller of goods which were produced continuously needed some nearby market since he could not afford to spend more than one day a week taking his goods to market, selling them, buying what he required, and then returning home.

While fairs were, therefore, located relatively wide apart, markets had to be thickly sprinkled over settled areas. If, however, they became too numerous, the supply of goods or of buyers in each might be inadequate or uncertain, and the owner of the market would suffer a severe decline in the income he received from tolls, stall dues and other charges. During the rapid expansion of the western European economy in the 13th century the supply of markets seems to have outrun the demand to such an extent that strong efforts were made to prevent new ones from being set up wherever they might injure existing ones. Lawyers urged that markets should be at least two leagues (six miles) apart. This figure was probably quite reasonable and acceptable; it was near to the seven-mile radius which even in the early 19th century protected the markets in London from excessive competition; and it emphasized the essentially local character of the business transacted in the market.

Some markets remained general in character, and were chiefly devoted to the exchange of farm produce for urban manufactures. John Ramsay M'Culloch, in his *Dictionary of Commerce and Commercial Navigation* (1835 edition), defined a market as "a public place in a city or town where provisions are sold." Producer and consumer met there face to face. But if an area specialized in some staple product, middlemen would flock there to obtain their supplies for a wider national or foreign market. One classic illustration of this condition was the cloth markets of Yorkshire and other textile areas. To them small producers residing over a radius of not more than five or six miles brought their weekly output of one or tuo pieces of cloth, and sold it to merchants, commission agents or factors. Held at first in a main street or market place for a fixed period of time on the regular market day, they were eventually transferred indoors when large "cloth halls" were built, often sponsored and financed by the merchants who bought the fabrics. Larger producers did not rely on such local outlets, but sent their wares in bulk to the central market at Blackwell hall in London.

Similar developments took place in many continental markets. In Bruges, Belgium, the large open market place had by 1240 become flanked on one side by a *halle* in which cloth was sold on three days each week. By 1300 a second hall (the *Waterhalle*) was built astride a small river so that goods could easily be unloaded, and was open every day. A third hall, the *Cruudhalle* (Spice Hall) appeared, to serve as market centre for Spanish wool, drugs, spices and other goods from the Mediterranean.

Legally a market was the property and source of income of the person on whose land it was held or to whom it had been granted. In feudal society subordinate lay or religious landowners sought from their superiors the right to hold a fair or market; and in modern states the same rule may prevail that the right has to be obtained from the state. The charter which granted the mediaeval franchise gave the owner power to collect tolls on goods sold—or even on all goods displayed, and fees for the use of stalls; it protected his clients from competition by restricting sales in stores on market day; occasionally it conferred the right to operate a mint. In return it explicitly or by implication imposed the obligation to see that the king's peace or the peace of God prevailed, and to preserve law and order in the market's operations. This involved the provision of a market court to deal promptly with disputes concerning sales, disorder, or violations of the regulations touching weights and measures, price, quality, forestalling, etc. A clerk of the market had to be provided to approve all weights and measures, and a steward to preside over the court.

Some markets passed eventually into the hands of the towns in which they were located; but private or corporate persons continued to seek permission to establish markets well into modern times, as for example the grant of Covent Garden market to the Duke of Bedford in 1670.

With the rise of large towns, factory production, and intensified commercial activity in the 19th century the need for public markets increased in some respects and declined in others. Where production of manufactured articles passed into the hands of fewer larger units, private buying and production to fill orders caused the cloth halls and similar markets to shrink in importance and finally disappear. At the same time the maintenance of direct contact betneen large bodies of urban consumers and the rural food producers became well-nigh impossible because of the vast number of the former, the need for obtaining supplies from a wider national or international area, and the call for large storage facilities.

The development of large-scale rapid transportation, bulk handling, refrigeration and local or terminal produce warehouses bridged the physical gap so far as the commodities were concerned; but the commercial transactions involved the expansion of the class of intermediaries, whether purchasers or commission agents, wholesalers or retailers. In addition they led to an increase in the importance of private sales, wholesale markets, or auction sales, in which the consuming public played little or no part as buyer, but relied for its supplies on the storekeeper who bought his goods in the wholesale market, often at an hour when most of his customers were fast asleep.

The history of most expanding European cities reveals the efforts made by civic or private enterprise to expand the accommodation for both wholesale and retail purchases. For instance, Leeds, a Yorkshire cloth centre, more than trebled its population between 1801 and 1851. In 1801 it had a weekly market for grain, cattle and hogs, and a twice-weekly one for cloth and provisions. By 1851 it had added a fortnightly fair for cattle and sheep, and eight periodical leather fairs each year; it had removed the markets for provisions and livestock from the narrow main street, created a large open "free market" area for use by farmers, and set up a meat market with an underground slaughterhouse. Meanwhile groups of investors had erected buildings for a bazaar, a meat and fish market, a central provision market, a corn exchange, leather fairs and a stock exchange.

On the continent private and municipal markets were expanded as populations became more dense. The municipal *Halles Centrales* in Paris eventually covered ten acres in the middle of the city, and the customers were retailers and consumers alike. Yet they could not handle all the needs of the metropolis, and other markets, therefore, had to be created or expanded.

In North America the European type of market developed naturally, rather than as the result of charter grants, to meet similar requirements, and in its most simple form can still be seen in operation in the market squares or halls of some of the older United States and Canadian towns. The expectation of getting fresher or cheaper produce from a farmer still takes customers there in spite of the lavish array of retail stores. Of larger markets to supply retailers as well as consumers, the Fulton fish market in New York city or the Faneuil Hall market in Boston are examples. Rapid urbanization and the rising cost of living after 1900 stimulated interest in efficient and economical marketing and led to considerable activity in providing city markets. Private enterprise, especially by the railroads, began to establish terminal markets at which country produce is unloaded and displayed for sale. But in most of the public markets the customer is rarely the consumer. The spread of suburban stores, the extension of chain stores, the congestion of traffic around public markets, and possibly the American consumer's lack of interest in the possibility of saving a few cents by taking a trip to the big market, have all made that institution a minor part in the system of distribution. (*See* also EXHIBITIONS AND TRADE FAIRS.)

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ECONOMIC THEORY

In economic theory the term "market" means the general conditions under which buying and selling are conducted.

In the theory of the market several types are distinguished. At one end of the scale is the perfectly competitive market, at the other end is perfect monopoly, and there are many intermediate forms. It may be said that perfect competition and perfect monopoly are limiting cases rarely to he found in practice, and that most actual markets fall into the intermediate forms known as "imperfect competition." A perfectly competitive market is characterized by the following conditions: (1) the number of buyers and sellers in effective contact must be large enough so that the action of any one of them has no appreciable effect on the price. That is to say, the operations of each individual buyer or seller are so small a proportion of the total, that each can buy or sell as much as he wishes at the prevailing price. (2) The commodity involved must be homogeneous in the sense that each buyer does not care from whom he buys, and each seller does not care to whom he sells, as long as the standard commodity is involved in the transaction. In a perfectly competitive market any price differences between different parts of the market will be equal to the costs of transport of the commodity from one part to the other. This conformity of prices is effected through the operation known as arbitrage, *i.e.,* by operators buying in the "cheap" place (which will raise the price there) and selling in the "dear" place (which will lower the price there). The equilibrium price in a competitive market is that which "clears the market," *i.e.,* the price at which the quantity of the commodity offered for sale is equal to the quantity which people are willing to buy. If the price is above this level, more will be offered for sale than buyers can be found to accept, and the fear of being left without a buyer will induce sellers to lower their prices. If the price is below that level, less will be offered for sale than people are willing to buy, and buyers will raise their prices for fear of not finding a seller.

The closest approach to the perfectly competitive market is to be found in the organized commodity and security exchanges, such as the grain and cotton markets, the metals markets and the stock markets. Such markets tend to arise wherever men deal in exchangeables that are homogeneous and simple enough to be bought and sold by description. Such markets are characterized by great flexibility of prices, and also by short-run speculative price movements which may be caused by the temporary emotional states of the marketers rather than by any basic underlying factor. The organized markets in different centres are closely connected by telegraphic communication and by specialized "arbitrageurs" who operate in many centres, so that in peacetime there is a world market for many of the standard raw material commodities and for many securities.

When the commodity is not homogeneous enough to be graded and sold by description, a common form of market is the auction. Wool, livestock, eggs, meat and vegetables are frequently sold in this manner. When the commodities sold by auction are fairly homogeneous, the results of this form of market are not very different from those of perfect competition. The price lies somewhere between the highest price which the most eager buyer and the second most eager buyer will pay.

At the other extreme to perfect competition stands monopoly. A monopolist may be defined as a seller whose product is different from that of any other seller. A seller is in a situation of perfect monopoly if, in addition, the demand for his product does not depend upon the price or sales policy of any other individual seller or small group of sellers. Whereas the seller in a perfectly competitive market can sell as much as he wishes at the prevailing price, a monopolist must either lower his price or increase his selling cost in order to expand sales. The relationship between price, selling costs and sales is sometimes known as the "market" of an individual seller. In perfect competition the seller has a "perfect market," and there are no selling costs! for if the seller can sell as much as he wants at the prevailing price, obviously there is no need for him to advertize. The existence of a sales problem is a sign of monopoly.

Probably most firms operate under some form of "imperfect competition" exhibiting both monopolistic and competitive elements. Three main types may be distinguished. Monopolistic competition is a situation where there is a large cluster of sellers (firms) selling similar but not identical products, and where firms are free to enter the cluster or to withdraw from it. The fact that the products are not identical (*i.e.,* there is "differentiation of the product") means that each firm is to some extent in a position of monopoly in that it has an imperfect market; it can have a price and sales policy, for if it lowers its price it will attract only a finite amount of business from its competitors, and if it raises its price it will not lose all its business to its competitors, the products of different firms not being perfect substitutes. On the other hand the ability of new firms to enter the cluster makes it impossible in the long run for the firms in it to make abnormal (monopoly) profits, for if the firms in the cluster are making abnormally high profits, other firms will be attracted into it, and the competition of the products of the new firms will lower the demand for the product of each of the other firms, and so will lower profits. This process will go on until profits are normal; *i.e.*, are at a level at which on balance no firms are attracted or repelled. It can be shown that the end result of monopolistic competition is that firms operate at a level of output which is below the optimum efficiency.

Virtually the whole retailing industry, and the great part of the manufacture of consumers goods, are carried on under monopolistic competition. Thus, if a single retail store raises its prices without neighbouring stores raising their prices, it will not lose all its business, since it has a certain clientele that will stay by it for reasons of convenience or of personal preference even if its prices are relatively higher. Similarly the manufacturer of a single breakfast food could raise his price without losing all his sales to other breakfast foods, since the different breakfast foods are not perfect substitutes. Nevertheless, these elements of monopoly probably do not enable retailers, or most manufacturers, as a group to enjoy abnormal profits, because if profits are high new firms will be attracted to that locality or to the production of a similar commodity. It is probable also that most retailers, and many manufacturers, could produce more efficiently if their sales were higher; they are prevented from expanding sales, however, by the limited (*i.e.*, monopolistic) nature of their market.

Another form of imperfect competition is called oligopoly, this being a situation where there are few sellers. If the product of each seller is perfectly substitutable for that of any other the situation is known as perfect oligopoly. In such a case any price change by one firm will be immediately followed by a similar price change by the other firms. It can be shown that this condition is likely to result in price leadership by one firm. This is a common phenomenon in industries producing fairly standardized products; *e.g.*, steel, cement, sugar. If there are few sellers in a cluster producing products which are highly but not perfectly substitutable, a situation known as imperfect oligopoly may develop. In this condition a cut in price by one firm will not be imitated immediately by others. Hence, price-cutting, or "cut-throat competition," may arise, and a highly unstable situation ensue. There is, therefore, a strong tendency for firms in oligopoly to come to some agreement on division of markets or on price policy: the "basing point system" found in the steel and cement industries is a case in point, also the market-sharing arrangements of cartels. The possible varieties of oligopoly are many, as many different plausible assumptions about the behaviour of firms under these circumstances may be made.

The market forms which have been described above also apply to buying markets: thus we may have monopsony (a single buyer), oligopsony (few buyers), in various forms! and so on. Various forms of selling markets may be combined with various forms of buying markets in almost infinite variety. A very important market situation is bilateral monopoly, in which a single buyer faces a single seller. All cases of collective bargaining (*e.g.*, between labour unions and employers associations, or between milk producers and milk distributors) fall into this category. The price (or wage) then depends, within certain limits, on the relative bargaining power of the two parties. The "strike" (a temporary failure to effect a bargain) is a characteristic feature of bilateral monopoly. It should be noted that the above classifications are rough divisions only, and that in practice one market form shades imperceptibly into another.

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MARKET GARDENING: see HORTICULTURE.

MARKET HARBOROUGH, a manufacturing and market town and urban district in the Harborough parliamentary division of Leicestershire, Eng., on the Welland river, 15 mi. S.E. of Leicester by road. Pop. (1951) 10,400. Area 7.5 sq.mi. The church of St. Dionysius (*c.* 1250), has one of the finest broach spires. The grammar school, founded in 1614, occupies modern buildings, but the original half-timbered building, raised upon pillars of wood, remains. Industries include rubber, textile goods, corsets, light engineering, patent foods, accumulators and shoe heels. As the market town for a large agricultural area, the cattle and general markets have been held without break on Tuesdays since about 1200. It is also an important fox-hunting centre. Dingley hall ($2\frac{1}{2}$ mi. E.) is Elizabethan and later and has a fine gatehouse.

MARKET INDEX, a term used, in marketing and economics, with two possible meanings. In one sense, it refers to an indicator of business activity in one or more industries. The Dow-Jones daily average of the prices of 30 selected industrial stocks became perhaps the leading example of a market index of stock-market activity. Similarly, the Federal Reserve index of industrial production can be interpreted as a market index of activity in U.S. mines and factories. Electric power output, regional income analysts, expenditures on new construction and life insurance sales are further examples of market indexes in this sense.

In its second and more restricted sense, a market index measures the actual or potential capacity of the population, or a segment thereof, to buy an article or service offered for sale. Some market indexes limit the scope of the term in this sense to the allocation of sales among territories, in which case the market index becomes a series of percentages, each estimating the proportion of total sales that should be made in a particular region. Others, however, extend the term to cover forecasting of total sales, thereby using it more or less synonymously with "sales forecast" and "sales potential."

In some cases, a single indicator, such as retail sales, or a general index, such as the Sales *Management* estimates of effective buying income, is considered sufficiently representative of product sales to be used as the "specific" market index for the product. More often than not, however, the specific market index is derived as a composite of the main factors believed to affect sales of the product. These may include variables measuring national business conditions, as well as those of industry, and even company, factors.

There are at least two main methods of approach for deriving the index in such a case. One method involves modifying actual sales figures on the basis of a rule-of-thumb judgment (sometimes supplemented by field surveys) as to the effect and relative importance of other relevant factors (population, prices, sales of competing products, etc.) and deriving forecasts by extrapolation. The other method seeks to derive an equation reflecting the numerical effect of each of the main relevant variables on product sales. Thus, the sales of Company Y's gas refrigerators in a given year may be found to depend on national income in that year, availability of natural gas, number of families, number of sales-... representing the company and the company's advertising expenditure. With the aid of statistical (correlation) analysis, an equation can be set up reflecting the extent to which these variables affect sales. Sales estimates or regional sales allocations for a future period are then obtained by making assumptions as to the probable values of these variables in that period and substituting these values in the equation.

Whatever the method used, the result provides an index of the possible (or potential) market for the product and thereby aids the firm in evaluating past operations and in planning future operations. It enables sales quotas to be set by territories and/or predictions to be made of the effect on sales of such changes as a 10% increase in advertising expenditure or of a given percentage rise in population.

A market index is usually reliable only as a measure of past performance, and often possesses major limitations even in this sense. Experience showed that market indexes are more accurate in estimating territorial distribution of sales than in forecasting their total amount. Their use as a forecasting tool is invariably predicated on the implicit extrapolation of past relationships into the future. Faulty judgment regarding the future course of the variables incorporated in the market index is another serious source of error in forecasting Over-all market forecasts tend to be most accurate when product sales continue in the same direction as in the recent past, but are likely to err considerably when business activity changes direction.

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MARKETING. Marketing consists of those activities which effect transfers in the ownership of goods and services and provide for their physical distribution. In the broadest sense, marketing covers not only dealings in merchandise, but in a wide variety of services and in such intangibles as insurance, stocks and bonds. Normally, however, the term marketing is limited to tangible commodities other than real estate.

As commonly used in business terminology, distribution is broadly synonymous with marketing; however, it is sometimes used in a more restricted sense to describe the buying and selling functions of marketing and the institutions and methods which implement them.

Although the term merchandising is almost always used to describe only certain activities or phases of marketing, there is no universal acceptance of just what these activities are. The committee on definitions of the American Marketing association defined merchandising as "the planning involved in marketing the right merchandise or service at the right place, at the right time, in the right quantities and at the right price." Merchandising is also used synonymously with sales promotion, which has been defined broadly as "the coordination of publicity (including advertising) and personal salesmanship"

The Marketing Process and Functions. — The ultimate objective of all marketing activities is to place goods in the hands of consumers. The machinery for doing this is built around three major processes — the concentration, dispersion and equalization of goods. The methods of concentration and dispersion vary greatly from product to product. For example, some farm products are concentrated in large markets and then dispersed without processing toward the household consumer. Other farm products are concentrated as raw materials, then are processed and dispersed as manufactured products. In the marketing of most manufactured goods, concentration is of minor importance, but dispersion assumes large importance.

Production and consumption are often seasonal, demand may change frequently and neither the amounts nor the quality of goods as they come from individual producers may meet the needs of those who wish to use them. Thus there arises the need for a third process. equalization, consisting broadly of all the activities by which the supply of goods ready for sale is adjusted to the demand.

In the marketing processes of concentration, dispersion and equalization certain specific functions must be performed Although there is no unanimity among marketing authorities as to how many or which services should be designated marketing functions, the folloning classification has wide acceptance: the functions of exchange (buying, selling) ; the functions of physical supply (transportation, storage) ; the facilitating and managerial functions (standardization and grading, financing, risk taking, and collection, interpretation and dissemination of market information).

This classification emphasizes the major aspects of getting goods from producers to consumers; *i.e.*, the transfer of ownership of goods. the physical distribution of goods and management of these activities. The transfer of ownership involves the complementary functions of selling and buying. Physical distribution is accomplished through the transportation service of moving goods to the place of consumption and the storage function of holding products from the time of their production until the time of their purchase. The facilitating functions are the activities or services which must be performed to aid in effecting transfers in ownership of goods and in providing for their physical distribution. Management plans and organizes the marketing activities.

UNITED STATES

Farm Products. — Although some farm products are sold by the farmer directly to ultimate household consumers or to manufacturers or processing plants, indirect marketing methods predominate. The marketing problems of farmers are complicated by the following factors: small-scale and scattered production; a concentrated market at great distance from the producing areas; seasonal production with the resultant peak load on marketing facilities; variations in quantity and quality grown from year to year because of changing weather conditions; bulkiness and perishability; lack of marketing knowledge and need of immediate funds on the part of many farmers. Because of these and other difficulties, the services of middlemen are required.

The first step in the concentration of products from a number of farmers is carried out in local markets. These markets, close to the areas of production. provide a convenient place at which the grower can sell his product; they also facilitate the collection of products from the surrounding growers in sufficient quantities for economical shipment. Although some sales are made in these markets by the farmer directly to the household consumer or to local processing plants, a far greater number is made to local middlemen who have established business relations with middlemen and manufacturers in outside markets to whom they ship the products assembled in small lots from individual farmers.

From the local markets or directly from the larger growers, farm products are frequently concentrated into a small number of large central wholesale markets. These large markets serve as a source of supply for the raw materials used in the food factories of the central market's metropolitan area; some products are also sold to jobbers and retailers for local consumption. However. a large proportion of the products concentrated in central markets is reshipped to other cities for sale to mills or factories, or for sale without further processing through jobbers and retailers to reach the ultimate consumer.

Co-operative Marketing of Farm Products. — Although there were some earlier attempts by farmers to market collectively. the development of co-operative marketing is commonly dated from about 1865. The first period of marked growth in co-operative marketing associations came during the 1870s, and especially during the depression years of 1873–77. The Grange (Patrons of Husbandry) movement of this period was one of the important factors that gave impetus to the growth.

Beginning in the period 1895–1900, the number of co-operative associations began to increase at a rapid rate, and the movement continued to grow until the early 1920s. After 1900 independent local associations federated into state, district and national organizations and central-market selling activities developed. After the early 1920s changes in the co-operative marketing movement were much less marked than in the earlier period. There was a decline in the number of associations but an increase in the average membership and volume of products handled per association.

By the 1950s there were more than 10,000 co-operative marketing and purchasing associations with a total estimated membership of 6,000,000 and a volume of business of about $9,000,000,000. Of these associations, approximately two-thirds were engaged primarily in the marketing of farm products. The other farmers' co-operative groups were primarily engaged in purchasing farm supplies.

Consumers' Goods.—The most common methods of marketing consumers' goods are: (1) manufacturer to retailer to consumer; (2) manufacturer to wholesale merchant (who takes title to the goods) to retailer to consumer; (3) manufacturer to an agent middleman (who does not take title) to wholesale merchant to retailer to consumer; and (4) manufacturer to consumer.

The bulk of consumers' goods is purchased from retailers. The manufacturer may elect to sell directly to the retailer. Automobiles, major appliances, furniture, women's apparel, men's clothing, shoes and hats are familiar examples of products sold in this manner. On the other hand, many manufacturers reach the retailer through selling to wholesalers, commonly called jobbers. This manufacturer-wholesaler-retailer-consumer channel of distribution is often called the orthodox, or regular, method for marketing such staples as groceries, hardware, drugs and dry goods to small and medium-size retailers. Larger retail organizations. such as chain stores, mail-order sellers and department stores tend to buy directly from manufacturers, in some cases operating their own warehouse in which they perform wholesale tasks.

Another method of marketing consumers' goods includes an agent middleman who represents the manufacturer. This middleman does not own the product but sells it on a commission basis for the manufacturer; he may sell either to a wholesaler or the retailer. Most commonly he operates between the manufacturer and wholesaler, and the channel of distribution then becomes manufacturer-agent-middleman-wholesaler-retailer-consumer. Many textile and some grocery and hardware products are sold in this way.

The three general means by which a manufacturer may sell directly to the consumer are by mail, through the use of house-to-house salesmen and through his own retail stores. Well-known examples of direct sale by the manufacturer are house-to-house selling of brushes, electric sweepers and hosiery; and the sale of candy, shoes and clothing through manufacturers' stores. Direct sale, however, accounts for only a small share of the total volume of consumers' goods.

Manufacturers often use a combination of marketing methods. For example, they may decide to sell directly to retailers in larger cities, but may consider it wise to use wholesalers to distribute to retailers in smaller cities. A variety of channels may also be used to reach different trades, for example, direct sales to certain types of retailers such as electrical appliance dealers and sale through hardware wholesalers to obtain distribution through hardware stores. Some manufacturers may use agent middlemen for some products and wholesalers for other products while still other products are sold directly to retailers. These various combinations of marketing methods illustrate the alternatives available because of the variety of middlemen operating in the market.

Manufacturers also have various alternatives presented because of the division of tasks they may develop between themselves and middlemen. Thus a manufacturer may undertake a portion of the sales task by using his own salesmen to supplement the sales activities of wholesalers. Or he may establish regional stocks and thereby assume a portion of the warehousing task. The most common way for the manufacturer to supplement the sales activities of middlemen, however, remains direct advertising to consumers.

Industrial Goods.—The three common methods of marketing manufactured products to industrial or business users are: (1) direct sale to the users by the manufacturer's sales headquarters or by his own sales branch; (2) through agent middlemen (who do not take title to the goods), such as manufacturers' agents and brokers, to the users; and (3) through merchant wholesalers (who take title to the goods), commonly known as industrial distributors, to the users.

Although the extent of use of these three methods varies with the product and the nature of the market, most manufactured industrial goods are sold directly from manufacturer to user. The relatively great importance of direct marketing of industrial goods as contrasted with that of consumers' goods, is largely because there are limited numbers of buyers, who are often highly concentrated geographically or organizationally, and who make large individual purchases. Technical considerations are also important; buying on a specifications, or made-to-order, basis often makes close and constant contacts necessary.

Many manufacturers, however, use agent middlemen in marketing industrial products; these manufacturers are generally smaller ones who are financially unable to sell directly to the consumer, and ones who are attempting to reach relatively widely scattered markets. The major services of these agent middlemen centre in the selling, including the locating of buyers, negotiation of sales and the furnishing of marketing information.

The third main channel of distribution for manufactured industrial goods is from manufacturer to industrial distributor to user. Broadly, industrial distributors include all wholesale merchants in the industrial-goods field, such as mill-supply firms which sell a wide line of equipment and supplies to many different types of industrial buyers, and those firms which specialize in a particular line (*e.g.*, steel jobbers) or which specialize according to industry (*e.g.*, oil well-supply firms and barber-supply houses). The common characteristic of this group of middlemen is that goods are purchased outright from manufacturers, to be stored until purchased by industrial-user customers.

Manufacturers of industrial goods, perhaps more than manufacturers of consumers' goods, often use both direct and indirect methods of marketing. They may sell directly in areas where customers are highly concentrated and use agent middlemen and industrial distributors to sell prospects in other areas. They may sell directly to large-volume buyers when such action seems desirable from the point of view both of cost and of their customers' preferences, leaving smaller buyers to be supplied by middlemen.

Wholesaling Institutions.—In the marketing channels or methods previously described, all sales made to those who buy for resale or for industrial or business use are broadly called wholesaling transactions, as contrasted with retailing transactions which include all sales to ultimate, or household, consumers. The census data on wholesale trade, however, are gathered on an establishment basis and thus include only those places of business that are primarily engaged in wholesaling. Consequently, wholesaling transactions of a producer are included as a part of the wholesale trade totals only if carried on in a separate establishment devoted to wholesaling, such as a manufacturer's sales branch.

The 1954 *Census* of *Business* reported that there were 252,000 wholesale establishments in the U.S., with a sales volume of about $235,000,000,000. In 1948, the last previous census reported 216,000 wholesale establishments, with a sales volume of about $180,000,000,000. Thus from 1948 to 1954 the number of wholesalers increased almost 17% and the sales volume more than 31%. As measured both by number of establishments and sales, merchant wholesalers were the most important; in 1954 they numbered about 165,000 and accounted for 43% of total wholesale trade in the U.S. All of these wholesalers are alike in that they buy and sell on their own account; but, on a basis of services or functions performed, they are classed as service wholesalers or limited-function wholesalers. The service wholesalers usually carry relatively complete stocks, use salesmen to call on customers, extend credit, make delivery and perform other services. The limited-function wholesalers do not perform all the usual functions of the service wholesaler, as, for example, a cash-and-carry wholesaler.

Manufacturers' sales branches and sales offices, owned and operated by manufacturers apart from their plants, accounted for the second largest share of wholesale trade in 1954. Their share of total trade in that year—30% compared with 28% in 1948, 25.9% in 1939 and 24.2% in 1929—indicated the trend on the part of many manufacturers toward more direct marketing.

Petroleum bulk plants and terminals are classified separately by the U.S department of commerce because of their special storage and distributing facilities (on railroad or other transportation lines) for gasoline, oil and other bulk petroleum products. In 1954 they accounted for almost 7% of the total volume of wholesale trade.

Agents and brokers negotiate sales or purchases or both but usually do not take title to the merchandise. They may represent either buyers or sellers and they are paid on a fee or commission basis. This group, including such types of operation as auction companies, merchandise brokers, commission merchants, export and import agents, manufacturers' agents and selling agents, accounted for about 17% of wholesale trade in 1954.

The assemblers type of wholesale establishment consists of wholesalers primarily engaged in assembling farm products and sea foods at local producing points and in the cities of producing regions. They are engaged primarily in the concentration phase of marketing, while most other wholesalers are engaged mainly in the dispersion phase.

Status of the Service *Wholesaler*.—Although the disappearance of the service wholesaler had been predicted for a number of years, he continued in the mid-1950s to be an important factor in distribution. He faced increasingly difficult competition, however, in the form of: (1) increasing attempts by manufacturers to assume the wholesaler's functions and to distribute directly to the retailer; (2) the increase in co-operative buying groups formed by retailers; (3) the growth of limited-function wholesalers; and (4) the use by manufacturers of agent middlemen in place of the service wholesaler. The tendency of manufacturers to sell more of their output through their own wholesale branches or branch offices and directly to retailers arose because of: (1) dissatisfaction with the use of the service wholesaler as a marketing method; (2) the development of marketing facilities, such as public warehouses and central-market display marts. which make direct sale more convenient for the manufacturer; and (3) factors in the retailing field favourable to direct purchase from the manufacturer, such as the growth of large retail organizations.

Because of these changed competitive conditions, the service wholesaler's share of the total volume moving from manufacturer to consumer decreased. How far this trend would continue depended upon the wholesaler's ability to adapt his organization and methods to new conditions and new competitors. There was increasing evidence in the mid-1950s that the service wholesaler was adapting to these changed conditions through such efforts as the following: (1) improvement of his own internal efficiency; (2) development and active merchandising of his own private brand; (3) development of aids for the small retailer; (4) formation of voluntary chains of retailers: (5) formation or purchase of retail chain stores; and (6) development of a cash-and-carry or other limited-function department to compete with the limited-function wholesaler.

Retailing Institutions.—The 1954 Census of Business reported 1,721,650 retail establishments in the U.S. with total sales of almost $170,000,000,000. In 1948 the *Census* reported 1,668,-479 retail establishments. with total sales of almost $129,000,000,-000. Thus from 1945 to 1954 the number of retailers increased but 3% while the sales volume increased 32%—the percentage increase in retail sales and wholesale sales being almost identical. From 1939 to 1954 there was little change in the number of retail establishments but sales volume quadrupled: taking into account price rises the physical volume almost doubled.

Types *of* Retailers.—Retail establishments may be classified on many ditierent bases, depending upon the purpose of the classification. On the basis of kind and variety of merchandise handled, there are general stores. general-merchandise stores and single-line or limited-line stores. General stores carry a limited assortment in a wide variety of products including groceries and dry goods, are not generally departmentized and are usually located in rural communities. General-merchandise stores also handle a variety of lines but usually in much wider assortment and. in some types (*e.g.*, department stores and limited-price variety stores) are highly departmentized. A single-line store, such as a food, hardware or clothing store, tends to specialize in handling some one line or general type of merchandise.

A second common method of classifying stores is by type of operation—independents, chain stores or other types; *e.g.*, mail-order houses. house-to-house establishments, commissary or company stores, consumer co-operative stores and establishments selling through coin-operated vending machines. Independent retail stores in the mid-1950s comprised approximately 90% of the total number of stores and accounted for about 70% of total sales. Chain stores accounted for about a fourth of total retail sales.

Among the other types at mid-century. mail-order selling was well known largely because of the large mail-order sales volume of Sears, Roebuck and Co. and Montgomery Ward & Co.. Inc. (although their sales through their chains of retail stores made up more than half their total volume). However. mail-order retail establishments accounted for only a small share of total retail sales.

House-to-house selling accounted for a very small share of total retail trade. Automatic vending also was relatively unimportant in terms of its share of total retail sales, but its use was growing rapidly. In addition to the adaptation of automatic vending to a constantly wider variety of products, there was experimentation with stores restricted to the use of vending machines. Shortage of labour. increasing labour costs and the need to cut selling expense in retailing were factors that worked toward the expansion of automatic vending, just as they had stimulated the strong trend toward self-service in retail stores.

Consumer Co-operative Stores.—Another type of retail operation is the consumer co-operative store, which is owned and managed by a group of ultimate consumers not to make profits from the enterprise as such, but primarily to obtain lower prices for the members in their purchases.

Although experiments in consumer co-operation date back to the second half of the 18th century, the modern consumers' co-operative movement was begun in England in 1534. (See CO-OPERATIVES.)

In the U.S. it was a weak, minor movement, with little indication of becoming a dominant factor in marketing. The definite increase in consumers' co-operation after the middle 1920s was mostly in purchasing co-operatives to provide farmers with supplies (industrial-goods purchases rather than ultimate consumers' purchases!. Even if the sales of farmers' purchasing groups were combined with those of consumer co-operative stores, the total volume probably represented less than 1% of total U.S. retail sales by the mid-1950s.

Among the reasons advanced to explain the failure of consumers' co-operative stores to progress more rapidly in the U.S. are the following: (1) absence of social solidarity on the part of large groups: (2) a more mobile population; and (3) the widespread development of large-scale retailing institutions, particularly the chain store, which made it possible for the U.S. consumer to obtain considerable price reductions matching or exceeding the savings that might be obtained through belonging to a consumers' co-operative.

Small-Scale Retailing.—Although "mass" type retailers were increasing their proportion of total retail trade in the mid-1950s, the most common type of retail enterprise was still the small independently owned store. In many lines that type of store still accounted for the largest share of total volume. The most common type of small-scale retailing is the single-line independent store, but many stores handling a general merchandise line are small-volume stores independently owned and operated.

Among the advantages of the small independent retailer are his freedom of action or flexibility of management, incentive of ownership, close relationship with his employees, often a personal relationship with his customers and a resulting friendly atmosphere, and often relatively low operating expenses. Among his disadvantages are limited buying power (which many have attempted to solve by joining co-operative chains), limited trading area and. frequently, poor management.

As each type of large-scale retailing developed—the department store, the mail-order house. the chain store and the supermarket —the ruin of the independent merchant mas predicted. However, although the small independent retailer had declined in relative importance, in the mid-1950s he was still the predominant type of retailer.

Large-Scale Retailing.—The rise of the department store (*q.v.*) began after the Civil War, but the period of most rapid growth was from about 1900 to 1920. Although department stores made up only a fraction of 1% of the total stores in the U.S. in the mid-1950s, they accounted for more than 6% of retail sales volume.

The mail-order house gained a prominent place in large-scale retailing during 1900–15. Mail-order volume declined in relative importance during the depression years following 1930, but later regained its former position in the system of retail distribution. Mail-order houses did 1% of retail volume in 1954. Starting in the last half of the 1920s, Sears. Roebuck and Co. and Montgomery Ward & Co., Inc., the two giants of the mail-order field, started establishing chains of stores, and by mid-century the volume from these stores exceeded mail-order sales. (See MAIL-ORDER BUSINESS.)

The origin of the modern chain-store system is commonly dated from 1858, in which year the first unit of what was to become the Great Atlantic & Pacific Tea company was established. Many other chains were established before 1900 and had shown a fair rate of growth by that time. The volume of business increased more rapidly from 1900 to 1920 and tremendously from 1920 to 1930. From 1929 to the mid-1950s the proportion of total retail sales made by chains varied between 20% and 25%. The proportion varied widely for different kinds of business. as, for example, from more than 85% in limited-price variety stores to less than 5% in hardware stores and for motor-vehicle dealers.

After 1929 the number of chain-store units decreased while the number of independent stores increased substantially. At the same time the chains maintained or increased their proportion of retail sales, The reason was that many chains had strengthened and consolidated their positions by weeding out the poorer stores and replacing many smaller stores with a few larger ones. (See CHAIN STORE.)

The independent retailer in his competition with the chains learned to make use of various chain-store techniques, such as development of contract, or co-operative, chains. These are groups of independent retailers acting co-operatively, either by themselves or with a wholesaler, to obtain advantages in buying, advertising or other retailing activities. Although the earliest known organization of this type, the New York Consolidated Drug company, was organized in 1887, the movement developed slowly until the 1920s, when the rapid growth of regular corporate chains greatly affected the position of the independent retailer and gave a great impetus to the growth of co-operative. or contract, chains. Their growth was remarkable after 1925, particularly among grocery retailers and also among retailers of drugs, variety goods, dry goods and hardware. In general these groups improved the merchandising methods of the independent merchant and enabled him to meet competition more effectively.

A newer type of large-scale retailing was the supermarket, which developed rapidly and attracted wide attention during the depression years of the early 1930s. There is great variation in size, appearance and location of the stores called supermarkets, but, in general, they are large departmentized retail stores dealing in a wide line of food products (and sometimes other lines of products) on a self-service or highly limited service basis. Other common characteristics are emphasis upon the sale of goods at low prices and mass displays of merchandise which are readily accessible for the buyer's inspection. Most of the earlier supermarkets were owned by independent retailers, but by the mid-1950s chain store supermarkets were doing a much larger share of the sales volume.

The supermarket had a profound impact upon food retailing, particularly because of its great expansion of the self-service idea and its relatively low operating costs. The movement of population to suburban areas, the increase in the number of automobiles and their wide use in shopping, and higher labour costs all contributed to the growth of the supermarket. This type of large-scale retailing increased its proportion of total retail trade both as a result of the establishment of new supermarkets and as a result of old stores increasing their sales by adding many additional lines of products (many were nonfood). Also, certain features of supermarket operation, particularly self-service, spread to other retail fields. (See RETAILING.)

The discount house became more important as a type of retail establishment in the 1950s. By offering well known goods at discounts from prices customary at conventional retailers, discount houses were able to attract patronage despite inconvenient locations and the elimination of some services. They had special impact on the market for electrical appliances, radio and television sets, furniture and house furnishings, jewellery and other higher value lines. A market opportunity for discount selling in these lines arose because consumers had confidence in the quality of the products and the reputation of the manufacturers and because conventional retailers continued to charge margins higher than current market conditions required. The growth of such retailers was seen as forecasting a new type of retail outlet, or forcing changes in the margins and methods of selling some commodities.

Governmental Relationships to Marketing.—Governmental activities that bear directly on marketing can be conveniently divided into two broad classes: (1) those designed to preserve the competitive system and to improve its efficiency; and (2) those designed to restrict the competitive system; *i.e.*, to substitute some degree of central governmental direction in place of complete reliance on a competitive system. Although all governmental activities and regulations do not fall clearly or neatly into one or the other of these two groups, it is a useful grouping for the purposes of understanding the basic policy back of regulatory activities, particularly of the federal government.

Governmental Activities to Maintain Competition.—Prior to 1929 the regulatory activities of government were based on a belief in competition as a regulating force in U.S. economy. Thus, the desire to maintain competition among businessmen and make the competitive system work effectively was a basic consideration in legislative policy and governmental activities as they related to marketing. These various efforts to maintain an effective competitive system may be grouped into three classes: (1) those designed to restrict monopoly and monopolistic tendencies; (2) those designed to limit unfair competitive practices and control the plane of competition; and (3) those designed to promote efficiency in marketing. Again, these classifications are not mutually exclusive. The first is well illustrated in both federal and state antitrust acts, particularly the Sherman Anti-Trust act of 1890. Although it was desirable to maintain competition, it became apparent that competition itself might lead to unfortunate results unless competition was on a proper plane. Thus, the later Clayton Anti-Trust act (1914) and more particularly the Federal Trade Commission act (1914), through emphasis upon unfair methods of competition, represented to a considerable extent legislation designed to control the plane of competition. Other examples of governmental efforts to control monopoly and monopolistic tendencies were the Interstate Commerce Commission act (1887) and state acts regulating public utilities. On the other hand, such efforts as pure food, drug and cosmetic acts, control of weights and measures, restriction of unfair trade practices and the investigation of business practices by legislative and administrative bodies were primarily attempts to control the plane of competition.

The third broad group of government efforts to make competitive economy work better are all those activities designed to aid business and promote efficiency in marketing. The establishment and enforcement of such standards as weights and measures, standard bills of lading and commodity standards may be considered as falling at least partially into this group. Other examples are the research and statistical work of the bureau of the census, the bureau of foreign and domestic commerce, the bureau of agricultural economics and many other governmental agencies.

Governmental *Efforts* Restricting Competition.—In the 1930s the activities of the federal government with respect to marketing indicated a decided turning away from reliance upon competition as the regulating force in U.S. economy. Many regulations and activities were primarily attempts to establish some degree of central governmental direction rather than rely entirely on the price mechanism of a competitive economy. Examples were the various legislative acts and related activities to control agricultural marketing.

State legislation permitting resale price maintenance contracts (Fair Trade laws) and prohibiting sales below cost (Unfair Practice acts) illustrate laws intended to limit price competition or to protect competitors. Federal legislation was also enacted to facilitate the use of resale price maintenance contracts. Although the Robinson-Patman amendment to the Clayton act ostensibly controls the plane of competition by prohibiting discriminatory pricing its effect appears to be in the direction of restricting competition.

There was a marked expansion during World War II in governmental efforts to establish central direction of marketing activities in such ways as allocation of materials, rationing of many commodities and price control. Although most of these efforts were discontinued after the war, the so-called garrison-state economy of the mid-1950s with its heavy demands on materials and manpower and its problem of serious inflation again added to the growth of efforts to substitute central governmental direction for much of the working of the competitive system.

Marketing Costs and Efficiency.—Although costs vary widely for different products, and for the same product at different times, evidence for specific commodities lends support to estimates that marketing costs on the average make up more than half of the price paid by the consumer.

The costs of marketing different products vary because of differences in the conditions which affect the cost of performing the marketing functions. Among the more important of these conditions are: (1) degree of perishability, physical or commercial; (2) seasonality of supply and demand; (3) extent and kind of selling effort; (4) relation between bulk and value, which affects particularly the cost of performing the physical distribution functions of transportation and storage; (5) size of the unit sale; (6) degree of standardization; (7) extent of need for mechanical servicing; and (8) need of retailing operations. For example, most farm products sold as raw materials to factories are less perishable than farm products used as consumers' goods with little or no change in form. In addition, they are often handled in carloads from local shipping points to the factory; and they do not go through the retailing operations which constitute the most expensive phase of marketing. Largely as a result of these differences, the cost of marketing farm raw materials to the factory is much lower than the cost of marketing farm products as consumers' goods. Those raw materials that are processed into manufactured consumers' goods, however, are then sold to ultimate consumers through wholesale and retail channels. Thus, the total cost of marketing them from farm to factory to consumer may be fully as great as the 50% or more of the consumer's dollar normally going for marketing costs in the case of nonprocessed farm products.

The cost of marketing manufactured products is likewise high, with estimates for different products ranging roughly from one-third to two-thirds of the price paid by the consumer.

During the first half of the 20th century a growing proportion of U.S. labour supply was involved in performing marketing functions and, as pointed out, the total cost of these services and other marketing costs accounted for more than half the price the consumer paid for goods. As a result, marketing costs frequently were condemned as too high and the entire marketing system rated as inefficient.

Undoubtedly there were many marketing inefficiencies which added to the cost of getting goods to the consumer; but most of the high cost of marketing was the result of the necessity of performing expensive services or functions. The increase in costs was largely caused by fundamental changes in the economic organization which placed an increasingly heavy burden on the marketing structure. Among these changes were the transfer of many production operations from the home to the factory; development of specialized production both on an individual or company basis and by areas; growth of cities; the increasing variety of new products and the need for selling them; more frequent buying; the trend toward smaller packaging; the increased importance of fashion in many fields; and consumers' demand for more services.

The division of the consumer's dollar between production and marketing costs is a reflection, in general, of the character of the economy and, in particular, of the production and marketing conditions of any specific commodity. The important question is not "What share of the consumer's dollar goes for marketing costs?" but rather "What combination of production and marketing costs will result in the consumer's receiving the most goods and services for his dollar?"

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(I. D. A.; H. W. HY.)

GREAT BRITAIN AND OTHER COUNTRIES

In the modern age, there are many forms of marketing. The simplest is a direct sale from producer to consumer, such as the sale of eggs and produce by a smallholder to his neighbours. More complicated forms demand the intervention between producer and consumer of one or more wholesalers, or retailers, or a combination of both. When trade between different countries is concerned, there are the problems of export, transport and import to be interposed in the marketing chain; and the place of interposition largely depends on the product to be sold.

Allied to any marketing process is the advertising of it: the smallholder may put up a notice on his gate advertising his products, the large manufacturer or retailer may spend considerable sums in advertising by every means at his command.

In export marketing European countries took the lead. In the middle ages these countries were—and still are—far from self-sufficient in raw materials and they freely traded with each other and with the Asian and African continents as means of communication with these territories developed. When the Industrial Revolution came to Britain there was a clamour for its industrial products and, in return, the United Kingdom took increasing quantities of produce in payment from its overseas customers. Some of this produce was sold to other countries and thus the commodity markets developed in London, which soon acquired an unrivalled knowledge of commodities and of international exchange operations. Specialist commodity markets also developed in provincial centres such as the cotton exchanges in Liverpool and Manchester and the wool exchange in Bradford. Parallel markets developed in Amsterdam and other European centres and by degrees the primary exporting countries also developed their own markets such as the wool auctions in Sydney, the cotton market in Alexandria, the tea auctions in Ceylon and the grain and livestock markets in Chicago. Once consumer goods have arrived in the country of their consumption, marketing usually conforms to the following pattern: (1) the wholesaler or industrial consumer buys, often at auction, from the importer; (2) the wholesaler sells either to regional wholesalers, to smaller manufacturers, to large retailers or to chain stores; (3) the regional wholesaler sells to the smaller retailers; (4) the retailer sells to the consumer. Goods such as wool, fish, fruit, meat, tea, pepper, spices are marketed in this manner.

Futures.—In many commodities used for industrial purposes and particularly in cotton, cocoa, coffee, hides, grain, rubber and metals there is an extensive business in what is known as "futures." A speculator, or importer in the manufacturing country, will undertake to sell to a manufacturer, or other speculator, a given quantity of merchandise for delivery in, say, three months time at a certain price. When making the contract the seller may not have already bought, or contracted for, any of the particular commodity but from his specialized knowledge of the market he feels confident that he will be able to buy before the specified date at a price which mill give him a profit on the transaction. This confidence is not always justified and sometimes the merchandise has to be bought at a loss at the last possible moment to enable the contract to be fulfilled. A futures market enables manufacturers to proceed with their manufacturing free from day-to-day worries about fluctuating raw material prices. They have also no worries about storing considerable stocks and the consequent tie-up of capital as they can stagger their "futures" purchases for delivery as required.

Retailing.—It is alleged that Napoleon once called Britain a nation of shopkeepers and a study of the 1951 census of distribution, details of which were published by the board of trade in 1953–54, strongly supports this description. The census disclosed that in 1950, when the population of Great Britain was a little more than 49,000,000, there were nearly 685,000 retail and service trades establishments. Of these about 530,000 were retail establishments divided as follows (round figures): grocery, food, tobacco, news agents 320,000; clothing 90,000; hardware 30,000; chemists and photographers 17,000; furniture 16,000; jewellery, leather, sports, toys 14,000; others 43,000. In 1950 the total sales of these establishments amounted to about £5,000,000,000 and this figure had grown to about £7,500,000,000 by 1955. Food accounted for about half the sales. From the monthly index figures published by the board of trade it was calculated that independent shops handled about 60% of all sales, the multiples (defined as an organization with ten or more branches) 22%, the co-operatives 13% and the department stores 5%.

Export Marketing. — When World War II ended in 1945, the United Kingdom found itself almost denuded of realizable overseas resources and investments. The industrial mechanism was geared to wartime production, and to effect a rehabilitation of its mode and standard of living, a great increase in the prewar volume of United Kingdom export trade was necessary. The government assisted by increasing commercial diplomatic representation abroad, by giving improved services through the board of trade and by developing the facilities of the Export Credits Guarantee department. In 1953 the volume of U.K. exports was estimated to be about 70% higher than in 1938 and the increase continued.

In export marketing, different methods are employed according to the nature of the product and the size of the firm producing it. For the large firm it is usual to have overseas branches directed by personnel from the parent company. Many of these branches carry local stocks. Where the volume of business (actual or potential) is insufficient to justify a wholly owned branch, the firm will generally operate through a local merchanting house to whom the manufacturer may send one of his own specialists to co-operate in the marketing of the company's products. For the smaller firm the normal procedure is to appoint a local selling agent in the different centres of interest, usually on a commission basis, and the agent books orders for direct delivery from the U.K. exporter to the buyer, who may be either an industrialist, a wholesaler or a retailer. Most enterprising export firms have travelling representatives who visit such overseas agents at regular intervals. It is an advantage when a principal of the exporting firm can visit his overseas agents and customers. Thus he can better understand any adaptations which are required for his products to satisfy conditions different from his own. He can better decide the need for a more extensive advertising campaign and possibly for a change to a more enterprising agent.

In most leading importing centres some of the larger import houses prefer to have their own buying organization in the manufacturing countries. By this means they can always keep in touch with new developments or products suitable for their own market. On a lesser scale, some smaller importers use what is known as a London confirming house. The confirming house will buy any product on the instructions of the overseas buyer and it will also advise him as to where he can buy the best, or the cheapest, product. Usually the confirming house will pay cash for the goods in the United Kingdom and grant its customers an appropriate amount of credit. These services are usually rendered for quite a small commission. Similarly also, colonial or commonwealth governments or public authorities often make purchases in the United Kingdom through the "crown agents." This government organization, known in full as the crown agents for overseas governments and administrations, maintains an expert staff in London that is fully aware of colonial needs and conditions and has also a wide knowledge of appropriate British manufacturers; products and prices. The crown agents often invite tenders for larger contracts. They also keep an eye on the manufacturing process and inspect the finished article before shipment.

Before 1914 trade between countries was comparatively simple, the main obstacle in general being import tariffs. Most currencies were fixed in relation to gold and any country which ran a deficit in its overseas trading usually settled it in the end by a transfer of gold. World War I, by eliminating the reserves of many countries, destroyed this system of economic freedom and a regime of increasing tariffs and quota restrictions was gradually built up in the interwar years. Countries also entered into bilateral trade treaties under which Country A agreed to send Country B a given quantity of its own products in exchange for an equivalent value in B's products, generally without the need for any transfer of currencies. This system greatly complicated overseas marketing. Under Adolf Hitler, the financier Hjalmar Schacht made Germany foremost in methods of barter trade. Germany was also active during this period in building up an elaborate system of multiple exchange rates, which was extensively copied in many countries after World War II. Experience showed, however, that these devious marketing and financial methods in the end restricted trade rather than developed it. Under a bilateral trading system Country A can only export as much as Country B can pay for. Where there are strict reciprocal quotas the tendency is for trade to stabilize at the lowest level for either commodity, a level which is usually lower than it would have been under an international multilateral system. Accordingly after World War II the more enlightened economic countries did what they could to educate their less advanced economic brethren by such means as the European Payments union—a practical example of limited multilateralism which showed that multilateral trading could still be practised to the benefit of all in spite of a weakness in internal financial reserves. In addition, the United Kingdom, the Federal Republic of Germany and the Netherlands later agreed to multilateralism among themselves in their commercial relations with certain South American countries and with Egypt.

Co-operative Societies. — The co-operative system in its retailing form started in Rochdale, Lancashire, in the 19th century. The theory behind it is that consumers by banding together and purchasing in bulk can buy more cheaply than they do by buying individually; profits are shared by means of dividend on turnover among the participating members. The movement grew considerably, particularly in Scotland and in many other countries. According to Co-operative Union statistics there were in Great Britain in 1955 more than 964 retail co-operative societies. These employed about 280,000 people and had a sales turnover of more than £790,000,000. The societies also manufacture many of their own food and clothing products.

Sellers of produce also banded together on similar lines to sell their products on a co-operative basis, particularly in the egg and poultry trades. Such co-operation of producers became extensive in Denmark, the Netherlands, Israel and other food-producing countries.

Empire Marketing Board. — To develop the marketing of British empire products in the United Kingdom an Empire Marketing board was set up in 1926 with the proviso that the "empire should have a preference over foreign countries as regards that part of the home market which cannot be supplied by the home producer." The board came to an end in 1933 largely owing to lack of interest by the dominions in its work. However successor bodies were later formed to take over similar functions in relation to the colonial territories and since World War II many ambitious research, development and marketing schemes in the colonies have been undertaken by the Colonial Development corporation.

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(ED. B.)

MARKET PLACE, the mediaeval descendant of the Greek agora and the Roman forum (*qq.v.*); an open space, generally approximately rectangular. It was usually placed near the centre of the town, as in the market cross of Chester! at the intersection of the two main streets. The town hall (see GOVERNMENTAL ARCHITECTURE) was frequently built on the market place, and occasionally its ground floor was open and served as additional market space. A market cross was a monument topped by a cross, situated in the market place; or the market place itself, so-called from the monument.

MARKETS, PRIMITIVE: see TRADE, PRIMITIVE.

MARKHAM, SIR CLEMENTS ROBERT (1830–1916), C.B. (1871), K.C.B. (1896), English geographer and historical writer, son of the Rev. David F. Markham, canon of Windsor, was born on July 20, 1830 at Stillingfleet, near York, and went to Westminster school. He entered the navy in 1844 and passed for a lieutenant in 1851. In 1850–51 he served on the Franklin search expedition in the arctic regions, under Captain Austin. He retired from the navy in 1852, and then travelled in Peru and the forests of the eastern Andes. In 1853 Markham entered the civil service, and in 1854 was appointed on the board of control of the East

India company. He visited South America again in 1860, in order to arrange for the introduction of the cinchona plant into India, a service of the highest value. In 1865 he visited Ceylon and India, to report upon the Tinnevelly pearl fishery and the cinchona plantations. From 1867–77 the geographical section of the India office was under his charge. On the Abyssinian expedition of 1867–68 he served as geographer, and was present at the storming of Magdala. He was elected F.R.S. in 1873. In 1875 he accompanied the arctic expedition under Sir George Nares as far as Greenland. In later years Sir Clements Markham travelled extensively in western Asia and the United States. He was secretary to the Hakluyt society from 1858–87, and its president from 1889–1909. From 1863–88 he acted as secretary to the Royal Geographical society, and was elected president in 1893, retaining office for the unprecedented period of 12 years. He was president of the International Geographical congress, which met in London in 1895. It was almost entirely because of his exertions that funds were obtained for the National Antarctic expedition under Capt. Robert Scott, which left England in the summer of 1901. After his retirement from the India office, he continued to devote himself to geographical research and travelled widely. He died in London on Jan. 30, 1916.

Sir Clements Markham conducted the *Geographical Magazine* from 1872–78, when it became merged in the *Proceedings of the Royal Geographical Society*. Among his many publications may be mentioned: *Peru* (1880); *The War between Chili and Peru* (1879–81; 3rd ed., 1883); *Life of John Davis the Navigator* (1889) ; a *Life of Richard III.* (1906) ; also lives of *Admiral Fairfax, Admiral John Markham, Columbus* and *Major Rennel;* a *History of Peru;* editions with introduction of 20 works for the Hakluyt society, of which 14 were also translations; about 70 papers in the Royal Geographical society's *Journal*. *The Lands of Silence,* an important history of arctic and antarctic exploration, was completed posthumously by H. H. Guillemard and published in 1921.

MARKHAM, EDWIN (originally CHARLES EDWARD ANSON MARKHAM) (1852–1940), U.S. poet, author of "The Man With the Hoe," was born in Oregon City. Ore., on April 23, 1852, the youngest son of pioneer parents. He grew to manhood on an isolated valley ranch in the Suisun hills in central California, attended the California State Normal school at San Jose and later graduated from the Christian college at Santa Rosa. He subsequently became a high school principal and superintendent at various places, and finally headmaster at the Tompkins Observation school, Oakland, connected with the University of California. Markham abandoned school administration in 1899, after his poetry had won favour, and devoted himself to writing and lecturing. In that year he gained national fame with the publication in the *San Francisco Examiner* of "The Man With the Hoe," his most widely known poem. Icspired by Millet's painting, Markham made the French peasant the symbol of the exploited classes throughout the world. The poem so well expressed the economic and social mood of the time that it was reprinted in nearly every newspaper of the country and was the subject of wide editorial comment. His first book of verse, *The Man With the Hoe and Other Poems* (1899), was followed in 1901 by *Lincoln and Other Poems,* the dignified title piece of which found almost as much favour as "The Man With the Hoe." His succeeding volumes—Shoes *of Happiness* (1915), *Gates of Paradise* (1920), *New Poems: Eighty Songs at Eighty* (1932) and *The Star of Araby* (1937)—have the commanding rhetoric but lack the passion of the early works. On March 7, 1940, Markham died at Staten Island, N.Y., where he had made his home since 1901.

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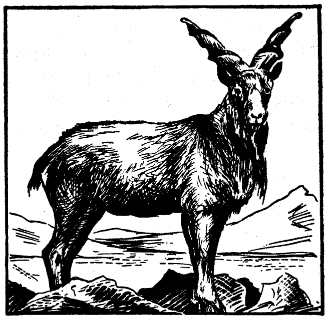
MARKHAM, GERVASE (or JERVIS) (1568?–1637), English poet and writer, third son of Sir Robert Markham of Cotham, Nottinghamshire, was born probably in 1568. He was a soldier of fortune in the Low Countries, and later was a captain under the earl of Essex's command in Ireland. He was acquainted with Latin and several modern languages, and had an exhaustive practical acquaintance with the arts of forestry and agriculture. He was a noted horse breeder, and is said to have imported the first Arabian horse. Very little is known of the events of his life. The story of the murderous quarrel between Gervase Markham and Sir John Holles related in the *Biographia Britannica* (*s.v.* Holles) has been generally connected with him, but in the *Dictionary of National Biography* Sir Clements R. Markham, a descendant from the same family, refers it to a contemporary of the same name. Gervase Markham was buried at St. Giles's, Cripplegate, London, on Feb. 3, 1637.

Markbarn's writings include: *The Most Honorable Tragedie of Sir Richard Grinvile, Knight* (1595), reprinted (1871) by E. Arber; *The Poem of Poems, or Sions Muse* (1595), dedicated to Elizabeth, daughter of Sir Philip Sidney; *Devoreux* (1597) ; *The Teares of the Beloved* (1600) and *Marie Magdalens Lamentations* (1601), long and rather commonplace poems on the Passion and Resurrection of Christ, both reprinted by A. B. Grosart in the *Miscellanies of the Fuller Worthies' Library* (1871). *The True Tragedy of Herod and Antipater* (1622) was written with William Sampson, and with Lewis Machin he wrote a comedy called *The Dumbe Knight* (1608). *A Discourse of Horsemanshippe* (1593) was followed by other popular treatises on horsemanship and farriery. *Honour in His Perfection* (1624) is in praise of the earls of Oxford, Southampton and Essex, and the *Souldiers Accidence* (1625) turns his military experiences to account. He edited Juliana Berners' *Boke of Saint Albans* under the title of *The Gentlemans Academie* (1595), and produced numerous books on husbandry, many of which are catalogued in Lowndes's *Bibliographer's Manual,* Bohn's ed. (1857–64).



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MARKHOR (CAPRA FALCONERI)

MARKHOR ("snake-eater"), a large Himalayan wild goat *(Capra falconeri)*, characterized by its spirally twisted horns and long shaggy winter coat. From the Pir-Panjal range of Kashmir the region of the markhor extends westward into Baltistan, Astor, Hunza, Afghanistan and the trans-Indus ranges of the Punjab. The twist of the horns varies locally.

MARKIRCH: *see* STE-MARIE-AUX-MINES.

MARKO KRALYEVIĆ, Serbian hero, was a son of the Serbian king or prince, Vukašin (d. 1371). Chagrined at not himself becoming king after his father's death, he headed a revolt against the new ruler. Later he took service with the sultan, and was killed in battle about 1394. Stories of strength and wonder have gathered round his name. He is supposed to have lived for 300 years, to have ridden a horse 150 years old, and to have used his enormous physical strength against oppressors, especially against the Turks. He is a great figure in Serbian poetry, and his deeds are also told in the epic poems of the Rumanians and the Bulgarians. One tradition relates how he retired from the world owing to the advent of firearms, which, he held, made strength and valour of no account in battle.

MARKOV, ANDREI ANDREEVICH (1856–1922), Russian mathematician, was the first to give a complete and strict proof of the so-called central limit theorem. Markov passed through the academic grades at the University of St. Petersburg; he was appointed ordinary professor in 1886 and ordinary member of the Academy of Sciences in 1896. The earlier part of his work was devoted to number theory and analysis, notably to continued fractions, the limits of integrals, the approximation theory, and the convergence of series. From about 1900, he was mainly occupied with probability theory. Under fairly general assumptions, he proved the central limit theorem, which states the asymptotically normal (gaussian) distribution of the sum of a large number of independent random variables. Markov then turned to study mutually dependent variables, introducing the important notion of chained events (Markov chains). A sequence x_1, x_2, . . . of mutually dependent random variables constitutes a Markov chain if, roughly speaking, any prediction about x_{n+1}, . . ., knowing x_1, . . ., x_n may without loss be based on x_n alone. He extended several classical results concerning independent events to certain types of chains. Markov's work is one of the starting points of the modern theory of stochastic processes. A selection of Markov's works in number theory and probability theory, including a biography and a bibliography, was published in Moscow in 1951. (G. Eg.)

MARKOVA, ALICIA (Alicia Marks). (1910–), is an English ballerina noted for the ethereal lightness and poetic delicacy of her interpretations of Giselle, Les *Sylphides,* Swan Lake and other ballets. Born in London, Dec. 1, 1910, she studied with Seraphima Astafieva and Enrico Cecchetti. Phenomenally gifted, she made her debut with the Diaghilev Ballet at 14, and was soon dancing leading roles. Alicia Markova has appeared as ballerina of Ballet Rambert, Sadler's Wells Ballet. Ballet Russe de Monte Carlo, Ballet Theatre, and as guest artist with the Metropolitan Opera. With Anton Dolin, she headed the Markova-Dolin Ballet (1935–38), and Festival Ballet (1949–52). (Ln. Me.)

MARK SYSTEM. At the middle of the 19th century, the opinion prevailed widely among scholars that throughout the Germanic world society tended to be organized in communities whose members claimed kinship with each other, cultivated their lands in common, and administered justice in their own assemblies. It was held that these communities were known as "Marks," from the march, or boundary, which separated each from its neighbours, and that traces of their existence still survive in the numerous place names containing the element *-ing,* which are found in all regions of Germanic settlement. Later research proved that early Germanic society was far more complicated than the framers of this theory had realized, and demonstrated a strong element of individualism in primitive Germanic law. On the philological side it has been shown that the element *-ing* bore a far wider sense than that of kindred alone, that, for example, the original *Readingas* of Reading are as likely to have been the free and unfree dependents of *Read* as his actual or reputed kinsmen. The Mark theory, in fact, was much too simple an explanation of the complex phenomena of primitive society, but it still deserves respect as one of the great constructive generalizations which have determined the direction of research into the problems of social history. (F. M. S.)

MARL, an earthy mixture of fine-grained minerals. The term is applied to a great variety of sediments and rocks with a considerable range of composition. Calcareous marls grade into clays by diminution in the amount of lime, and into clayey limestones. Greensand marls contain the mineral glauconite, which is a complex silicate of alumina, iron and potassium. The greensand marls are widely distributed along the Atlantic coast in the United States and in Europe. Similar deposits occur in New Zealand. Because of their base-exchange properties the glauconitic marls are used in water-softening units. (See also Greensand; Glauconite.)

Both marine and fresh-water marls are most commonly earthy and of a white, gray or brownish colour. However, red and black marls are found. In calcareous marine marls some lime is present in the form of shells (as in the Coralline crag of East Anglia, the Oligocene marls of the Isle of Wight, etc.); in others it is a fine impalpable powder mixed with clay and siliceous silt. Fresh-water marl may be similar in composition to marine marl. Much of the calcium carbonate in lake deposits is precipitated by bacteria and by algae such as the stoneworts. However, some lake marls contain numerous fragments of the shells of fresh-water snails and bivalves. Large deposits of fresh-water marl which contain from 80% to 90% of calcium carbonate and less than 3% of magnesium carbonate have been used as the calcareous material required in the manufacture of insulating material and portland cement. Marl also is used as a liming material and in making bricks. (G. A. T.)

MARLBOROUGH, EARLS AND DUKES OF. The earldom of Marlborough was held by the family of Ley from 1626 to 1679. James Ley, the 1st earl (c. 1550–1629), was lord chief justice of the King's Bench in Ireland and then in England; he was an English member of parliament and was lord high treasurer from 1624 to 1628. In 1624 he was created Baron Ley and in 1626 earl of Marlborough.

In 1689 John Churchill was created earl and in 1702 duke of Marlborough (see below). After the death of his only son Charles in 1703 an act of parliament was passed in 1706 settling the duke's titles upon his daughters and their issue; from them the present family is descended.

The 7th duke of Marlborough, John Winston Spencer-Churchill (1822–83), a prominent Conservative, was lord-lieutenant of Ireland 1876–1880, and when marquess of Blandford (the courtesy title borne by the duke's eldest son in his father's lifetime) was responsible for the act of 1856 called the "Blandford Act," enabling populous parishes to be divided for purposes of Church work.

MARLBOROUGH, JOHN CHURCHILL, 1st Duke of (1650–1722), English soldier, was born on May 26, 1650, in the small manor house of Ashe, in Musbury, Devonshire, the son of Sir Winston Churchill of Wootton Glanville, Dorset. He went to St. Paul's school from 1664 to 1665. When 15 he became page of honour to the duke of York. About the same time his sister Arabella became maid of honour to the duchess and eventually mistress of the duke. These events contributed greatly to the advancement of the Churchills. In 1667 John received through the influence of his master a commission in the guards. Soon afterward he left England for service at Tangier but returned home in 1670. For a short interval he remained in attendance at the court, and it was during this period that his natural carefulness was shown by his investing in an annuity a present of £5,000 given him by the duchess of Cleveland.

When the Third Dutch War broke out, his first active service was aboard the fleet and after the battle of Sole bay, in May 1672, he was promoted to captain. In the following December he went to the continent with the English troops sent to assist Louis XIV against the Dutch. He served under the duke of Monmouth at the siege of Maastricht in June 1673 and there won the praise of Louis XIV. In 1674 he acted as colonel of an English regiment under Turenne, who warmly commended his conduct at the battle of Enzheim (October). He then returned to England and for the next few years was at court or engaged on minor diplomatic missions. Some time during the winter of 1677–78 he married Sarah Jennings (b. June 5, 1660), the favourite attendant on the princess Anne, younger daughter of the duke of York. In Dec. 1682 he was created a Scottish peer as Lord Churchill of Eyemouth and in Nov. 1683 he became colonel of the royal regiment of dragoons.

On the accession of James II the Churchills received a great increase in fortune, and for his services on a special mission from the new monarch to Louis XIV John Churchill was made in May 1685 Baron Churchill of Sandridge in Hertfordshire. When Monmouth attempted his ill-fated enterprise in the western counties, the second position in command of the king's army was bestowed on Lord Churchill, and in July 1685 he was raised to the rank of major general. Through his energy at the battle of Sedgemoor (July 6) the king's side was victorious. After the death of Monmouth he withdrew as far as possible from the administration of public business. While on his embassy to the French court he had declared that if the king of England should change the religion of the state he would leave his service, and Churchill was one of the first to send overtures of obedience to the prince of Orange, to whom he had gone on a mission in 1678. Although he continued in a high position under James and drew the emoluments of his places, he promised William of Orange to use every exertion to bring over the troops to his side. James had been warned against him, but the warnings were in vain, and on the landing of the Dutch prince at Torbay Churchill was promoted to be lieutenant general (Nov. 7, 1688). When the royal army had advanced to the downs of Wiltshire and a battle seemed imminent, James was dismayed to find that at night his general had gone to the opposite camp.

After the revolution Churchill was sworn as a privy councillor in Feb. 1689 and in April became earl of Marlborough. In May 1689 he was sent with an English force to the Netherlands. In the next year he was commander in chief of the forces in England and one of the council of nine which helped Mary to govern the country during William's absence in Ireland. In the autumn, after William's victory at the Boyne, Marlborough planned and executed the highly successful expedition that resulted in the rapid capture of Cork and Kinsale. Gradually, however, he lost favour with William. The growth of an estrangement between Anne and the court, and Marlborough's active loyalty to the princess, intensified William's suspicions. In May 1692 he was thrown into the Tower on an accusation of treason. Though the evidence against him was flimsy, and he was soon released, there is no doubt that Marlborough was. like most leading Englishmen of the time, corresponding with the exiled king at St. Germain. The accusation that he even went so far as to disclose, in May 1694, to his late master the intention of the English to attack Brest rests, however, upon somewhat doubtful evidence. During the Fenwick plot of 1696 he was charged again with treason, but William ignored the accusation.

During the last years of William's reign Marlborough once more was placed in positions of responsibility. Higher honours came on the accession of Anne in March 1702. He was appointed a knight of the Garter, captain general of the English troops both at home and abroad, and master general of the ordnance. On May 4, 1702, the War of the Spanish Succession began with declarations of war by England, the Netherlands and Austria against France. Marlborough was soon afteruard made commander in chief of the united armies of England and the Netherlands, but throughout the war his plans were impeded by the jealousy of the commanders who were nominally his inferiors and by the opposite aims of the allied countries. He himself wished to penetrate into the French lines; the anxiety of the Dutch was for the maintenance of their frontier and for an augmentation of their territory: the desire of the Austrian emperor was to secure that his son the archduke Charles should rule Spain. Nevertheless, in the first year of the campaign it was shown that the armies of the French were not invincible. Several fortresses which Louis XIV had seized upon surrendered to the allies. Kaiserswerth on the Rhine had surrendered in June, and the capture of Venlo in September and Liège in October cleared the line of the Meuse. For these brilliant exploits Xarlborough was raised (Dec. 14, 1702) to be duke of Marlborough and awarded £5,000 per annum for the queen's life. His only surviving son. the marquess of Blandford, was seized with smallpox while at King's college, Cambridge, and died on Feb. 20, 1703.

The result of the campaign of 1703 inspired the French king with fresh hopes. The plans of Marlborough were frustrated by his Dutch colleagues. When he wished to invade the French territory they urged him to besiege Bonn, and he was compelled to give way. It surrendered in May, whereupon he returned to his original plan of attacking Antwerp; but because of the incapacity of the Dutch leaders, the French surprised one Dutch force in June and inflicted on it a loss of many thousands of men. Marlborough was forced to abandon his enterprise, and all the compensation which he received was the capture of the insignificant fortresses of Huy and Limburg. After a year of comparative failure for the allies, Louis XIV entered upon an offensive movement against Austria; and Rlarlborough, smarting under the misadventures of 1703, was eager to meet him. The French king sent Marshals Camille de Tallard and Ferdinand de Marsin to join the elector of Bavaria and to march by the Danube to seize Vienna. Marlborough divined their intention and, drawing the duc de Villeroi's forces from the Netherlands after him by feints of attacks on the Moselle and in Alsace, led his troops into Bavaria. On Aug. 13 (N.S.) he brought Tallard, Marsin and the Bavarians to battle near the village of Blenheim on the left bank of the Danube. The early part of the fight was in favour of the French. Three times the troops led by Prince Eugilne against the Bavarians on the enemy's left wing were driven back in confusion; but Marlborough concentrated superior forces on the enemy's centre and, after hard fighting, broke through there. In the end the victory of the allies was conclusive. Nearly 30,000 of the French and Bavarians were killed and wounded, and 12,000 of the French who had been driven down to the Danube were forced to surrender. Bavaria fell to the allies, and on his way back to the Netherlands Marlborough also took Trilves and Trarbach on the Moselle. Poets and prose writers were employed to do Marlborough honour. The manor of Woodstock, which was transferred by act of parliament from the crown to the duke, was a reward more after his own heart. Blenheim palace was built in the park at the royal expense, and £240,000 of public money was spent on the buildings. Marlborough was also created a prince of the empire, and the principality of Mindelheim was formed in his honour.

During the following year Marlborough was hampered by tedious formalities at The Hague and by jealousies at the German courts. The armies of the French mere again brought up to their full standard, but the generals of Louis were instructed to entrench themselves behind earthworks and to act on the defensive. On a July night Marlborough broke through the famous "lines of Brabant" near Tirlemont. and the French were forced to shelter in Louvain. The duke in vain urged an attack, and when 1705 had passed away the forces of the French king remained unbroken. This tempted Villeroi in the next spring into meeting the allies in an open fight. But through the superior tactics of Marlborough the battle of Ramillies (May 23 [N.S.], 1706) ended in the rout of the French and caused the transference of nearly the whole of Brabant and Flanders to the allies. Five days afterward the victor entered Brussels in state, and the inhabitants acknowledged the rule of the archduke. Antwerp, Ostend, Menin and Termonde soon surrendered. Again a year of triumph was succeeded by a period of depression. During 1707 fortune inclined to the other side, with the result that in July 1708 Ghent and Bruges returned to the allegiance of the French, and Marlborough, fearing that their example might be followed by other cities, advanced toward Oudenarde. The battle, which raged on the high ground above Oudenarde. ended in defeat of the French (July 11 [S.S.], 1708).

Marlborough then wished to advance on Paris, but he was overruled. The allied army invested the town of Lille, and after nearly four months and a loss to the combatants of 30,000 men the citadel surrendered in December. By the end of the year Brabant was again subject to the allies. The French king sued for peace, and the marquis de Torcy, his minister, endeavoured by promises of large sums to obtain the support of Marlborough for his proposals. These attempts were vain. and when the winter passed a French army of 110,000, under the command of Villars. took the field. In Sept. 1709 Marlborough and Eugilne took Tournai and led their forces to Mons. For the last time during the protracted war the two armies met in fair fight at Malplaquet, on the south of Mons (Sept. 11 [N.S.], 1709). The fight was long and doubtful; although the French ultimately retreated. it was in good order, and their losses were less than those of their opponents. The campaign lasted for two years after this, but it was not signalized by any such "glorious victory" as Blenheim. The French concentrated on the construction of fresh lines of defense, and Marlborough, despite a successful campaign in 1711, was not able to force the contest to a final decision before his own downfall at the end of that year.

For all these victories had not prevented the position of Marlborough from being undermined by intrigues at home. In the early part of Anne's reign his political friends were among the Tories, and the ministry under Sidney Godolphin was chiefly composed of members of that party. After a year or two. however. the more ardent Tories withdrew. and two younger adherents of the same cause, Robert Harley and Henry St. John. were introduced in May 1704 into the ministry. The duchess, partly through the influence of her son-in-law. the earl of Sunderland. who came into office against the queen's wish in Dec. 1706, and partly through the opposition of the Tories to the French war, pressed Whig views on the sovereign with more vehemence than discretion; and the love of the two friends changed into hate. Sunderland and Godolphin were the first to fall (June-August 1710); a few months later the duchess was dismissed from her offices, and the fall of Marlborough himself came on the last day of 1711. He went to the continent in Dec. 1712 and remained abroad until the death of Anne (Aug. 1, 1714).

Then he once more returned to England and resumed his old military posts, but he took little part in public affairs. He died on June 16, 1722, at Cranbourn lodge. near Windsor. His remains were deposited in Westminster abbey, in the vault at the east end of King Henry VII's chapel, but they now rest in a mausoleum in the chapel at Blenheim. His widow, to whom must be assigned a considerable share both in his rise and in his fall, survived until Oct. 18, 1744. To William Pitt she left £10,000 and to Lord Chesterfield twice that sum and a reversionary interest in her landed property at Wimbledon.

Marlborough's successes were attributable not only to his military genius and diplomatic skill but also to his attention to detail and his care for the welfare of his troops. Alike in planning and in execution he took infinite pains. Nothing escaped his observation, and in the hottest moment of the fight the coolness of his intellect was conspicuous.

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MARLBOROUGH, a municipal borough and market town in the Devizes parliamentary division of Wiltshire, Eng., 25 mi. N. of Salisbury. Pop. (1951) 4,557. It is northwest of Savernake forest and in the valley of the river Kennct in the Downs.

The antiquity of Marlborough is shown by the Castle mound. an earthwork which local legend makes the grave of Merlin; and the name of Marlborough has been regarded as a corrupt form of Merlin's berg or rock. Near the site of the modern Marlborough (Merleberge, Marleberge) was originally a Roman *castrum* called Cunetio. and later there was a Norman fortress in which William I cstahlished a mint. In Domesday it was royal demesne. The castle, built under Henry I by Roger, bishop of Salisbury. was held for Matilda against Stephen. and became a favourite residence of Henry II, Savernake being a royal deer park. In 1267 Henry III held his last parliament there, at which the Statute of Marlborough was passed. Marlborough was captured by the royalists in 1612 and partly burned. The town was constituted a suffragan see by Henry II. Henry Sacheverell, the politician and divine. was born there in 1674. In 1652, 1679 and 1690 the town was nearly destroyed by fire, after which an act was passed forbidding the use of thatch.

The first charter was granted by John in 1204 and conferred a guild merchant. together with freedom from all pleas except pleas of the crown and from all secular exactions by sea and land. Later charters were obtained from Henry IV in 1407 and from Elizabeth I in 1576. The former granted some additional exemptions. while the latter incorporated the town under the title of mayor and burgesses of Marlborough. Marlborough returned two members to parliament until 1867 when the number was reduced to one. In 1885 the representation was merged with the county.

The church of St. Peter and St. Paul, a Perpendicular building. was the scene of the ordination of Thomas Wolsey in 1498. The church of Preshute. largely rebuilt but preserving its Norman pillars, has a curious piscina and a large black basalt font dating from 1100–50. There is a 16th-century grammar school. Marlborough college was opened in 1813, originally for the sons of clergymen. Trade is mainly agricultural. and light industries include engineering and the making of puppets. tiles and ropes.

MARLIN, common name for several large sea fishes of the billfish family (Istiophoridae), which includes also sailfishes. They are among the most prized of big game fishes. The upper jaw is prolonged into a rounded spear: ventral fins are present and the dorsal fin: unlike that of the sailfishes, is not prominently enlarged to form a saillike superstructure. They occur in the warm parts of all oceans and seasonally visit temperate regions in the northern hemisphere as far north as Nova Scotia and in the southern hemisphere as far south as Chile and the Cape of Good Hope. They are generally found traveling alone, in pairs or in small groups. The white marlin sometimes schools. Marlins feed on all kinds of smaller fishes that swim near the surface, such as mackerel, mullet and sardines, and on larger invertebrates, such as squids.

Because ichthyologists have had difficulty in obtaining enough specimens for comparative studies, there is considerable uncertainty regarding the number of species. Among those best known is the striped marlin (*Makaira audax*), ranging from southern California to northern Chile and westward into the Indian ocean and attaining 700 lb.; the blue marlin (*M. ampla*), widely distributed in the warm parts of the Atlantic and Pacific oceans and attaining over 1.600 lb.; and the white marlin (M. albida). ranging in the Atlantic from Brazil to Nova Scotia, in the Mediterranean and off the coast of Portugal and attaining hardly more than 160 lb.

The black marlin (Istiompax *indicus*) is the largest species, growing to over 15 ft. and near to 2,000 Ib. It ranges over tropical and temperate waters of the Pacific and Indian oceans. Another genus of marlins, *Tetrapturus,* is distinguished from *Makaira* in having pectoral fins that are not much if at all longer than the lower jaw and a spear that is hardly longer than the deepest depth of the body. *Tetrapturus* species range in the warm parts of the Atlantic and Indian oceans and in the Pacific as far east as Hawaii. See also FISHES. (L. A. WD.)

MARLOW, an urban district in the Wycombe parliamentary division of Buckinghamshire, Eng., 31 mi. W. of London by road. Pop. (1951) 6,481. Area 2.6 sq.mi. At Marlow the Thames is crossed by an iron suspension road bridge, built by W. Tierney Clark in 1831. connecting Berkshire with Buckinghamshire. All Saints' parish church. built in 183j on the site of a 12th-century church. stands by the bridge on the river bank and contains interesting monuments from the former church. A weir and lock separate two reaches of the river. Lying on a pretty stretch of the Thames with the wooded Chilterns behind, Marlow is a residential town much frequented for boating and fishing. A one-day regatta is held every June. The only large industry is brewing (since 1758), but it mas famous for fine needlework (with a school of needlework) and lacemaking until the 19th century. Of many old houses the earliest is the Old Parsonage, dating from the 14th century, which was probably part of the manor house. A 17th-century house contained the Royal Military college from 1802 until 1812 when it was moved to Sandhurst; in the house opposite the poet Shelley lived from 1817 to 1818, and close by is the Borlase school (now state-controlled) founded in 1624 by Sir William Borlase to teach 24 boys to read, write and keep accounts and 24 girls to make bone lace. The council offices and a museum share an 18th-century house.

MARLOWE, CHRISTOPHER (1564–1593). English dramatist, the father of English tragedy and instaurator of dramatic blank verse; the eldest son of a shoemaker. was born in Canterbury on Feb. 6, 1564. He was christened at St. George's church. Canterbury. on Feb. 26, 1563/4, two months before Shakespeare's baptism at Stratford-on-Avon. His father. John Marlowe, is said to have been the grandson of John Morley or Marlowe, a substantial tanner of Canterbury. The father. who survived by a dozen years or so his illustrious son, married on May 22, 1561, Catherine, daughter of Christopher Arthur. at one time rector of St. Peter's. Canterbury. who had been ejected by Queen hfary as a married minister. The dramatist had as fellow pupils at the King's school, Canterbury. Richard Boyle, afterward earl of Cork, and Will Lyly, the brother of the dramatist. He matriculated at Benet (Corpus Christi) college, on March 17, 1571, taking his B.A. degree in 1554 and that of M.A. three or four years later.

Francis Kett, the mystic, burned in 1589 for heresy, was a fellow and tutor of his college, and may have had some share in developing Marlowe's opinions in religious matters. Marlowe's classical acquirements were of a kind which was then extremely common, being based for the most part upon a minute acquaintance with Roman mythology, as revealed in Ovid's *Metamorphoses.* His spirited translation of Ovid's *Amores* (printed 1596) mas at any rate commenced at Cambridge. His translation of "The First Book of Lucan," printed posthumously in 1600, belongs to the last years of his short life. The famous lyric "Come Live With Me and Be My Love" was first printed in its entirety in *England's* Helicon (1600). Hero and *Leander*, based on hfusacus, also belongs to the last years. Before 1587 he seems to have quitted Cambridge for London; of his life there, apart from his four great theatrical successes and his connection as a dramatist with the Lord Admiral's and Strange's companies, hardly anything is known; but he evidently knew Thomas Kyd, who shared his unorthodox opinions. Nash criticized his verse, Greene affected to shudder at his atheism; Gabriel Harvey maligned his memory.

On the other hand, Marlowe was intimate with the Walsinghams of Scadbury, Chiselhurst, kinsmen of Sir Francis Walsingham: he was also the personal friend of Sir Walter Raleigh, and perhaps of the poetical earl of Oxford, with both of whom, and with Walter Warner and Robert Hughes the mathematicians, Thomas Harriott the astronomer, and Matthew Royden, the dramatist is said to have met in free canverse. He seems at least to have been associated with what was denounced as Sir Walter Raleigh's school of atheism, and to have dallied with opinions which were then regarded as putting a man outside the pale of civilized humanity. In October 1588 Marlowe gave bail for his appearance for an unspecified offence. Serious charges were brought in 1593. As the result of some depositions made by Thomas Kyd under the influence of torture, the Privy Council were upon the eve of investigating some charges against Marlowe when his career was abruptly terminated. Thanks to the researches of Dr. Hotson, it is now established definitely on the evidence of documents in the Public Record Office, that Marlowe was killed by a companion of his, one Ingram Frizer, at an inn at Deptford on May 30th, 1593. Frizer and Marlowe, together with two friends named Robert Poley and Nicholas Skeres, had repaired to the inn to dine and sup. A quarrel arose about paying the bill; Marlowe in a sudden fit of temper attacked Frizer from behind. Frizer in the ensuing struggle stabbed Marlowe, who died instantly. Frizer was subsequently pardoned, as having killed Marlowe in self-defence. A full account of the documentary evidence which supports these facts is given in Dr. Hotson's book, *The Death of Christopher Marlowe* (1925). Dr. Hotson points out that it is important to note that Ingram Frizer was, in the relevant documents, described as "gentleman" and did not forfeit the good graces of his employers, the Walsinghams, who were friends of the man whom he slew.

Thus the various stories of Marlowe's death, as retailed by Thomas Beard *(The Theatre of God's Judgments)* in 1597, Francis Meres in his *Palladis Tamia* (1598), Anthony à Wood in his *Athenae Oxonienses* (1691) and repeated by later writers, may be dismissed as mere legend.

Marlowe was buried on June 1, 1593, at Deptford.

Marlowe's career as a dramatist lies between the years 1587 and 1593, and his four great plays are *Tamburlaine the Great,* an heroic epic in dramatic form divided into two parts of five acts each *(c.* 1587, printed in 1590); *Dr. Faustus* (1588, entered at Stationers' Hall 1601); *The Famous Tragedy of the Rich Jew of Malta* (dating perhaps from 1589, acted in 1592, printed in 1633); and *Edward the Second* (printed 1594). The very first words of *Tamburlaine* sound the trumpet note of attack in the older order of things dramatic:—

From jigging veins of riming mother wits
And such conceits as clownage keeps in pay
We'll lead you to the stately tent of war,
Where you shall hear the Scythian Tamburlaine
Threatening the world with high astounding terms
And scourging kingdoms with his conquering sword.

It leapt with a bound to a place beside Kyd's *Spanish Tragedy,* and few plays have been more imitated by rivals (Greene's *Alphonsus of Aragon,* Peele's *Battle of Alcazar, Selimus, Scanderbeg)* or more keenly satirized by the jealousy and prejudice of out-distanced competitors. Other plays in which Marlowe is said to have had a share are *The Massacre at Paris* (1593), printed in his name; *Dido, Queen of Carthage* (1593), with Nashe; *Lust's Dominion* (*c.* 1600), the original draft of which may have been by Marlowe; and the lost play, *The Maiden's Holiday,* in the list of plays burnt by Warburton's cook. Some critics have traced his hand in other plays, among these being the Shakespearian *Titus Andronicus, Henry VI.,* and *Richard III.* The following notes on the plays and on the poems are taken from the article written by Swinburne for the 9th ed. of the *Encyclopædia Britannica.* *(T. S.; X.)*

Estimate on the Plays.—With many and heavy faults, there is something of genuine greatness in *Tamburlaine the Great;* and for two grave reasons it must always be remembered with distinction and mentioned with honour. It is the first poem ever written in English blank verse, as distinguished from mere rhymeless decasyllabics; and it contains one of the noblest passages, perhaps indeed the noblest, in the literature of the world, ever written by one of the greatest masters of poetry in loving praise of the glorious delights and sublime submission to the everlasting limits of his art.

The just and generous judgment passed by Goethe on the *Faustus* of his English predecessor in tragic treatment of the same subject is somewhat more than sufficient to counterbalance the slighting or the sneering references to that magnificent poem which might have been expected from the ignorance of Byron or the incompetence of Hallam. What most impressed the author of *Faust* in the work of Marlowe was a quality the want of which in the author of *Manfred* is proof enough to consign his best work to the second or third class at most. "How greatly it is all planned!" the first requisite of all great work, and one of which the highest genius possible to a greatly gifted barbarian could by no possibility understand the nature or conceive the existence.

Tamburlaine is monotonous in the general roll and flow of its stately and sonorous verse through a noisy wilderness of perpetual bluster and slaughter; but the unity of tone and purpose in *Doctor Faustus* is not unrelieved by change of manner and variety of incident. In the vision of Helen, for example, the intense perception of loveliness gives actual sublimity to the sweetness and radiance of mere beauty in the passionate and spontaneous selection of words the most choice and perfect; and in like manner the sublimity of simplicity in Marlowe's conception and expression of the agonies endured by Faustus under the immediate imminence of his doom gives the highest note of beauty, the quality of absolute fitness and propriety, to the sheer straightforwardness of speech in which his agonizing horror finds vent.

It is now a commonplace of criticism to observe and regret the decline of power and interest after the opening acts of *The Jew of Malta.* This decline is undeniable, though even the latter part of the play (the text of which is very corrupt) is not wanting in rough energy; but the first two acts would be sufficient foundation for the durable fame of a dramatic poet. In the blank verse of Milton alone—who perhaps was hardly less indebted than Shakespeare was before him to Marlowe as the first English master of word-music in its grander forms—has the glory or the melody of passages in the opening soliloquy of Barabbas been possibly surpassed.

In *Edward the Second* the interest rises and the execution improves as visibly and as greatly with the course of the advancing story as they decline in *The Jew of Malta.* The scene of the king's deposition at Kenilworth is almost as much finer in tragic effect and poetic quality as it is shorter and less elaborate than the corresponding scene in Shakespeare's *King Richard* **II.**

Of *The Massacre at Paris* (acted in 1593, printed 1600?) it is impossible to judge fairly from the garbled fragment of its genuine text which is all that has come down to us. To Mr. Collier, among numberless other obligations, we owe the discovery of a noble passage excised in the piratical edition which gives us the only version extant of this unlucky play.

In the tragedy of *Dido, Queen of Carthage* (completed by Thomas Nashe, produced and printed 1594), a servile fidelity to the text of Virgil's narrative has naturally resulted in the failure which might have been expected from an attempt at once to transcribe what is essentially inimitable and to reproduce it under the hopelessly alien conditions of dramatic adaptation.

The Poems—One of the most faultless lyrics and one of the loveliest fragm ts in the whole range of description and fanciful poetry would have secured a place for Marlowe among the memorable men of his epoch, even if his plays had perished with himself. His *Passionate Shepherd* remains ever since unrivalled in its way—a way of pure fancy and radiant melody without break or lapse. The untitled fragment, on the other hand, has been very closely rivalled, perhaps very happily imitated, but only by the greatest lyric poet of England—by Shelley alone. Marlowe's poem of *Hero and Leander* (entered at Stationers'

Hall in September 1593; completed and brought out by George Chapman, who divided Marlowe's work into two sestiads and added four of his own, 1598), closing with the sunrise which closes the night of the lovers' union, stands alone in its age, and far ahead of the work of any possible competitor between the death of Spenser and the dawn of Milton.

The place and the value of Christopher Marlowe as a leader among English poets it would be almost impossible for historical criticism to over-estimate. To none of them all, perhaps, have so many of the greatest among them been so deeply and so directly indebted. Nor was ever any great writer's influence upon his fellows more utterly and unmixedly an influence for good. He first, and he alone, guided Shakespeare into the right way of work; his music, in which there is no echo of any man's before him, found its own echo in the more prolonged but hardly more exalted harmony of Milton's. He is the greatest discoverer, the most daring and inspired pioneer, in all our poetic literature. Before him there was neither genuine blank verse nor a genuine tragedy in our language. After his arrival the way was prepared, the paths were made straight, for Shakespeare. (A. C. S.)

Marlowe's fame, so finely appreciated by Shakespeare and Drayton, was obscured from the fall of the theatres until the generation of Lamb and Hazlitt. Collected editions are by A. Dyce (1858, 1865, 1876); A. H. Bullen (3 vols., 1884–85); "Best Plays" in the Mermaid series by Havelock Ellis with an Introduction by J. A. Symonds (1887–89). The best modern text is that edited by C. F. Tucker Brooke (Oxf. Univ. Press, 1910). *See* J. G. Lewis, *Marlowe, Outlines of his Life and Works* (1891); J. H. Ingram, *Christopher Marlowe and his Associates* (1904); H. Jung, *Das Verhältnis Marlowes zu Shakespeare* (1904). For further information the reader should consult the histories of the stage by Collier, Ward, Fleay, Schelling and E. K. Chambers, and the studies of Shakespeare's predecessors by Symonds, Mezières, Boas, Manley, Churton Collins, Feuillerat and J. M. Robertson. *See* also Verity's *Essay on Marlowe's Influence* (1886); *Mod. Lang. Rev.* iv. 167 (M. at Cambridge); Swinburne, *Study of Shakespeare* (1880); C. F. T. Brooke, *The Marlowe Canon* (Baltimore 1922), and *Marlowe's Versification and Style* (1922); E. Seaton, *Marlowe's Map* (1924); and the separate editions of *Dr. Faustus, Edward II.*, etc. The main sources of Marlowe were as follows: for *Tamburlaine*, Pedro Mexia's *Life of Timur* in his *Silva* (Madrid, 1543), Anglicized by Fortescue in his *Foreste* (1571) and Petrus Perondinus, *Vita Magni Tamerlanis* (1551); for *Faustus:* a contemporary English version of the Faust-buch or *Historia von D. Johann Fausten* (Frankfort, 1587), and for *Edward II.*, the *Chronicles* of Fabyan (1516), Holinshed (1577) and Stow (1580).

MARLOWE, JULIA (SARAH FRANCES FROST) (1866–1950), U.S. actress, was born near Keswick. Eng., on Aug. 17, 1866, and at an early age went with her family to the United States. Her first formal appearance on the stage was in New York in 1887, although she had before that traveled with a juvenile opera company. Her first great success was as Parthenia in *Ingomar,* and her subsequent presentations of Rosalind, Viola and Julia in *The Hunchback* confirmed her position as a "star." In 1894 she married Robert Taber, an actor, with whom she played until their divorce in 1900. Subsequently, she had great success as Barbara Frietchie in Clyde Fitch's play of that name, and in other dramas. For many years, beginning in 1904, she acted with E. H. Sothern (*q.v.*)—to whom she was married, Aug. 17, 1911—in a notable series of Shakespearian plays, as well as in modern drama.

In 1924 she retired from the stage. She died in New York city on Nov. 12, 1950.

MARLY-LE-ROI, a village of northern France in the *département* of Seine-et-Oise, 5 mi. N. by W. of Versailles by road. Pop. (1954) 3,681.

Marly-le-Roi owes its celebrity to the Chbteau built towards the end of the 17th century by Louis XIV, and now destroyed. The remains now consist of a large basin, the park and a small forest. Near Marly-le-Roi is the hamlet of Marly-la-Machine, where, in 1684, an immense hydraulic engine, driven by the current of the river, was erected; it raised the water to a high tower, where the aqueduct of Marly began (700 yds. in length, 75 in height, with 36 arches) carrying the waters of the Seine to Versailles.

MARMALADE, a preserve originally made of quinces, but now commonly of Seville or other tart oranges, or of other citrus fruit. The term is sometimes (improperly) used for jams. A standard recipe for marmalade is: Two lemons. 12 Seville oranges, slice thin, remove pips, cover and steep for three days in cold water, allowing three pints water to each lb. of fruit. Then boil in a preserving pan till tender, let cool and add 1 lb. of sugar for each lb. of fruit. Boil, skimming well and cook until the mixture stiffens quickly when dropped on a cold plate.

MARMANDE, a town of southwestern France, capital of an *arrondissement* in the *département* of Lot-et-Garonne, 35 mi. N.W. of Agen, on the Southern railway from Bordeaux to Cette. Pop. (1954) 8,536. Marmande was a *bastide* founded about 1195 and its position on the Garonne made it an important place of toll. It soon passed into the hands of the counts of Toulouse, and was three times besieged and taken during the Albigensian crusade, its capture by Amaury de Montfort in 1219 being followed by a massacre of the inhabitants. It was united to the French crown under Louis IX. A short occupation by the English in 1447, an unsuccessful siege by Henry IV. in 1577 and its resistance of a month to a division of Wellington's army in 1814, are the chief events in its subsequent history. Marmande is situated on the Garonne at its confluence with the Trec. The Garonne is here crossed by a suspension bridge. Public institutions include the sub-prefecture, and tribunals of first instance and commerce. Apart from the administrative offices, the only building of importance is the church of Notre-Dame, which dates from the 13th, 14th and 15th centuries. Among the industries are iron-founding, steam sawing, manufacture of woollens and brandy-distilling.

MARMONT, AUGUSTE FREDERIC LOUIS VIESSE DE, DUKE OF RAGUSA (1774–1852), marshal of France, was born at Chbtillon-sur-Seine on July 20, 1774, the son of an ex-officer in the army. He studied mathematics at Dijon with a view to entering the artillery, and there met Bonaparte, with whom he later served in Toulon. Marmont became Bonaparte's aide-de-camp, remained with him during his disgrace, and accompanied him to Italy and Egypt, being promoted to general of brigade. He returned to Europe in 1799, organized the artillery for the expedition to Italy, and was made general of division for his services at Marengo. In 1801 he became inspector-general of artillery, and in 1804 grand officer of the Legion of Honour, but was not made marshal. In 1805 he fought at Ulm, and then became for five years governor of Dalmatia, where his beneficent régime was long remembered. In 1808 he became duke of Ragusa, and in 1809 Napoleon summoned him to take part in the closing operations of the Austrian War, and made him governor-general of the Illyrian provinces of the empire. In July 1810 Marmont succeeded Masséna in command in the north of Spain, and was wounded at Salamanca. He was hardly cured when, in April 1813 Napoleon gave him the command of a corps with which he served throughout the defensive campaign of 1814, until the last battle before Paris, from which he drew back his forces to the commanding position of Essonne, where he had 20,000 men. Marmont then took upon himself a political role which has been stigmatized as treasonable, concluding a secret convention with the enemy. This act was never forgiven by Marmont's countrymen, and although made a peer of France and a major-general of the royal guard at the Restoration, he was never trusted. In July 1830 he was ordered to put down any opposition to the ordinances, and although opposed to the court policy he only gave up the attempt to suppress the revolution when it became clear that his troops were outmatched. The duc d'Angoulême ordered him under arrest, fearing further treachery, but Marmont went into exile with the king, forfeiting his marshalate. He finally settled in Vienna, and became tutor to the duke of Reichstadt. He died at Venice on March 22, 1852. Marmont's *Memoires* are of great value for the military history of his time.

His works include *Voyage en Hongrie, etc.* (4 vols. 1837); *Voyage en Sicile* (1838); *Esprit des institutions militaires* (1845); *Mémoires* (8 volumes, 1856).

MARMONTEL, JEAN FRANÇOIS (1723–1799), French writer, was born at Bort (in Cantal), on July 11, 1723. After studying with the Jesuits at Mauriac, he taught in their colleges at Clermont and Toulouse; and in 1745, acting on the advice of Voltaire, he set out for Paris to try for literary honours. From 1748 to 1753 he wrote a succession of tragedies which, though only moderately successful on the stage, secured the admission of the author to literary and fashionable circles. He wrote a series of articles for the *Encyclopédie;* also the libretti of several comic operas, among others Sylvain (1770) and *Zémire* et *Azore* (1771). In the Gluck-Piccini controversy he was an eager partisan of Piccini with whom he collaborated in *Didon* (1783) and *Pénélope* (1785). In 1758, through Madame de Pompadour, he obtained a place as a civil servant, and the management of the official journal Le *Mercure,* in which he had already begun the famous series of Contes moraux. The merit of these tales lies partly in the delicate finish of the style, but mainly in the graphic and charming pictures of French society under Louis XV. The author was elected to the French Academy in 1763. In 1767 he published a romance, *Bélisaire,* which incurred the censure of the Sorbonne and the archbishop of Paris for a chapter on religious toleration. Marmontel retorted in *Les* Incas (1778) by tracing the cruelties in Spanish America to the fanaticism of the invaders.

He was appointed historiographer of France (1771), secretary to the Academy (1783), and professor of history in the Lycée (1786). Marmontel retired in 1792 to Evreux, and soon after to a cottage at Abloville in the department of Eure. To that retreat we owe his *Mémoires d'un père* (4 vols., 1804, new ed. by M. Tourneux, 3 vols., 1891), giving a picturesque review of his whole life, a literary history of two important reigns, a great gallery of portraits extending from the venerable Massillon, whom more than half a century previously he had seen at Clermont, to Mirabeau. He died on Dec. 31, 1799 at Abloville.

The *Contes Moraux* were early translated into English, and many editions of them exist. A summary of the best of them is given by G. G. Saintsbury in *Hist.* of the French Novel, vol. i. (1917).

See also C. A. Sainte-Beuve, Causeries *du lundi,* iv.; S. Lenel, *Un* Homme de *lettres au XVIII. siècle, Marmontel* (1902).

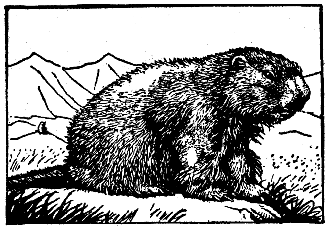
MARMORA (anc. Proconnesus), an island in the sea of the same name. (See below.) Originally settled by Greeks from Miletus in the 8th century B.C., Proconnesus was annexed by its powerful neighbour Cyzicus in 362. The island has at all times been noted for its quarries of white marble which supplied the material for many of the buildings of Constantinople.

See C. Texier, Asie mineure (1839–49); M. I. Gedeon, Προκόννησος (Constantinople, 1895); an exhaustive monograph by F. W. Hasluck in Journ. Hell. Stud., xxix. (1909).

MARMORA, SEA OF, the small inland sea which (in part) separates the Turkish dominions in Europe from those in Asia, and is connected through the Bosporus with the Black Sea (*q.v.*) and through the Dardanelles with the Aegean. It is 170 m. long (E. to W.) and nearly 50 m. in extreme width, and has an area of 4,500 sq.m. Its greatest depth is about 700 fathoms, the deepest parts (over 500 fathoms) occurring in three depressions in the northern portion—one close under the European shore to the south of Rodosto, another near the centre of the sea, and a third at the mouth of the Gulf of Ismid. There are several considerable islands, of which the largest, Marmora, lies in the west, off the peninsula of Kapu Dagh, along with Afsia, Aloni and smaller islands. In the east, off the Asiatic shore between the Bosporus and the Gulf of Ismid, are the Princes' Islands. The Sea of Marmora is the ancient *Propontis,* Turk. Marmara *Denizi.*

MARMOSET, the name of any of the small tropical American monkeys classed in the family Callithricidae. Marmosets are not larger than squirrels and present great variation in colour; all have long tails, and many have the ears tufted. They differ from the other American monkeys in having one pair less of molar teeth in each jaw. The common marmoset, or ouistiti, is *Callithrix jacchus.* See PRIMATES.

MARMOT, a large, thickly built, burrowing Alpine rodent allied to the squirrels, and typifying the genus *Marmota,* of which there are numerous species ranging from the Alps through Asia north of the Himalaya, and in North America. All these may be included under the name marmot. In addition to their stout build and thickly haired tails, marmots are characterized by the absence of cheek-pouches. Europe possesses two species, the Alpine or true marmot (*M. marmota*), and the more eastern bobac (M. bobac); and there are numerous kinds in Central Asia, one of which, the red marmot (M. caudate), is a larger animal, with a longer tail. Marmots inhabit open country, either among mountains, or in the plains; and associate in large colonies, forming burrows, each tenanted by a single family. During the daytime the hillock at the entrance to the burrow is frequently occupied by one or more members of the family. In the winter when the ground is deep in snow, marmots retire to the depths of their burrows, and the winter sleep is probably unbroken. From two to four is the usual number of young in a litter. There are three species in North America, the most widespread of these known as woodchucks (*q.v.*); two other species occur in the western mountains.



THE ALPINE MARMOT. A RODENT RELATED TO THE GROUND SQUIRRELS

The red-bellied marmot (M. *flaviventris* ranges from New Mexico and southern California to British Columbia, while the hoary marmot or whistler (M. caligata) is found from Alaska to the high mountains of Idaho. (See RODENTIA.)

MARNE, a department of north-eastern France, made up from Champagne-Pouilleuse, Rémois, Haute-Champagne, Perthois, Tardenois, Bocage and Brie-Pouilleuse, districts formerly belonging to Champagne, and bounded west, by Seine-et-Marne and Aisne, north by Aisne and Ardennes, east by Meuse, and south by Haute-Marne and Aube. Pop. (1936) 410,238. Area 3,168 sq. miles.

The western half of the department is hilly (920 ft. near Reims) with Tertiary rocks of the Paris basin deeply cut by Marne, Vesle and Suippe. From beneath the eastward-facing scarp edge of these rocks the chalk emerges to floor the eastern half of the department (Champagne Pouilleuse), the surface of which rises eastward up the dip slope of the rock to the forested scarp (860 ft.) of the Lower Chalk, again facing east. From beneath this, in turn, emerge the impervious Lower Cretaceous rocks of La Champagne humide, drained by the upper Aisne, which runs northward, parallel to the scarp.

Marne has the temperate climate of the Seine region; the annual mean temperature is 50°, the rainfall about 24 in. Oats, wheat, rye and barley, lucerne, sainfoin and clover, and potatoes, mangold-wurzels and sugar-beet are the principal agricultural crops, and choice vegetables are grown. The raising of mixed merino sheep and of other stock and bees is profitable The vineyards on the hill slopes of Reims, Épernay and Chblons produce the best Champagne. Pine woods are largely planted in Champagne-Pouilleuse. The department produces peat, fire-clay, millstones and chalk.

Reims has an old-established woollen industry. The manufacture of wine-cases and other goods for the wine trade is carried on. There are also small metalworks. Besides these there are glassworks, whiting and oil works. The chief imports are wool and coal; exports are wine, grain, live-stock, stone, whiting, pit-props and woollen stuffs. Communication is afforded chiefly by the river Marne and by the Eastern railway. There are four arrondissements—namely those of Chblons (the capital), Épernay, Reims, and Vitry-le-Franqois—with 33 cantons and 662 communes. The department belongs partly to the archbishopric of Reims and partly to the see of Chblons. Châlons is the headquarters of the VI. army corps (Metz). Its educational centre and court of appeal are at Paris. Tbe principal towns are Chblons-sur-Marne, Reims, Bpernay and Vitry-le-François, Ay and Sézanne.

MARNE, a river of northern France, 328 m. long, rising on the Plateau of Langres, 3 m. S. of Langres, flowing in a wide valley across the Jurassic and Cretaceous rocks of the Paris basin and uniting with the Seine at Charenton, an eastern suburb of Paris. Leaving Langres on the left the river flows northward, passing Chaumont, as far as St. Dizier, where it turns west, receives the Blaise (left), passes Vitry-le-François where it receives the Saulx (right), Chblons and Epernay, where it enters picturesque and undulating country of Tertiary rocks. It passes Chateau-Thierry and Meaux and is joined by the Petit-Morin (left), Ourcq (right) and Grand-Morin (left). It is canalized from Paris to Dizy beyond which it is accompanied by a lateral canal which connects with the Saône. It is also connected by canal with the Rhine and the Aisne.

MARNE, THE FIRST BATTLE OF THE (Sept. 6–9, 1914), the first great turning point in the World War. A strategically decisive victory for the Allies, it brought the rapid and apparently resistless advance of the German hosts through Belgium and France to a halt and forced them to retire northwards. The French reckon in the battle only the Armies west of Verdun, thus excluding Dubail's and de Castelnau's Armies[1] in Alsace-Lorraine; the Germans include the whole front from Belfort round to Paris, and, as they attacked on this with all their seven Armies and the fighting east of Verdun formed an important part of their plan, their definition is followed here.

After the "Battles of the Frontier" in the later part of August and the retreat of the French and British forces, Gen. Joffre attempted to lengthen his line to the westward and prevent envelopment of the Allied left flank by collecting near Amiens on the left of the British Expeditionary Force a new army, under Gen. Maunoury, formed of divisions drawn from other parts of the line. Before this Army could be completely organized, its leading divisions came into contact with the enemy and became involved in the general retirement.

At this period the B.E.F., under Field-Marshal Sir John French, consisted of:—

I. Corps (Lieut.-Gen. Sir D. Haig)
 1st Division (Maj.-Gen. S. H. Lomax),
 2nd Division (Maj.-Gen. C. C. Monro).
II. Corps (General Sir H. L. Smith-Dorrien),
 3rd Division (Maj.-Gen. H. I. W. Hamilton),
 5th Division (Maj.-Gen. Sir C. Fergusson).
III. Corps (Maj.-Gen. W. P. Pulteney),
 4th Division (Maj.-Gen. T. D'O. Snow), with 19th Infantry Brigade attached.

The Cavalry Division (Maj.-Gen. E. H. H. Allenby), of 4 cavalry brigades, and the 5th Cavalry Brigade.

The Royal Flying Corps (Brig.-Gen. Sir D. Henderson) of 5 squadrons.

Lines of Communication troops.

The German Movements and Orders Before the Battle.—As the German pursuit proceeded, Gen. von Kluck, commanding the German I. Army on the extreme west of the line, which had fought at Mons and Le Cateau and occupied Amiens, came to the conclusion that the B.E.F. and Maunoury's troops were routed and practically dispersed, and that Gen. Lanrezac's Army on the right of the British was in consequence the left of the French line. The action of Lanrezac in attacking at the battle of Guise (Aug. 29–31), without assistance on his left, confirmed him in these views. In conjunction, therefore, with Gen. von Bülow (II. Army), instead of continuing the advance in order to cross the Seine below Paris, as ordered, Kluck on Aug. 31 wheeled south-eastwards past the northern front of the French capital, with the object of striking the supposed French flank. After some of his advanced troops and his cavalry corps had been roughly handled by the British on Sept. 1, he turned south, but subsequently resumed his south-eastward course. The German Supreme Command at first accepted Kluck's views, but on Sept. 4 Gen. von Moltke, the Chief of the General Staff and virtual Commander-in-Chief, became alarmed. Information reached him that the French were passing divisions from east to west, and that there were considerable assemblies of troops near Paris. On the evening of the 4th he despatched to the seven German Armies, warning messages, which he consolidated into a formal operation order on the 5th. This order brought to an end the great wheel that was to sweep the French into Switzerland, and substituted for it a plan by which the Paris forces were to be held off by the I. and II. Armies, whilst the other five armies attacked and enveloped what remained of the French forces. The supreme command operation order, the only one issued in regard to the battle, is of such importance that the greater part of it is quoted:—

"The enemy is bringing up new formations and concentrating superior forces in the neighbourhood of Paris to protect the capital and threaten the right flank of the German Armies.

"The I. and II. Armies must therefore remain (sic) facing the east front of Paris. Their task is to act against any operations of the enemy from the neighbourhood of Paris and to give each other mutual support to this end.

"The IV. and V. Armies are still operating against superior forces. They must maintain constant pressure to force them south-eastwards . . . Whether by co-operating with the VI. and VII. Armies they will then succeed in forcing any considerable part of the enemy's forces towards Swiss territory cannot yet be foreseen.

"The VI. and VII. Armies will continue to hold the enemy in position in their front, but will take the offensive as soon as possible against the line of the Moselle between Toul and Epinal, securing their flanks against these fortresses.

"The III. Army . . . will be employed as the situation demands either . . . to support the I. and II. Armies or to co-operate . . . in the fighting of our Armies on the left wing."

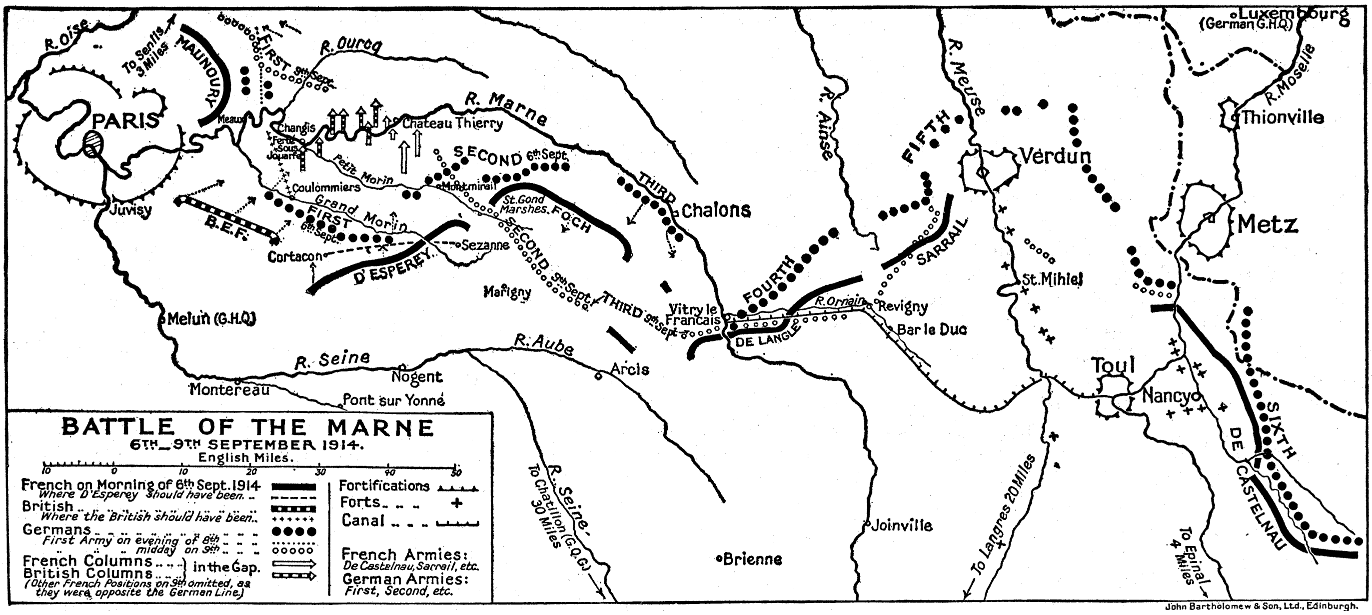
Regardless of the fact that the I. Army was beyond the Marne going south, it was ordered to remain, facing west, between the Oise and the Marne, and the II. Army, not yet across the Marne, was ordered to remain between that river and the Seine. The II. Army took immediate steps to obey this order; Bülow ordering his right corps as pivot to halt and the remainder to wheel forward so as to change front from south to west. The first stage of the wheel, to be carried out on the 6th, was to be to the line Montmirail–Marigny, a position not quite reached by the II. Army when the battle came to an end on the 9th. The I. Army continued its advance on Sept. 5 towards the Seine, Kluck reporting that he considered it best to settle with the French armies in the field first and then invest Paris. He, however, began preparatory steps for facing west, and when, in the afternoon, the representative of the supreme command, Lieut.-Col. Hentsch arrived, he approved of the preparations, but added that "the movement to face west might be made at leisure; no special haste was necessary." Thus on the afternoon of September 5 four corps of the I. Army were across the Grand Morin, with two cavalry corps ahead of them; but there was only a weak flank guard, the IV. Reserve Corps (3 infantry brigades) and the remains of the 4th Cavalry Division (smashed up by the British on Sept. 1) in échelon behind its right flank. The II. Army was a day's march behind the I., still facing south; the other German Armies were acting in conformity with their orders.

The French and British Movements and Orders.—The change of direction, to the south-east, of the German I. Army had been observed and reported by British aviators on the morning of Sept. 3, and they added at 5 P.M. that it was crossing the Marne. At 7 P.M. Maunoury reported that there were no German troops west of a line Paris–Senlis; at 8:45 P.M. the British found that there was only one German corps (IV. Reserve) left in the Ourcq valley All this information was fully confirmed on the 4th. Gen. Joffre, however, did not at once change his plans. Three days previously on Sept. 1, by instruction No. 4, sent out by officers in motor cars at 2 P.M., he had provisionally fixed as the limit of the retirement the moment when his armies were situated as follows:—

"Sarrail's army north of Bar de Duc;
De Langle's army, behind the Ornain east of Vitry;
Foch's army behind the Aube, south of Arcis;
Lanrezac's army, behind the Seine, south of Nogent."

On the 2nd, at 11:40 P.M., he had by a note changed this limit and put the general line on which his forces as a whole should establish themselves considerably farther back on the right. It was defined by Joinville, Brienne, Arcis, Nogent and Pont sur Yonne.

[1]For the sake of clearness, the French Armies are called by the names of their commanders; the Germans by their numbers.



The British were to be behind the Seine, close to Paris, from Melun to Juvisy, their left in touch with Maunoury's Army, now part of the garrison of the entrenched camp of Paris. The Military Governor of Paris, Gen Galliéni, who had been warned on Sept. 3 (apparently about 8 A.M.) that his troops in the eventual offensive would be required to act in the direction of Meaux, seems to have been the first to realize that there was no time to lose in taking advantage of the tremendous opportunity that the Germans were offering by their flank march past Paris. At 9 A.M. on the 4th he proposed to Gen. Joffre by telephone to use his forces at once to attack from north of Paris eastwards against the German flank. The French commander-in-chief replied at noon by telegraph approving of the idea, but preferring that the attack should be made south not north of the Marne, which meant postponement and loss of time. Joffre then set about ensuring the co-operation of the B E.F., and about 4 P.M. received through the mission at Sir John French's headquarters at Melun, to which Galliéni had paid a visit, a definite assurance of the fullest support. Meantime he had been in communication with d'Esperey—now in command, vice Lanrezac of the V. Army—as to the condition of his troops and when they could attack. Between 5 P M. and 8 P.M. two telegraph messages arrived from d'Esperey—the exact hour cannot be fixed, the times of receipt are not marked, but they are between letters received at 5 P.M. and 8 P.M. In these he stated that he could not attack before the 6th, and that Gen. H. Wilson, the sub-chief of the general staff of the British army, who was with him, agreed that the B.E.F. could be on the line Coulommiers–Changis on that date. Gen. Joffre had meantime fixed on the 7th. In the evening, however, Galliéni on return from British G.H.Q. again telephoned personally to him informing him of the measures taken for the eastward march of the Army of Paris and urging him that there was not a moment to be lost, with the result that Joffre definitely informed Galliéni that the general attack would take place on the 6th, and that he might attack north of the Marne as he wished, and gave him a summary of his orders, in which the destination of the B.E.F. as mentioned above was specified. Orders were then prepared, and telegraphed in cypher timed 11:15 P.M. on Sept. 4, to Maunoury and d'Esperey, 11:50 P.M. to Foch and Galliéni, and 12:10 A.M. on the 5th to British headquarters. Duplicates were sent by motor car

General Joffre's orders directed the forces on the left of his line to take up positions during Sept 5 ready to attack on the front and flank of the German I and II. Armies on the morning of the 6th. Maunoury was to be north-east of Meaux, ready to cross the river Ourcq eastwards in the direction of Château Thierry; the B.E.F. to advance to the line Coulommiers–Changis, ready to move north-eastwards; d'Esperey to fall back to the line Sezanne-Courtacon, and then attack northwards; Foch was to cover the right of d'Esperey by holding the exits of the Marais de St. Gond.

In order to profit by the coolness of the night the troops of Foch, d'Esperey and Sir J. French had marched off before the orders arrived. Galliéni received his copy at 2:35 A.M., but, knowing Joffre's intentions after his telephone conversation, which closed before 10 P.M., had already passed the information on to Maunoury. Foch, whose headquarters were nearest to the Grand Quartier-Général, then at Chatillon, received his at 1:30 A.M. and between 5 and 6 A.M. he was able to stop the retirement of his corps. D'Esperey was not so fortunate; what time he received the telegram is not recorded, but his orders founded on it are timed 6 A.M. His corps, having moved off at midnight to continue their retirement, he could not do more than modify the halting places of some of them; his centre arid left passed the line defined by Joffre, and the right detained by rear-guard fighting with the enemy did not reach it. The B.E.F. was in worse case. The orders carried by motor reached G.H.Q. before the telegram, at 3 A.M., and the corps had already started southwards, one of them five hours earlier. Thus the British made a march farther to the south than Joffre counted on, and had two marches to the front to reach the place assigned, instead of one. It was in all probability a fortunate circumstance that the B.E.F. was not in a position to obey and try to reach the line Coulommiers–Changis on the 5th. For if it had done so its five divisions and one cavalry division cut off from all help would have come isolated into collision with the greater part of eight divisions of the German I. Army and four cavalry divisions. Early on Sept. 5, Joffre issued orders to his centre: to de Langle to stay his retreat and attack northwards; to Sarrail to attack westwards against the German flank presented to the troops near Verdun.

Sept. 5: The First Contact.—The Germans, the exponents of envelopment, by thrusting forward between Verdun and Paris, had placed themselves in a position exposed to envelopment on both flanks. They had completely misunderstood the situation, over-estimated their initial successes and under-estimated the fighting powers of the Allies. Gen. von Kuhl, Kluck's chief of the staff, has written:—

"Neither the supreme command nor I. Army headquarters had the remotest idea of an immediately imminent offensive of the whole French Army. The continuation of the French retreat was accepted as settled. There was only a question of our flank being threatened from Paris. . . . The great offensive on the whole front of the forces came as a complete surprise. No sign, no prisoner's statement, no newspaper tattle had given warning of it."

But this was not the end of their mistakes. By Moltke's orders of the evening of Sept. 4, the I. and II. Armies were to face towards Paris. This might guard the flank of the German army as a whole, but would expose their own particular left flank in the new position to the oncoming French, and would leave an enormous gap in the original front towards the south. Yet this extraordinary order Biilow was proceeding to carry out, although Kluck was in no hurry to do so, seeing no necessity to be frightened at the "Paris bogey." Events of the 5th, however, were to scare the latter commander out of his optimism. Pressing on south-eastwards with four corps and taking no precautions to investigate the situation on his flank either by cavalry or aeroplane, his flank guard came in contact about 1:30 P.M. with an advanced guard of Maunoury's army, north-west of Meaux, and was forced back. This began the battle of the Ourcq. Owing to bad staffwork, or an attempt to conceal a defeat, news of this disaster—which meant that his right, now 6m. south of Meaux was completely uncovered—did not reach Kluck until "shortly after midnight." At last he set hurriedly about obeying the supreme command's orders to take position between the Marne and the Oise. But even now only partially. Early on the 6th he sent first the II. Corps (his right) and then the IV. back across the Marne to the assistance of his flank guard, leaving his other two corps with Biilow. Before dealing with the fighting on the Ourcq and in the British sector of the battle, where the decision fell, the events on the eastern flank and centre, where practically deadlock set in, will be summarized.

The Battle on the Eastern Flank and in the Centre.—The German VII. and VI. Armies, under Crown Prince Rupprecht, were "to attack against the Moselle between Toul and Epinal." That is, they were required to force the fortress line of the French eastern frontier. Yet it was to avoid the uncertainties and difficulties of this very task that the German Government had taken the momentous decision to allow their Armies to enter Luxembourg and violate Belgian neutrality. Until Moltke had "watered down" the plan of his predecessor, Field-Marshal Graf Schlieffen, it had been intended to enter Netherlands territory also. The enterprise proved beyond the powers of the Germans. Met by the stout defence of Dubail's and de Castelnau's armies, Rupprecht's armies were unable to make any progress and lost heavily, so that on Sept. 8 he stopped the offensive in order to spare the troops, and was ordered "to prepare to occupy a rear defensive position at once."

The German V. and IV. Armies did no better. Pushing on past the west side of Verdun, the V. (crown prince of Prussia) had to face eastwards towards the fortress. It prevented Sarrail from making any attempt to roll up the German line, but suffered most severely from French artillery fire and for three days was pinned to the ground. A diversion by small forces east of Verdun had no effect. At 2 P.M. on the 9th the Crown Prince, in desperation, ordered a night attack in the hope of capturing the French guns that were killing his men. This operation, owing to short notice, was a complete fiasco, the Germans firing on each other.

The German IV. Army, assisted by half of the III. Army, encountered de Langle, who stood on the defensive and then counter-attacked. After severe fighting on his flanks (actions of Revigny and Vitry), the Germans failed to make ground. By the morning of the 9th, the Germans were reduced by the French artillery fire to seeking what shelter they could in trenches and dead ground. Thus on the eastern half of the battlefield, where the Germans were the attackers, they had the worse of the fighting and there was no decision.

The II. Army (Biilow) and the other half of the German III. Army co-operating with it were at the opening of the battle facing nearly south, half-way between the Seine and Marne. Opposite them were Foch's army and the right of d'Esperey's. The former general—owing to his having received Joffre's orders of Sept. 4 in time to act on them—was actually in contact with the enemy. Severe fighting at once ensued near the Marais de St. Gond. But it was not Biilow's object to break through. He was merely pivoting on his centre so as to change from facing south to facing west towards Paris, between the Seine and the Marne, endeavouring to reach the line Montrnirail-Marigny. Thus heavy pressure was brought on Foch, and he was forced back and had to call on d'Esperey for help. But, with the assistance of the X. Corps lent by d'Esperey and of the XVII. Corps sent by Joffre to fill the gap between his army and de Langle's, Foch was able to remain in the line and fulfil his task of guarding the flank of Joffre's main attack of the left wing—d'Esperey, French and Maunoury.

The Allied Left Wing.—It has been seen how on the morning of the 6th Kluck (I. Army) had withdrawn the II. and IV. Corps to succour his flank guard threatened by Maunoury on the Ourcq. This left in front of d'Esperey and French the right half of the German II. Army (the pivot of Biilow's wheel), the IX and III. Corps of the I. Army, rear guards of the II. and IV. Corps, and two cavalry corps. During the day d'Esperey made no progress but the B.E.F. gained ground against a weakening opposition, about 5m. on the right, which had to wait for the French, and 12m. on the left. Maunoury also made an advance, and so dangerous did it appear that on the morning of the 7th Kluck summoned the IX. and III. Corps from their place in the line next to the II. Army, and sent them also back across the Marne to join the rest of his army on the Ourcq. These two corps were thus marching on the 7th and 8th, and were wasted so far as the battle went; for they only appeared opposite Maunoury on the 9th. In the great gap, some 30m. wide, left in the German front by the removal of the I. Army were now only two cavalry corps (which contained five Jager battalions and extra machine-gun companies) and some infantry detachments, and no one was appointed to take command of them as a whole.

The way through the German front appeared almost open: the Germans themselves had created a gap in their front such as, in the succeeding years of trench warfare, each side strove in vain to batter through its opponent's line. Unfortunately Gen. Joffre's plan, like the famous Plan XVII. with which the campaign had been opened, took no account of ground. In Aug. 1914 the French were committed to an offensive into the defiles of the Vosges and the forests of the Ardennes, where they were ambushed by the enemy. Now the advance of d'Esperey and the B.E.F. was confronted by a series of transverse rivers, the Grand Morin, the Petit Morin and the Marne, all passable only at the bridges, some of which had been destroyed by the French in the retreat. Nevertheless, in very hot, dry and dusty weather, the Allies forced the passage of the Grand Morin on the 7th and of the Petit Morin on the 8th. The German resistance in the gap was practically broken, and there was every chance of cutting off Kluck and falling on his rear, although he hastily despatched first a composite brigade and then the 5th Division to stop the British. On the evening of the 8th Sir John French's five divisions were close up to the Marne. D'Esperey, having farther to go, was not within reach of the river; but his right had driven back the right of the German II. Army and widened the gap. Maunoury's army (of seven divisions, only two of which were active troops, the rest being reserve), had ceased to make any progress against the six divisions of the German I. Army, to reinforce which four more were now on the way.

Sept. 9th: The Passage of the Marne.—Early on Sept. 9 the British cavalry, driving off the Germans, seized two bridges over the Marne below Château Thierry; the 6th Infantry Brigade secured another, and by 7:30 A.M. the I. Corps (Haig), the right of the B.E.F. was beginning to cross the river. In the centre, the II. Corps (Smith-Dorrien) found two bridges intact and undefended, and by 9 A.M. the vanguards of both its divisions were across. Reports were now received from the Flying Corps that there were large masses of Germans north of Château Thierry (actually the German jth Cavalry Division and infantry attached to it), and the I. Corps, as there were no French troops across the river on its right, halted and began to entrench to secure itself against a counter-stroke. As the French historian, Gen. Palat, has written, "our Allies were very notably ahead of Conneau's Cavalry Corps, which itself was bound to outpace the V. Army (d'Esperey)." The head of the jth Division, the left of the II. Corps, met with considerable resistance after crossing from a German composite brigade, and the 3rd Division, learning this and finding the I. Corps on its right at a standstill, also halted.

On the left, the 4th Division (Snow) had started at 4:45 A.M. with the intention of crossing at La Ferté sous Jouarre. It found both bridges over the Marne, there nearly a hundred yards wide and very deep, broken (they had been blown up by the French in the retreat); the enemy were holding the farther bank at all likely points of passage. About 1 P.M., two battalions, followed later by a third, managed to cross by a weir a mile above La Ferté, and another battalion crossed at a railway viaduct 3m. above. But by this time, 2:30 P.M., the Germans had abandoned the defence of the passages, and were making off. Conneau's cavalry on the British right did not begin crossing the Marne at Azy just below Château Thierry until 1 P.M. (Palat), and did not get up level with the British I. Corps until the latter had halted for the night. Meanwhile, farther east, Foch was again heavily attacked, particularly on his right, but d'Esperey was making good progress, driving back Bülow's right, so that he was able to lend Foch a division. The latter therefore withdrew Grossetti's division from his left in order to restore the combat on his right by counter-attack.

On the British left, Maunoury's left was being forced back on the exterior defences of Paris, for he had against him the additional weight of the greater part of Kluck's III. and IX. Corps, which had now reached the battlefield, and also the fourth brigade of the IV. Reserve Corps which had appeared from Antwerp on his outer flank. But the farther the German I. Army advanced from the Ourcq the more it suffered from the fire of the heavy guns of the Paris defences, which had been brought into the field, and had already taken heavy toll of it in the previous three days' fighting. Where, therefore, the enemy seemed to be advancing—opposite Foch's right and against Maunoury—further progress was unlikely and a decision impossible. Kuhl goes even farther, and says:—

"Even a victory over Maunoury could not prevent us [I. Army] from having our left flank enveloped by superior force, and from being driven away from the main army. The I. Army stood isolated."

At this crisis, at 1 P.M., the Germans began their retirement from the battlefield.

The German Retirement.—What happened on the German side was the subject of a special enquiry in 1917, after Hindenburg had become chief of the general staff; numberless books have been written in Germany on the battle, and a strenuous endeavour has been made to show that the German retreat was unnecessary. One school would attribute it to a misunderstanding—the I. Army (Kluck) and the II. Army (Bülow) retiring because each thought the other was doing so. The German official history and an official monograph entitled *Das Marnedrama* issued by the *Reichsarchiv* take the view that the retreat was ordered by Lieut.-Col. Hentsch as the representative of the Supreme Command with full powers for the purpose. The monograph sums up the matter in the words:—

"Thanks to the initiative of the German Army and corps commanders, thanks to the ability of the regimental leaders right down to platoon and section leaders, thanks to the valour of the troops, the battle ended with the victory of the German arms at the decisive point. . . . Then the forces on the Western Front were called back from the victory they had won by the word of the representative of the supreme command."

This view does not, however, seem to be borne out by admitted facts. Gen. von Bülow (subsequently promoted to Field-Marshal) definitely claimed to have ordered a retirement of his army, and thereby to have saved the situation. The committee of enquiry found that Bülow came to this decision "independently." At 9 A.M. on the 9th he received definite air reports that six columns (five British and one French cavalry) were approaching the Marne, and, no news of any success of the I. Army reaching him, by 11 A.M. he had issued orders for the retreat to begin at 1 P.M. and so informed the I. Army; the movements took place accordingly, and the III. Army conformed to them.

What happened at I. Army (Kluck) headquarters is not quite so clear. There are two distinct versions, those of Lieut.-Col. Hentsch, the emissary of the supreme command. and Gen. von Kuhl, Kluck's chief of the staff. Hentsch had been despatched by Gen. von Moltke at midday on the 8th to visit the V., IV., III., II. and I. Armies in succession, a round trip of 400m. According to the court of enquiry, the proceedings of which Ludendorff promulgated to the general staff, Hentsch was given full powers to co-ordinate a retreat, "should rearward movements have been initiated"—and he was despatched by Moltke in full expectation that such movements had been begun. Hentsch found none had taken place in the V., IV. and III. Armies, and then spent the night of the 8th–9th at II. Army headquarters, where he observed a spirit of depression and pessimism. He left early on the morning of the 9th, before definite orders for the retreat had been given, but apparently convinced that they would soon be given. Owing to blocks and panic on the road, it was past midday when he arrived at I. Army headquarters, taking seven hours to go 60m.; he did not see Gen. von Kluck, dealing only with Kuhl. Hentsch states that he found orders for retirement had already been issued. Kuhl denies this, but admits that such orders had gone out by telephone owing to the overzeal of a subordinate officer, since dead, who had misunderstood him. What, according to Kuhl, had been ordered at 11:30 A.M., and was in course of execution in view of the British advance, was a wheel backwards of the left only of the I. Army. Thus Kuhl's contention is that Hentsch, in view of the situation of the II. Army, ordered the I. to retreat and quoted his full powers given for the purpose of co-ordinating a retirement. Hentsch's statement is to the effect that the retirement had been decided on, and that he merely gave Kuhl the direction in which the I. Army was to retire, north-eastwards, so as to join up with the II. Army. The court of enquiry accepted Kuhl's view, adding, however, that Hentsch was justified "as the case provided for in his instructions, the initiation of rearward movements, had arisen." A curious feature of the events at German I. Army headquarters is that Kuhl, by his own account, accepted Hentsch's verbal instructions without requiring that so important a decision should be in writing, and without taking him to see Kluck, the army commander. In one of the books that he has written on the battle he has admitted that:—

"The break-through of the British and the French V. Army which was threatening brought about the decision in the battle of the Marne."

At 2 P.M. the retirement of the I. Army in the general direction of Soissons was begun. Its preliminary movements having brought it from facing west to facing south-west, and all the roads having been cleared by sending back the transport and trains, it was a comparatively easy matter. But, owing to the direction of the British advance, the I. Army could not incline inwards towards the II. Army and retreated due north, still leaving a gap in the German line. The German withdrawal, covered by rear guards, was not immediately obvious. It was not until 3 P.M. that the British I. Corps resumed its advance, and then owing to its fatigue only a short one was made to a line 5m. from the Marne. The left (5th) division of the II. Corps remained in contact with the enemy until dusk. It was not until 9 P.M. that the 4th Division on the extreme left was able to begin a bridge over the Marne at La Ferté, ten of its 16 battalions (including the 19th Brigade) being then still south of the river. Conneau's Cavalry Corps had crossed the Marne at Château Thierry, and now came up alongside the I. Corps but none of d'Esperey's infantry had reached the Marne. In Foch's Army Grossetti's division brought from the left to counter-attack arrived too late to follow the enemy except with a few shells. It was not until 5 P.M. that Maunoury, after a hard day's fighting in which he had been reinforced by every man that Galliéni could send from the Paris garrison, was able to report that the Germans were in retreat, covered by their artillery.

The evening reports from the air confirmed that everywhere along the battle line retrograde movements of the enemy were taking place; but, his main bodies having got a good start during the day, and his rear guards being able to slip off in the darkness, there was no pursuit until next day. and then Joffre's instructions to Maunoury were to gain ground to the left and endeavour to envelop the enemy's right; the order to head the columns off by flanking them from the west was not issued until the 13th. The

German I. and II. Armies were thus able to pursue their way practically undisturbed back to the Aisne, there to make another stand. The gap between them was then filled by fresh troops released by the capitulation of Maubeuge. At 5 P.M. on the 10th orders were sent by the supreme command to the IV. Army to retire, and at noon on the 11th to the V. Army. The VI. and VII. Armies had ceased their attacks on the 9th and retired to a selected line.

The Victory. — At 8:15 P.M. on the 9th Sir John French's orders changed the word "advance" of the previous days to "pursuit"; Gen. d'Esperey, in an order issued from the historic field of Montmirail on the same evening, accurately summarized the battle:—

"Held on his flanks, his centre broken, the enemy is now retreating towards the east and north by forced marches."

The Germans had entered Belgium and France with 78 divisions, excluding cavalry divisions. Of these they only managed to bring 44 divisions on to the great front between Verdun and Paris, 22 divisions being engaged on the Alsace-Lorraine front, four sent back to East Prussia and eight (XV., III. Reserve, IX. Reserve Corps) kept from the battle at the investments of Antwerp, Maubeuge, etc. The French, with 23 divisions in Alsace-Lorraine against 22 German, had 51 divisions and five British divisions on the Verdun-Paris front. Thus there were 56 Allied divisions against 44 German. The French Reserve divisions were not up to the standard of the German Reserve formations, but all the Allied divisions in falling back had received reinforcement, whilst the Germans hampered by the destruction of the railways and handicapped by the very rapidity of their advance, had not been able to get up drafts to fill the gaps in their ranks, so that as regards actual combatants, numbers were still more in favour of the Allies. Neither the French nor the Germans have yet published their losses, but the Allies captured 38,000 prisoners and 160 guns besides other trophies including colours.

The moral effect of the victory both on the Allies and on the Germans was immense, for the legend of German invincibility was broken. That the material and tactical results were not more important is due partly to the immense fatigue of the Allies after the earlier battles, the long retreat of 13 days and a four-day battle in summer heat. But it would seem to be partly due to the direction of the main Allied attack having been frontal and across the courses of several rivers. Greater success would no doubt have been achieved had Maunoury's flank attack, between the rivers, been made stronger. Possibly his army would have done better even if it had been no stronger but composed of better troops; for it consisted of only two active divisions (7th and 14th), badly mauled in the frontier fighting, an Algerian division and four Reserve divisions shaken by fighting near Amiens. Had some of the 14 British Territorial Force Divisions and 14 mounted brigades with the 6th Division, still in England, been landed at the Channel coast ports to fall on the German communications and rear, a decisive tactical result might have been obtained and the war finished. In any case, with such addition to their forces, the Allies would have been better placed to have obtained a decision in the "Race to the Sea," in which actually they were always "an army corps too few and 24 hours too late."

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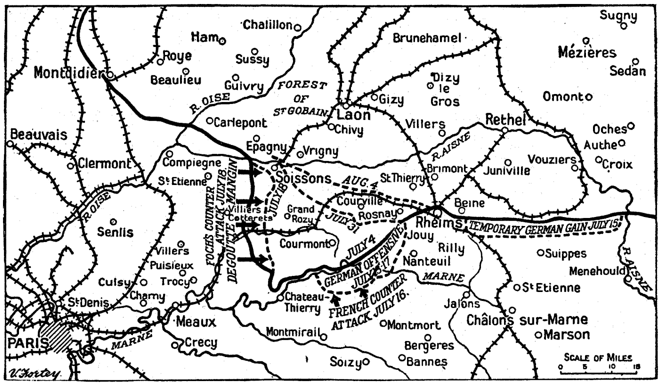
(J. E. E.)

MARNE, SECOND BATTLE OF THE. This marked the turning of the tide in the final year of World War I (*q.v.*). On July 15, 1918, the Rheims district was the scene of the last German offensive on the Western Front, and three days later, when this was stemmed, the ebb began under pressure of the great Allied counterstroke. It was thus composed of two acts, which require separate analysis.

I. THE GERMAN OFFENSIVE IN CHAMPAGNE

This opened on July 15, 1918, and the German plan was to attack on either side of Rheims, the principal effort being made by the German I. and III. Armies towards Châlons, while the VII. Army sought to cross the Marne near Dormans and to converge with the main advance in the region of Épernay. But although this day marked the last German bid for victory, the actual attack was by no means the Germans' supreme effort, nor had it the decisive aims popularly ascribed to it at the time. For Ludendorff still adhered to his guiding idea that the British, severely shaken in the great battles of March and April, should be the target for his decisive blow and that their front in Flanders should be the stage on which he would produce his final drama of victory.



FROM BUCHAN, "HISTORY OF THE GREAT WAR" (THOS. NELSON & SONS)

PLAN OF SECOND BATTLE OF THE MARNE, WHICH DEVELOPED BETWEEN JULY 15 AND AUGUST 4, 1918

The attack on May 27 (*see* CHEMIN-DES-DAMES, BATTLE OF THE, 1918) across the Aisne had been conceived merely as a diversion to draw the Allied reserves away from Flanders. So also with the June 9 attack, less bountiful in its fruits, that had been launched near Compiègne to break down the buttress of Allied territory that lay between the huge salients created by the German attacks of March and May. When, instead, this German attack was broken off by Ludendorff, with little gained but his own reserves still further drained, he considered "the enemy in Flanders still so strong that the German army could not attack" there yet. So he planned a further diversion—to be made by forty-seven divisions attacking on either side of Rheims.

But the sands of time were slipping out for the Germans, and American reinforcements, like the sands of the shore in potential number, were slipping in to become a cement for the Allied line of battle. Appreciating this, Ludendorff intended his Flanders attack, once more towards the nodal point of Hazebrouck, to follow on the 20th, only five days after the Rheims diversion. On July 16 actually, as soon as the Rheims attack was under way, artillery and aircraft were sent off by train to the Flanders front, and Ludendorff himself moved to Tournai to supervise the preparations.

But preparation was never to be completed by execution. For the Rheims diversion had not even the opening success of its predecessors, and on July 18 the Allied counterstroke so jeopardized the Germans' situation that Ludendorff felt compelled to postpone, if not yet to abandon, the fulfilment of his dream. One reason of the failure of the July 15 attack was that east of Rheims it was met by an "elastic defence" in face of which the German onslaught lost its momentum before it reached the real position of the French resistance. Much misplaced praise has been lavished on this "Gouraud manoeuvre." For this ascription of its origin is yet another of the many war legends. The manoeuvre was actually due to Pétain, that cool, unemotional military economist who, called to be commander-in-chief after the Nivelle fiasco of 1917, had systematically worked to rebuild the French army and to restore the stability of its man-power and moral, previously undermined by the extravagant offensives of 1914–1917. One illuminating illustration of the damage done is that cases of desertion alone had risen from 509 in 1914 to 21,174 in 1917.

Not content merely to reorganise, Pétain had set himself to insure against a recurrence of the trouble by tactics that should be an economy both of force and of the nervous force of the combatant. To this end, one method was an elastic defence in depth, to allow the initial shock and impetus of the enemy's attack to be absorbed by a thinly held forward position, and then to await him on a strong position in rear, when the enemy's troops would be beyond the range of the bulk of their supporting artillery. This method Pétain had sought to apply against the attack of June 9, but, although it was partially successful, its full effect was lost through the reluctance of the local commanders, still clinging to their old offensive dogmas, to reconcile themselves to a voluntary yielding up of a few square miles of worthless ground. And before July 15, when the coming German attack was definitely expected, a week's argument was required before Pétain could persuade the lion-hearted Gouraud, in command of the French IV Army east of Rheims, to adopt this elastic manoeuvre. It was finally decided to leave nothing along the line of outposts (constituted by the Monts de Champagne) but "islands" of resistance, which would be required to sacrifice themselves for the purpose of dissipating the enemy attack and keeping it under the well-controlled fire of the main position established in the rear.

But even when we have ascribed it to the right source, the accumulation of historical error is not fully corrected. For the method was not the revolutionary innovation that it has been termed. The Germans, in fact, had used it on Sept. 25, 1915—nearly three years before—to discomfit the great French autumn offensive in Champagne. And the underlying idea can be traced back another 2.000 years—to Cannae, where Hannibal applied it against the Romans in a distinctly more subtle and decisive way. But it sufficed,even in the mild way of 1918, to thwart the German attack east of Rheims, where its effect was immeasurably strengthened by the German failure to achieve such a surprise as had marked their earlier offensives of 1918. Even the exact hour was discovered by an evening raid on July 14 which brought in 27 prisoners who, on being questioned, revealed the fact that the German attack was to be launched next morning, the artillery preparation being timed for 12.10 A.M. Before it began. the French counter-preparation and counter-battery fire opened on the whole of the enemy front Between 4.15 and 5.30 A M., the already shaken German infantry advanced to the attack on a 50 mile front, from Chbteau-Thierry to Massiges (leaking out the Rheims Salient). To the east of Rheims the enemy infantry was broken up by French artillery fire and decimated by the machine-guns distributed along the outpost line before even reaching the main line of resistance, which, in spite of repeated assaults, they failed to break at a single point. To the west of Rheims the situation was less favourable for the French.

German Success at Dormam — But the dramatic nature of this repulse east of Rheims has obscured the fact that it was not the whole battle. West of Rheims the front had only been stabilised for a month since the last German thrust, and the newly improvised position was a handicap to the execution of the elastic method by commanders who were slow to grasp it. In front of the French V. Army (Berthelot) the Germans made some progress between the Marne and the Ardre in the direction of Épernay, and the French centre (V. French Corps and II. Italian) was thrown back on the second position along the line Pourcy-Belval-Reuil-sur-Marne. Lastly, the right of the VI Army (Degoutte) was not able to stop the attackers from crossing the Marne on either side of Dormans. between Jaulgonne and Verneuil. The VII. German Army thus established a bridgehead south of the river, in front of the V. Army's left and the VI. Army's right; it also regained touch with the I. German Army on the slopes of the hlontagne de Reims. Thus here the German attack had deepened the corner of the great bulge made in May, and not only pushed across the Marne but behind Rheims, so that it threatened to cut under this pivot of the Allied resistance. If the threat had an important influence on the French plan for the counter-stroke, its physical progress was stopped on July 16. The German attack had degenerated into local actions, disconnected and therefore useless. By vigorous counter-attacks the French had even recaptured some of the lost ground, while their artillery and aircraft, by bombarding the Marne crossings, made it increasingly difficult for the Germans to obtain supplies. The only progress in the attack—to the south-west of Rheims between the Vesle and the Marne, on July 16—remained fruitless, for it had cost the enemy too dear for him to repeat such sacrifices. Next day a queer hush of expectation spread over the whole battlefield. The stage was set for the great "revanche."

II. THE COUNTER-OFFENSIVE

The Allied counter-offensive under Pétain's direction comprises two phases: (1) the first extends from July 18–25, and includes the victorious battles of Fayolle's main group of armies in the Soissonnais and on the Ourcq, and the closing stage of the defensive battle of Champagne and Rheims during the same period, in which the centre group under Maistre re-established its front and passed to the attack. This first phase, again, comprised three successive manoeuvres: the breaking of the enemy positions by the Reserve group of armies on July 18 and 19; the re-occupation of Château-Thierry and the south bank of the Marne by the centre group of armies, in combination with the right of the Reserve group, on July 20 and 21; and the co-ordination of the advance of the two groups of armies on both banks of the Ourcq in the general direction of Arcy-Sainte-Restitue and Fère-en-Tardenois on July 23 and 24. (2) The second phase, sometimes called the battle of Tardenois, July 29 to Aug. 4, which included the recapture of Soissons and the push towards the Vesle.

French Preparations.—Acting upon Pétain's instructions, Fayolle, commanding the Reserve group of armies, had prepared a counter-offensive against the west flank of the great German salient which protruded between Soissons and Rheims towards the Marne. These preparations were continued with the utmost secrecy while the centre group of armies (Maistre) were checking the last enemy offensive (July 15 and 16) and (from the 17th) arranging a riposte. This was entrusted to two armies, the V. and the EX.—which adjoined the right of the Reserve group of armies. The V. Army (Berthelot), which had been so heavily attacked at Rheims, had eight divisions in first line (including the Italian 3rd Div.), and one infantry and two cavalry divisions in second line. The British 51st and 62nd Divisions were on the move to reinforce it. The IX. Army (de Mitry) had five divisions, including the American 3rd Division in first line, one division in second line, and two reserve divisions, including the American 28th Division.

The Reserve group was to operate with the X. and VI. Armies. The X. Army, under Gen Mangin, who was responsible for the principal attack, had 10 divisions in front line, including the American 1st and 2nd Divisions, placed on the flanks of the Moroccan Division in the centre of the army, and six divisions in second line, making a total of 16 infantry divisions—besides three cavalry divisions. In the rear of the army the British 15th and 34th Divisions were in reserve. In addition, the army was given a large number of tanks and strong artillery reinforcements. The task which Mangin set before his troops was "to break through the enemy front between the Aisne and the Ourcq and push straight on in the direction of Fère-en-Tardenois in *liaison* with the offensive of the VI. Army." On his right the VI. Army, commanded by Degoutte, whose own right was engaged in the defensive battle, had only seven divisions in front line—among them the American 4th and 26th Divisions (American I Corps)—and one division in second line. Degoutte was to attack with his own resources only, reinforced, however, by tanks and by British bombing aircraft.

The attack had been prepared with infinite precautions for maintaining secrecy. The reinforcing divisions were only brought up to the front during the last two days, their movement being carried out by night, between July 14 and 16, the mounted elements marching and the unmounted carried by motor transport. A violent storm which burst during the night of the 17th–18th intensified the darkness and made movements in the woods difficult; but it was favourable to surprise and by 4 A.M. the attacking divisions of the X and VI. Armies were in position and ready to move without any sign of uneasiness having been shown by the enemy. At 4.35. without a single preliminary round, the whole of the artillery opened fire from the Aisne to the Marne, and 16 front line divisions moved forward with the tanks, while all the air squadrons went up. In the X. Army the infantry and tanks advanced without an artillery preparation behind a rolling barrage, turning the enemy's strong defensive positions and quickly gaining a footing on the plateau north-east of the forest of Villers-Cotterets. In the VI. Army, on the contrary, the attacking divisions continued their artillery preparation against the enemy's defensive position for $1\frac{1}{2}$ hours, and only attacked at 6:15 A.M.

The Attack. — The surprise was complete, and along the whole front the enemy lost practically all his advanced units and batteries. His resistance was only effective in two localities--one on the front of the XI. Army Corps, which had no tanks, the other on that of the II. Corps, which came under oblique fire from the heights of Chouy. Mangin received information of the first results achieved towards 8 o'clock, and exploited them without delay by the judicious use of his reserves. Robillot's Cavalry Corps, however, had experienced extreme difficulty in debouching from the forest of Villers-Cotterets, as it was encumbered with troops and baggage, and could as yet operate only with dismounted squadrons. On the first day the enemy lost 12,000 prisoners and 250 guns. The battle raged throughout the night and the next day. The two French armies made substantial progress, even in the difficult region of Louatre-Chouy-Neuilly-Saint-Front, where the XI. and II. Corps combined their attacks to subdue the enemy resistance. The bombing aircraft attacked the Marne crossings and the enemy concentrations at Oulchy-le-Chbteau and Fère-en-Tardenois.

Meanwhile the centre group was preparing to clear the south bank of the Marne. But its units were exhausted by resisting the German attacks of July 15–18, and to reinvigorate them the British XXII. Corps (51st and 62nd Divs.) was brought in to relieve the Italian Corps. Pétain took care to insist that it was not a question of a simple relief. "It will be carried out on the move — that is to say, it will take the form of a surprise attack, carried out with the co-operation of the French units on either side." Nevertheless it was not until the 20th that the Centre group was able to push forward. On that day its IX. Army reached the south bank of the Marne, evacuated by the enemy during the night, while in the V. Army the British XXII. Corps was heavily engaged in the Courton wood.

The fighting continued to be severe throughout July 21 and 22. On the two extreme wings the Germans offered a stubborn resistance to the attacks of the X. and V. Armies which pressed on their flanks. It was clear that they were seeking to gain time to evacuate the material and troops that had been pushed into the Marne "sack." On July 21 the French 30th Division reoccupied Chbteau-Thierry, and the 'American 3rd Division crossed the Marne to the east of the town, and entered the Barbillon wood. In the VI. Army the American I. Corps and the French VII. and II. Corps advanced on the plateau of Etrepilly and Latilly, and on the 22nd, at noon, the VI. Army re-established its communications by way of Château-Thierry. On the same evening fractions of the V. and IX. Armies gained a footing north of the Marne.

The interest of the battle came to be focussed on the heights dominating the Ourcq valley from the north--Orme du Grand Rozoy and Butte Chalmont. Once these heights were captured the Germans could not hope to hold on to the line of the Ourcq. A pause occurred for the relief of tired divisions and the redistribution of the forces. The IX. Army was withdrawn from the front, and the convergence of the advance had so shortened the front that the IX. Army was withdrawn, and even the VI. Army, now reinforced by the fresh American 42nd division, closed up.

Advance Checked at **Fère-en-Tardenois.**—Some progress was made on July 27 and 28: the VI. Army reached the Ourcq and gained a foothold in Fère-en-Tardenois; the V. Army re-occupied its positions on July 15. But from the 28th at noon, the VI. and V. Armies met with a stubborn resistance that was solidly established from Fère-en-Tardenois to Ville-en-Tardenois. The II. Corps was unable to debouch from Fère. The American I. Corps, which had advanced as far as Sergy, was violently counter-attacked there by a Guards Division. The village was taken and retaken four times and finally held by the American 42nd Division, though only at the cost of heavy losses.

In the centre, therefore, the situation remained practically ~ n - changed on July 29 and 30. Only the right of the X. Army made definite progress. On the 28th the XI. Corps took Butte Chalmont, and on the 20th the XXX. and XI. Corps with the British 34th Division occupied Grand Rozoy; but the divisions in line had reached the limit of their powers after several days of incessant fighting.

The Germans had solidly maintained their flanks as a safeguard to cover their line of retreat towards the Vesle. All that could be done was to hasten their retreat by convergent action against the plateaux of the Tardenois. The French counter-offensive had at least cleared the Marne valley and the Paris-Avricourt railway line. The second phase was now to begin, and the French armies, on July 29, received fresh instructions from Pétain. The VI. Army, reinforced by the III. Corps and charged with the main effort was to "push vigorously, and without stopping, in the general direction of Fismes and Bazoches with its whole front, its left to establish itself in the region of Saponay so as to facilitate the debouching of the right wing of the X. Army towards Cramaille." The X. Army was, by successive actions starting from its right (the south), to press in the general direction of Braine. The V. Army was to support the right wing of the VI. Army.

Reliefs were carried out within the armies. The VI. Army put considerable American forces into line: the 42nd and 32nd in the first line, the 4th and 28th in second line, while the 26th and 3rd were being reconstituted in the Marne valley. On the 31st the American 28th, 32nd and 4th Divisions entered Cierges and the Meuniitre wood. In this way the enemy's attention was drawn to the centre on the evening of the 31st, while the next morning (Aug. 1), at 4:45, the right of the X. Army attacked in its turn and, after severe fighting, occupied the whole crest that extends from L'Orme du Grand Rozoy to Saponay inclusive. On the same day the VI. Army, though it succeeded in capturing the Meunière wood, failed before Saponay on account of the extreme fatigue of its attacking divisions.

German Retirement to the **Vesle.**—But at dawn on Aug. 2 the three French armies found themselves facing void. The enemy had fallen back on the Vesle, where he intended to establish himself firmly. On the 3rd, the left of the X. Army, which had reoccupied Soissons unopposed the previous evening, reached the Aisne. Its right, together with the VI. and V. Armies, arrived in the immediate vicinity of the Vesle. Contact was re-established everywhere. All along the front the German artillery and machine-guns were active. On Aug. 4 and 5 the Allied troops aligned themselves along the banks of the Vesle, the American 32nd Division entered Fismes and the advanced guards succeeded in crossing the river at some points. But the enemy counter-attacked vigorously, and in view of this well-organized resistance and of the impending Allied operations elsewhere (see AMIENS, BATTLE OF, 1918, and WORLD WAR I), Foch decided to suspend the offensive. (B. H. L. H.)

MARNIX VAN SINT ALDEGONDE, PHILIPS VAN (1540–1598), Flemish nobleman, statesman and author, one of the earliest Calvinist uriters in the Netherlands. Born in Brussels in 1540, he studied at Louvain, Paris and Dôle. He intended to take orders but while staying in Italy became a Calvinist and studied at Geneva, 1560–61. Returning to the Netherlands, he took an active part in the Reformation, but fled to Germany, where he wrote his famous and influential satire, *Biencorf* der H. *Roomsche Kercke* (1569; German trans. by J. Fischart, 1580), apparently defending the Church of Rome but in reality ridiculing it. In 1571 he entered the service of William of Orange. He went on a mission to England, 1581–82; took part in the settlement of the Pacification of Ghent (1576); requested help for the Netherlands at the diet of Worms (1578); and in 1583 was made burgomaster extraordinary of Antwerp, which he had to surrender in 158j to the duke of Parma. Disheartened, he retired to his castle. West-Souburg, in Walcheren, **a** here he revised his fine translation of the Psalms from the Hebrew (1st ed. 1580; 1591). In 1594 he was entrusted nith the translation of the Bible, but only completed Genesis and the Psalms. He also adapted his *Biencorf* as a *Tableau dcs Différends de la Religion* and wrote essays on politics and religious polemics. The words of the *Wilhelmus,* the Dutch national anthem, are attributed to him. but his authorship has not been proved. He died in Leyden on Dec. I j, 1598.

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MARONI (Dutch: MAROWIJNE), a river forming the boundary between Dutch and French Guiana. South America, rises in the Tumuc-Humac mountains and flows 450 mi. mostly through tropical forest to reach the Atlantic about 18 mi. below Alhina and Saint-Laurent. Its upper course is called the Itani in French and Litani in Dutch and its middle course the Aoua or Lawa. Moderate-sized vessels can reach Saint-Laurent. Gold placer mining is conducted on a small scale along the Lawa but the basin is otherwise undeveloped. The river's chief tributary is the Tapanahoni from the southwest. (G. LN.)

MARONITES (AL-MAWARINAH), Roman Catholics following the Syro-Antiochene rite, form the most numerous religious community of the republic of Lebanon (*q.v.*). Their immediate spiritual head under the pope is the Maronite patriarch, residing in Bkirki near Beirut, the capital of the republic; his title is "patriarch of Antioch and. all the east." The name of the group derives from two historical figures, the first an influential Syrian solitary of the late 4th and early 5th centuries, called St. Maron id. *c.* 423). At his tomb a monastery was built near Apamea on the Orontes. Because of persecution from the Jacobites, the monks transferred the monastery to more remote Lebanon. where it becaine the dynamic religious centre of the region. According to Maronite legend, a later monk of this community. St. John Maron, became patriarch of Antioch in 68j–jo; and the father of the Maronite nation. The tradition is uncritical. though St. John Maron may well have been an energetic patriotic bishop of Lebanon. The Maronites, hardy, martial mountaineers, have always valiantly preserved their liberty and folkways. The Moslem empire could not absorb them. and two Omayyad caliphs paid them tribute. Under John Maron they became a fully independent people after routing the invading Byzantines of Justinian II in 694.

According to Maronite tradition. the Maronites were always orthodox Christians in union with the Roman see, but the best evidence indicates that for centuries they were Monothelites (*q.v.*), following the heretical doctrine of Sergius, patriarch of Constantinople. who affirmed that there was a divine but no human will in Christ. According to the medieval bishop William of Tyre, the Maronite patriarch sought union with the Latin patriarch of Antioch in 1182. .kt this time the Maronites were certainly close friends and allies of the French crusaders, and an unstable union with Rome at this early date is most probable. At a1l events: a definitive consolidation of the union came in the 16th century, thanks in great part to the work of the Jesuit John Eliano. In 1584 Pope Gregory XIII founded the Maronite college in Rome, which still flourishes under Jesuit administration. In this centre great scholars and leaders were trained. of whom the most distinguished were the four Assemani (al-Sam'ani), two brothers and their two nephews. who worked in the 18th century.

During the days of the Ottoman empire the Maronites, largely unhampered because of their isolation. maintained their religion and customs under the protection of France. In the 19th century the Turkish government incited the neighbouring Moslem sect, the Druzes (*q.v.*), to harass the blaronites. This policy culminated in the great Maronite massacre of 1860, and as a result of this tragedy the Maronites achieved formal autonomy within the Turkish empire under a nonnative Christian ruler. After the downfall of the Ottoman empire, the Maronites of Lebanon along with Syria became self ruling in 1920 under French protection. In 1944 the fully independent republic of Lebanon was established. Other religions in addition to that of the Maronites, exist in the republic, but the president is always a Maronite.

The language of the Maronites is Arabic but their liturgical tongue is West Syriac. The Maronite cultural centre is the University of St. Joseph, conducted by French Jesuits at Beirut. According to the 1952 census there are 392,656 Maronites in Lebanon and Syria. In addition some 15,000 live in Egypt and Palestine.

Cnder the pressure of the persecutions of the 19th century, the Maronites began to emigrate from the near east in great numbers, and as many as 475,000 can be found in the lands of southern Europe and in Sorth and South America. The *émigrés* keep their own liturgy and have their own clergy (some of whom are married?, but are subject to the local Latin-rite bishops who work in collaboration with the Maronite patriarch, who remains the true head of the dispersed congregations.

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MAROT, CLÉMENT (1496–1544), French poet, was born at Cahors. the capital of the province of Quercy, some time during the winter of the year 1496–1497. His father, Jean Marot ic. 1463–1523), whose name appears as des Mares. Marais or Marets. was a Korman, a poet of considerable merit, and held the post of *escripvain* (apparently uniting the duties of poet laureate and historiographer) to Anne of Brittany. Clitment appears to have been educated at the university of Paris, and to have then begun the study of law. Jean Marot took great pains to instruct his son in the fashionable forms of verse-making, after the complicated rules of the *rhétoriqueurs.* Clément himself practised with diligence this poetry (which he was to do more than any other man to overthrow), and he has left panegyrics of its coryphaeus Guillaume Crétin, the supposed original of the Raminagrobis of Rabelais, while he translated Virgil's first eclogue in 1512.

Clément became page to Nicolas de Neuville, seigneur de Villeroy, and this opened to him the way to court life.

As early as 1514, before the accession of Francis I, Clément presented to him his *Judgment of Minos,* and shortly afterwards he was either styled or styled himself *facteur* (poet) *de la reine* to Queen Claude.

In I j19 he was attached to the suite of Marguerite d'Angoulême, the king's sister, the great patron of letters. He was also a great favourite of Francis himself, attended the Field of the Cloth of Gold in 1520, and celebrated it in verse.

In 1524, Marot accompanied Francis on his disastrous Italian campaign. He was wounded and taken at Pavia, but soon released, and he was back again at Paris by the beginning of 1525. His luck had, however, turned. Marguerite for intellectual reasons; and her brother for political, had hitherto favoured the double movement of *Aufklärung,* partly humanist, partly Reforming, n-hich distinguished the beginning of the century. Formidable opposition to both forms of innovation, however. was manifested. and Marot. who was at no time particularly prudent, was arrested on a charge of heresy and lodged in the Chbtelet, February 1526. A friendly prelate. acting for Marguerite, extricated him before Easter. His imprisonment is described in a vigorous poem entitled *Enfer.* His father died about this time, and Marot appears to have succeeded to his place of valet de chambre to the king. He was certainly a member of the royal household in 1528 with a stipend of 250 livres, besides which he had inherited property in Quercy. In 1530, probably, he married.

Sext year Marot was again in trouble. not it is said for heresy, but for attempting to rescue a prisoner, and was again delivered; this time the king and queen of Navarre seem to have bailed him themselves.

In 1532 he published (it had perhaps appeared three years earlierj, under the title of *Adolescence Clémentine,* the first printed collection of his works. Of the many editions of this work Dolet's edition of 1538 is believed to be the most authoritative. Unfortunately, Marot was implicated in 1535 in the affair of

"The Placards,"[1] and this time he was advised or thought it best to fly. He passed through Béarn, and then made his way to Renée, duchess of Ferrara. At her court he wrote his celebrated *Blasons* (a descriptive poem, improved upon mediaeval models), which set all the verse-writers of France imitating them. But the duchess Renée was not able to persuade her husband, Ercole d'Este, to share her sympathy with the Reformers, and Marot had to quit the city. He then went to Venice, but before very long the pope Paul III. remonstrated with Francis I. on the severity with which the Protestants were treated, and they were allowed to return to Paris on condition of recanting their errors. Marot returned with the rest, and abjured his heresy at Lyons. In 1539 Francis gave him a house and grounds in the suburbs.

It was at this time that his famous translations of the psalms appeared. The powerful influence which the book exercised on contemporaries is not denied by anyone. The psalms were sung in court and city, and they materially advanced the cause of the Reformation in France. Indeed, the vernacular prose translations of the Scriptures were in that country of little merit or power, and the form of poetry was still preferred to prose. At the same time Marot engaged in a literary quarrel with a bad poet named Sagon, who represented the reactionary Sorbonne. Half the verse-writers of France ranged themselves among the Marotiques or the Sagontiques. The victory, as far as wit was concerned, naturally rested with Marot, but probably a certain amount of odium was created against him, which may have had something to do with his subsequent misfortunes.

The publication of the psalms gave the Sorbonne a handle, and the book was condemned by that body. In 1543 it was evident that he could not rely on the protection of Francis. Marot accordingly fled to Geneva; but he had, like most of his friends, been at least as much of a freethinker as of a Protestant, and the austere city of Calvin was no place for him. He had again to fly, and made his way into Piedmont, and he died at Turin in the autumn of 1544.

In character Marot seems to have been a typical Frenchman of the old stamp. cheerful. good-humoured and amiable enough, but probably not very much disposed to elaborately moral life and conversation or to serious reflection. With other poets like Mellin de Saint Gelais and Bordeau, with prose writers like Rabelais and Bonaventure Desperiers, he was always on excellent terms.

His importance in the history of French literature is very great. and was long rather under- than overvalued. Coming immediately before a great literary reform—that of the Pléiade—Marot was both eclipsed and decried by the partakers in that reform. In the reaction against the Pléiade he recovered honour; but its restoration to virtual favour, a perfectly just restoration, again unjustly depressed him. Marot was a reformer, and a reformer on perfectly independent lines, and he carried his own reform as far as it would go. His early work was couched in the *rhétoriqueur* style, the distinguishing characteristics of which are elaborate metre and rhyme, allegoric matter and pedantic language. In his second stage he entirely emancipated himself from this, and became one of the easiest, least affected and most vernacular poets of France. In these points indeed he has, with the exception of La Fontaine, no rival, and the lighter verse-writers ever since have taken one or the other or both as model. In his third period he lost a little of this flowing grace and ease, but acquired something in stateliness, while he lost nothing in wit.

The most important early editions of Marot's *Oeuvres* are those published at Lyons in 1538 and 1544. In the second of these the arrangement of his poems which has been accepted in later issues was first adopted. In 1596 an enlarged edition was edited by François Mizière. Among modern editions are those of P. Jannet (1868–72; new ed., 1873–76); and of G. Guiffrey, only vols. ii and iii (1875–81) of which were issued. For iniormation about Marot himself *see* the section concerning him in G. Saintshury's *The Early Renaissance* (1901); *A.* Tilley, *Literature of the French Renaissance,* vol. i, ch. iv (1904); P. Villey, *Recherches sur la Chronologie des oeuvres de Marot* (1921); *P. A.* Becker, *Clément Marot, Sein Leben und Seine Dichtung* (1926).

[1]These "placards" were the work of the extreme Protestants. Pasted up in the principal streets of Paris on the night of Oct. 17, 1534, they vilified the Mass and its celebrants, and thus led to a renewal of the religious persecution.

MAROT, DANIEL (1661–1752), architect, engraver and decorative designer, was trained under his father, Jean Marot (*q.v.*), in his native Paris. He was a Protestant and retired to Holland in 1684, thereby anticipating the revocation of the Edict of Nantes. He entered the service of the stadholder, the prince of Orange, for whom he designed the audience chamber at The Hague (1686), as well as apartments and gardens at the new palace of Het Loo (c. 1692); he also worked for private Dutch clients. In 1694 he followed his master. now William III. to England and henceforward often introduced the royal arms and cipher into his engraved designs. In the frontispiece to his collected works he is styled Arclzitecte de *Guillaume III,* but if he received any official appointment it was as intendant of the royal gardens only. He certainly provided several designs for the east parterre at Hampton court, and was probably consulted about the interior decoration and furniture also. though his pay seems to have been borne on Dutch, not English, funds. A group of delftware tulip vases, milk pans and tiles bearing the royal insignia, some of which survive, appear to have been made for Hampton court after his designs, and a state coach for William III was constructed at The Hague to Marot's design. He returned to Holland about 1698 and until his death (at The Hague. June 4, 1752) continued to work for the stadholder's family, notably at Slot Oranienstein, in Friesland, and in the Huis ten Bosch. His later work for private patrons at The Hague included the houses of the Fagel, Van Schuylenburch and Van Wassenaar families, the present royal library and the Portuguese synagogue.

His numerous engraved designs for furniture, silver, .textiles, interior decoration, etc., in an opulent and often fantastically elaborate style, exercised a widespread influence. As a record of contemporary fashions. particularly of the beginnings of the European taste for oriental motifs, they are invaluable. Although Marot's style derives in some degree from Jean Lepautre and J. Bérain (*q.v.*) it contributed nothing to the formation of the Louis XIV style in France itself, but is rather a Dutch variant of that style.

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MAROT, JEAN (c. 1619–1679), French architect and engraver, was one of a large family of Parisian craftsmen and artists. He was architect of various private houses, including the Hôtels de Pussort, de Mortemart and de Monceau, but he is chiefly renowned for his two great series of architectural engravings known as "Le Petit Marot" and "Le Grand blarot," essential for the study of French 17th-century architecture. In addition he engraved a large number of ornamental designs for chimneys, ceilings, etc., a practice in which he was followed by his son Daniel Marot (*q.v.*).

Jean Marot died in Paris, Dec. 15, 1679. (F. J. B. W.)

MARPRELATE CONTROVERSY, a war of pamphlets waged in 1588 and 1589 between a puritan writer who employed the pseudonym "Martin Marprelate" and defenders of the established church. Martin's tracts are characterized by violent and personal invective against the Anglican dignitaries, and by a plain and homely style combined with pungent wit. The special point of his attack was the episcopacy. The pamphlets were printed at a secret press established by John Penry, a Welsh puritan. After three tracts had been issued, it appeared to some of the ecclesiastical authorities that the only way to silence Martin was to have him attacked in his own railing style, and accordingly certain writers of ready wit, among them John Lyly, Thomas Nashe and Robert Greene, were secretly commissioned to answer the pamphlets. Among the productions of this group were *Pappe With* an Hatchet (1589), probably by Lyly, and ***An*** Almond for a *Parrat* (1590), which. with certain tracts under the pseudonym of Pasquil. has been attributed to Nashe (*q.v.*).

Meanwhile, in July 1589, Penry's press, now at Wolston near Coventry. produced two tracts purporting to be by "sons" of Martin. but probably by Martin himself, namely, Theses *Mar-*

tinianae by Martin Junior, and *The Just Censure of Martin Junior* by Martin Senior The press was seized; Penry. however was not found, and in September issued from Wolston or Haseley *The Protestation of Martin Marprelate,* the last work of the series. though several of the anti-Martinist pamphlets appeared later Penry then fled to Scotland. but nas later apprehended in London. charged nith inciting rebellion and hanged (May 1593).

BIBLIOGRAPHY.—*See,* for list and full titles of the tracts, related documents and discussion of the authorship, E. Arber's *Introductory Sketch to* the *Martin Marprelate Controversy* (1880), which. however, gives no connected account of the matter. *See* also articles on Penry and Job Throckmorton in *Dict. of Nat. Biography.* The more important tracts have been reprinter1by Petheram in his series of *Puritan Discipline Tracts* (1842–60), in Arber's *English Scholar's Library* (1879–80), in *R.* W. Bond's edition of Lyly and in the editions of Nashe.

MARQUESAS or MENDAÑA **ISLANDS.** The island of Fatu Hiva in the Marquesas archipelago, discovered by Alvaro Mendaña in 1595, was the first of the islands of French Polynesia to be made known to the outside world. He gave the archipelago the name Islas Marquesas de Mendoza in honour of the wife of the viceroy of Peru, who was the patron of his expedition. The name was shortened by the French to Marquesas. Comprising an archipelago of 11 islands between 8° and 11° S. latitude and 138" and 140° W. longitude, they are the archipelago of French Polynesia nearest the equator. Their total area is 385 sq.mi. They are of volcanic origin. Ua Pou Island having been formed the most recently. All of them are the tops of a high submarine chain of mountains, the peaks of some of which are at elevations of more than 3,000 ft. Radiating from them are secondary chains between which are valleys that terminate on the shore in deep hays. Knife-edged ridges, separating most of the valleys on the larger islands, isolated the original Polynesian inhabitants into a number of hostile communities. These people occupy the only cultivable and hahitable areas. Streams! made torrential by frequent rains. course through the islands over high cascades between vertical walls. Subterranean watercourses debouch at the shore, and even ofishore, where a native fisherman can get fresh water by plunging into the sea with hall a coconut shell fastened to his breast.

These islands, near the equator, have a hot climate. The mean annual temperature at sea level is about 78° F., and the range from the coldest month (August) to the warmest month (November) is only 4°. The rainfall, subject to great fluctuations, varies from 30 to 100 in. Prolonged droughts which injure the breadfruit trees sometimes cause famines. There are only small areas of level land near the coast where wet-land taro can be raised. Ripe breadfruit is preserved in storage pits for times of scarcity. Thirty-three varieties of this tree have been identified in the islands.

The vegetation of the larger, higher islands, typically oceanic, is classified in zones from sea level to the high elevations. In the lower areas are found the breadfruit. pandanus, hibiscus. guava. chestnut, coconut and many herbaceous plants. In the intermediate zones there are dense thickets of hibiscus, many ferns and coarse grasses. The higher zones. often shrouded in clouds, have dense rain forests of tree ferns and other evergreen trees and, in the gulches. wild bananas and bamboo.

The Marquesans, a handsome and charming people of excellent physique. are among the taller and lighter-skinned Polynesians. They fell prey to many diseases introduced by Europeans in the middle of the 19th century. The population steadily decreased from about 100,000 at the time of their discovery to 3.936 (1956). The more common diseases in modern times are filariasis, yaws, tetanus and especially tuberculosis. The livestock of the indigenous population includes pigs and cattle. Pork is the main food at all ceremonial feasts. Wild cattle roam on extensive plateaus on some islands. The natives also raise horses. The land belongs to the French government, but any land available for colonization is accessible with difficulty, and several attempts at settlement proved unsuccessful.

The Marquesas, like the other islands in French Polynesia. are divided into districts; they were placed under the authority of a physician representing the governor. Of the more important islands, the northern district comprises Nuku Hiva (capital Tiaohae). Ua Huka. Ua Pou and Hanae. The southern district includes Hiva Oa (capital Atuona), Motane, Tahuata and Fatu Hiva.

See also PACIFIC ISLANDS. (J. W. CR.)

MARQUESS or MARQUIS, a title and rank of nobility. Etymologically the word has the same meaning as margrave (*q.v.*), denoting a count or earl holding a march or mark, that is. a frontier district; but this original significance has long been lost.

In England the Late Latin term *marchiones* (plural) was early applied to the lords of the Welsh marches *(see* MARCH, EARLS OF) ; but it was there used in a sense descriptive only of their lordships' location near the frontier without implying that they were superior to other earls. On Dec. 1. 1385, however. Robert de Vere. 9th earl of Oxford. was created marquess of Dublin with precedence between dukes and earls; the other earls resented this creation. and the patent of the marquessate was revoked on Oct. 13. 1386, after its holder had been created duke of Ireland. John Beaufort, earl of Somerset: a legitimated son of John of Gaunt. was created marquess of Dorset on Sept. 29, 1397, but degraded to his former earldom on Nov. 3. 1399; and when the commons petitioned for his restoration to the marquessate in 1402, he objected because "le noun de Marquys feust estraunge noun en cest Koialme." On June 24, 1443, honever, his son Edmund Beaufort was raised to be marquess of Dorset, after which the title retained its place in the peerage. As earlier creations became extinct or were raised to dukedoms, the premier marquessate of England in the 20th century was that of Winchester, created on Oct. 11, 1551.

A marquess has precedence next after a duke, is "most honourable" and is styled "my lord marquess"; his mantle of parliament is scarlet. with three and a half double linings of ermine; his coronet is worn at coronations.

In western Europe the Carolingian *marchiones* or margraves had been royal officials whose duty of defending a frontier might justify an exception's being made to the normal rule that no count should hold more than one countship or county. Their authority was thus not much less than that of a duke (*q.v.*); indeed the term *Markherzog* is occasionally iound instead of *Markgraf.* But as conditions on the frontiers or the frontiers themselves were changed, the special importance of the old marches diminished.

In France, as the great feudatories' power grew at the expense of the king's, the old *marquisats* were practically lost in the great duchies or countships. Then, with the multiplication of little fiefs, minor counts holding several such lordships took to assuming the style of marquis to distinguish themselves. The kings indeed were very chary of erecting *marquisats;* that of Trans in Provence, raised from *baronnie* in 1505 for Louis de Villeneuve. is reckoned as the *premier marquisat de France.* Moreover the rank of marquis. always inferior to that of a duke, was in a controversial relation to that of a count. Sometimes a count's nobility was better established and his fief greater than that of any marquis; sometimes a marquis with a royal patent should obviously have precedence.

These ambiguities served to bring the title into disrepute in the 17th and 18th centuries. as being too often self-made or pretentious; and after the Revolution had abolished it Napoleon did not see fit to revive it. Louis XVIII, reviving it after the Restoration, gave its holders definitive precedence between dukes and counts.

In Italy the mark (*marca,* plural *marche*) long survix-ed as a major territorial unit, though the original Carolingian demarcations were considerably altered. By the 14th century. however, barons and *signori* had begun to erect their fiefs into *marchesati,* after which the title gren· to have much the same fate as the French *marquisat.*

In Spain the remnant of the original Marca Hispanica was merged in the countship of Barcelona. The first Castilian *marquesado* was that of Villena (on the Valencian frontier). created for Don Alonso of Aragon in 1376: the Pacheco family. who acquired it from the cron-n in 1445, subsequently became dukes of Escalona. The next senior *marquesado* was that of Santillana (1445).

MARQUETRY (Fr. *marqueterie,* from *marqueter,* to inlay, literally to mark, *marquer),* an inlay of ornamental woods. ivory. bone, brass and other metals, tortoise-shell, mother-of-pearl, etc., in which shaped pieces of different materials or tints are combined to form a design. It is a later development of the ornamental inlays of wood known by the name of Intarsia, and though in the main the latter mas a true inlay of one or more colours upon a darker or lighter ground, while marquetry is composed of pieces of quite thin wood or other material of equal thickness laid down upon a matrix with glue, there are examples of Intarsia in which this mode of manufacture was evidently followed. In order to gain greater relief the wood was shaded or tinted. A combination of tortoise-shell and metal, the one forming the ground and the other the pattern upon it, which may be classed as marquetry also appears in the 17th century. The subjects of the *intarsiatori* are generally arabesques or panels with elaborate perspectives, either of buildings or cupboards with different articles upon the shelves seen through half-open doors. The later *marqueteurs* used a freer form of design for the most part, and scrolls and bunches of flowers appear in profusion, while if architectural forms occur they are generally in the shape of ruins amid landscape. The greater portion of the examples in England are importations, either from Holland (in which country very fine work was produced during the latter half of the 16th and 17th centuries) or from France. The reputation of the Dutch *marqueteurs* was so great that Colbert engaged two, named Pierre Gole and Vordt, for the Gobelins at the beginning of the 17th century. Jean Macé of Blois, the first Frenchman known to have practised the art, who was at work in Paris from 1644 (when he was lodged in the Louvre), or earlier, till 1672, as a sculptor and painter, learned it in the Netherlands. His title was "menuisier et faiseur de cabinets et tableaux en marqueterie de bois"; but as early as 1576 a certain Hans Kraus had been called "marqueteur du roi." Jean Macé's daughter married Pierre Boulle, and the greatest of the family, André Charles Boulle (*q.v.*), succeeded to his lodging in the Louvre on his death in 1672. The members of this family are perhaps the best known of the French *marqueteurs*. Their greatest triumphs were gained in the marquetry of metal and tortoise-shell combined with beautiful ormolu mountings. The names of Roentgen, under whom the later German marquetry perhaps reached its highest point, Riesener and Oeben, testify to their nationality. A good deal of marquetry was executed in England in the later Stuart period, mainly upon long-case clocks. cabinets and chests of drawers, and it is often of real excellence. Marquetry in a shallower form was also extensively used in the latter part of the 18th century. The most beautiful examples of the art in Italy are mainly panels of choir stalls or sacristy cupboards, though marriage coffers were also often sumptuously decorated in this manner. With the increase in luxury and display in the 17th and 18th centuries in France and Germany cabinets and escritoires became objects upon which extraordinary talent and expenditure were lavished. In south Germany musical instruments, weapons and bride chests were often lavishly decorated with marquetry. In modern practice as many as four or even six thicknesses are put together and so cut. When all the parts have been cut and fitted together face downwards, paper is glued over them to keep them in place and the ground and the veneer are carefully levelled and toothed so as to obtain a freshly worked surface. The ground is then well wetted with glue at a high temperature and the surfaces squeezed tightly together between frames called "cauls" till the glue is hard. There are several modes of ensuring the accurate fitting of the various parts, which is a matter of the first importance if the artistic effect is to be secured. *(See* INLAYING.)

MARQUETTE, JACQUES (1637–1675), French Jesuit missionary and explorer, codiscoverer (with Louis Jolliet) of the Mississippi river, was born at Laon, France, went to Canada in 1666 and was sent in 1668 to the western end of Lake Superior. In 1672 he was ordered to accompany Jolliet in the exploration of the Mississippi, of which the French had gained some knowledge from various Indians living near the Great Lakes. In the spring of 1673. the expedition left St. Ignace. Mich. The route taken lay up the northwest side of Lake Michigan, up Green bay and the Fox river, over the portage to the Wisconsin river and down the latter into the Mississippi river, which was descended to within 700 mi. of the sea, near the confluence of the Arkansas river.

Having entered the Mississippi on June 17, Marquette and his companions turned back at the end of July and returned to Green bay (by way of the Illinois river): passing through the Chicago portage at the end of Sept. 1673. After the journey, Marquette fell ill of dysentery, and a fresh excursion which he undertook to plant a mission among the Indians of the Illinois river in the spring of 1675 proved fatal.

Marquette died on his way home to St. Ignace, at Ludington. Mich., near the lesser and older Marquette river (May 18, 1675).

The state of Wisconsin has placed his statue in the capitol at Washington, D.C. His name has been given to a railroad, to a town and to a diocese.

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MARQUETTE, a city and port of the upper peninsula of Michigan. U.S., and seat of Marquette county, surrounded by rugged hills, is located on Lake Superior in a summer and winter resort area. about 400 mi. N. of Chicago.

Established in 1549 as Worcester. it was the first shipping point on the lake for the iron ore, pig iron and lumber of the region. It was renamed in 1850 for Father Jacques hiarquette. the Jesuit missionary-explorer, incorporated as a village in 1859. was largely destroyed by fire in 1868 but rapidly rebuilt, and chartered as a city in 1871.

A city commission form of government was established in 1914 and a city-manager form was adopted in 1946.

Marquette is still an important ore shipping centre with railroad shops and impressive docks. Other industries include chemicals, foundry products, mining machinery, wood products and foods. It is the home of Northern Michigan college (1899, state supported) and Michigan State Branch prison (1885), and is a Roman Catholic diocesan centre (St. Peter's cathedral). Presque Isle. within the city. is a 328-ac. natural park deeded to Marquette by the U.S. government in 1886. Sugar Loaf mountain. K. I. Sawyer air force base and Cherry Creek fish hatchery are nearby. For comparative population figures *see* table in MICHIGAN: *Population.* (K. B.)

MARQUIS, DON (DONALD ROBERT PERRY MARQUIS) (1878–1937), U.S. poet and playwright, creator of Archy and Mehitabel, was born in Walnut, Ill., July 29, 1878, and educated at Knox college, Galesburg, Ill.

Marquis worked as a reporter on several newspapers and assisted Joel Chandler Harris in editing the *Uncle Remus* magazine. From 1912 to 1922 he conducted a column, "The Sun Dial," in the *New York Sun,* and in it first appeared that extraordinary pair of creatures. Archy the cockroach and Mehitabel the cat. Archy's poetic reflections on the world as seen "from the under side," and Mehitabel's racy misadventures, were combined in a unique record, part whimsical, part bitter, wholly philosophical. Among Marquis' published collections of humorous poetry, satirical prose and plays are *Danny's Own Story* (1912), *Dreams and Dust* (1915), *Hermione* (1916), *The Old Soak* (1921), *Sonnets to a Red Haired Lady* (1922), *The Dark Hours* (1924), *Out of the Sea* (1927) and *Archy and Mehitabel* (1927).

Marquis died at Forest Hills, N.Y., on Dec. 29, 1937, after a long illness.

MARR, CARL (1858–1936), U.S. painter, was born at Milwaukee, Wis., on Feb. 14, 1858. He was a pupil of Henry Vianden in Milwaukee, of Schauss in Weimar, of Gussow in Berlin, and of Otto Seitz, Gabriel and Max Lindenschmitt in Munich. His first work, "Ahasuerus, the Wandering Jew," received a medal in Munich. One of his pictures, "Germany in 1806," received a gold medal in Munich and is in the Eichendorfschule of Konigsberg. A large canvas, "The Flagellants," in the Milwaukee Auditorium building, received a gold medal at the Munich exposition in 1889. Another canvas, "Children's Party," in the Phoebe Hearst collection at the University of California, Berkeley, was exhibited in Munich.

Marr became a professor in the Munich academy in 1893, and in 1895 a member of the Berlin academy of arts.

MARR, NIKOLAI JAKOVLEVICH (1865–1934), Soviet linguist, archaeologist and philologist was born on Jan. 6, 1865, at Kutais. In 1930, he nas elected vice-president of the Academy of Sciences of the U.S.S.R. Marr's substantial achievements in Caucasian archeology and philology have been obscured by his notorious linguistic theories. He postulated a stage development (corresponding to Marxist economic stages) of all the aorld's languages from an original word stock of four elements: *sal, ber, yon* and *rosh.*

Marr died on Dec. 20, 1934, at Leningrad

See L. L. Thomas, The Linguistic Theories of *N.* Ja. Marr, vol. 14 (1957). (L. L. T.)

MARRAKESH (erroneously MOROCCO or MAROCCO CITY), southern capital of Morocco. It lies in a spacious plain — Blad el Hamra, "The Red" — about 15 mi. from the northern underfalls of the Atlas, and 96 mi. E.S.E. of Safi, at a height of 1,500 ft. Ranking during the early centuries of its existence as one of the greatest cities of Islam, Marrakesh has long been in a state of grievous decay, but it is rendered attractive by the exceptional beauty of its situation, the luxuriant groves and gardens by which it is encompassed and interspersed, and the magnificent outlook which it enjoys toward the mountains. Open spaces of great extent are numerous within the walls. Tabiya or rammed concrete of red earth and stone is the almost universal building material, and the houses are consequently seldom more than two stories in height. The great square, Djemaâ-el-Fna, situated in the middle of Marrakesh, is crowded daily; the very extensive suks are situated on the edges of the square. The palace of the sultan covers an extensive area, and beyond it lie the imperial parks of Agudal, 2 mi. long and about 5,000 feet wide, planted with fruit trees of all sorts; the palm grove which surrounds Marrakesh stretches as far as the Tensift; it covers 32,000 acres and contains 90,000 palm trees.

The ramparts of Marrakesh are pierced by monumental gateways; the most beautiful is the Kasba gate, Bab-Aguenaou. The chief religious buildings are the mosque of Koutoubiya, or Mosque of the Scribes (12th century), with its monumental tower 221 ft. high, the most beautiful monument of Marrukesh; the mosque of Kasba or Djama-Moulay-Yazid, near to which are the tombs of the Sa'adi sharifs, fine monuments in which are buried the sovereigns of the last-but-one Moroccan dynasty (16th–17th centuries); Djama-el-Mouasine; Djama-Bab-Doukkala, the sanctuary of Sidi-ben Slimane-el-Djazouli, that of Sidi-bel-Abbés, patron of Marrakesh; the medersa Ben-Youssef (16th century). There are three beautiful monumental fountains, those of El-Mouasine, of Sidi-el-Hassan or Ali and of Sekkaia Echrob ou-Chouf. The palace of Bahia, built from 1894 to 1900, serves as a residency.

A European town was built 1½ mi. from the original one, at the foot of the hill of Gueliz (1,728 ft.), which is crowned by a military camp. Founded in 1913, it is traversed by wide avenues bordered with trees. The pop. (1960) of Marrakesh was 243,134. The natives are a mixture of the descendants of Andalusian Moors of original Rehemna of the neighbouring plains, of Chleuh mountaineers and of Sahara Draoua.

Marrakesh is the chief town of the province of Marrakesh, the residence of a khalif of the sultan and the centre of action of the grand Kaid Glaoui. It is connected by good roads with Mazagan, Mogador, Safi Taroudant, Warzazat and Casablanca; a broad-gauge railway (56.7 inches), finished in 1928, joins Marrakesh to Casablanca (158 miles).

Marrakesh, designated Morocco by the old European authors, was founded in 1062 by Youssef-ben-Tachfin, founder of the dynasty of the Almoravides. It was from Marrakesh that Abd-el-Moumen, the first sovereign of the dynasty of the Almohades, set out to conquer all northern Africa, and it was that town that he made the capital of his empire (1147). From 1184 to 1198, the sultan Yakout-el-Mansour built there the mosque and the tower of Koutoubiya, at the same time that he caused to be built the Giralda at Seville and the mosque of the tower of Hassan at Rabat, the most famous monuments of the Almohade period and the best built of the Maghreb. The Merinide sultans preferred Fez to Marrakesh, but the Saadi sharifs again made it the chief Moroccan capital. The Alaouite sharifs of the reigning dynasty, from time to time, stay there for more or less prolonged periods. After a violent combat at Sidi-bou-Othman, where he put to flight the bands of the insurgent El-Hiba, Col. Mangin entered Marrakesh with the French troops on Sept. 7, 1912.

An important airport was constructed there in 1940 which was subsequently greatly enlarged by the U. S. army after the North Africa landings in Nov. 1942.

See A. Chevrillon, Marrakesh *dans les palmes* (Paris, 1919); Z. and I. Tharaud, Marrakesh ou *les* seigneurs de *l'Atlas* (Paris, 1919).

MARRAM GRASS (Ammophila breviligulata), an important sand-binding grass, called also beach grass and sea marram, native to sandy seacoasts of Europe and North America from North Carolina northward and to the shores of the Great Lakes. It is an erect somewhat coarse perennial, with hard, tough, scaly, creeping rootstocks; long involute leaf blades; and a pale dense spikelike flowering panicle. Marram is employed in Europe to hold in place the barrier dunes along coasts, as in the Netherlands; also with like success on Cape Cod, Mass., and at San Francisco, Calif.

MARRANO, a derisive name meaning "swine." applied to crypto-Jews in Spain and Portugal who accepted baptism to escape massacre or expulsion, but practised Judaism secretly.

In the late 14th century Spanish Jewry was threatened with extinction at the hands of mobs. Thousands of Jews accepted death, but tens of thousands found safety at the baptismal font. The number of "saved" converts is moderately estimated as over 100,000. By the mid-15th century the persons who had been bsptized but continued to practise Judaism in secret — marranos — formed a compact society. The marranos began to grow rich and to rise to high positions in the state, the royal court and the church hierarchy. They intermarried with the noblest families of the land. The hatred directed against them by the old Christians, ostensibly because they were suspected of being untrue to their converted faith was, in fact, directed indiscriminately against all *conversos,* even those who became denunciators of Judaism and persecutors of Jews and marranos.

In hlarch 1473 riots broke out in Córdova, with pillage and carnage lasting for three days. The massacres spread from city to city. instigated by fanatical priests. The one institution that seemed adequate to deal with the marranos was the Inquisition, but so strong was the opposition to it that it was not until 1480, under the strong rule of Ferdinand and Isabella, that the Inquisition was finally introduced. In its first year, over 300 marranos were burned, their estates reverting to the crown. The number of victims grew into tens of thousands.

To the Jews, the marranos were pitiful martyrs. They were not renegades but *anusim,* "forced converts," Jews at heart, nho could be trusted to escape from intolerable religious duplicity at the first opportunity. At grave danger to themselves. the Jews maintained religious bonds nith the marranos and kept strong their faith in the God of Israel. By giving religious comfort to the *conversos,* honever, the Jens also came under the surveillance of the Inquisition, which was finally convinced that only the total expulsion of the Jews could end the alliance Purity of faith became the national policy of the Catholic sovereigns. and thus came about the final tragedy. the edict of expulsion of all the Jews from Spain on March 31, 1492 Portugal promulgated an edict of expulsion in 1497 and Navarre in 1498.

A considerable minority of Jews saved themselves from expulsion by baptism, thus adding strength and numbers to the marranos, but the mass of Spanish Jens nent into exile. The physical separation of the marranos from their spiritual sympathizers, however, did not make them more amenable to inquisitorial discipline. The

Jewish religion remained deeply rooted in their hearts and they continued to transmit their beliefs to the succeeding generations.

In Portugal, where the Inquisition was established in 1497, the same process was repeated. The Inquisition also followed the marranos to the Spanish and Portuguese dependencies in Latin America. It is difficult to estimate accurately the number of marranos who settled in Latin America in the centuries following the expulsion of the Jews from Spain and Portugal. A fair estimate of those who died at the stake in the Americas would be approximately 2,000; in addition, a far larger number was sentenced to whipping, incarceration or the galleys. It may be assumed that there was considerable assimilation of Jews in the general population; intermarriage with Indians was particularly noticeable in Mexico.

The more fortunate marranos emigrated to safer countries in North Africa and, on the European continent, to Holland and to Italy as temporary stations on the way to the Ottoman Empire. In Amsterdam the marranos openly avowed Judaism and established there a notable cultural centre. Other smaller marrano centres were established in Bordeaux, Hamburg and London. The first Jewish group that settled in North America (New Amsterdam, 1654) were religious refugees from the Portuguese colony of Brazil.

The decreasing number of marrano trials at the tribunals of the Spanish Inquisition during the 17th and 18th centuries indicates that marranism died out gradually and virtually disappeared a century before the Inquisition tribunals were abolished early in the 19th century. This was not the case in the Balearic Islands. where marrano descendants known as Chuetas ("swine'!) still persist as an isolated stigmatized community.

Marrano communities continue to linger in Portugal. Having been isolated from the Jews and the stream of living Judaism for centuries. they developed strange customs and religious beliefs. many of them alien to the faith of their fathers. Many Portuguese marranos still adhere to their rites and customs and resist the efforts of Jewish communities to educate them in the traditional tenets of Judaism. See also INQUISITION, THE.

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MARRIAGE.

MARRIAGE. Human beings, like all higher animals, multiply by the union of the two sexes. But neither conjugation, nor even the production of offspring, is as a rule sufficient for the maintenance of the species. The further advanced the animal in the order of evolution, the longer the immaturity and the helplessness of the young and the greater the need for prolonged parental care and training. It is thus the combination of mating with parenthood which constitutes marriage in higher animals, including man. Even in its biological aspect, "marriage is rooted in the family rather than the family in marriage" (Westermarck).

1. **The Biological Foundations of Human Mating.**—In human societies, however, there are added to the sexual and parental sides of marriage other elements: marriage is given the hall-mark of social approval; it becomes a legal contract; it defines the relations between husband and wife and between parents and children, as well as the status of the latter; it imposes duties of economic co-operation; it has to be concluded in a public and solemn manner, receiving, as a sacrament, the blessings of religion and, as a rite, the good auspices of magic.

Human marriage also appears in a variety of forms: monogamy, polygyny and polyandry; matriarchal and patriarchal unions; households with patrilocal and matrilocal residence. Other forms, such as "group-marriage," "promiscuity," "anomalous" or "gerontocratic" marriages have been assumed by some writers as an inference from certain symptoms and survivals. At present these forms are not to be found, while their hypothetical existence in prehistoric times is doubtful; and it is important above all in such speculations never to confuse theory with fact.

Marriage again is in no human culture a matter of an entirely free choice. People related by descent or members of certain classes are often debarred from marrying each other, or else they are expected to marry. The rules of incest, of exogamy, of hypergamy and of preferential mating form the sociological conditions of marriage. To these are added in certain societies such preparatory arrangements and conditions as initiation, special training for marriage, moral and economic tests, which have to be satisfied before marriage can be entered upon. The aspects, the forms and the conditions of marriage have to be discussed in turn, though it is not possible to draw a sharp line of division between these subjects.

2. Love and Marriage.—Love and marriage are closely associated in day-dreams and in fiction, in folk-lore and poetry, in the manners, morals and institutions of every human community —but marriage is more than the happy ending of a successful courtship. Marriage as an ideal is the end of a romance; it is also the beginning of a sterner task, and this truth finds an emphatic expression in the laws and regulations of marriage throughout humanity.

Love leads to sexual intimacy and this again to the procreation of children. Marriage on the whole is rather a contract for the production and maintenance of children than an authorization of sexual intercourse. The main reason why marriage has not been regarded as establishing an exclusive sexual relationship lies in the fact that in many human societies sexual relations have been allowed under certain conditions before marriage, while marriage did not necessarily exclude the continuance of similar relations.

Marriage, however, remains the most important form of lawful intercourse, and it dominates and determines all extra-connubial liberties. In their relation to marriage the forms of licence can be classified into prenuptial liberty, relaxations of the marriage bond, ceremonial acts of sex. prostitution and concubinage.

3. Prenuptial Intercourse.—In the majority of savage tribes unmarried boys and girls are free to mate in temporary unions, subject to the barriers of incest and exogamy and of such social regulations as prevail in their community. But there are other tribes where chastity of the unmarried is regarded as a virtue, especially in girls, and any lapse from it severely censured or even punished. Many of the lowest savages, such as the Veddas, Fuegians, Kubu of Sumatra, Senoi and other Malayan negritos, do not tolerate sexual intercourse before marriage. Among the Bushmen and the Andamanese instances of prenuptial unchastity do occur, but they are not condoned, still less provided for by custom and moral approval. The Australians, however, allow prenuptial freedom, except perhaps a few of the South-eastern tribes.

On a higher level we find considerable variety in this respect. All over the world, in Oceania, in Asia, in Africa and in both Americas, examples could be quoted of peoples who demand continence more or less stringently, and of their neighbours who allow full freedom. In a few cases only can we find the demand of chastity expressed in very definite usages, which physically prevent incontinence, such as infibulation, practiced among the N.E. African, Hamitic and Semitic peoples and reported also from Siam, Burma and Java. The testing of the bride by a publicly exhibited token of defloration, which forms part of certain marriage ceremonies and which expresses the value of virginity, is carried out more or less thoroughly and naturally lends itself to deception and circumvention. It is found sporadically throughout the world, in the noble families of Oceania (Tonga, Samoa, Fiji), in Asia (Yakuts, Koryaks, Chuwash, Brahui of Baluchistan, Southern Celebes), in America (Chichimec of Mexico), in Africa (Mandingo, Kulngo, Ruanda, Yoruba, Swahili, Morocco, Algeria and Egypt) and likewise among many Semitic and Hamitic peoples. In other parts of the world we are merely informed that chastity is praised and prenuptial intercourse censured (Bantu, Kavirondo, Wa Giyama, Galla, Karanga, Bechuana of Africa; Dobu, Solomon Islanders, of Melanesia; Omaha, Mandan, Néz-Pércé, Apache, Takelma of N. America; Canelas and Kanaya of S America, Bódo and Dhimál of Indo-China, Hill Dyaks of Borneo).

Freedom to mate at will may be fully allowed and even enjoined and provided for by such institutions as the mixed houses for bachelors and girls (Trobriand Islanders, Nandi, Masai, Bontoc

Igorot). In some communities prenuptial intercourse is not meant to lead to marriage, and there are even cases (as among the Masai, Bhuiya and Kumbi of India, Guaycuru and Guana of Brazil), where two prenuptial lovers are not supposed to marry. Elsewhere prenuptial mating is a method of courtship by trial and error, and it leads gradually into stable unions, and is finally transformed into marriage. Thus among the Trobriand Islanders "sexual freedom" is considerable. It begins very early, children already taking a great deal of interest in certain pursuits and amusements which come as near sexuality as their unripe age allows. This is by no means regarded as improper or immoral, is known and tolerated by the elders and abetted by games and customary arrangements. Later on, after boys and girls have reached sexual maturity, their freedom remains the same, with the result that there is a great deal of indiscriminate mating. In fact, at this age both sexes show a great deal of experimental interest, a tendency to vary and to try, and here again a number of arrangements and customs play into the hands of these juvenile lovers. As time goes on, however, and the boys and girls grow older, their intrigues naturally and without any outer pressure, extend in length and depth, the ties between lovers become stronger and more permanent. One decided preference as a rule develops and stands out against the lesser love affairs. It is important to note that such preferences are clearly based on genuine attachment resulting from real affinity of character. The protracted intrigue becomes a matter of public notice as well as a test of mutual compatibility, the girl's family signify their consent and marriage is finally concluded between the two lovers. (Malinowski). Similar forms of prenuptial selection are found in other tribes (Igorot of Luzon, Akamba of E. Africa, Munshi of N. Nigeria).

In no instance, however, is prenuptial liberty regarded by the natives as a negation or substitute for marriage. In fact it always is in such communities in the nature of a preliminary or preparation to marriage; it allows the young people to sow their wild oats, it eliminates the cruder forms of sex impulse from matrimonial selection and it often leads youths and girls to exercise a mature choice based on attraction of personality rather than on sexual appeal.

4. The Principle of Legitimacy.—Perhaps the most important fact in the consideration of prenuptial unchastity is the rule that freedom of sexual intercourse does not generally extend to freedom of procreation. One of the symptoms of this is that in all communities where chastity is demanded and enforced, the lapse from it entails more censure on girls than on boys, while prenuptial pregnancy is penalised much more severely than mere wantonness. But even where prenuptial unchastity becomes an institution not merely condoned but enjoined by tribal law, pregnancy is often regarded as a disgrace.

Among the aristocratic fraternities of Polynesia, the *areoi* of Tahiti and the *ulitao* of the Marquesas, licence between the men and the women was universal, but children of such unions were killed, unless adopted by a married couple. Among the Melanesian communities of New Guinea and the adjacent archipelago which allow of full sex liberty before marriage the occurrence of pregnancy under such circumstances is a grave disgrace to the mother and entails disabilities on the child. The Masai punish a girl for prenuptial pregnancy, although with them the free unions of unmarried boys and girls are an institution. A similar combination of prenuptial full licence with severe punishment of illegitimate childbirth is recorded from several African tribes (Wapore, Bakoki, Banyankole, Basoga, Akikuyu, Nandi, Beni Amer), from America (Indians of Brit. Guiana, Guaycuru and Guana of Brazil, Creeks and Cherokees), from Asia (Lisu of Burma, Nias Islanders of Malay Archipelago), from Melanesia (Mekeo and N. Solomon Islanders) and from Siberia (Aleut). In all such cases pregnancy is no doubt prevented by contraceptive practices, which however have been reported from very few savage tribes by trustworthy informants; or by abortion, which is far more frequent; or expiated by a punishment of the mother, and sometimes also of the father.

The main sociological principle embodied in these rules and arrangements is that children should not be produced outside a socially approved contract of marriage. In several tribes, the remedy for the disgrace of a prenuptial child consists therefore in an obligation of the presumptive father to marry the girl (S.E. Bantu, Madi, Bavuma, Kagoro of Africa; Tepehuane and Hupa of America; Kacharis, Rabhas, Hajongs and Billavas of India and Assam; Kayans and Punans of Borneo). In some cases again a child of a free union is desired and expected to come, indeed it is a condition to marriage, which is concluded upon its arrival (Sea Dyak, Hill Dyak, Iruleas, Moi, Bontoc Igorot of Asia; natives of Bismarck Archipelago; Lengua, Guarayos and Pueblo Indians of America; R'olofs and Bambata of Africa). Such cases, although they are in a way the opposite of those in which a prenuptial child is a disgrace, involve the same principle: the provision of a father for the child, that is the elimination of illegitimate offspring. As a matter of fact, in all instances where a prenuptial pregnancy is welcomed, the reason for it is that children are regarded in that community as an advantage. The father consequently need not, be forced to marry the mother, he does so of his own accord because fruitful marriage is desirable. Thus in all human societies a father is regarded as indispensable for each child, *i.e.,* a husband for each mother. An illegitimate child—a child born out of wedlock—is an anomaly, whether it be an outcast or an unclaimed asset. A group consisting of a woman and her children is a legally incomplete unit. Marriage thus appears to be an indispensable element in the institution of th family. (See Malinowski, Sex and Repression, pp. 212–217.)

5. Relaxations of the Marriage Bond.—Among tribes where chastity is demanded from unmarried girls and youths, marital fidelity is also usually enjoined. As a rule adultery is regarded as a grave offence and more severely penalised than prenuptial incontinence, though exceptions to this rule do exist. In many communities where freedom is granted before marriage, once the matrimonial knot is tied both partners or the wife at least are bound to remain faithful, under more or less serious penalties (Trobrianders, Mailu, Nukuhiva, Maori of Oceania; Land and Sea Dayaks, Kukis, Hajongs, Saorias, Ceramese of Indonesia; Botocudos and Guarayos of S. America: Illinois, Comanche, Iroquois, Pawnee, Californian Indians of N. America; Timne, Ashanti, Konde, Zulu, Kafirs and Thonga of Africa). The penalty inflicted upon an adulterous wife is invariably much graver than upon an unfaithful husband, and considerable differences obtain according to the circumstances of the offence, the status of the third party, the husband's anger and his attachment to his wife.

There are, however, a number of communities in which the marriage bond is broken as regards the exclusiveness of sex with the consent of both partners and with the sanction of tribal law, custom and morality. In some societies the only occasion on which the wife is allowed connection with other men, nay, has to submit to their embraces, is at the very beginning of marriage. This custom has apparently been known in mediaeval Europe under the name of "ius primae noctis." It certainly exists in many savage cultures (Brazilian Indians, Arawaks, Caribs, Nicaraguans, Tarahumare of S. and C. America; Ballante, Bagele, Berbers of Africa; Bánaro and S. Massim of Melanesia; Aranda, Dieri and other Australian tribes). Such customs are to be regarded not so much as the abrogation of matrimonial exclusiveness, but rather as expressing the superstitious awe with which sexual intercourse, and above all defloration, is regarded by primitive peoples (Crawley, Westermarck). As such they should be considered side by side with the numerous instances in which girls are artificially deprived of their virginity, without the intercourse of any man; with prenuptial defloration by strangers; with temporary prostitution of a religious character, and with sexual intercourse as a puberty rite.

A greater encroachment upon sexual exclusiveness in marriage is found in the custom of wife-lending as a form of hospitality. This is very widely distributed over the world (see the comprehensive references in Westermarck, History of *Human Marriage,* vol. 1, pp. 225–226). It must be realised that this practice is not an infringement of the husband's rights, but rather his assertion of authority in disposing of his wife's person. Very often indeed a man will offer his sister, daughter, slave or servant instead, a fact which indicates that this custom is not so much the right of another man to infringe upon the matrimonial bond as the right of the head of the household to dispose of its female inmates.

Very often sexual hospitality is exercised in anticipation of future reciprocal benefits, and must be considered side by side with the custom of wife-exchange (Gilyak, Tungus, Aleuts of N. E. Asia; Bangala, Herero, Banyoro, Akamba, Wayao of Africa; various Himalayan and Indian tribes; S. Massim of Melanesia; Marquesas, Hawaii, Maori of Polynesia; and various Australian tribes). At times there is an exchange of wives at feasts, when general orgiastic license prevails (Araucanos, Bororo, Keres of S. America; Arapahos, Gros Ventres and Lower Mississippi tribes of N. America; Dayaks and Jakun of Indonesia; Bhuiyas, Hos, Kotas of India; Ashanti, Ekoi and various Bantu tribes of Africa; Kiwai Papuans). On such festive and extraordinary occasions not only are the sexual restrictions removed, and the sexual appetite stimulated, but the ordinary discipline is relaxed, the normal occupations abandoned and social barriers over-ridden, while at the same time people indulge in gluttony, in desire for amusement and social intercourse. Sexual license, as well as the other relaxations, liberties and ebullitions at such feasts fulfils the important function of providing a safety-vent which relieves the normal repressions, furnishes people with a different set of experiences, and thus again tends to safeguard ordinary institutions.

These cases where wives are exchanged for sexual intercourse only must be distinguished from the less frequent instances of prolonged exchange. with common habitation, more or less legalised. Among the Eskimo of Repulse Bay, "If a man who is going on a journey has a wife encumbered with a child that would make travelling unpleasant, he exchanges wives with some friend who remains in camp and has no such inconvenience. Sometimes a man will want a younger wife to travel with, and in that case effects an exchange, and sometimes such exchanges are made for no special reason, and among friends it is a usual thing to exchange wives for a week or two about every two months" (Gilder, Schzantka's Search, p 251). Analogous forms of prolonged exchange are found among certain tribes of S. India, while among the Siberian Chukchi a man will often enter on a bond of brotherhood with those of his relatives who dwell in other villages, and when he visits such a village his relative will give him access to his wife, presently returning the visit in order to make the obligation mutual; sometimes cousins will exchange wives for a prolonged period.

Again, among the Dieri, Arabana and cognate tribes of C. Australia, a married woman may be placed in the so-called pirrauru relationship to a man other than her husband. Such a man may, with the husband's permission, have access to her on rare occasions. Or if the husband be absent and give his consent the woman may join her paramour for some time at his camp, but this is apparently rare. In order to lend his wife in this way a man must wait until she is allotted by the tribal elders as the pirrauru to another man. Then he may consent to waive his marital rights for a short time, though we are expressly told he is under no constraint to do so. Circumstances, jealousy, even the disinclination of the woman are obstacles all of which must make the carrying-out of pirrauru rights extremely rare. This custom has been adduced as a present-day occurrence of group marriage, but this is obviously incorrect. It is always a temporary and partial surrender of marital rights consisting of a long and permanent connubium with occasional rare episodes of extra-marital liaison.

It is important to remember that we have come to regard marriage as defined primarily by parenthood. Now social parenthood in native ideas, behaviour, custom and law is not affected by these various forms of relaxation just described. The children are reckoned as belonging to the legal husband, and in this as in many other ways—economic, legal and religious—these temporary relaxations do not seriously disturb the marriage relationship. It must be realised with regard to fatherhood that even where the main principles of physiological procreation are known, savages do not attribute an undue importance to actual physiological paternity (see KINSHIP). It is almost always the husband of the woman who is considered the legal father of her children, whether he be their physiological father or not..

6. Concubinage.—This can be defined as a legalised form of cohabitation, which differs from marriage in that it implies a considerably lower status of the female partner and her offspring, than that enjoyed by the legal wife. It is a terminological confusion to speak of concubinage, when there is temporary access to a woman, or exclusively sexual rights in her. On primitive levels of culture real concubinage does not exist. Some similarity to it can be found in the institution of subsidiary wives. In certain polygynous communities there is one principal wife and the subsidiary ones have a much lower status, as is the case among the Guarani, Central Eskimo, Araucanians. Apache, Chippewa (America); Chukchi, Koryak, Yakut (N.E. Asia); Marquesas Islanders, Tongans, Tahitians, Maori, Marshall Islanders (Polynesia); Awemba, Wafipa, S E. Bantu, Herero, Nandi, Yoruba, Ewhe (Africa); Ossetes, Kadaras, Khambis (India); Battas, Bagobo, Kulaman (Indonesia).

It is not correct to regard the institutions of temporary and limited partnership described above, such as the pirrauru of C. Australia or the protracted exchange of partners among the Eskimo, as concubinage.

7. Prostitution.—The institution of commercial eroticism or prostitution has a very limited range among primitive peoples It has been reported from Melanesia (Santa Cruz, Rossel Island), Polynesia (Line Islands, Caroline Islands, Easter Island, Hawaii), Greenland, N. America (Omaha), S. America (Karaya, Uitoto, Boro), W. Africa, E. Africa (Banyoro). In its relation to marriage it begins to play a very important part only in higher cultures (see PROSTITUTION). On the one hand it provides an easy satisfaction for the sexual appetite to unmarried men or those who for some reason cannot cohabit with their wives. It thus constitutes an institution complementary to marriage. On the other hand, in certain communities, of which Ancient Greece is a notable example, *i.e.*, "hetairism," prostitution in a higher and more refined form, allowed some women to devote themselves to cultural pursuits and to associate with men more freely than was possible to those legally married.

On the whole it is rather a subsidiary institution than either a relaxation or a form of sexual preparation. Unlike the other forms of sexual licence, prostitution is neither directly correlated with marriage nor does it affect its integrity so seriously as do the forms of matrimonial relaxation which involve both husband and wife.

8. The Economics of the Household and Family.—We are thus led at all stages of our argument to the conclusion that the institution of marriage is primarily determined by the needs of the offspring, by the dependence of the children upon their parents. More specially, the mother since she is handicapped at pregnancy and for some time after birth, needs the assistance of a male partner. The rôle of male associate and helpmate is almost universally played by the husband exclusively, though in some extremely matrilineal societies the wife's brother shares with the husband in some of the responsibilities and burdens of the household. The economic as well as the biological norm of a family is thus mother, child and husband—or exceptionally both the husband and the wife's brother.

In the vast majority of human societies the individual family, based on monogamous marriage and consisting of mother, father and children, forms a self-contained group, not necessarily however cut off from society. Within the household there is a typical scheme of division in functions, again almost universal. By virtue of natural endowment the wife has not only to give birth to and nourish the children, but she is also destined to give them most of the early tender cares: to keep them warm and clean. to lull them to sleep and soothe their infantile troubles. Even in this the husband often helps to a considerable degree, prompted by natural inclination as well as by custom. This latter often imposes upon him duties and ritual manifestations such as taboos during the pregnancy of his wife and at childbirth, and performances at the time of confinement, of which the couvade (*q.v.*) is the most striking example. All such obligations emphasize the father's responsibility and his devotion to the child. Later on in the education of offspring both parents have to take part, performing their respective duties, which vary with the society and with the sex of the children.

Apart from the special task of producing and rearing the children, the wife normally looks after the preparation of the food, she almost invariably provides the fuel and the water, is the actual attendant at the hearth or fireplace, manufactures, tends and owns the cooking-vessels, and she is also the main carrier of burdens. In the very simplest cultures the woman also erects the hut or shelter and looks after camp arrangements (Australians, Bushmen, Andaman Islanders). The husband is the protector and defender of the family, and he also performs all the work which requires greater strength, courage and decision, such as hunting game, fishing, heavy building of houses and craft, and clearing the timber.

The division of labour between husband and wife outside the household follows the line of men's and women's occupations which differ with the community, but on the whole make fighting, hunting, sailing, metal work purely male occupations; collecting, agriculture, pottery, weaving predominantly female; while fishing, cattle-tending, making of clothing and utensils are done by one sex or the other according to culture.

The division of labour outside the household does not mean merely that husband and wife collect food and manufacture goods for their family each in a different manner.' It means also as a rule that each has to collaborate with other members of the community of the same sex in some wider collective enterprise, from which the family benefits only partially and indirectly. In spite of repeated theoretical assertions as to the existence of the "closed household economy" or even of individual search for food among primitive peoples, we find in every community, however simple, a wider economic collaboration embracing all members and welding the various families into larger co-operative units (*cf.* B. Malinowski, "Primitive Economics of the Trobriand Islanders," *Econ. Journal,* 1921; "Labour and Primitive Economics," *Nature,* December, 1925).

The fuller our knowledge of relevant facts, the better we see on the one hand the dependence of the family upon the rest of the community, and on the other hand the duty of each individual to contribute not only to his own household but to those of others as well. Thus in Australia a great part of a man's yield in hunting has to be divided according to fixed rules among his relatives, own and classificatory. Throughout Oceania a network of obligations unites the members of the community and overrules the economic autonomy of the household. In the Trobriand Islands a man has to offer about half of his garden produce to his sister and another part to various relatives, only the remainder being kept for his own household, which in turn is supported substantially by the wife's brother and other relatives. Economic obligations of such a nature cutting across the closed unity of the household could be quoted from every single tribe of which we have adequate information.

The most important examples however come from the communities organised on extreme mother-right, where husband and wife are in most matters members of different households, and their mutual economic contributions show the character of gifts rather than of mutual maintenance.

9. The Split Household Under Matrilocal Mother-right.—Most of what has been said so far refers to the marriage based on a united household and associated as a rule both under father-right and mother-right with *patrilocal* residence. This means that the bride moves to the husband's community, when she either joins his family house or camp, or else inhabits a house built for the new couple and owned in the husband's name. Patrilocal marriages are by far the most prevalent all over the world.

Matrzlocal marriage consists in the husband's joining the wife's community, taking up residence in her parents' house and often having to do some services for them. Matrilocal residence may be permanent; or it may be temporary, the husband having to remain for a year or two with his parents-in-law, and having also possibly to work for them. (Eskimo, Kwakiutl, Guaycuru. Fuegians of America; Bushmen, Hottentots, Bapedi, Bakumbi, Nuer of Africa; negrites of Philippines; Ainu of Japan.) (*See* also Westermarck, *History of Human Marriage,* vol. ii., 360–364; Briffault, The *Mothers,* vol. i. pp. 268–302.)

In a few cases which might be regarded as the extreme development of mother-right combined with matrilocal conditions, the wife remains at her mother's residence and the husband does not even take up a pernianent abode there, but simply joins her as a frequent and regular but still temporary visitor (Menangkabau Malays of Sumatra, Pueblo and Seri Indians of N. America, Nairs of Malabar). Such extreme cases of mother-right are an exception. They are the product of special conditions found as a rule at a high level of culture and should never be taken as the prototype of "primitive marriage" (as has been done by Bachofen, Hartland and Briffault).

The most important fact about such extreme matriarchal conditions is that even there the principle of social legitimacy holds good; that though the father is domestically and economically almost superfluous, he is legally indispensable and the main bond of union between such matrilineal and matrilocal consorts is parenthood. We see also that the economic side can have a symbolic, ritual significance—the gift-exchange functions as token of affection—it marks thus a sociological interdependence, while it has hardly any utilitarian importance.

10. Marriage as an Economic Contract.—This last point, together with the foregoing analysis of the household and family economics, allows us to frame the conclusion that while marriage embraces a certain amount of economic co-operation as well as of sexual connubium, it is not primarily an economic partnership any more than a merely sexual appropriation. It is as necessary to guard against the exclusively economic definition of marriage as against the over-emphasis of sex. This materialistic view of marriage, to be found already in older writers such as Lippert, E. Grosse, Dargun, appears again in some recent important works. Criticising the exaggeration of sex, Briffault says about marriage: "The institution, its origin and development, have been almost exclusively viewed and discussed by social historians in terms of the operation of the sexual instincts and of the sentiments connected with those instincts, such as the exercise of personal choice, the effects of jealousy, the manifestations of romantic love. The origin, like the biological foundation, of *individual marriage being essentially economic,* those psychological factors are the products of the association rather than the causes or conditions which have given rise to it." And again: "Individual marriage has its *foundation* in *economzc* relations. In the vast majority of uncultured societies marriage is regarded almost *exclusively* in the light of *economic* considerations, and throughout by far the greater part of the history of the institution the various changes which it has undergone have been *conditioned by economic causes." (The Mothers,* vol. ii., p. 1; the italics are those of the present writer.)

This is a distortion of a legitimate view. Marriage is not entered upon for economic considerations, exclusively or even mainly; nor is the primary bond between the two parties established by the mutual economic benefits derived from each other. This is best shown by the importance of matrimonial bonds even where there is neither community of goods nor co-operation nor even full domesticity. Economics are, like sex, a means to an end, which is the rearing, education and dual parental influence over the offspring. Economic co-operation is one of the obligations of marriage and like sexual cohabitation, mutual assistance in legal and moral matters it is prescribed to the married by law and enjoined by religion in most cultures. But it certainly is not either the principal end or the unique cause of marriage.

11. "Marriage by Purchase."—As erroneous as the over-emphasis on economics and its hypostasis as the *vera causa* and essence of marriage is also the tearing out of some one economic trait and giving it a special name and thus an artificial entity. This has been done notably with regard to the initial gifts at marriage, especially when given by the husband. More or less considerable gifts from the husband to his wife's family at marriage occur very widely (*see* the comprehensive list of references In Westermarck, *History of Human Marriage,* vol. II., chap. xxiii.).

The term "marriage by purchase" applied to such gifts usually serves to isolate them from their legal and economic context, to introduce the concept of a commercial transaction, which is nowhere to be found in primitive culture as a part of marriage, and to serve as one more starting point for fallacious speculations about the origin of marriage.

The presents given at marriage should always be considered as a link—sometimes very important, sometimes insignificant—in the series of services and gifts which invariably run throughout marriage. The exchange of obligations embraces not only the husband and the wife, but also the children, who under mother-right are counted as one with the mother while under father-right they take over the father's obligations. The family and clan of the wife, and more rarely of the husband, also become part of the scheme of reciprocities. The presents offered at marriage by the husband are often made up of contributions given him towards this end by his relatives and clansmen (Banaka, Bapuka, Thonga, Zulu, Xosa, Bechwana, Madi of Africa; Toradjas, Bogos of Indonesia; Buin, Mekeo, Roro, Trobrianders of Melanesia), and are not all retained by the girl's parents but shared among her relatives and even clansmen (Achomawi, Delaware, Osage, Araucanians of America; S.E. Bantu, Swahili, Pokomo, Turkana, Bavili, Ewhe, Baganda, Masai, Lotuko of Africa; Ossetes, Samoyeds, Aleut, Yakut, Yukaghir of Siberia; Koita, Mekeo, S. Massim, Buin of Melanesia). The giving of presents is thus a transaction binding two groups rather than two individuals, a fact which is reflected in such institutions as the inheritance of wives, sororate, levirate, etc. A correct understanding of the initial marriage gift can be obtained only against the background of the wider economic mutuality of husband and wife, parents and children, maternal and paternal families and clans.

Another type of marriage gift is the *lobola* found among the patrilineal and patrilocal communities of the S.E. Bantu, who live by combined agriculture and cattle-raising. The wife and children are here regarded as a definite economic and sociological asset. The wife is the main agricultural and domestic worker, while the children are valuable because the boys continue the line and the girls bring in wealth at marriage. Marriage is concluded by the payment of cattle, the amount varying greatly according to tribe, rank and other considerations from a couple of head to a few score. These cattle are known as *lobola,* or "bride-price," as is the current but incorrect anthropological expression. The *lobola* in fact is not the motive for the transaction, nor is there any bidding on any market, nor can the cattle be disposed of at will by the receiver, *i.e.,* the girl's father. Some of them have to be distributed by him according to fixed tribal custom among particular relatives of the girl; the rest he has to use for the provision of a wife for his son, *i.e.*, the girl's brother, or else, if he has no male heir, he contracts another wife for himself, in order to obtain the desired male descendants. In case of divorce the marriage gift has to be returned as the identical cattle given and not merely in an equivalent form. The *lobola* is thus rather a symbolic equivalent representing the wife's economic efficiency, and it has to be treated as a deposit to be spent on another marriage.

In Melanesia the husband's initial gift at marriage is a ritual act, and is always reciprocated by the wife's family. This is the case also among certain American tribes (Tshimshian, Coast Salish, Bellacoola, Delaware, Ojibway, Navaho, Miwok); in Siberia (Mordwin, Ainu, Buryat, Samoyed, Koryak), and in Polynesia (Samoa). This return gift may take the form of a dowry given to the bride by her father or parents or other relatives but also directly or indirectly benefiting her husband (Greenlanders, Brazilian aborigines, Yahgans of America, Ibo, Ovambo, S.E. Bantu, Banyoro, Masai of Africa; Buryat, Yukaghir, Samoyed of Siberia; Toda of India; Banks Islanders, Buin, Maori of Oceania). In some communities the balance of gifts is so much in favour of the husband that instead of wife purchase we could speak of buying a husband for the girl (N. Massim; coast tribes of Br. Columbia; Tehuelches of Patagonia; Yakut). Both concepts, however, that of "wife purchase" and "husband purchase" are obviously inadmissible.

12. Property and Inheritance Within **Marriage.**—As a rule, whatever the manner of economic inauguration of marriage, and whatever the mutual services exchanged between the partners, the latter have not only their own sphere of activity but their own possessions. The wife usually claims the title and right of disposing of her articles of apparel, of the domestic utensils and often of the special implements and fruits of her pursuit. The importance of woman's work in agriculture, her social influence due to this and her specific claims to the agricultural produce —not the ownership of the land, which is generally vested in man—have given rise to the economic theory of mother-right (see below, 13 and 14).

Very often the possessions of the husband and wife are inherited by their respective kindred, and not by the surviving partner. The inheritance of the wife by the husband's brother (the custom of levirate *q.v.*), which is known from the Old Testament, but has a fairly wide range of distribution (see the extensive lists given by Westermarck, *loc. cit.* vol. iii., pp. 208–210; Briffault, The Mothers, vol. i., pp. 767–772) is not to be regarded as an economic transaction. Like the inheritance of a widow under mother-right and like the custom of killing the widows and the suttee of India, it is the expression of the matrimonial bonds outlasting death, and defining the widow's behaviour afterwards (see below, 20).

13. Marriage as a Legal Contract.—Marriage is never a mere cohabitation, and in no society are two people of different sex allowed to share life in common and produce children without having the approval of the community. This is obtained by going through the legal and ritual formalities which constitute the act of marriage, by accepting in this the obligations which are entailed in marriage and the privileges which it gives, and by having later on to submit to the consequences of the union as regards children.

The legal side of marriage is therefore not made up of special activities, such as constitute its sexual, economic, domestic or parental aspect. It is rather that special side in each of these aspects, which makes them defined by tradition, formally entered upon, and made binding by special sanctions.

First of all, the whole system of obligations and rights which constitute marriage is in each society laid down by tradition. The way in which people have to cohabit and work together is stipulated by tribal law: whether the man joins his wife or vice versa; whether and how they live together, completely or partially; whether the sexual appropriation is complete, making adultery in either partner an offence, or whether, subject to certain restrictions, there may be waiving of the sexual rights; whether there is economic co-operation and what are its limits. The details and the typical rules and variations of all this have already been discussed, as well as, incidentally, the ways in which the rules are enforced. But it must be added that in no other subject of anthropology is our knowledge so limited as in the dynamic problems of why rules are kept, how they are enforced, and how they are evaded or partially broken. (Cf. B. Malinowski, Crime and Custom in Savage Society, 1926.)

Only on one or two points are we habitually informed by ethnographic observers, as to what penalties attach to a breach of law and custom and what premiums are set on their careful and generous observance. Thus, we are often informed how adultery is dealt with, though we usually get exaggerated accounts of the severity of the law on this point Again, to anticipate, incest and exogamy are usually surrounded with definite sanctions, some social and some supernatural. The manners and morals of daily contact within the household are usually laid down and enforced by that complicated and imponderable set of forces which governs all human behaviour in its everyday aspects and makes people distinguish between "good" and "bad form" in every human society. The validity of the economic duties of husband and wife are as a rule based on the fact that the services of the one are conditional on the services of the other, and that a very lazy or unscrupulous partner would eventually be divorced by the other.

14. Divorce.—This brings us to the subject of the dissolution of marriage. Marriage is as a rule concluded for life—at times

beyond death, as mentioned above. It is questionable whether the short period "marriages" reported from isolated districts (Eskimo of Ungava district, some tribes of the Indian Archipelago, Arabia, Persia, Tibet) deserve the name of marriage, *i.e.,* whether they should not be put into a different sociological category; but our accounts of them are too slight to allow of deciding this question. In some tribes we are told that marriage is indissoluble (Veddas, Andarnanese, certain tribes of the Indian Archipelago and Malay Peninsula). The general rule, however, is that divorce (*q.v.*), is possible, but not easy, and entails damages and disabilities to both partners. Even where divorce is said to be easy for husband and for wife, we find on further enquiry that a considerable price has to be paid for the "liberty to divorce," that it is easy only to exceptionally powerful or successful men and women, and that it involves in most cases loss of prestige and a moral stigma. Often also divorce is easy only before children have been born, and it becomes difficult and undesirable after their arrival. In fact the main ground for divorce, besides adultery, economic insufficiency or bad temper, is sterility in the wife or impotence in the husband. This emphasizes the aspect of marriage as an institution for the preservation of children.

The threat of divorce and of the disabilities which it entails is one of the main forces which keep husband and wife to their prescribed conduct. At times the husband is kept in check by the payment he gave at marriage and which he can reclaim only when the union is dissolved through no fault of his. At times the considerable economic value of the wife is the motive of his good and dutiful conduct.

15. The Status of Husband and Wife.—The duties of the wife towards the husband are apparently in some communities enforced to a considerable extent by his personal strength and brutality, and by the authority given him by custom. In others, however, husband and wife have an almost equal status. Here again, unfortunately, we find too often in ethnographical accounts generalities and stock phrases such as that "the wife is regarded as the personal property of the husband," as "his slave or chattel," or else again we read that "the status of the wife is high." The only correct definition of status can be given by a full enumeration of all mutual duties, of the limits to personal liberty established by marriage, and of the safeguards against the husband's brutality or remissness, or, on the other hand, against the wife's shrewishness and lack of sense of duty. It is often held that mother-right and the economic importance of woman's work, especially in agricultural communities, go with a high social status of the wife, while in collecting, nomadic and pastoral tribes her status is on the whole lower (E. Grosse, in *Die Formen der Familie und die Formen der Wirtschaft;* Schmidt and Koppers, in *Völker und Kulturen).*

Marriage not only defines the relations of the consorts to each other, but also their status in society. In most tribes, marriage and the establishment of an independent household are a condition for the attainment of the legal status of full tribesman in the male and of the rank and title of matron in the woman. Under the system of age grades the passage through certain initiation rites is a condition of marriage and this is as a rule concluded soon after it is permitted *(cf.* Webster, *Primitive Secret Societies;* Schurtz, *Altersklassen und Mannerbunde).* In all tribes, however, all normal and healthy tribesmen and women are married, and even widows and widowers remarry if they are not too old, under the penalty of losing some of their influence. The attainment of a full tribal status is always a powerful motive for marriage.

16. The Laws of Legitimate Descent.—Marriage affects not only the status of the consorts and their relations, but imposes also a series of duties on the parents with regard to children, and defines the status of children by reference to the parents.

As we know already in virtue of the universal principle of legitimacy, the full tribal or civil status of a child is obtained only through a legal marriage of the parents. Legitimacy is at times sanctioned by penalties which devolve on the parents, at times by the disabilities under which illegitimate children suffer, at times again by inducements for the adoption of children or for their legitimisation by the presumptive father or some other man.

In connection with this latter point it is necessary to realise that the children have invariably to return in later life some of the benefits received earlier. The aged parents are always dependent on their children, usually on the married boys. Girls at marriage often bring in some sort of emolument to their parents and then continue to help them and look after them. The duties of legal solidarity also devolve on the children, uniting them to father or mother according to whether we deal with a matrilineal or a patrilineal society.

One of the most important legal implications of marriage is that it defines the relation of the children to certain wider groups, the local community, the clan, the exogamous division and the tribe. The children as a rule follow one of the parents, though more complex systems are also in existence, and the unilateral principle of descent is never absolute. This however belongs to the subject of Kinship (*q.v.; cf.* also MATRIARCHY).

17. Modes of Concluding Marriage. — In studying the legal aspect of marriage, it is extremely important to realise that the matrimonial contract never derives its binding force from one single act or from one sanction. The mistake has often been made in discussing the "origin of marriage," of attributing to this or that mode of concluding it a special genetic importance or legal value. Marriage has in turn been derived from mere subjugation by brutal force (the old patriarchal theory); from appropriation by capture in foreign tribes (McLennan's hypothesis); from feminine revolt against hetairism (Bachofen); from economic appropriation or purchase (the materialist interpretation of early marriages); from pithecanthropic patriarchy (Atkinson, Freud); and from *matria potestas* (Briffault). All these views overstate the importance of one aspect of marriage or even of one element in the modes of its conclusion; some even invent an imaginary state or condition.

In reality marriage is the most important legal contract in every human society, the one which refers to the continuity of the race; it implies a most delicate and difficult adjustment of a passionate and emotional relationship with domestic and economic co-operation; it involves the cohabitation of male and female, perennially attracted and yet in many ways for ever incompatible; it focuses in a difficult personal relationship of two people the interest of wider groups: of their progeny, of their parents, of their kindred, and in fact of the whole community.

The validity of the marriage bond derives its sanctions from all these sources. This expresses one of the most important truths concerning marriage. The complexity of motives for which it is entered, the utility of the partners to each other, their common interest in the children's welfare, last, not least, the interest which the kindred and the community have in the proper upbringing of the offspring—these are the real foundations of marriage and the source of its legally binding character.

All this finds an expression in the modes of contracting marriage. These always contain the element of public approval; the collaboration of the families and the kindred of each partner; some material pledges and securities; some ritual and religious sanctions; last, not least, the consent of the parties concerned.

In the old manuals and statements concerning marriage an important place is usually taken by the classical list of the various "modes of concluding" it: marriage by capture, by purchase and by service, by infant betrothal, elopement, exchange, mutual consent, and so on (cf. even such an excellent and recent account as the article on "Marriage," by Rivers, in Hastings' *Enc.* of *Religion and Ethics).*

This classification is unsatisfactory. It exaggerates as a rule one aspect out of all proportion, and attributes to this one aspect an overwhelming influence upon the whole institution which it never possesses. "Marriage by purchase" we have already dismissed as a crude misnomer, while "service" is but a detail in the economics of certain marriages. "Marriage by capture," which has played such a prominent part in speculation and controversy from McLennan onward, never could have been a real institution: though a man may occasionally wed a woman captured by force in a war, such an occurence is always an exception; it never was a rule, still less a "stage in human evolution?' Tribal endogamy (see below, 22) is the universal rule of mankind. Ceremonial fights and ritual capture occur at wedding ceremonies over a wide area (see Westermarck, History of Human *Marriage,* ii., 254–277; Crawley, ii., 76–100; Briffault, ii., 230–250). They are capable of interpretation in terms of actual psychology and of existing social conditions (Westermarck, Crawley, Briffault, Havelock Ellis). To regard them as survivals of "marriage by capture" is erroneous, and on this point there is now an almost universal agreement. Capture and violence, as well as purchase from other tribes, or on the slave-market, lead to concubinage, and at times supply prostitutes, but only very rarely legal wives.

Like the contract itself, so also the modes of concluding it contain a great variety of binding and of determining factors. But a real and relevant distinction can still be made between those marriages which are contracted primarily by rules of tradition; those which are arranged for by the families or the kindred of the consorts; and those which arise from free and spontaneous choice of the mates. In no type of marriage is any of these three elements — tradition, arrangement by families or their consent, and free choice--completely absent. But one or other may be conspicuously predominant.

The most usual type of traditionally prescribed union is cross-cousin marriage (see COUSIN MARRIAGE), with a wide distribution, practised very extensively all over Oceania, Australia and S. India, and sporadically in Africa, N. America and Asia. The marriage of parallel cousins is less frequent, and found notably among Semitic peoples (cf. Frazer, Folk-Lore in the Old Testament, vol. ii., pp. 145 *sqq.;* B. Z. Seligman, "Studies in Semitic Kinship," Bull. School *Oriental* Studies, 1923–24). Even less common are marriages prescribed between other classes of relatives, *e.g.,* between a man and his brother's daughter (N. Australia, some parts of Melanesia), or his sister's daughter (S. India), or his father's sister (certain parts of Melanesia, Dene of N. America). Another type of prescribed marriage is by inheritance, of which the levirate and sororate (*q.v.*) are the most notable.

Besides such traditionally defined unions, there are also marriages recognised as convenient and desirable by the respective families and arranged for by them. Infant betrothal (prevalent in Australia and Melanesia), where a definite claim is established; or infant marriage (reported especially from India), where the bond is effectively concluded, are two of the most usual forms of these. The main motive for infant unions is the determination of the families to secure a convenient union. In Australia, where an infant is often allotted to a mature male, the power of old men and their keenness to secure young wives, are at the root of this institution. Whether similar conditions existed, or even still survive in Africa, is an interesting problem (see B. Z. Seligman, "Marital Gerontocracy in Africa," *Journal* of the *Royal* Anthropological Institute, 1924).

In many communities, including some advanced nations of Europe, marriage is mainly determined by social or financial considerations, and in this the parents of bride and bridegroom have as much to say as the two people directly concerned. In some primitive tribes two brothers exchange sisters (Australia), or a man's matrilineal uncle or patrilineal aunt has some say (Melanesia). Where the initial payments are very heavy and where they are used to secure a wife for the bride's brother, marriage is usually also a matter for an arrangement rather than free choice.

With all this free choice still remains the most important element. Very often an infant betrothal or some other form of arranged union is broken by one of the people directly affected, and marriage by elopement, with the subsequent consent of family and kindred, overrules all other considerations. Invariably in all communities the majority of unions come from the initiative of the partners. Marriage by free personal choice is the normal marriage, and the choice is mainly determined by personal attraction, which does not mean merely a sexual or erotic attraction. In general the physical appeal combines with compatibility of character, and such social considerations as suitability of rank and of occupation and of economic benefits, also influence the choice. Here again the nature of marriage entails a complexity of motives, and its stability has always to be secured by a suitable compromise between conflicting interests.

18. The Religious and Ceremonial Side of **Marriage.**— The sanctity of the marriage bond is not found merely in the Christian religion, nor is it a prerogative of the higher cultures. The supernatural sanction, derived from a solemn, publicly celebrated, spiritually as well as ethically hallowed ceremony, adds to the binding forces of mere law. Marriage is valid as a legal contract in so far as its breach is visited by worldly retributions and its generous fulfilment carries worldly benefits. As a sacrament, marriage in primitive and civilised societies alike, is protected by spiritual powers, rewarding those who observe matrimonial duties meticulously and piously, and punishing those who neglect them.

The religious aspect of marriage is therefore closely akin to the legal, in that it adds to the validity and sanctity of other functions, rather than establishes new ones. It finds expression in the acts of establishment and those of dissolution: religious rites are to be found at betrothal and wedding, while divorce is often religiously defined and qualified, and at death the breach of the bond finds its spiritual expression in the duties, observances and ceremonies incumbent on the surviving partner. Besides these ceremonial manifestations in which the bonds of marriage are religiously tied or dissolved, religious ethics establish those rules of matrimonial conduct which are sanctioned supernaturally or felt binding through their appeal to moral sense rather than to self-interest.

19. **Ceremonies of** Betrothal and Wedding. — Betrothal can be defined as an act preliminary to marriage, establishing mutually presumptive claims. The period between betrothal and marriage varies, and where it is short, it is often difficult or even impossible to decide whether we deal with an act of betrothal or an inaugural wedding rite. It is also unprofitable to draw a very sharp line of distinction between infant betrothal and infant marriage. Where betrothal imposes real obligations and a valid tie, the rites then observed usually fulfil in their religious bearing the same function as thos: of marriage, and consist of the same or similar actions, both as regards ritual technique and symbolic meaning. It will be best therefore to discuss the binding rites of marriage and betrothal together.

These rites and ceremonies cover a very wide range, from the simplest act, such as a meal openly taken in common, to complex and elaborate tribal festivities, extended over a considerable period of time. But in every human society marriage is concluded by a ritual enactment. It might be disputed whether such rites in their simplest form present a genuine religious character; but most sociologists would agree that they always possess some religious elements in that they are solemn and public; in their more developed form and in higher cultures they become definitely religious. It will be best in discussing the nature of wedding rites not to draw too pedantic a distinction between their legal and religious aspects, since the two often merge or shade into each other imperceptibly.

"The most general social object" of a wedding rite is "to give publicity to the union" (Westermarck). By this the legal as well as the religious sanction of the union is established. The contract is made binding in that all the members of the community bear witness to it; it is hallowed in that the two mates solemnly and openly declare before man, God or other spiritual powers that they belong to each other.

20. The Symbolism of Marriage Ritual. — A marriage rite is as a rule also a ritual act with a symbolic significance, and as such it is often conceived to possess a magical efficacy, it contains a moral precept or expresses a legal principle.

A. Biological Symbolism. — Thus the fundamental purpose of marriage, the continuity of the race, is indicated in wedding ceremonies by ritual, intended to make the union fruitful, to obviate the dangers associated with sexual intercourse, especially with defloration, and to facilitate the various stages of the process of generation from the first act to delivery. Among the fertility rites a prominent place is taken by the use of fruit or grain or other cereals, which are sprinkled over the newly-wedded couple or on or round the nuptial bed, or handed to them or brought into contact with them in some other way. Rites, such as the accompaniment of the bride by a little child, the use of various symbols of generation, and the direct offering of prayers and sacrifices, are all intended to make the union fruitful. The breaking of some object at the wedding serves to avert the dangers of defloration and to facilitate the consummation of the union. The undoing of knots and laces, found in many wedding rites, makes for easy delivery at childbirth. In all these acts we see the ritual expression of the biological nature of marriage.

B. Marriage as a *Crisis*.—As an official and public recognition of a biological fact, as the most important contract ever entered by two individuals, and as the act which creates a new social entity, the family, marriage is a crisis. Now a crisis in human life is always surrounded by powerful emotions: forebodings and hopes, fears and joyful anticipations. Innumerable wedding rites are in existence which are obviously intended to remove the dangers associated with the crisis of marriage.

Dangers apprehended in subjective forebodings are usually conceived in the form of evil agencies: demons or ghosts or malevolent spirits, forces of black magic, mysterious concatenations of ill-luck. These have to be kept at bay or counteracted, and we find innumerable rites intended to avert ill fortune and bring happiness and good chance to the new household. Among these are the avoidance of certain days and places as unlucky, or on the other hand the selection of certain days as being of good omen; the shutting out of evil influences from the place where the wedding is being celebrated; the making of noises, the firing or brandishing of some weapon; the bathing or washing of bride and bridegroom or sprinkling them with water; the lighting of fires and waving of torches; the circumambulation of the bridegroom's tent or of the church; the beating of the bridegroom's tent, and the observance by the bride and bridegroom of various kinds of abstinences with regard to action and eating. Other forms in which bad luck can be side-tracked are: the disguising of the real actors, who may dress in the clothes of the opposite sex, cover themselves, or paint their faces.; the substitution for them of effigies; marriage by proxy; and the contracting of mock marriages with trees or animals or inanimate objects. Finally an important antidote against all supernatural dangers is the state of spiritual invulnerability which is achieved by moral purity and the observance of those mixed ethical and ritual rules which in primitive culture often surround important acts of human life. The most important tabu of this kind, in connection with marriage is obviously the tabu of serf-continence. The principle that the bride and the bridegroom have to abstain from intercourse for some time after the wedding, is known all over the world from primitive savagery to the most refined ethics of the Christian church, from Australia to the New World (cf. Westermarck, II., 547–564), while on the wedding night there are occasionally other minor abstinences.

It is characteristic that while the bride and the bridegroom are often considered in a state dangerous not only to themselves but also to others, they are at the same time a source of blessing and of beneficent influences. Thus certain rites are supposed to influence favourably the welfare of other persons even independently of their relations to the principals; joining in at a wedding is sometimes believed to produce benefit; a wedding is looked upon as a potential cause of other weddings; while good luck is often expected from contact with the bride or bridegroom or something worn by them.

C. *Marriage* as a Sociological *Change*.—Marriage is a crisis not merely in the spiritual sense. It is also an actual sociological transition from one state to another, both partners forsaking their old families to form a new one. The rupture with the parental family, clan, local community or tribe is expressed in a number of interesting wedding rites. Sham fighting between the bridegroom or his party and the bride's family, or some other kind of resistance made by the latter; the barring of the wedding procession; weeping and other ritual expressions of grief and unwillingness on the part of the bride and her relatives; and the mimic enactment of capture or abduction of the bride—these are mostly the dramatic expression of the fact that the bride has to be torn from her old home, that this is a violent and critical act, a final one.

D. Marriage as a New Bond.—But the most important type of wedding rite is that which lays down that marriage is a sacramental bond. Here again the symbolism is wide and varied, from the most direct expression of union by the joining of hands or of fingers, the tying of garments, the exchange of rings and chains, to complicated dramatic enactments of the separation and union. An important symbolism of the new ties to be established consists in the performance of some act which in future will constitute one of the normal duties or privileges of married life. Such acts in a way define the nature and exclusiveness of marriage by anticipation in ritual performances. Among them, naturally the most important are the ceremonial performance of the sexual act and the ceremonial participation in a common meal. In certain ceremonies the symbolism lays down the relative domains of marital influence. Thus in some cases the assertion of the husband's power is prominent: he is presented with a whip, or he boxes the bride's ears, or mimically beats her, and so on. In others again the wife may attempt by similar acts to mark her independence and her power over her husband. The economic aspect of marriage is often also expressed in some magical act, intended to ensure prosperity to the future household, *e.g.*, by the smearing of butter and honey by the bride over the pole of the tent to ensure abundance of staple food. Again, the division of economic functions is expressed in other rites, as where the wife tends the fire, prepares and cooks food for her husband, etc.

E. *The* General *Function* of Wedding Symbolism.—These examples cover the most important though by no means all the ideas expressed in wedding rites. It is easy to see that the symbolism is extremely rich and varied, and that it embraces almost all the aspects of marriage. There are rites which bear directly upon sex and upon gestation; there are rites with a clear domestic and those with an economic significance; there are rites referring to emotional attitudes at marriage and to moral ideas as to its ends. In technique they are all legal, magical or religious. In short, the ceremonial of marriage covers and expresses all the relevant sides of the institution of marriage, and as such it has been a most fruitful and revelatory subject of anthropological study. It also has been the main source of errors and pitfalls.

In order to avoid them it is important to realise that all ritual symbolism is necessarily vague. Speaking of the marriage ceremonies, Professor Westermarck rightly lays down that "Anthropologists are often apt to look for too much reasoning at the bottom of primitive customs. Many of them are based on vague feelings rather than on definite ideas" (History of *Human Marriage*, II., 563). The ritual symbolism at marriage also expresses as a rule mixed and compound meanings in most of the acts. Thus the spilling of corn over the couple may mean fecundity, prosperity, good husbandry as well as union, and probably it vaguely expresses all these elements. Sham fights and captures, tree marriages or marriages by proxy have obviously a plurality of meanings.

Nor is the function of symbolism exhausted by its direct and literal meaning. A ritual act, fixed by tradition, defining the relevant manner of concluding a contract, impresses by pomp and circumstance its social importance and its binding force in the moral sense. The ethical rules and tabus which usually go hand in hand with ritual add to this spiritualising function of wedding ceremonies. The public and official nature of the marriage act, often marked by the presence of an officiating priest, ruler or magician; heralded by banns and public announcements; sealed by witnesses and documents; enhanced by the sacredness of place and of time constitutes the widest and most general function of the rite, and that is to make marriage public, binding, sacred and morally impressive.

21. The Dissolution of Marriage in Ritual.—The binding forces of the marriage contract, and its ritual and moral character, are expressed as clearly at the dissolution by divorce or death as at its inception. Unfortunately our information is so defective on this point that a brief survey only can be given.

Divorce in higher cultures is a religious matter, to be carried out under the supervision of the church, and with the observance of certain formalities which express and safeguard the sanctity of the sacrament. From lower cultures we find only a few examples of divorce rites, where such symbolic acts as the breaking of a rod, the tearing of a leaf, or the casting away of some object are publicly performed (Kacharis, Hajongs, Khasis of N.W. India; Bagobo of Mindanao; Tumbuka of C. Africa; certain Canadian Indians; Maori of New Zealand).

Far more material is at our disposal referring to the persistence of the matrimonial bonds at death. They are never dissolved automatically by the decease of either partner, and their tenacity is greater for the widow than for the widower. But in either case the death of one consort imposes a number of ritual and moral observances on the other, the fulfilment of which is an essential part of the marriage contract.

The widow, or widower, usually plays the most prominent part among all mourners. Thus among certain peoples the widow has to perform various duties, extending over a more or less considerable period, at the grave of her husband. She has to sleep beside or over it; to supply it with provisions; to keep a fire burning there perpetually (Takulli, Kutchin, Mosquito, Pima Indians of America; Minas, Nsakara, Baganda of Africa; Pentecost Islanders and certain Papuans of Oceania; Kukis of India). Even more telling are the long series of tabus and duties to be observed by the widow before she is allowed to remarry: she must remain chaste, refrain from bathing or renewing her garments, avoid certain foods, etc. (Omaha, Stlathlumh, Creek, Chickasaw, Algonkin, Iroquois, Dakota, Eskimo of N. America; Angoni, Bakoba, Baya, Bawele, Baganda, Akamba, Herero, BaThonga, Zulu of Africa; Amoor tribes and Kukis of India; Bontoc Igorot of the Philippines; Maori of New Zealand; Ainu, Yakuts, Kamchadal of N.E. Asia).

Similar regulations prevent the widower from entering into a new alliance immediately after he has been set free by his wife's death. Thus among many peoples (Greenlanders, Eskimo, Aleut; Dakota, Omaha, Shawnee of N. America; Herero, Bushmen, BaThonga, Zulu of Africa; certain Papuan tribes; the Bontoc Igorots and the Ainu) the surviving husband has to live single for a time during which he is subjected to various restrictions and observances, such as refraining from sexual intercourse.

The most definite affirmation of the persistence of marital bonds is found among those people who completely forbid remarriage to widows (Tikopians, Rotumans, Marquesans, Line Islanders in Polynesia; Chinese; Ainu of Japan; Formosans; Brahmans of India) or to widowers (Ainu, Formosans, Biduanda Kallang of Malay Peninsula).

Even this is overshadowed by the institution of suttee, the sentence of death passed by religious tradition over the widow at her husband's death so that her spirit might follow his into the next world. This institution is found not only in India, from where we have borrowed its name, but also among the Comanche, Cree and certain Californian tribes of N. America; in Dahomey and among the BaFiote of Africa; in the New Hebrides, Fiji, Solomon Islands, Pentecost Island and New Zealand of Oceania.

22. **The** Social Conditions of Marriage. Endogamy.—With this we have finished the analysis of the various aspects of marriage, biological, domestic, economic, legal and religious. It will be necessary still briefly to consider marriage in relation to other modes of grouping, and to discuss certain barriers to and qualifications for matrimony, connected with membership in wider groups.

Marriage is never free in the sense that any man would be at liberty to marry any woman. Natural and physical impediments obviously do not come here under consideration, since we are only concerned with social rules. Thus it is clear that in order to marry, two people must come into contact with each other, and under primitive conditions this is possible only when they belong to the same tribe, or to tribes who meet in peaceful commerce or in warfare. Tribal or natural endogamy (*q.v.*), is thus the first condition of marriage, but it is of secondary interest to the sociologist, and must be distinguished from strict, endogamy.

Endogamy *proper* is the rule which allows marriage only between members of a section of a tribe and forbids unions between members of two sections. Strict endogamy is rare. It occurs mainly in India where members of the same caste only are allowed to marry (see Caste *and Endogamy*). In other parts of India we find a system called *hypergamy* (*q.v.*) in which a man is allowed to marry a woman of a lower section in his caste. He may also marry a woman of the same section if other conditions allow this. But a woman may not marry a man of a lower section on penalty of loss of status of her whole family. In some communities there is competition to secure husbands of high sections.

In primitive communities endogamy is not very widespread. It occurs in tribes where there is a degraded class of artisans or else stratification by rank (Polynesia; Korea, Japan; Trobriand Islands of Melanesia; Algonkin, Salish of N. America; Masai, Banyankole, Karanga and other tribes of E. and S. Africa). In such cases we often find endogamy in what might be called an approximate form. Indeed such approximate endogamy, as a tendency to marry within the profession, class or rank, is, as an unwritten law, well-nigh universal in primitive and civilized communities.

Another type of endogamy which is widespread is that associated with religion. In few religions is marriage outside the group of the faithful permitted. Islam, Judaism, Christianity and Hinduism are cases in point. Primitive religion as a rule need not be intolerant as regardsmixed marriages, because there the tribal barriers and lack of communication act with sufficient stringency.

23. The Prohibition of Incest.—The most widely spread and most rigidly enforced qualification to marriage is the set of rules which prohibit unions between the members of the same family. These are known as the rules of incest (*q.v.*), and play a great part in the constitution of the family (*q.v.*) and in the regulation of primitive kinship (*q.v.*). Incest has become also of great importance in modern psychology through the speculations of Freud and the psychoanalytic school (see also PSYCHOANALYSIS).

Although incestuous unions between near relatives are universally abhorred and prohibited, the rules differ greatly from one society to another as regards the prohibited degrees as well as the stringency and character of the sanctions. Marriages between mother and son and between father and daughter are universally prohibited by law, custom and moral sentiment. Statements can be quoted, it is true, of tribes among whom more or less irregular unions between parents and children do occur. Thus marriages between mother and son have been reported from the Caribs, Eskimo, Pioje, Tinne of America; Minahassa of Celebes and Kalang of Java; New Caledonians; and the Banjoro of Africa. Again unions between father and daughter are said to occur among the Minahassa of Celebes, Karens of Burma, and in the Solomon, Marshall and Pelew Islands of Oceania. Even better attested are the marriages between brother and sister (Marshall Islands and Hawaii; ancient Irish, Egyptian and Inca royal families).

When we go beyond the family group, the prohibitions of marriage between uncles and nieces, aunts and nephews, first and second cousins, and so on, vary greatly. In some communities certain of these unions are explicitly encouraged and regarded as desirable; in others forbidden. About preferential marriages between relatives we have already spoken (see above, 17). Extensive prohibitions of marriage between distant kindred exist. besides the Western Christian civilizations also among a number of other tribes and cultures (Salish, Eskimo, Pipites of Salvador, Aztecs, Araucanians, Abipones, Ona, Yahgan of America; Koryak, Yukaghir, Kalmuck of N.E. Asia; Torres Straits Islanders, Mekeo. Polynesians of Oceania; S.E. Bantu of Africa).

24. Exogamy.—This is the system under which far larger groups of people are regarded as related to each other and their members forbidden to intermarry. It is found mainly in association with the classificatory nomenclature of kinship terms and the clan organisation (see also EXOGAMY; KINSHIP; KINSHIP TERMINOLOGY). Whether exogamy is genetically connected with incest, *i.e.*, whether it is an extension of the tabu on intercourse and marriage nithin the family, or an independent institution, is a

debated question (*see* Westermarck, *H.H.M.*, II., pp. 192–218; Frazer, *Totemism and Exogamy*, vol. IV., *passim;* Malinowski, *Sex and Repression in Savage Society*, part *IV.).*

Exogamy embraces the widest number of people, where it is based on the dual organisation and debars from intercourse or marriage one half of the tribesmen and tribeswomen (*cf.* DUAL ORGANIZATION). Normally exogamy is an attribute of clan, *i.e.*, of the group of people who trace their descent to a common ancestor, have in most cases the same totem, and fulfill a number of functions together (*see* CLAN, TOTEMISM, KINSHIP). The clans are sometimes a subdivision of the tribe, based numerically on the dual principle, as where we have two, four or eight clans. At times there is an odd and more or less considerable number of clans, and exogamy is enforced only within each of these divisions. The prohibitions as a rule apply unilaterally (Iroquois, Huron, Lenape, Mohegan, Miami, Shawnee, Creek, Sauk, Fox, Kickapoo, Blackfoot, Dakota, Seminole of N. America; Arawak and Goajiro of S. America; Tungus, Yakut, Samoyed, Ostyak, Tartars of N.E. Asia; various aboriginal peoples of India; Torres Straits Islanders, Papuans, Melanesians, Polynesians and Micronesians of Oceania; Hottentot, S.E. Bantu, Anyanja, Wayao, Awemba, Makololo, Akonde, Masai, Akamba, Baganda and other E. African tribes; Ashanti and other W. African tribes). Only in a few cases has exogamy to be observed with regard to the clans of both parents (Omaha, Osage of N. America; certain Naga tribes of Assam; S. Massim of Melanesia; Herero, Lango of Africa).

A specially complex set of conditions prevails in the tribes of central Australia, where there is a twofold division into: (a) totemic clans, which are not strictly exogamous; and (b) matrimonial classes, which strictly correspond to kinship divisions, and which are not only exogamous but regulate marriage to the extent that a member of one of them has to marry into one and one only of the remaining three or seven classes, as the case may be.

25. The **Forms** of Marriage. — From the foregoing description it will be clear that there is a considerable range within which the constitution of marriage can vary. For as we have seen there can be many different arrangements in the domestic, legal, economic and ceremonial sides of marriage, and each of their manifold combinations constitutes a distinct form of marriage.

The term "form of marriage" has been as a rule applied to what might be called the *numeric variation* in marriage, *i.e.*, the variation according to the number of consorts united to each other; and the main "forms of marriage" usually listed are monogamy, polygyny, polyandry and group-marriage. To deal with this classification adequately it is necessary to distinguish hypothetical assumptions from actually existing social arrangements. From this point of view we can at once eliminate "group-marriage," since our previous analysis (*see* above, 5) has shown that the *pirrauru* relationship of Australia and similar institutions among the Eskimo and in Siberia can not in their parental, economic, legal or religious functions be regarded as a form of marriage.

26. Polyandry. — This is the name given to a union in which several men are legally bound in marriage to one woman. Polyandry is the rarest of the numeric varieties of marriage, and unfortunately the one on which, in spite of its great theoretical importance. we possess but very meagre and inadequate information. Polyandry is not found among any of the more primitive peoples, and its distribution is almost completely confined to the highlands of S. India and C. Asia, with isolated exceptions, such as one African tribe (Bahima) and some Eskimo, among whom it occurs, but infrequently.

In Tibet and the adjacent countries there exists polyandry of the fraternal type, *i.e.,* several brothers share the wife in common. All the husbands live together with their common wife as members of the same household, and cohabit successively with her. Children born of these marriages are sometimes regarded as the legal descendants of the eldest brother-husband only; in other cases it appears that when a child is born it is attributed to him by whom the mother asserts that she has conceived it.

Among the Nayars of S W India there is a so-called form of polyandry which has played an important though rather deceptive part in the theories of marriage. A girl goes through a form of marriage with a man, but then really consorts with a number of men who need not be related to one another. She lives apart from her partners, who cohabit with her successively by agreement among themselves. Owing to the matrilineal institutions of this people, the children of such marriages inherit from their mother's brother, but the social importance of fatherhood is seen in the fact that the woman, when pregnant, always nominates one or other of the men as the father of the child, and he is obliged to provide for it and to educate it.

Another account is that by Dr. Rivers, of the Toda polyandry, which can be taken as the representative of the simpler type of this institution in S. India. Among the Toda, several men, usually two or three brothers, share the wife, but it is the rule that they cohabit with her in succession. Again, the children are not owned in common by the husbands, but each child is allotted individually to one, not with reference to any presumption of physical paternity, but in virtue of a ritual act performed by the man over the child, an act which establishes social paternity and confers legitimate descent on the child (*see* above, 4).

Polyandry is thus a compound marriage, in which cohabitation is usually successive, and not joint, while children and property are not shared by the husbands.

27. **Polygyny.**—This is a form of marriage in which several wives are united to one man, each having the status of legal consort, while her offspring are regarded as the legal descendants of the husband. As an institution polygyny (*q.v.*) exists in all parts of the world. There are very few primitive tribes about whom we are informed that a man is not allowed, if he can, to enter into more than one union. Many peoples have been said to be monogamous, but it is difficult to infer from the data at our disposal whether monogamy is the prevalent practice, the moral ideal, or an institution safeguarded by sanctions. It must be remembered at once that polygyny is never practised throughout the community: there cannot exist a community in which every man would have several wives, since this would entail an enormous surplus of females over males (*cf.* however the important contribution to this subject by G. Pitt-Rivers, *The Clash of Cultures and the Contact of Races*, 1927). The second important point with regard to polygyny, which is seldom brought out clearly, is that in reality it is not so much a form of marriage fundamentally distinct from monogamy as rather a multiple monogamy. It is always in fact the repetition of a marriage contract, entered individually with each wife, establishing an individual relationship between the man and each of his consorts. As a rule each relationship is little affected legally or economically by the others.

Where each wife has her separate household and the husband visits them in turn, polygynous marriage resembles very closely a temporarily interrupted monogamy. In such cases there is a series of individual marriages in which domestic arrangements, economics, parenthood as well as legal and religious elements do not as a rule seriously encroach on each other. The polygyny with separate households is more universally prevalent Among the great majority of the Bantu and Hamitic peoples of Africa, where the number of wives, especially in the case of chiefs is often considerable, each wife commonly occupies a separate hut with her children, and manages an independent household with well-defined legal and economic rights. Where, on the other hand, as among many N American tribes, two or more wives share the same household, polygyny affects the institution of matrimonial life much more deeply.

In most cases the motive for polygyny is economic and political. Thus in the Trobriand Islands (Melanesia) the chief's income is due to his wives' annual endowment. In many African communities the chief derives his wealth from the plurality of his wives, who by means of the produce of their agricultural labour enable him to exercise the lavish hospitality upon which so much of his power rests. A multitude of wives, however, may increase not only a man's wealth but also his social importance, reputation and authority, apart from the influence of the number of his children. Hence we find in many Bantu communities of Africa that the desire to have many wives is one of the leading motives in the life of every man; while the fact that in many Melanesian and Polynesian communities polygyny is a prerogative of the chief testifies to the social prestige attaching to it.

28. Monogamy.—Monogamy is not only the most important form of marriage, not only that which predominates in most communities, and which occurs, statistically speaking, in an overwhelming majority of instances, but it is also the pattern and prototype of marriage.

Both polyandry and polygyny are compound marriages, consisting of several unions combined into a larger system, but each of them constituted upon the pattern of a monogamous marriage. As a rule polygamous cohabitation is a successive monogamy and not joint domesticity; children and property are divided, and in every other respect the contracts are entered individually between two partners at a time.

Monogamy as the unique and exclusive form of marriage, in the sense that bigamy is regarded as a grave criminal offence and a sin as well as a sacrilege, is very rare indeed. Such an exclusive ideal and such a rigid legal view of marriage is perhaps not to be found outside the modern, relatively recent development of Western Culture. It is not implied in Christian doctrine even. Apart from such isolated phenomena as the recent Church of Latter Day Saints (Mormons) and the heretical sect of Anabaptists (16th century), polygyny was legally practised and accepted by the Church in the middle ages, and it occurs sporadically as a legal institution accepted by Church and State as recently as the middle of the 17th century (Westermarck, H.H.M., III., 50–51).

Monogamy as pattern and prototype of human marriage, on the other hand, is universal. The whole institution, in its sexual, parental, economic, legal and religious aspects, is founded on the fact that the real function of marriage—sexual union, production and care of children, and the co-operation which it implies—requires essentially two people, and two people only, and that in the overwhelming majority of cases two people only are united in order to fulfil these facts.

Conjugation necessarily takes place only between two organisms; children are produced by two parents only, and always socially regarded as the offspring of one couple; the economics of the household are never conducted group-wise; the legal contract is never entered upon jointly; the religious sanction is given only to the union of two. A form of marriage based on communism in sex, joint parenthood, domesticity, group-contract and a promiscuous sacrament has never been described. Monogamy is, has been and will remain the only true type of marriage. To place polygyny and polyandry as "forms of marriage" co-ordinate with monogamy is erroneous. To speak about "group-marriage" as another variety shows a complete lack of understanding as to the nature of marriage.

29. Theories of Marriage.—The last conclusions reveal once more the important truth of scientific method that a full knowledge of facts cuts the ground from under most hypothetical speculations. The theories of human marriage have mainly been concerned with its "origins" and "history," and attempts were made at ranging the various "forms of marriage" into an evolutionary series. Once we come to recognise that marriage is fundamentally one, and that its varieties correspond not to stages of evolution, but are determined by the type of community, its economic and political organisation, and the character of its material culture, the problem becomes one of observation and sociological analysis, and ceases to move on the slippery plane of hypothesis.

The view that marriage originated in "promiscuity," "hetairism" or "matrimonial communism," and that monogamy is a product of gradual development through a multitude of stages, has been advanced by Bachofen, Morgan and McLennan; has found whole-hearted or partial support by a number of eminent writers (Lord Avebury, Fison, Howitt, Tylor, Spencer and Gillen, Post, Kohler, Kovalevsky, Lippert, Schurtz, Frazer and others); and has been criticised and combated by Darwin, Westermarck, Lang, Grosse and Crawley.

The writings of Morgan's school suffer from an over-emphasis of the sexual aspect, often coupled with prudish reticences; from a misinterpretation of linguistic evidence; from a neglect of the parental and economic aspect of marriage. They are full of fantastic and meaningless concepts such as "promiscuity," "group-marriage," "primitive communism," which as a rule are not even laid down with sufficient concrete details to give hold to our imagination and remain mere words on paper. The German writers of this school, who have contributed a voluminous output, especially in the *Zeitschrift* fur *vergleichende Rechtswissenschaft,* have certainly not neglected the legal side of marriage, but in applying to primitive societies the dry legal formalism of modem jurisprudence, and in ruthlessly forcing all facts into the cut and dried scheme of "marriage stages," they have contributed but little which will have lasting value.

The recent advocates of Morgan's and Bachofen's view, notably Sumner, Rivers, Keller, Briffault, have given a much better and more concrete outline of the hypothetical early stages of marriage. But even this last stand of the "group-marriage" theory is based on an inadequate analysis of the institution and an unwarranted assumption of early sexual and economic communism as well as of group-motherhood

Modern theories of marriage follow closely the lead of Darwin on the biological side, of Westermarck in his sociological analysis, and of Crawley in some of his psychological suggestions. Such writers as Lowie, Kroeber and Howard in America; Thurnwald, W. Schmidt and Koppers in Germany; A. R. Brown, Malinowski, and Pitt-Rivers in Great Britain, both in their theories and in their field work show a far greater interest in the sociological analysis of marriage, in its relation to the family, in the correlation of its aspects, in the sociological working of sexual customs, whether these be tabus, relaxations or excesses, in their reference to marriage.

Some new light on marriage has been thrown by those psychoanalysts, notably J. C. Flügel, who are prepared to give serious consideration to facts in their bearing upon the Freudian doctrine (cf. Malinowski, Sex and Repression in Savage Society). Finally important contributions to the theory of marriage have been made by those students who approach the problem in its practical applications: the eugenists (see Eugenics Review): students of population (see Raymond Pearl's Journal of Human Biology); and scientific aspects of social hygiene (American J. of Social Hygiene).

Marriage like most problems of anthropology is ceasing to be a subject of speculation and becoming one of empirical research.

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MARRIAGE, LAW OF. Marriage may be defined either as the act, ceremony or process by which the legal relationship of husband and wife is constituted; or as a physical, legal and moral union between man and woman in complete community of life for the establishment of a family.

While the consent of parties is universally deemed one of the conditions of a legal marriage, all the incidents of the relationship constituted by the act are absolutely fixed by law. The jurist has to deal with marriage insofar as it creates the legal status of husband and wife. It should be added that, while marriage is generally spoken of by lawyers as a contract, its complete isolation from all other contracts is invariably recognized. Its peculiar position may be seen at once by comparing it with other contracts giving rise to continuous relationships with more or less indefinite obligations, like those of landlord and tenant, master and servant, etc. In these the parties may in general make their rights and duties what they please, the law only intervening when they are silent. In marriage every resulting right and duty is fixed by the law.

Inferior Forms of Union.—Besides true marriage, inferior forms of union have from time to time been recognized, and may be briefly noticed here. These have all but disappeared from modern society, depending as they do on obsolete matrimonial restrictions.

The institution of slavery is a fruitful source of this kind of debased matrimony. In Roman law no slave could contract marriage whether with another slave or a free person. The union of male and female slaves (contubernium) was recognized for various purposes; a free woman entering into a union with a slave incurred under the S.C. Claudianum the forfeiture of her own liberty; but the bondwoman might be the concubine of a freeman. In the United States. where slavery was said to be regulated by the principle of the civil law. the marriage of slaves was so far recognized that on emancipation complete matrimony took effect and the children became legitimate without any new ceremony.

In Roman law no legal marriage could be contracted unless there was connubium between the parties. Originally there was no connubium between plebs and patricians, and in later times between the Latini and Peregrini, unless it had been expressly conferred. The Lex Julia et Papia Poppaea introduced restrictions depending on the condition of the parties which later legislation extended and perpetuated. Senators under that law were forbidden to marry freedwomen or women of inferior rank, and the husband of a freedwoman on becoming a senator was set free from his marriage. In the canon law new restrictions were developed. The order of the clergy were forbidden to marry. Disparity of faith was recognized by the early church as a bar to matrimony; *e.g.,* between Christians and pagans and between orthodox and heretics.

Concubinage, which such restrictions tended to develop, is noticed under a separate heading. In the left-handed or "morganatic" marriages of the German royal families is the nearest approach ever made by concubinage to true marriage, the children being legitimate, but neither they nor the wife acquiring any right to the rank or fortune of the husband. The marriage of persons of different religions frequently requires the intervention of the law as to the faith of the children, more particularly in Europe as between Roman Catholics and Protestants. English law gives the father, except under special circumstances, the right to dictate the faith of his children. The practice on this point varies in Europe—the question being ignored in French law, Germany following in some parts the same rule as England, in others giving effect to antenuptial stipulations. In Ireland mixed marriages (*i.e.,* between Roman Catholic and Protestant) were by 19 Geo. II c. 13 null and void if celebrated by a Roman Catholic priest. This act was repealed by 33 & 34 Vict. c. 110, which permits mixed marriages to be validly celebrated by an Episcopalian or Roman Catholic clergyman, subject to conditions set forth in s. 38.

Roman Law.—The three primitive modes of marriage were *confarreatio, coemptio in manum* and *usus,* all of which had the effect of placing the woman in the "power" (*manus*) of her husband, and on the same footing as the children. The first was a religious ceremony before ten witnesses, in which an ox was sacrificed and a wheaten cake broken and divided between the spouses by the priest. *Coemptio* was a conveyance of the woman by *mancipatio,* and might be described as a fictitious sale per *aes et libram. Usus* was the acquisition of the wife by prescription, through her cohabiting with the husband for one year, without having been absent from his house three continuous nights. But a true marriage might be concluded without adopting any of these modes, which all fell into desuetude and with them the subjection of the wife to the *manus.*

Marriage without *manus* was contracted by consent, without writing or formality of any kind. The restrictions as to age, relationship by consanguinity and affinity, previous marriage, etc., were in the main those which have continued to prevail in modem Europe with one important exception. The consent of the paterfamilias to the marriage of the children under his power was essential.

Canon Law.—The canon law of marriage is based partly on the Roman law, the validity of which the church from the first recognized, partly on the Jewish law as modified by the new principles introduced by Christ and his apostles, developed by the fathers of the church and mediaeval schoolmen and regulated and defined by popes and councils. The most important of these principles was that of the indissolubility of marriage, proclaimed by Christ without qualification according to Mark x, 11, 12, and with the qualifying clause "saving for the cause of fornication" according to Matt. v, 32. This lofty view of marriage, according to which man and wife are made "one flesh" by the act of God ("What therefore God hath joined together, let no man put asunder," Mark x, 9), was later modified by the heretical idea of the consummating act of marriage as in itself something unholy, a result of the fall. Christ himself, evidently, did not teach this. It is to St. Paul that the idea of marriage as a sacrament is to be traced, in the mystic comparison of the relations of husband and wife to those of Christ and his church. (Eph. v, 23–32.) Marriage. from being no more than a terminable civil contract, became a thing holy. a sacrament. a mystic union of souls and bodies never to be divided; valid, indeed, but not spiritually complete, without the public blessing of the church (Tertullian, *Ad uxorem,* lib. ii, cap. 9).

Remarriage (bigamy) was only allowed after many struggles, and then only to the laity; St. Paul had laid down that a "bishop" must be "the husband of one wife," and to this day the priests of the Orthodox Eastern Church may not remarry. Clerical celibacy, at first a counsel of perfection, was soon to become the rule of the church, though it was long before it was universally enforced in the west; in the east it still applies only to monks, nuns and bishops. *(See* CELIBACY). The marriage of the laity was hampered by the creation of a number of impediments. The few and definite prohibitions of the Roman and of the Jewish law (Lev. xviii, 6–18; xx) in the matter of marriage between kindred were indefinitely extended until in 506 the Council of Agde laid it down that any consanguinity or affinity whatever constituted an impediment. Moreover, man and wife being "one flesh," the church raised relationship by affinity into equal importance with that of consanguinity as an impediment to matrimony; and finally, to all this, added the impediments created by "spiritual affinity"; *i.e.,* the relations established between baptizer and baptized, confirmer and confirmed, and between godparents, their godchildren and their godchildren's relatives.

All this resulted in confusion and uncertainty, and it was early found necessary to modify it. Thus Pope Gregory I limited the impediment to the seventh degree of relationship inclusive (civil computation), which was afterward made the law of the empire by Charlemagne.

Later still Innocent III, by a decree (fourth Lateran council), permitted marriages between a husband and the relations of his wife, and vice versa, beyond the fourth degree inclusive (canonical computation). This remains the canonical rule of the Roman Catholic Church. Impediments resulting from spiritual affinity were limited by the Council of Trent to the relation of the baptizer and baptized; the baptizer and the parents of the baptized; the baptizer and the godfather and godmother; the godparents and the baptized and its parents; *i.e.,* a godfather may not marry the mother of the child he has held at the font, nor the godmother the father of such child.

In the fully developed canon law impediments to marriage are of two kinds, public and private. Near relationship, for instance, is a public impediment; impotence and force are private impediments.

Impediments are further divided into separating or merely suspensive. To the first class belongs, *e.g.,* a previous marriage not dissolved by death, which involves the nullification of the marriage even where through ignorance the crime of bigamy is not involved; to the second belongs the case of one or both of the contracting parties being under the age of puberty. Impediments, moreover, are absolute or relative. Near relationship, for instance, is an absolute impediment; difference of religion between the parties a relative impediment.

In addition to consanguinity and affinity, impuberty and existing marriage, the canon law lays down as public and absolute impediments to marriage the taking of holy orders and the vows of chastity made on entering any of the religious orders approved by the Holy See. In these impediments the canon law further distinguishes between those which are based on the law of nature (jus *naturae*) and those which are based on the law of the church (*jus* ecclesiae).

From impediments based on the law of nature, or of God, there is no power even in the pope to dispense; *e.g.,* marriage of father and daughter, brother and sister, or remarriage of husband or wife during the lifetime of the wife or husband of another marriage, which is held to be a violation of the very nature of marriage as an indissoluble union. From impediments arising out of the law of the church dispensations are granted, more or less readily, either by the pope or by the bishop of the diocese in virtue of powers delegated by the pope. (See DISPENSATION.)

Thus dispensations may be granted for marriage between persons related by consanguinity in any beyond the second degree and not in the direct line of ascent or descent; *e.g.,* between uncle and niece (confined by the Council of Trent to the case of royal marriages for reasons of state) and between cousins-german, or in the case of marriage with a heretic. In this latter case a dispensation is now (*i.e.,* since the papal decrees *ne* temere of Aug. 2, 1907, which came into force at Easter 1908) only granted on condition that the parties are married by a Catholic bishop or a priest accredited by him, that no religious ceremony shall take place except in a Catholic church and that all the children shall be brought up in the Roman Catholic faith.

In the absence of any impediment a marriage is according to the canon law completed between baptized persons by the facts of consent and consummation; the principle is still maintained that the parties to the marriage. not the priest, are the "ministers of the sacrament." From the first, ho ever, the church, while recognizing the validity of private contracts, enjoined the addition of a public religious ceremony (1 Tim. iv, 5). Tertullian (de *pudicitia*, cap. iv) says that clandestine marriages, not professed in the church, were reckoned among Christians as all but fornication, and he speaks of the custom of seeking permission to marry from the bishop, priests and deacons (De monogamia, cap. xi). This latter precaution became increasingly necessary as impediments were multiplied, and Charlemagne, in a capitulary of 802, forbade the celebration of a marriage until "the bishops, priests and elders of the people" had made diligent inquiry into the question of the consanguinity of the parties. This was the origin of the publication of banns which, long customary in France, was made obligatory on the whole church by Pope Innocent III. In the Eastern Church the primitive practice survives in the ceremonial blessing by the priest of the betrothal, as distinguished from the marriage ceremony. The ecclesiastical recognition of clandestine marriages, however, survived until the crying evil was remedied by a decree of the Council of Trent (Sess. xiv, de *matrim.*), which laid it down that for a valid marriage it was at least necessary that consent should be declared before a priest and in the presence of three witnesses.

Divorce. *i.e.*, the annulment of marriage for any cause but an impediment which makes the marriage *ipso* facto void: is unknown to the Roman Catholic Church. Separation a *vinculo matrimonii* is only possible under the canon law by a judicial decree of nullity (*annullatio matrimonii*), which implies, not the severing of the ties of a real marriage, but the solemn declaration that such marriage has never existed. There may, however, be a "separation from bed and board" (a *thoro* et mensa), even perpetual. which does not, however, give either party the right to remarry during the lifetime of the'other. But, marriage not being regarded as a sacrament until consummated, it may be dissolved, if nonconsummation be proved, by one or both parties taking the religious vows or by papal dispensation. The Roman Catholic Church claims exclusive control over marriage, and the Council of Trent anathematized the opinion held by Luther and other reformers, that it mas properly a subject for the civil courts (si quis dixerit causas *matrimoniales* non *spectare* ad judices ecclesiastic anathema sit, Sess. xxiv, cap. 2). This attitude became of extreme political importance when even in Catholic countries the codes established civil marriage as the only legally binding form.

(X.)

ENGLAND

Generally speaking, marriage as understood in England can well be described as "the voluntary union for life of one woman and one man to the exclusion of all others" (Lord Penzance in Hyde v. Hyde, 1866 L.R. 1 P. & D.).

In England, therefore, no union will qualify as a marriage unless it is monogamous in nature. A marriage which is contracted in a Christian country will be recognized provided there is that exclusiveness which is the essential feature in a Christian marriage. For example, if a man domiciled in England marries in Japan a Japanese girl according to the local forms there. it will be recognized when proof is given that the Japanese law of marriage is monogamous in nature. Further. marriage, although in some ways it can be regarded as contractual, in fact, because of its canon law origin and the fact that it gives the status of husband and wife, has effects in law not limited to those of an ordinary civil contract.

In England a valid marriage can be contracted except:

1. If either party is already married; or where a period must elapse after a decree of divorce before a party can remarry, a marriage which purports to have been celebrated during this period being null and void.

2. If either party is a certified lunatic (Marriage of Lunatics act, 1811).

3. If either party is under 16 years of age (Age of Marriage act, 1929).

4. If the ceremony of marriage is invalid (see below).

5. If the parties are within the prohibited degrees of consanguinity, (relationship by blood) or affinity (relationship by marriage). These are laid down in the Book of Common Prayer and are in part i of the first schedule of the Marriage act, 1949, between the ascending and descending lines in *infinitum* and collateral to the third degree; in part ii of this schedule 20 statutory exceptions are laid down and these include deceased wife's sister, deceased brother's wife, brother's deceased son's wife, etc. It is interesting to note that these exceptions do not, of course. modify the prohibition as regards a divorced spouse's relations. for whom the position is still the same as that laid down in the Book of Common Prayer, and that the relationships within the prohibited degrees include a half-blood and illegitimate relation.

6. If either party is coerced into marrying, or is fraudulently misled as to the identity of the other party or as to the nature of the ceremony. To invalidate a marriage there must be a fundamental lack of consent. Thus if a man were so drunk that he did not know what he was doing at the time of the ceremony. his consent would be vitiated and there would not be a valid marriage. If, on the other hand, a woman were to make a mistake as to the fortune of the other party, the marriage would be valid.

Void and Voidable Marriages.—The distinction between a void and voidable marriage is most important. If a marriage is a void one, strictly speaking no decree of the court is necessary because the marriage is deemed never to have existed and a decree of nullity in this case is of a declaratory nature only and may therefore be obtained after the death of one of the spouses. Subject to certain qualifications outlined in this article, a marriage is void on the grounds of: (1) invalid ceremony (but see below); (2) nonage, *i.e.,* if either of the parties is below the age of 16; (3) consanguinity; (4) bigamy; (5) insanity at time of marriage; (6) lack of consent; (7) impotence (canonical disability).

On the other hand, a voidable marriage is one which exists and is valid for all purposes until the court pronounces a decree, which it can do only on the grounds laid down in s. 8 of the Matrimonial Causes act, 1950, which are: (1) wilful refusal to consummate the marriage; (2) insanity, mental deficiency or epilepsy at the time of marriage; (3) venereal disease at the time of the marriage; (4) pregnancy by a person other than the husband at the time of marriage.

For these purposes, both parties must be alive when the petition is heard and for the purposes of (2), (3) and (4) the petitioner must satisfy the court that at the time of the marriage he was ignorant of the facts alleged, that proceedings were instituted within one year from the date of the marriage and that marital intercourse had not taken place since the discovery of the grounds for the decree.

Procedure. — The Marriage act, 1823, as re-enacted in the Marriage act, 1949, regulates marriage within the Church of England. It requires either the previous publication of banns or a licence from the proper ecclesiastical authority. As to banns, the rule of the rubric, so far as not altered by the statute, is required to be observed. They must be published on three successive Sundays at morning service after the second lesson, in the church of the parish in which the parties dwell; the bishops may, however, authorize the publication of banns in a public chapel. Seven days' notice must be given to the clergyman of the names of the parties, their place of abode and the time during which they have lived there. If either party is under age, the dissent of the parents or guardian expressed at the time of publication of banns renders such publication null and void.

Licence in lieu of banns may only be granted by the archbishop, bishop or other authority, for the solemnization of a marriage within the church of the parish in which one of the parties shall have resided for 15 days before. Before a licence can be granted an oath must be taken as to the fact of residence and, when either party is under 21, that the necessary consent has been obtained in the case of persons under that age. The father or lawful guardian is the proper person to consent to the marriage of a minor and the place of any such person if incapacitated mentally is taken by the lord chancellor. The absence of such consent does not, however, avoid a marriage once solemnized. But if persons wilfully intermarry (unless by special licence) in a place not being a church or public chapel, or without due publication of banns or proper licences, or before a person not in holy orders, the marriage is null and void to all purposes. Marriage must be celebrated within three months after banns or licence, and between the hours of 8 A.M. and 6 P.M.

The Marriage act of 1836 as re-enacted in the Marriage act, 1949, lays down alternative ways of being married. It permits marriage to be solemnized in two additional ways: (1) by certificate of the superintendent registrar of a district without licence and (2) by such certificate with licence. As far as the first way is concerned, notice must be given to the registrar of the district or districts within which the parties have resided for seven days previous, which notice is inscribed in a marriage notice book, open to public inspection at all reasonable times and thereafter suspended for 21 days in some conspicuous place in the registrar's office. Any person whose consent is necessary to an ecclesiastical licence may forbid the issue of a certificate but in default of such prohibition the certificate will issue at the end of 21 days. The marriage may then take place on any day within three months of the entry of notice and in one of the following ways: (1) in a certified place of religious worship registered for the solemnization of marriage; in that case a registrar of the district and two witnesses must be present and the ceremony must include a mutual declaration of assent by the parties and a disavowal of any impediment; (2) at the superintendent registrar's office, with the same declaration but with no religious service; (3) according to the rites of the Church of England; (4) according to the usages of the Jews and Quakers. (The place of marriage must in all cases have been specified in the notice and certificate.)

In the second case, when it is desired to proceed by licence, notice must be given to the registrar of the district in which one of the persons resides, together with a declaration that he or she has resided for 15 days therein, that there is no impediment and that the necessary consents, if any, have been obtained. The notice is not exhibited in the registrar's office and the certificate may be obtained at the expiration of one whole day after entry, together with the licence. No registrar's licence can be posted for a marriage in an Anglican church or one according to the form of the Church of England.

The effect of a default in the formalities of a marriage will depend on the nature of the defect and on the parties' knowledge of it. The following defects in the celebration of the marriage will not invalidate it:

1. Noncompliance with conditions as to residence under the Marriage act, 1823, s. 26., and the Marriage Registration act, 1856, s. 17 (now re-enacted in the Marriage act, 1949).

2. Failure to obtain parents' consent where one or both parties are under age, see R. v. *Birmingham Inhabitants* (1828 813 & C. 29) and Marriage and Registration act, 1856, s. 17, now re-enacted in the Marriage act, 1949.

3. Marriage not celebrated in front of two people.

4. Misdescription of the parties as to name, address, age and condition only invalidates a marriage which is solemnized after publication of banns and then only if the misdescription is fraudulent and is known to both parties of the marriage before the ceremony.

5. Other defects in the formalities rendered necessary by statute, or described above, invalidate a ceremony only if both parties are aware of the defect, for example, if a ceremony were solemnized in a church where the banns were not published, or not before a clerk in holy orders, etc.

The form and ceremonies of entering into a contract of marriage are regulated by the place where the marriage was celebrated but the essentials of a marriage depend on the law of the country in which the parties are domiciled at the time of the marriage and in which the matrimonial residence is contemplated. Foreign law is assumed, until the contrary is shown, to be the same as English.

Royal marriages have been subject to special laws. The Royal Marriages act, 1772, laid down that no descendant of George II who is under 25 shall be able to marry without the consent of the sovereign, under the Great Seal. If such a descendant is over 25, and his intended marriage is disapproved of by the sovereign. then he should give 12 months' notice in writing of it and after that time, unless both houses of parliament disapprove, the marriage can be validly solemnized.

In the Sussex Peerage case it was held that the language of the act was sufficiently strong to invalidate such a marriage contracted by such a descendant where no consent had been given, even though the local law required no consent, thus making the consent required by the act an essential of a valid marriage. (It is interesting to contrast the case of the consent of a parent to a marriage of a child under 21, where the courts have held, in the so-called Gretna Green cases, that this consent is only formal and that a marriage of English persons in Scotland, where until the Marriage (Scotland) act, 1939, no such consent was needed, was valid even though the necessary consent according to English law had not been obtained.)

It is a criminal offense to solemnize a marriage in contravention of the provisions of the Marriage act, 1823 (s. 2), the Marriage act, 1836 (s. 39), and the Royal Marriages act, 1772 (s. 3).

Legal **Effects** of Marriage. — Until the Law Reform (Married Women and Joint Tortfeasors) act, 1935, a husband could in certain circumstances be held liable in tort for his wife's wrongful acts. but since that act a woman is in the position of a feme sole and her husband is exempt from liability unless it can be shown that the wife was in fact an employee or agent. Similar considerations apply to the law of contract.

A husband is not liable for obligations contracted by his wife unless it can be shown that she acted as an agent of necessity. This position is said to arise when a husband wrongfully expels his wife from the matrimonial home without giving her a reasonable allowance, in which event she is deemed to have authority to pledge his credit in respect of necessaries requisite to maintain her in her station of life.

Marriage has the following effect upon the disposition of a spouse's property upon his death. If he or she leaves no will, then under the Administration of Estates act, 1925, a surviving spouse, whether husband or wife, is entitled on an intestacy of the other to: (1) the personal chattels absolutely (this includes furniture, houses, cars, plate, books. etc.); (2) £5,000 absolutely, free of duty and costs, with interest thereon at the rate of 5% per annum from the date of death until payment (this sum was £1,000 in the 1925 act but was amended to £5,000 by the Intestates' Estates act, 1952); and (3) a life interest in half of the residuary estate if the deceased left issue, and in the whole of the estate if the deceased left no issue.

Further, under the provisions of the Inheritance (Family Provision) act, 1938. where a person dies domiciled in England having (1) a wife or husband or (2) an unmarried daughter or a son or daughter who by reason of disability is unable to maintain himself or herself or (3) an infant son, then if a court on application by any of these dependents is of opinion that the will does not make reasonable provision for such dependent, an order making such provision may be made, provided the application is made within six months of death and provided the testator has bequeathed less than two-thirds of such estate where there is a spouse and other dependents or one half where there is only a spouse. This act of 1938 is by the Intestates' Estates act, 1952, extended to cases of intestate persons where the laws relating to intestate succession make insufficient provision for intestate person's dependents.

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OTHER COUNTRIES

Scotland. — For the law of marriage in Scotland see SCOTS LAW.

France. — In France articles 144–226 of the Code Civil, as amended by several acts, prescribe the qualifications and conditions of marriage. The man must be 18 and the woman 15 years of age. A son or daughter under 21 cannot marry without consent of the father and mother, or of one of them (act of July 17, 1927) if they disagree or have been divorced or of the survivor if one is dead. If both parents are dead, the grandfather and grandmother or one of them take their place. If the grandparents are also dead the consent of the family council, deciding by a majority, must be given. Between the ages of 21 and 30 the parties are quite qualified and do not have to obtain the consent of their parents but must make a "respectful and formal act" before a notary when consent is failing (act of Feb. 2, 1933). Adoptive children under 21 cannot marry without consent of their adoptive parents (act of July 29, 1939). These rules apply to natural children when affiliated. Those not affiliated require the consent of a tutelage council. The act of July 29, 1939, created such a council in every canton, provided by the justice of the peace and deciding like a family council.

Marriage is prohibited between all ascendants and descendants in the direct line. and between persons related by marriage in the same line, between brother and sister, between uncle and niece, aunt and nephew. between adopter's and adoptive children and between adoptive children. In the collateral line, the act of July 1, 1914, suppressed the prohibition between brother-in-law and sister-in-lam unless the marriage producing the affinity has been annulled by divorce.

Before the solemnization of marriage, a publication notice must appear on the door of the town hall for a period of ten days. The notice contains the names, Christian names, occupations, domiciles or residences of the parties and the place where marriage is to be celebrated. Since the act of Aug. 9, 1919, the notice has contained nothing about the parents. According to an act of Nov. 2, 1945, the parties must give a less than two months' old medical certificate to the civil officer. If the marriage cannot be celebrated during the year, a fresh notice must be put up. The marriage is celebrated, in the parish to which one of the parties belongs, by the civil officer or registrar. He reads over to the parties the various necessary documents, with the chapter of the code relating to husband and wife, receiving from each a declaration that they take each other for husband and wife and drawing up the act of marriage. 411 this must be done in the presence of two witnesses. Marriages contracted abroad between French subjects or between French subjects and foreigners are valid in France if celebrated according to the forms of French law, before French competent consuls, or according to the forms of the foreign law provided the French conditions as to consent of parents have been observed.

(J. M.-M. L.)

Germany. — The law of marriage and divorce is laid down uniformly for all parts of Germany by the Control council Marriage law of 1946; this law took over the Marriage law of 1938, with the exception of typical National Socialist provisions. The law recognizes only marriage concluded before the registrar; *i.e.,* civil marriage. Church marriage may only take place afterward. Since 1947 foreigners may be married in Germany before diplomatic or consular representatives according to their own laws.

A man may not contract a marriage before he has completed his 21st year (his 18th in the Democratic Republic and east Berlin); a woman before she has completed her 16th. With special permission, both may marry earlier.

Legally incapable persons may not contract marriages, and those of limited legal capacity only with the permission of their legal representative.

After public notice is given, the marriage is concluded when the contracting parties personally and in the presence of each other and before the registrar declare, in answer to the question put to them individually, that they wish to marry each other. Two witnesses should be present and the registrar should enter the marriage in the register.

Marriages are particularly forbidden and, when celebrated, are void, between ascendants or descendants or full or half brothers and sisters, or if one of the parties is already married. Also forbidden and void (unless special permission is given before or after the marriage) are marriages between relations by marriage in a direct line; and between a person divorced for adultery and the person with whom the adultery was committed.

Marriages should not be contracted (although such marriages are not therefore void) by persons between whom there is an adoption relationship; by a woman whose former marriage has ended less than ten months previously; where no certificate can be produced from the guardianship court regarding the property settlement made for children of a former marriage; and by foreigners without a certificate from their own country stating that there is no impediment to the marriage.

Marriages are also void where, at the time of the marriage, one of the parties was legally incapable. or where the essential form of the ceremony was infringed. In these cases marriages are. however, valid if the parties have lived together for a certain time. After 1945 formally invalid "free" marriages between persons persecuted on racial or political grounds, displaced persons and refugees were under certain conditions recognized by law.

Void marriages count as being so from the beginning; but this effect only comes into operation once a court decision has been given. Children of such marriages count as legitimate if they would have been so had the marriage been valid. The disposition of the property of the partners is regulated according to the divorce rules if at least one partner is ignorant of the nullity.

A marriage can only be declared null by the court for grounds existing at the time when the marriage took place: lack of consent by legal representative; an error over the marriage ceremony, the person or the person's essential characteristics; wilful deceit; and threats. The marriage only becomes invalid when the court dissolves it (before 1938 it counted as invalid from the beginning).

Special grounds of divorce are: adultery; guilty disruption of the marriage by a serious violation of the duties of marriage; and cessation of domestic companionship for three years, together with a complete disruption of the marriage. The consequences of divorce (particularly whether the wife may use the husband's name, alimony, custody of children) are decided in different ways according to whether divorce is granted because of the guilt of one or both parties (adultery, serious violation of marriage duties) or on other grounds.

Being a law of the Control council the Marriage law is not affected by the principle of the equal rights of man and woman which came into force in Germany after World War II. The principle does, however. operate in essentials in general matrimonial matters and in property rights, which are regulated by the Civil Code of 1900. (G. K.)

The **U.S.S.R.**—The basic law governing marriage in the U.S.S.R. was passed on Dec. 31, 1917, and established that from that time only civil marriages would be recognized by the state. Marriage in church was "a private affair." It was then sufficient for two unmarried persons of marriageable age to record their intention to marry at the local registrar's office for the marriage to become legally effective. A marriage could be annulled on the petition of both or one of the parties to the local court. Subsequent legislation was aimed at increasing respect for the marital state and making divorce more difficult. A law of Nov. 1926 confirmed the basic principles and established the marriageable age at 18 for both sexes. In June 1936 the divorce law was amended to "combat an irresponsible attitude toward the family and family obligations." It increased the fees payable for divorce proceedings and required both parties to be present at the hearing of the case. A law of July 1944 required that marriages should in future be recorded in the parties' passports and that divorce proceedings were to be heard by the local courts in public. These proceedings were made appreciably more difficult in that the courts were instructed to inquire more closely into the reasons for the petition and to try to reconcile the parties. Only a higher court could annul a marriage. Steps were taken to make the marriage ceremony a more "solemn procedure." Marriage between relatives in the direct line, full and half brothers and sisters and the insane has always been prohibited by Soviet law. (D. Fd.)

UNITED STATES

The fundamental principle of U.S. marriage law, a subject wholly regulated by state rather than national law, is simply that a man and a woman, each possessed of the requisite capacity, may become married by mutual consent. Although a statute may require that a judge or a clergyman officiate at a wedding, the status of marriage is truly created by assent of the parties themselves. It follows that a marriage is not valid if consent is obtained by fraud or duress nor if the ceremony was not intended to be a real wedding. Thus marriage is frequently referred to as a contract albeit a very special kind of contract.

The statutes of every state make provision for the issuance of marriage licences. Many states, however. recognize common-law marriages; *i.e.*, informal marriages without a licence or a solemnizing official. In those states the licencing laws are interpreted as merely providing one. but not the only, way of marrying. In some common-law marriage states the marriage takes place by the parties expressing their present intention to be married, in others by holding themselves out to the community as husband and wife. In the mid-1950s in 30 states a marriage under a licence could take place only after a waiting period of from one to five days.

A formal marriage demands no particular ceremony although statutes frequently require that a marriage be solemnized by a clergyman or some public official. A valid marriage may take place under a licence improperly issued provided the parties have the capacity to be married.

Capacity to marry turns on various factors determined by the law of the several states. Of course, a person presently married cannot marry again without an intervening divorce. The parties must have attained a certain age to be married. At common law, marriages below the age of 12 for girls and 14 for boys were void. These ages have been raised in almost every state. Typically, a state forbids the marriage of girls below 15 or 16 and of boys below 18. Whether the marriage of a person below the statutory age is absolutely of no effect (void) or is effective until nullified (voidable) depends upon the special facts of each case and upon the particular law of each state. Usually, males under 21 and females under 18 must obtain the consent of their parents before a licence can be issued. However, if the parties are actually married without parental consent the marriage is valid. Persons may not intermarry if there is between them a close relationship by blood (consanguinity) or by marriage (affinity). In general, a marriage is incestuous if one attempts to marry an ancestor, a descendant, an aunt (uncle), a sister (brother) of the whole or the half blood or any of their respective spouses. In the mid-1950s, 29 jurisdictions prohibited marriages between first cousins, 7 jurisdictions forbade marriage to a grandneice (grandnephew) and 6 prohibited marriage to a first cousin once removed. Several states, principally in the south and west, prohibitea persons of different races from marrying. In 1948 the California supreme court held the state statute prohibiting miscegenation unconstitutional as a violation of the 14th amendment to the constitution of the United States.

To an increasing extent U.S. marriage law takes into account the physical condition of the parties. particularly as that condition may be transmitted to offspring. Regulations respecting marriage of insane, epileptic or diseased persons are found in most of the states. At common law incurable impotency and insanity or idiocy were grounds for annulment—the first because the proper purpose of marriage was frustrated and the second because the required consent could not be given. In 1895 Connecticut prohibited the marriage of epileptics and since that time several other states have followed suit. Three states prohibited the marriage of persons having tuberculosis and three others sought to prevent the marriage of persons having any transmissible disease. Wisconsin pioneered in 1913, requiring a medical certificate showing that the male was free from venereal disease before a licence could be issued. The requirement was imposed in more than 40 states by the 1950s and generally upon both parties. A Massachusetts statute of 1943, perhaps reflecting medical progress. provided only that the parties be informed of the existence of the disease. (M. G. Pn.)

MARRIAGE RATE. In its most usual form, the marriage rate is expressed as the number of marriages occurring in a community during a calendar year per 1,000 of total population living in the community in that year. For example, it is estimated that there were 1,667,231 marriages in the United States during 1950. Since the total population for that year was 150,697,361, the number of marriages per 1,000 of population was 11.1. This rate would be doubled if the number of persons marrying, instead of the number of marriages, were related to the total population. By expressing annual marriages of communities in terms of a common unit, *i.e.*, per 1,000 of population, it is possible to make comparisons between communities of different size, or in the same community over different periods of years. However, the marriage rate computed in this way is not entirely satisfactory as a measure for comparison; for example, two communities may differ in their marriage rates simply because one of them happens to have a larger proportion of its total population within the marriageable ages than the other. Even if two communities had the same proportion of their total populations at the marriageable ages, the marriage rates computed in the manner indicated above might differ markedly if one of them should have a greater proportion of single, widowed or divorced marriageable persons than the other. The chances of marriage, according to studies made in the United States, are, age for age, greatest for the divorced. next best for the widowed and least for the single. Furthermore, the marriage rates are influenced by the ratio of the number of marriageable men to the number of marriageable women in the cotnmunity. Obviously, if a community had very few marriageable men, the marriage rate would be very low. For these reasons, marriage rates have on occasion been computed on bases other than total population, such as total population at ages 15 and over, single population at ages 15 and over and total females comprised within the ages from 15 to 45 years. Unfortunately. these more refined bases are not in common use and it therefore becomes necessary to make some allowance for the foregoing factors in comparing marriage rates based upon total population.

Allowance should also be made for the limitations of the statistics. Some nations keep more accurate and complete records of marriages than others, and there are differences in the definition of a legal marriage. For instance, some communities recognize common-law marriages as legal, while others do not. The low marriage rates of certain Latin-American countries: among others, are to be explained in part by the large Indian population whose marriages, if not performed according to the civil or religious requirements of the state, are not recorded as legal marriages.

International Comparisons.—The marriage rate for the United States is high compared with that for most other countries of the world for which records are available. None of the European countries listed in Table I, except Hungary. Poland and Yugoslavia, had marriage rates as high as the United States, where the rate was 10.j in 1950–52.

Of the European countries listed in Table I, Ireland had the lowest marriage rate of all, namely 5.4 per 1,000 population during 1950–52. Lower rates are shown only for certain countries of South America, namely, Peru and Venezuela. The highest rate shown is that of 12.5, for Israel.

Trend.—The marriage rates for the United States, England and Wales and the countries of continental Europe do not show the marked trends toward lower levels exhibited in their birth rates and death rates. In fact, the marriage rate is a relatively stable figure, and notable variations from the usual marriage rates for each country appear only during great wars or in periods of economic depression.

The United States, for the period 1901–40, had a comparatively stable marriage rate, not varying far from 10 per 1,000 (see Table II). The decade of the 1940s saw the average rate raised to 12.7, although in the early 1950s the rate again varied around 10. The level of the marriage rates in England and Wales during the half century from 1851 to 1900 was not appreciably below that for the half century from 1901–50, when it fluctuated around 8 per 1,000. The same is true for France, except that the average rate for the century (7.7) was a little lower than that for England and Wales (8.1). For Germany the average rate for 1851–1950 was 8.3, and for Sweden, 7. However, the Swedish rate, which averaged 6.5 for the eight decades from 1851–1930, rose to 8.6 for the period 1830–50.

Factors Influencing the Marriage Rate.—War.—The outbreak of World War II in 1939 resulted in declines in the marriage rates for France and Germany. In France the rate fell from a prewar average of 6.j per 1,000 in 1936–39 to 4.4 in 1940. In World War I the drop was even greater, to a low point of 2.3 in 1915. The decline in Germany was not so pronounced, from an average rate of 9.7 in 1936–39 to 7.2 in 1941. In 1915 and 1916 the rate in Germany dropped to 4.1. Italy did not enter World War II until 1940 and its low rate of 4.8 came in 1943 and 1944. The situation in England and Wales and in the United States was not as severe as in other countries. The marriage rate in England and Wales actually rose to a record peak of 11.2 in 1940 before falling back gradually to a low of 7.0 in 1943. In the United States the marriage rate rose from an average of 10.8 for 1936–38 to 13.2 in 1942, the first full year of participation by the United States in World War II, before dropping to 10.9 in 1944, the low point for the war period. After the war, in 1946, the rate rose to an all-time high of 16.4 in the United States and 12.8 in France because of the accumulation of several years of postponed marriages and the unusual economic prosperity.

Table I.—Average Annual Marriages in Certain Countries

Country	Marriages per 1,000, 1950–52	Country	Marriages per 1,000, 1950–52
North America		Europe (continued)	
United States	10.5	Ireland	5.4
Canada	9.0	Italy	7.2
Mexico	6.0	Netherlands	8.5
South America		Norway	8.3
Argentina	8.1*	Poland	11.0§
Chile	7.9	Portugal	7.8
Colombia	5.5	Scotland	8.0
Peru	3.5	Spain	7.5
Venezuela	4.9	Sweden	7.6
Europe		Switzerland	7.9
Austria	8.9	Yugoslavia	10.8
Belgium	8.0	Asia	
Denmark	8.5	Israel	12.5
England and Wales	8.1	Japan	8.2
Finland	8.1	Philippines	4.5''
France	7.6	Other countries	
Germany	10.1	Australia	8.8
Greece	6.3†	Sew Zealand	8.8
Hungary	10.7‡		

*Provisional. †1947, 1948, 1949. ‡1946, 1947, 1948. §1949, 1950.

Table II.—Average Annual Marriages per 1,000 Total Population in Selected Courctries for Specified Periods and Years

Period or year	United States	England and Wales	France	Germany†	Italy	Sweden
1851–60	*	8.j	8.0	7.8	*	7.6
1861–70	*	8.3	7.8	8.5	*	6.6
1871–80	*	8.1	8.1	8.6	7.7	6.8
1881–90	*	7.5	7.4	7.8	8.0	6.3
1891–00	9.0	7.8	7.4	8.2	7.3	6.0
1901–10	10.0	7.7	7.8	8.0	7.7	6.0
1911–20	10.7	8.3	7.4	7.6	6.7	6.2
1921–30	10.2	7.8	9.0	9.1	8.0	6.5
1931–35	9.2	8.1	7.4	9.3	6.8	7.3
1936	10.7	8.7	6.7	9.1	7.4	8.5
1937	11.3	8.8	6.5	9.1	8.7	8.9
1938	10.3	8.8	6.5	9.4	7.5	9.2
1939	10.7	10.6	6.2	11.2	7.3	9.7
	12.1	11.2	4.4	8.8	7.1	9.3
	12.7	9.3	5.8	7.2	6.1	9.1
	13.2	8.8	6.9	7.5	6.4	9.9
	11.7	7.0	5.7	7.3	4.8	9.7
1944	10.9	7.1	i4	*	4.8	9.9
1945	12.2	9.0	10.1	*	6.9	9.5
1946	16.4	9.8	12.8	8.8	6.2	9.3
1947	13.9	9.3	10.5	10.0	9.7	8.8
1948	12.4	9.1	9.0	10.6	8.4	8.4
1949	10.6	8.6	8.2	10.1	7.8	7.9
1950	11.0	8.2	7.9	10.6	7.7	7.7
1951	10.6	8.2	7.6	10.3	7.0	7.7
1952	10.0	7.9	7.3	9.4	7.0	7.4
1953	9.9	7.8	7.1	8.9	7.0	7.4

*Not available.
†Data for Germany through 1943 are for territory of 1937; *i.e.*, including the Saar; data for 1943–53 are for the German Federal Republic.

Business.—The marriage rate is very sensitive to fluctuations in the business cycle. A study of U.S. marriage rates for a group of industrial states (Connecticut, Massachusetts, Michigan and Rhode Island and the city of New York) in relation to an index of business failures for the period from 1868 to 1935 established a remarkably close correspondence between the two series. Years of economic depression—1878, 1884, 1893, 1896, 1907–08, 1921–22 and 1932—were also years of low marriage rates. The phenomenon noted for this group of states has also been observed in other countries.

Social Factors.—Several European countries introduced measures to stimulate the marriage rate in an effort to stem a rapid decline in birth rates. These measures are usually in the form of marriage loans, extra taxes on bachelors and preferential employment to married men. A factor of some importance in influencing the marriage rate in the United States is the high divorce rate. Remarriages following divorce bolster the marriage rate, but do not increase the proportion of married persons in the population.

In practically all countries there is a marked seasonal incidence in the marriage rate. In the United States and Canada, June is the predominant month. The fall seems to be preferred by agricultural countries. Greek Orthodox countries prefer February, before Lent, while Roman Catholic countries have high marriage rates in April, after Lent. The influencing factors in the seasonal distribution of marriages seem to be climate, religious customs and occupation.

The marriage rate is a highly significant phenomenon. Marriage is always a great event in the life of any person and has much to do with his future happiness and career. All other things equal, a high marriage rate probably bolsters sexual morality. Married persons in general live longer, have fewer mental breakdowns and commit fewer crimes than the unmarried.

Marriage Rate and Birth Rate.—An examination of data for New York state from 1919 to 1937 showed that, in any three-year period, an increase in the marriage rate from the first year to the second was followed, in turn, by an increase in the birth rate of first children from the second year to the third year. Similarly, a decrease in the marriage rate was followed by a corresponding decrease in the birth rate of first children. This correspondence is not usually found when birth rates in which all children are included are compared with marriage rates.

(A. J. Lo.; M. F. N.)

MARRUCINI, an ancient tribe which occupied a small strip of territory round about Teate (mod. Chieti), on the east coast of Italy. It is first mentioned in history as a member of a confederacy with which the Romans came into conflict in the second Samnite War, 325 B.C., and it entered the Roman Alliance as a separate unit at the end of that war (*see* PAELIGNI). The language of the Marrucini is known from an inscription called the "Bronze of Rapino," which belongs to about the middle of the 3rd century B.C. It is written in Latin alphabet, but in a dialect which belongs to the North Oscan group (*see* PAELIGNI). The name of the city or tribe which it gives us is *touta marouca,* and it mentions also a citadel with the epithet *tarincris.* Several of its linguistic features, both in vocabulary and in syntax, are of considerable interest. The earliest Latin inscriptions are of Ciceronian date.

The form of the name shows the suffix -NO- superimposed upon the suffix -CO-, a change which probably indicates some conquest of an earlier tribe by the invading Safini (or Sabini, *q.v.*).

For further details as to Marrucini inscriptions and place-names *see* R. S. Conway, *The Italic Dialects,* p. *253 et seq.*

MARRYAT, FREDERICK (1792–1848), English sailor and novelist, born at Westminster on July 10, 1792, was the grandson of Thomas Marryat (physician, author of *The Philosophy of Masons,* and writer of verse), and son of Joseph Marryat, agent for the island of Grenada, who wrote pamphlets in defence of the Slave Trade. Young Marryat ran away to sea more than once; at 14 he entered the navy. He served with great distinction in many parts of the world until his retirement in 1830.

Marryat brought ripe experience and unimpaired vivacity to his work when he began to write novels. *Frank Mildmay, or the Naval Officer,* was published in 1829, and *The King's Own* followed in 1830. The freshness of the new field which was opened up to the imagination—so full of vivid lights and shadows, light-hearted fun, grinding hardship, stirring adventure, heroic action, warm friendships, bitter hatreds—was in exhilarating contrast to the world of the historical romancer and the fashionable novelist. Moreover Marryat had an admirable gift of lucid, direct narrative, and an unfailing fund of incident, and of humour, sometimes bordering on farce. Of all his portraits of adventurous sailors, "Gentleman Chucks" in *Peter Simple* and "Equality Jack" in *Mr. Midshipman Easy* are the most famous, but he created many other types which take rank among the characteristic figures in English fiction. He went on, through a quick succession of tales, *Newton Forster* (1832), *Peter Simple* (1834), *Jacob Faithful* (1834), *The Pacha of Many Tales* (1835), *Japhet in Search of a Father* (1836), *Mr. Midshipman Easy* (1836), *The Pirate and the Three Cutters* (1836), till he reached his high-water mark of constructive skill in *Snarley-yow, or the Dog Fiend* (1837). The best of his books after this date are those written expressly for boys, the especial favourites being *Masterman Ready* (1841); *Percival Keene* (1842); *Monsieur Violet* (1842); *The Settlers in Canada* (1844), and *The Children of the New Forest* (1847). Among his other works are *The Phantom Ship* (1839); *A Diary in America* (1839); *Olla Podrida* (1840), a collection of various papers; *Poor Jack* (1840); *Joseph Rushbrook* (1841); *Privateer's Man* (1844); *The Mission, or Scenes in Africa* (1845); *The Little Savage* (1848–49), published posthumously; and *Valerie,* not completed (1849). His novels form an important link between Smollett and Fielding and Charles Dickens.

Captain Marryat had retired from the naval service in 1830, becoming equerry to the duke of Sussex. He edited the *Metropolitan Magazine* from 1832 to 1835, and some of his best stories appeared in that paper. He spent a great part of his time in Brussels. He visited Canada during Papineau's revolt and the United States in 1837, and gave a disparaging account of American institutions in a *Diary* published on his return to England. In 1843 he settled at Langham Manor, Norfolk. He indulged in costly experiments in farming, so that in spite of the large income earned by his books he was not a rich man. He died at Langham on Aug. 9, 1848, his death being hastened by news of the loss of his son by shipwreck.

His daughter, Florence Marryat, herself a novelist, published his *Life and Letters* in 1872. *See* also David Hannay, *Life of Marryat* (1889).

MARS, MLLE. [ANNE FRANÇOISE HYPPOLYTE BOUTET] (1779–1847), French actress, was born in Paris on Feb. 9, 1779, the natural daughter of the actor-author Monvel (*q.v.*), and Mlle. Mars Salvetat. In 1799, after the rehabilitation of the Comédie Française, she and her sister (Mars *aînée*) joined that company in which she remained for 33 years. She was incomparable in ingénue parts, and equally charming as the coquette; she was for many years the darling of Parisian audiences and a favourite with Napoleon I. She retired in 1841; she was then inspectress of dramatic studies at the Conservatoire. She died in Paris on March 20, 1847.

See R. de Beauvoir, *Mémoires de Mlle. Mars,* 2 vol. (1849) and *Confidences de Mlle. Mars,* 3 vol. (1855).

MARS (MAVORS, MAMAR, MARSPITER or MASPITER), after Jupiter the most important deity of the Roman state. He was commonly identified with the Greek Ares (*q.v.*), but was never so much affected by foreign influences as to lose his essentially Roman and Italian character. The importance of this deity throughout central Italy from the earliest times is reflected in the fact that Alba Longa, Falerii, the Hernici, Aricia, Tusculum, Lavinium, the Aequiculi, the Peligni and the Sabines all had months named for him. At Rome, Martius (March) was the first month of the old calendar.

ALINARI

MARS

In battle array, depicted in sculpture at the Museo Capitolino, Rome

In spite of his importance little is known of the original character of the Italian deity, and what is known (chiefly from the cult at Rome) is variously interpreted. It is clear that by historical times he has developed into a god of war (hence his connection with Ares [*q.v.*]), and in Roman literature he is protector of Rome, a nation proud in war, which traced its founding back to a son of Mars, Romulus. There are at least three tenable views, however, of his ultimate origin: (1) that he was originally a war god whose functions were extended to the physical and hence the spiritual protection of the fields and crops; (2) that he was originally a deity connected with the fertility of the soil, of chthonian nature and thus a god of death and war; and (3) that he was originally a high god of the Italic peoples who were both warlike and agrarian and thus he reflects their interests. The problem probably cannot be solved for evidences of all three possibilities are found in his cult.

Mars's festivals at Rome occurred in the spring and the fall, embracing both the agricultural and the military seasons. The month of March was, as might be expected, especially filled with festivals wholly or partially in his honour. The Feriae Marti, March 1, was New Year's day in the old Roman calendar; the second Equirria, "horse races," occurred on March 14 (the first Equirria, Feb. 27); the Quinquatrus on March 19 was originally a festival of Mars which eventually was extended over a five-day period and became a festival of Minerva (*q.v.*); and the Tubilustrium, a purification of the war trumpets, occurred on March 23. All these have a connection with the initiation of the war season. Significant also is the role played through this period up to March 23 by the ancient priesthood of the Salii (*q.v.*), particularly associated with Jupiter, Mars and Quirinus, who came out several times during the month to dance their ceremonial war dance in old-fashioned armour and chant a hymn to the gods. Again at the end of the season. October mas an important month for Mars. The festival of the October horse on Oct. 15 was marked by a two-horse chariot race in the Campus Martius, one of the winning pair being sacrificed to Mars. On Oct. 19 the Armilustrium marked the purification of the arms of war and their storage for the winter; and again there were dances of the Salii.

Certain features in the Mars cult, however, make it probable that the god was connected in early times at least with agriculture: and some of the features of the festivals already enumerated can be explained equally well as of agricultural origin. Thus Mars was invoked in the ancient hymn of the Arval brothers (*q.v.*), whose religious duties had as their object to keep off enemies of all kinds from crops and herds, and in this his association with the Lares (*q.v.*) would suggest that he is not regarded as a war god who could avert the raid of an enemy. Likewise in Cato's description of the annual lustration of his land by the Roman farmer (*de Agricultura*, 141), where pure Italian cult might be expected to be reflected, Mars (with the cult title Silvanus) is invoked to ward off disease, calamity, dearth and infertility with no mention of his war function. Cato describes the ritual in detail, with the procession around the field, the recitation of the prayer to Mars after libations to Janus and Jupiter and the sacrifice of the pig, sheep and ox (*suovetaurilia*), representing the farmer's most valuable stock. This description has been taken to be a miniature of the state rite in the lustration of the *Ager Romanus* which, if true, would make Mars the principal deity worshiped at the Ambarvalia (*q.v.*).

The festival of the October horse, mentioned above, an undoubtedly primitive rite. has definite associations as a harvest fertility ceremony. Although the animal sacrificed was a war horse, the head was cut off and decked with cakes as an object having the power to procur fertility. Thus the festival may equally mark the end of the harvest as well as the end of the war season. Even Quirinus (*q.v.*), who is associated with Mars as a war deity, is not without agricultural connections, for it mas his *flamen* who sacrificed the victims at the Robigalia on April 25, when the spirit of the mildew (Robigus) was invoked to spare the grain.

Until the time of Augustus, Mars had but two temples at Rome. One of these, originally only an altar, was in the Campus Martius, the exercising ground of the army. The other was outside the Porta Capena and there each year the Equites met in order to start in procession through the city. Each of these sites was outside the *pomerium,* and this has been explained to mean that the war god "must be kept at a distance" (J. B. Carter, *Religion* of *Numa,* p. 19). But in the heart of the city there was a *sacrarium* of Mars in the *regia,* originally the king's house, in which the sacred spears of Mars mere kept. or rather, Mars in spear form (Mars Hasta); for on the outbreak of war the consul had to shake these spears, saying as he did it, *"Mars vigila"* ("Mars, wake up!"). If the spears moved of themselves the omen was bad and called for expiation.

Under Augustus the worship of Mars at Rome gained a new impetus; not only was he traditional guardian of the war affairs of the Roman state but as Mars Ultor he became the personal guardian of the emperor in his role as avenger of Caesar. The temple of Mars Ultor vowed at Philippi nas not dedicated until 2 B C, but then it dominated the magnificent Forum of Augustus. occasionally referred to as the Forum of Mars His worship at times rivaled that of Capitoline Jupiter and about A D. 250, Mars became the most prominent of the *di militares* worshiped by the Roman legions.

In literature and art he is hardly distinguished from the Greek Ares.

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(R. B LD.)

MARS, in astronomy, is the fourth planet in order of distance from the sun. and the next outside Earth. To the naked eye it appears as a bright star of a decidedly reddish or lurid tint, nhich contrasts strongly with the whiteness of Venus, the second planet from the sun. At opposition (*i.e.,* when it is on the opposite side of Earth from the sun) it is brighter than a first magnitude star, sometimes outshining even Sirius, the brightest star in the heavens. By virtue of its position Mars is the most favourably situated of all the planets for observation from Earth. The eccentricity of its orbit, 0 0934, is greater than that of the other planets except Mercury and Pluto. The result is that at an opposition near perihelion (the point of the orbit of a planet where it is nearest the sun) Mars is markedly nearer to Earth than at an opposition near aphelion (the point of the orbit of a planet where it is farthest from the sun). the one distance being about 35,000,000 mi., the other 63,000,000. These numbers express only the minimum distances at or near opposition, and not the distances at other times. The time of revolution of Mars is 686.98 days. The mean interval between oppositions is 2 years $49\frac{1}{2}$ days. but because of the eccentricity of the orbit, the actual excess over 2 years ranges from 36 days to more than 2 3 months. The planet's period of rotation is 24 hr. 37 min. 22 6 sec.

TABLE I.—General Date on Mars

Mean distance from sun	141,700,000 mi.
Least (perihelion) distance from sun	128,470,000 mi.
Greatest (aphelion) distance from sun	154,940,000 mi.
Velocity at perihelion	16.46 mi /sec.
Velocity at aphelion	13 6_ mi /sec.
Eccentricity of orbit	0.0034
Equatorial diameter	4,265 mi.
Polar diameter	4,243 mi.
Mass	0.108 (Earth = 1)
Density	3.84 (water = 1)
Density	0.70 (Earth = 1)
Surface gravity	0.37g
Inclination of equator to orbit	24°
Position oi north pole	R.A.317°.3,Dec. + 53°.9(1905)
Velocity of escape	3.1 mi /sec
Sidereal rotation period	24 hr. 37 min. 22.6679 sec.
Visual albedo	0.148
Mean colour index at opposition	1.30
Pressure of aneroid barometer at surface	go millibars
Probable composition of atmosphere (% by vol.)	
Nitrogen	98.5
Argon	1.2
Carbon dioxide	0 24
Water and oxygen	0.1
Probable depth of atmosphere	do mi.

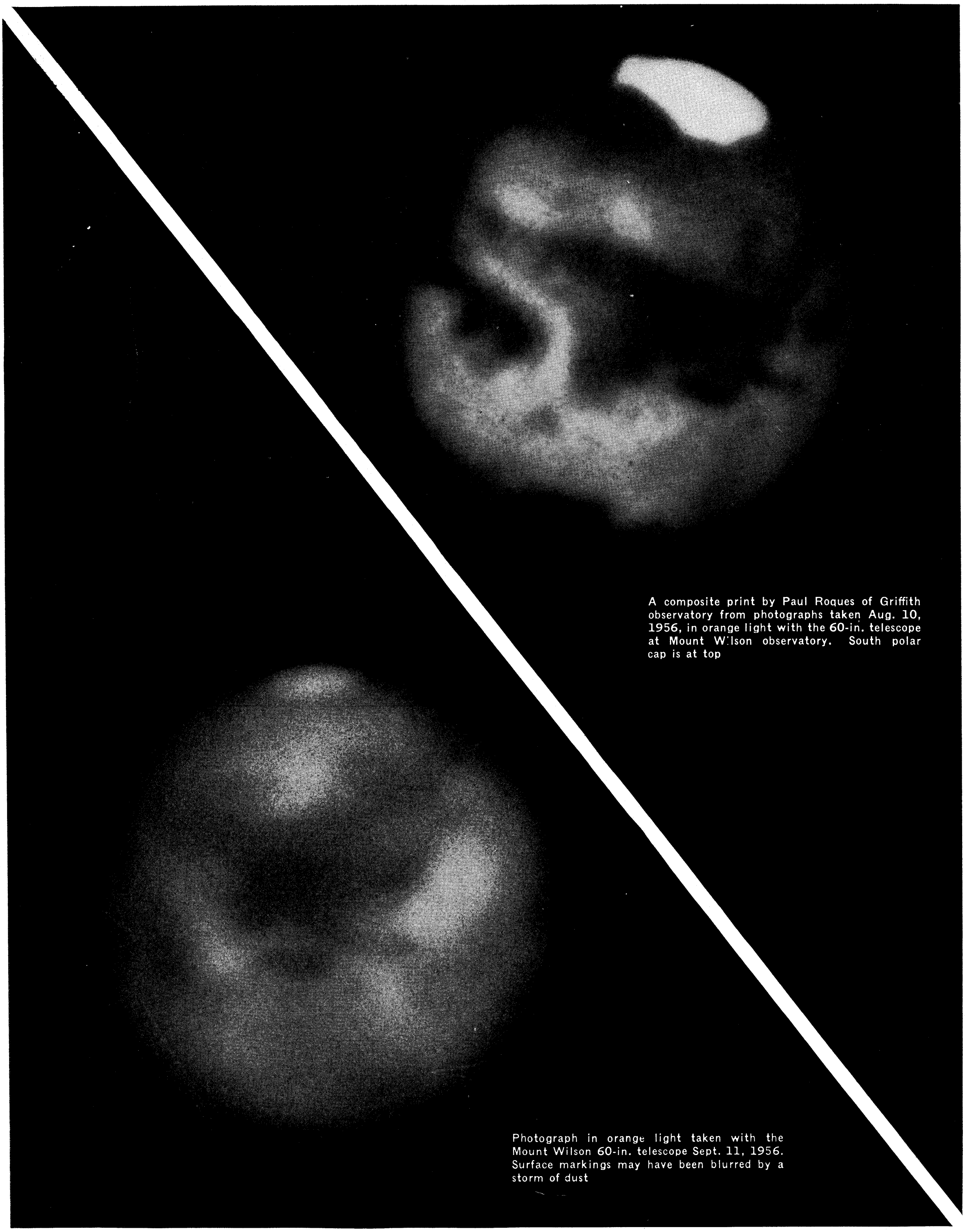
Note: Figures pertaining to the orbit of Mars may be accepted with confidence. Figures pertaining to the planet are subject to continual revision as better values become available.

This article is divided into the following sections:

I MOTIONS

The accompanying diagram (fig. 1) illustrates the order in which the oppositions of the planet follow each other. The outer circle represents the orbit of Mars, the inner circle that of Earth. Around the inner circle, representing Earth's orbit, are marked the months during which Earth passes through the different parts of the orbit. It mill be seen that the distance of Mars at the time of any opposition depends upon the month in which opposition occurs. The least possible distance would occur in an opposition about the end of August, a little before Mars reached the perihelion, because the eccentricity of Earth's orbit throws that planet a little farther from the sun and nearer the orbit of Mars in July than it does in August. From the diagram it is seen that the points of opposition travel around the orbit in about 16 years, so that oppositions near perihelion, when Mars is therefore nearest Earth, occur at intervals of 15 or 17 years.

The axis of rotation of the planet is inclined between 23° and 24° to the pole of the orbit, and the equator of the planet has the same inclination to the plane of the orbit. The north pole



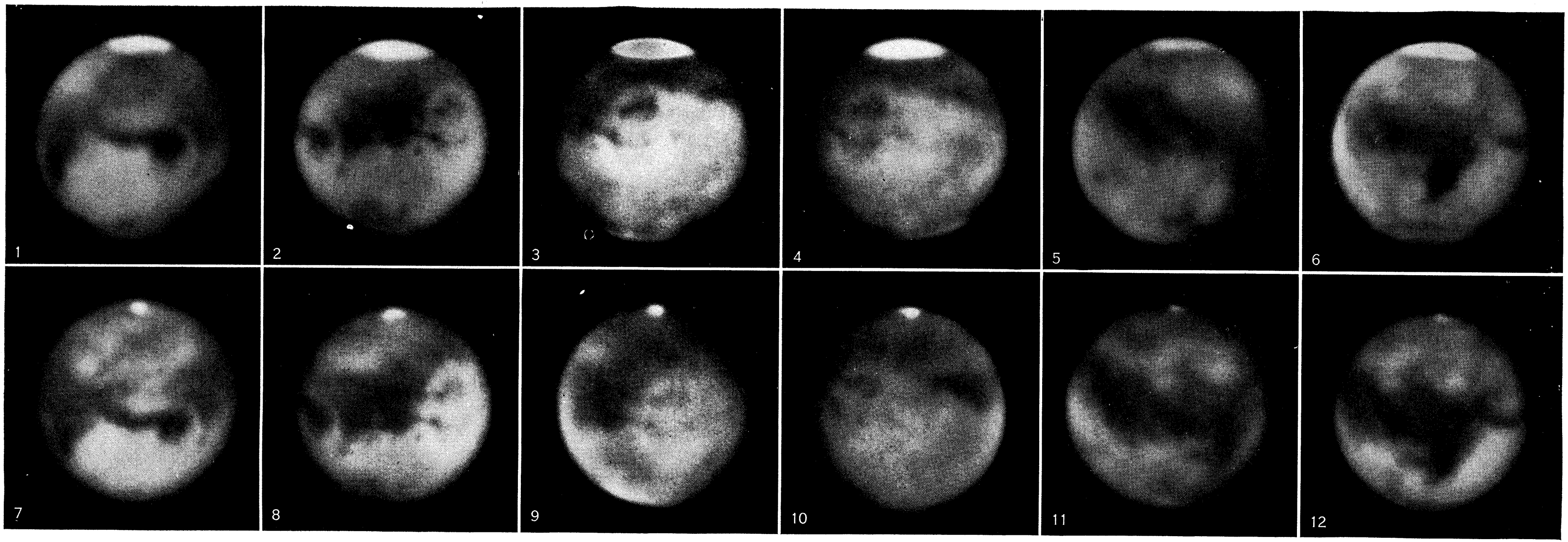
A composite print by Paul Roques of Griffith observatory from photographs taken Aug. 10, 1956, in orange light with the 60-in. telescope at Mount Wilson observatory. South polar cap is at top

Photograph in orange light taken with the Mount Wilson 60-in. telescope Sept. 11, 1956. Surface markings may have been blurred by a storm of dust

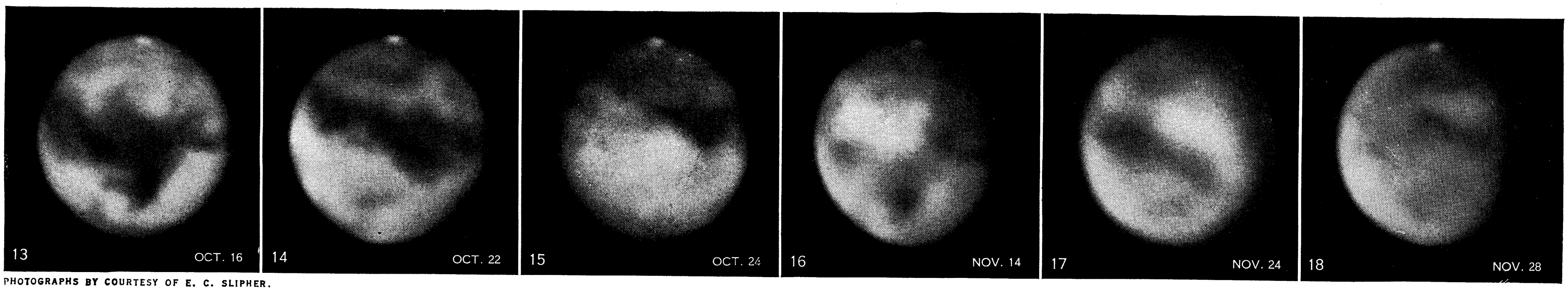
MARS: PHOTOGRAPHS OF THE APPROACHES OF 1956

81 COURTESY OF (TOP) PAUL ROQUES, GRIFFITH OBSERVATORY, (BOTTOM) MOUNT WILSON AND PALOMAR OBSERVATORIES

PHOTOGRAPHS OF MARS



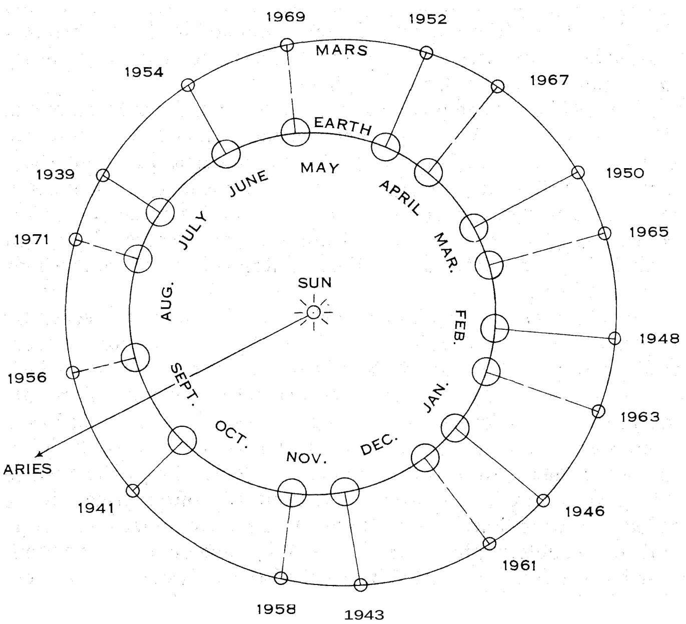
CLOUDS ON MARS



PHOTOGRAPHS BY COURTESY OF E. C. SLIPHER.

1-12. Photographs of Mars, showing various faces of the planet in **1939** (upper row figs. **1-6**) and the same faces in **1941** (beneath figs. **7-12**). In **1939** the southern hemisphere was in its springtime, in **1941** in its summer. (The **1939** photographs were made at Lamont-Hussey observatory, Bloemfontein, South Africa, the others at Lowell observatory)

13-18. Clouds on Mars. Photographs in **1941** displaying rare examples of widespread cloudiness in the atmosphere of Mars obscuring the familiar dark markings. Figures **13, 14, 15,** show the planet normally clear, figures **16, 17, 18,** taken within a few weeks of the same face of the planet, display the cloudy condition. Such Martian storms are often observed to move across the surface, but generally dissipate in a day or so is directed toward a point in longitude 355°, in consequence of which the projection of the planet's axis upon the plane of the ecliptic is nearly parallel to the line of Earth's equinoxes. The aspect of the planet at opposition, especially the hemisphere which is visible, varies with the month of opposition, the general rule



FROM "EARTH, MOON AND PLANETS," BY FRED L. WHIPPLE (THE BLAKISTON COMPANY)

OPPOSITIONS OF MARS FROM EARTH (1939—1971)

Relative distances are shown by straight lines joining the orbits. Mars is north of the equator for oppositions from September to March

being that the northern hemisphere of the planet is entirely seen only near aphelion' oppositions, and therefore when farthest from Earth, while the southern hemisphere is best seen near perihelion oppositions. The distances of the planet from the sun at aphelion and at perihelion are nearly in the ratio 6:5. The intensity of the sun's radiation on the planet is as the inverse square of this ratio. It is therefore more than 40% greater near perihelion than near aphelion. It follows from all this that the southern hemisphere is subjected to a more intense solar heat than the northern, and must therefore have a warmer summer season. However, the length of the seasons is the inverse of this, the summer of the northern hemisphere being longer and the heat of the southern hemisphere shorter in proportion.

(W. H. WR.; R. S. RN.)

II. TEMPERATURE

The only practical means of determining the temperature of a body (such as a planet) millions of miles from Earth is indirect: by measuring the heat or radiant energy it transmits to Earth. The hotter a body is. the more heat it radiates, and the amount of heat received at any point depends upon the distance from the source of radiation. The heat of a candle, for example, can be felt a few feet away. On the other hand, the sun's radiation is perceptible even at a distance 93,000,000 mi. away. If one can measure the amount of heat a body radiates per unit area of surface, one can calculate the temperature of the body from the laws of radiation. The absolute temperature is proportional to the fourth root of the energy radiated. The heat radiated from a planet is exceedingly weak but can be measured by sensitive detectors placed at the focus of a large telescope.

Radiation received from a planet is of two kinds: the sunlight reflected from its surface and the true planetary radiation resulting from the temperature of the emitting surface. The two kinds of radiation are widely separated in wave length: reflected radiation lies mostly in the visual region of the spectrum while low-temperature planetary radiation is in the far infrared region. The two kinds of radiation can be separated by interposing a suitable filter in the beam that is being measured. The sensitive receiver upon which the radiation falls is so small that the temperature of various parts of the surface of the planet may be measured individually.

Measures of the radiation from Mars were made in 1924 and 1926 by Seth B. Nicholson and Edison Pettit at the Mount Wilson observatory, and by W. W. Coblentz and C. O. Lampland at the Lowell observatory, Nicholson and Pettit found that the temperature of the south polar cap of Mars was about −70° C., that of the sunset edge about −13° C. and that of the point directly under the sun about 10° C. Coblentz and Lampland obtained somewhat higher values but the two sets of results were in remarkable agreement, considering the difficulties of the measurements. Since Mars never shows more phase than the moon when about three days from full, the radiation from the surface at midnight cannot be measured directly. But the minimum night temperature on Mars was estimated by Gerard P. Kuiper as −100° C.

Radiometric measures were made on Mars in 1954 with the 200-in, telescope at the Palomar observatory by John Strong and William M. Sinton. They found that the temperature at the equator reaches 2j° C., while the sunrise temperature on the equator is at least as low as −50° C. They also found that the maximum temperature occurs about 12:30 P.M., instead of about 3:00 P.M., as on Earth. This slight lag. they concluded. results mainly from thermal conduction into the ground. This "greenhouse effect" is produced by the blanketing effect of water vapour and carbon dioxide in the Martian atmosphere, and is consistent with the theory that the surface of the planet is covered with dust. They estimated the average night-time temperature as −70° C.

Observations by C. H. Mayer, T. P. McCullough and R. M. Sloanaker, made in Sept. 1956 with the 50-ft. radiotelescope of the Naval Research laboratory indicated that Mars has a black-body temperature of −5juC. (See BLACK BODY.) Radiometric measures of blars made with an optical telescope give an average temperature for the whole disk of −13° C. These observers considered it probable that the radio measurements referred to a slightly deeper and cooler level beneath the surface of Mars. since the longer wave length radio radiation would be expected to pass easily through the planetary crust.

III. ATMOSPHERE

That Mars has an atmosphere of some sort is evident from casual observations made when the planet is close enough to the earth for its surface features to be easily discerned. That these features are often obscured or dimmed as if by mists or clouds, was noted as early as 1784 by Sir William Herschel.

Valuable information concerning the atmosphere of Mars has been obtained from photographs of the planet made in light of different colours. Blue and violet light have slight ability to penetrate an atmosphere because they are strongly scattered by fine particles. Yellow, orange and red light, because of their longer wave lengths, are not so easily scattered and therefore are more penetrating. The effect is conspicuous on terrestrial photographs of distant objects. On photographs taken in violet light a distant landscape appears dim and flat or is wholly invisible, but the landscape generally stands out sharply on photographs taken in red light.

Attempts were made to photograph Mars even before the beginning of the 20th century, and several observers were successful in obtaining images of good quality at the close approach of Mars in 1909. Not until the opposition of 1924, however, was photography in light of different colours applied to Mars with conspicuous success by W. H. Wright at the Lick observatory, and by E. C. and V. M. Slipher at the Lowell observatory These photographs shoned the same effects as those exhibited by the terrestrial landscape. Thus photographs of Mars in visual light (yellow. orange and red) penetrated the atmosphere and revealed the surface markings. The polar cap is an inconspicuous feature on such images. In blue light the planet usually shows only a flat featureless disk except for the polar cap, nhich appears much larger than on the photographs taken in visual light.

Generally, images taken in blue light are appreciably larger than those taken in visual light, and attempts have been made to determine the thickness of the Martian atmosphere by measuring this difference in size. The visual images presumably show the solid surface of the planet, while the blue images include the outer atmospheric shell. Theoretically the method sounds plausible, but errors introduced by contrast effects and spreading of the image seem so serious as to render the method of doubtful value. For example, on blue and violet images the polar cap appears as a bright protuberance projecting considerably beyond the rest of the disk.

1. Clouds.—Mars shows two principal types of clouds: those that appear as conspicuous markings on the blue and violet images; and yellowish clouds that may be detected visually and that show on photographs taken in visual light. Occasionally there is a cloud that is visible in both blue and yellow light. Such a cloud was photographed at the edge of the planet from Mount Wilson observatory in 1954. The height of clouds may be measured, albeit roughly, when they project beyond the line between daylight and darkness (the terminator), or when they appear as protuberances at the edge of the disk. The blue clouds seem to be at a higher level than the yellow clouds, but reliable values for their relative heights are lacking.

A remarkable cloud showed on the blue images taken in 1954 and 1958, which, when viewed with the south pole uppermost, resembled the letter W. The marking was on the equator centred at about longitude 110°. There was a distinct knob at the western end of the W, and at the three intersections of the lines forming the strokes of the letter. The diameter of the knobs was about 280 mi. and the strokes between them 1,000 mi. in length. The knobs fell near the positions of "oases" and two of the stripes coincided roughly with the "canals," named Ulysses and Fortunae (see Canals below). Photographs of the W taken by E. C. Slipher in South Africa showed that it had an intermittent existence, forming in the afternoon and disappearing at night. Similar markings had been noted over this region at previous oppositions, *e.g.*, in 1926 by Wright and F. E. Ross. They also observed a cloud that formed about Martian noon and which became more intense as it was carried by rotation toward the evening terminator. Wright suggested that the cloud was a convective phenomenon of the Martian afternoons, recurrent over several days.

2. Blue Mist.—As already stated the atmosphere of Mars is transparent to yellow light but remarkably opaque to blue, violet and ultraviolet light. This opacity may be described as a blue mist. Photographs of the spectrum of Mars shows that the opacity to blue light begins at a wave length of about λ4,400.

On rare occasions, however, the blue mist clears to such an extent that the surface markings show almost as distinctly in blue light as in yellow. Notable instances of the blue clearing occurred in 1937, 1939 and 1941; in each case within a few days of opposition. At other oppositions, however, no blue clearing was observed. In 1954 the atmosphere of Mars was unusually transparent to blue light from May until July 2 (opposition date, June 25), when the atmosphere suddenly became opaque to blue light again.

At the opposition of 1956 extensive blue clearing was recorded by Gerard de Vaucouleurs in Australia, between Aug. 28 and Sept. 3, during which period the surface markings of the Syrtis Major and Mare Cimmerium were distinctly visible at wave lengths of λ4,400 and λ4,800. The end of the period was well defined, for the markings which were clearly recorded on plates taken Sept. 3 at 14:00–14:30 UT (universal time), were almost invisible on those taken Sept. 4 at 14:20–15:00 UT. No observations were taken near opposition on Sept. 10, but the violet layer was completely opaque and nearly uniform by Sept. 15.

Scarcely a trace of the blue clearing was observed in other parts of the world in 1956, possibly because of a dust storm which developed suddenly on Aug. 30 over the Mare Sirenum area, and which eventually obscured a major section of the southern hemisphere of the planet by late August and early September. By Sept. 5 the atmospheric dust had covered the entire planet except the south polar region. The blue clearing was detected from Australia because the face of the planet that was visible there was practically free of obscuration during the critical period.

There is no generally accepted explanation for the clearing of the blue mist. The fact that it has occasionally been observed to occur near opposition is of doubtful significance. This may be purely an observational effect since the planet is under intensive scrutiny at that time.

3. Composition of Martian Atmosphere.—The only substance positively identified in the Martian atmosphere is carbon dioxide (CO_2). The amount of carbon dioxide in the Martian atmosphere is estimated at about eight times (per unit of volume) more than that in Earth's atmosphere.

Attempts have been made to detect oxygen and water vapour in the atmosphere of Mars by spectroscopic analysis ever since the pioneer work of Jules Janssen and Sir William Huggins about 1867. The chief obstacle to detection is Earth's atmosphere. The problem is how to distinguish absorption due to oxygen and water vapour in the spectrum of Mars from the very strong absorption produced by these molecules in Earth's atmosphere. Two methods have been tried.

The older method (by which carbon dioxide was discovered by Kuiper in the atmosphere of Mars) consists in comparing the spectrum of Mars with the spectrum of another body, the moon, which is identical with Mars in every respect except that it has no atmosphere. Consider the history of a beam of light reaching Earth from Mars. Starting from the sun, it first passes through the Martian atmosphere down to that planet's surface. From the surface it is reflected through the atmosphere again into outer space. Light reflected toward Earth passes through the astronomer's telescope and onto a photographic plate or other recording device. The beam that reaches Earth therefore has passed twice through the atmosphere of Mars and once through Earth's atmosphere. Now consider a beam of light reflected from the surface of the moon. The moon has no atmosphere. Thus the spectrum of moonlight is nothing but reflected sunlight that has passed once through Earth's atmosphere. The absorption lines of oxygen (O_2) and water vapour in the spectrum of Mars are compared with those of the moon under as nearly identical conditions as possible. If these lines are stronger in the spectrum of Mars, it must be a result of the additional absorption produced by oxygen and water vapour in that planet's atmosphere. The method is sound in principle but difficult to carry out in practice. The moon and Mars must be observed at the same altitude in the sky, and the humidity at the point of observation must be the same at the time of both measurements—conditions that are seldom realized. Moreover, it is difficult to get photographs of two different objects that match so closely that detailed comparisons of them can be made. For this reason the method of lunar comparison has fallen into disuse.

About 1902, Percival Lowell devised another method which seemed more promising. As Mars and Earth revolve around the sun the distance between them is continually changing. At times the two planets are nearly stationary relative to each other as when they are nearest and farthest apart. At other times their velocity directly toward or away from each other may reach 12 mi. per second. This velocity should be sufficient to produce a Doppler effect (see LIGHT) which shifts a line in the spectrum of Mars slightly away from the position of the same line in the spectrum of Earth's atmosphere. This method consists of comparing the relative positions of spectrum lines on the same plate, a comparison much easier to make than one of the intensities of spectrum lines on differentplates.

Such tests for oxygen and water vapour in the spectrum of Mars were made in 1934, 1937 and 1941 by W. S. Adams and Theodore Dunham, Jr., with the 100-in. telescope at the Mount Wilson observatory when the planet had reached nearly its maximum velocity toward and later away from Earth. Study of the contours of the oxygen lines failed to reveal any asymmetry sufficient to indicate that oxygen was present in the Martian atmosphere to the extent of 1% of the quantity in Earth's atmosphere. A similar conclusion was reached regarding the presence of water vapour in the atmosphere of Mars.

High-dispersion spectra of Mars were taken by C. C. Kiess, C. H. Corliss, H. K. Kiess and E. L. R. Kiess in July 1956 (on Mauna Loa, Hawaii) at an altitude of 11,000 ft. Several photographs of the spectra of the moon and Mars were taken in juxtaposition for the purpose of detecting any unknown lines in the spectrum of Mars. The Doppler effect due to the motion of Mars toward Earth should have shifted lines in the spectrum of Mars by 0.200A to the violet of lines of terrestrial origin if water vapour were present.

These observations confirmed the earlier results of Adams and Dunham with respect to the small amount of oxygen and water vapour in the Martian atmosphere. In the case of water vapour it was possible to set an upper limit to the amount of moisture present. If the water vapour in the Martian atmosphere were entirely condensed over the surface of the planet it would form a film of liquid less than 0.0032 in. thick.

Of what then does the Martian atmosphere consist? The best guess is that it has the same composition as that of the atmosphere of Earth but with far less oxygen. This means that it consists chiefly of the inert gas nitrogen. Argon also may be present as the product of the decay of the radioactive isotope of potassium (K^{40}). Since neither nitrogen nor argon produces observable spectrum lines, their presence cannot be positively identified in the Martian atmosphere. An estimate of the probable composition of the Martian atmosphere is given in Table I.

Attempts made by various methods (none of them very reliable) to determine the atmospheric pressure at the surface of Mars have yielded surprisingly similar answers. By far the best determination is that by A. Dollfus (1957), which depends upon polarization measures over the disk of the planet and polarization measures in light of different colours. According to Dollfus, an aneroid barometer on the surface of Mars would indicate a pressure of 90 millibars. Since the force of gravity on Mars is 0.37g (g = surface gravity of Earth). a mercury ,barometer would register 90/0.37 or about 243 millibars, corresponding to a column of mercury of height 182 mm.. as compared with about 760 mm. on the surface of Earth. Since the surface gravity is about one-third as strong as that of Earth, a man who weighed 150 lb. on Earth would weigh about 57 lb. on Mars.

IV. SURFACE FEATURES

When viewed through a telescope of moderate power under favourable (good seeing) conditions. Mars presents the appearance of a bright-reddish or tawny-coloured disk girdled by darker markings in the southern hemisphere which may be at different times, blue-green. gray-green or light grayish-blue. The true colour of these dark markings is difficult to determine since it is strongly influenced by contrast with the bright-reddish colour of the neighbouring regions. At one of the poles there is usually a white cap ahich may appear as the most conspicuous marking on the disk, depending upon the Martian season and the orientation of the planet relative to Earth. During moments of exceptionally good seeing the observer also catches glimpses of detailed markings—small spots and specks and lines—which come and go so rapidly that it is impossible to set them down accurately in a sketch

The bright-reddish areas which cover about three-quarters of the planet and nhich give Mars its characteristic fiery red colour are apparently uniform expanses of barren desert. The dark areas which are situated mostly in the southern hemisphere are called maria (seas), since they were once supposed to be actual bodies of water. The absence of bright reflected sunlight from the maria, as well as the detail occasionally visible in them, indicate that they consist of dry land similar to deserts.

1. Polar Caps.—It was suggested by the British physicist George Johnstone Stoney, in 1898, that the polar caps consist of frozen carbon dioxide gas (dry ice) rather than snow and frost. Radiometric measures, as noted above. indicate a temperature of −70° C. at the polar caps, but carbon dioxide under the atmospheric pressure on Mars would not solidify unless the temperature were about −144° C. Measures by Kuiper in the infrared spectrum show that the polar caps reflect light like terrestrial snow. Snow becomes almost "black" beyond nave length 1 5μ, and almost completely black beyond 2.0μ, but dry ice remains "white" out to 2.jp. From his tests Kuiper concluded that the Martian polar caps are not composed of frozen carbon dioxide but are almost certainly composed of water (H_2O) frost at a temperature much below 0° C. Although the polar caps constitute direct observational evidence of the presence of water on Mars, the total amount for the entire planet is too slight to detect spectroscopically.

The melting polar cap in spring is surrounded by a dark band that remains in contact with the shrinking cap. This band was once regarded as marshy ground formed from the water of the melting polar snows, but it is extremely doubtful that there is enough water to form such a region. When viewed under the best conditions the band is seen to be discontinuous, broken up into individual spots. It appears to be part of the general wave of darkening in the Martian spring that spreads from the polar cap, over the maria. down to and beyond the equator.

2. Deserts.—Kuiper compared the reflectivity of the red Martian deserts nith that of red soil and red rock collected in Oklahoma. Texas and Arizona He found the reflectivity of these specimens to be quite different from that of the red regions of Mars. However, the reflectivity of a bronnish, fine-grained felsite closely matched that of the Martian deserts. He concluded, therefore, that the deserts of Mars consist of igneous rock similar to felsitic rhvolite

Dollfus advanced a more convincing theory. based on polarimetric and photometric studies of the red regions. He found that limonite properly pulverized reproduces the polarization and brightness curves of the deserts surprisingly well. The evidence from the polarization measures is particularly strong. since very few substances have a polarization curve resembling that of the Martian bright areas.

3. Maria.—As the polar caps in the southern hemisphere shrink in the Martian spring, the maria begin to darken and become more conspicuous, first near the pole, then gradually spreading toward the equator and even over into the opposite hemisphere. In the autumn some of the maria turn brown, brownish purple and carmine, while others are but little affected. There can be little doubt that seasonal changes occur in the maria, but they are more complex than was generally believed. These seasonal changes suggest the growth and decay of vegetation, and the idea that water vapour, not in the form of clouds but as an invisible gas, spreads from the pole toward the equator causing plant life to spring up in its make.

If the maria consist of vegetation, it must be of a type entirely different from that on Earth, and exceedingly hardy to withstand the freezing Martian nights. Plants of the type known on earth need oxygen for respiration, but there is no free oxygen present in the Martian atmosphere.

Evidence that the maria consist of some kind of organic substance was obtained by Sinton at the opposition of 19j6 and 1958. All organic molecules possess strong absorption bands near 3.4μ, the wave length of the carbon-hydrogen bond resonance. Measures on the spectra of Mars in this region indicate the probable presence of this band. This evidence, taken together with the observation of seasonal changes of the maria make it extremely probable that vegetation in some form is present on Mars. (See ***Life*** on *Mars?* below.)

In polarimetric and photometric studies of the maria made after 1947, Dollfus found that the maria have a powdery surface structure similar to that of the bright desert regions but more absorbent. He was able to simulate the variations in brightness of the maria in the laboratory by mixing pulverized limonite ($HFeO_2$) with a powder of very absorbing grains. Similar effects were obtained by partially covering the limonite with these grains and vice versa, by partially covering these grains with limonite.

The polarization of light from the dark regions of Mars is not unlike that from the bright deserts, but it varies with the change of seasons. This variation suggests a seasonal change in the nature of the surface, though on a microscopic scale. Physical or chemical changes in minerals are not alone sufficient to explain such changes. Dollfus found that certain algae, small lichens or minute mushrooms, when sprinkled on pulverized limonite: showed a polarization curve similar to that of the Martian dark spots. On Earth such microscopic organisms are generally creatures with a great power of adaptation. Their absorbent character suggests a superficial coloured pigment that offers protection against cold or excessive radiation by selective absorption of light.

Crustose lichens are among the hardiest plants on Earth, and exhibit the same general colours and reflection spectra as the maria; their size is consistent with the postulated size of the Martian organisms (calculated from the total amount of water on the planet). Moreover, lichens are known to tolerate extreme climatic conditions.

On the otlier hand. Frank Salisbury has presented several objections to the theory that the Martian maria are composed of lichen-like organisms. First, it is unlikely that lichens could subsist in an atmosphere of low oxygen content like that of Mars. Lichens do not change colour with the seasons as do the maria. Also, crustose lichens are extremely slow growing and are sparsely distributed. Yet it was observed in 1954 that, within a span of less than two years, a new dark region approximately the size of Texas had appeared on Mars.

An inorganic explanation of the maria may be considered along with the lichen hypothesis. Kuiper made observations of Mars in 1954 and 1956 with the 82-in. reflecting telescope of the McDonald observatory, paying special attention to the colours of the bright and dark areas. The colours which were expected to be green in the Martian spring were, instead, a neutral gray. The lack of vivid colouration suggested the possibility that the maria might be lava fields similar to the broad dark expanses on the moon. As a working hypothesis Kuiper suggested that the maria were lava fields partially covered by some very hardy vegetation.

In 1954 the astronomer Dean B. McLaughlin had already advanced an inorganic theory of the composition of the maria. He suggested that they were deposits of volcanic ash that had been weathered to a soil in which epidote and chlorite abounded, thereby accounting for the green colour. The seasonal darkening of the maria would result from the moistening of the surface minerals rather than from a chemical change. From observations that the maria terminated in funnel-shaped markings pointing north into the deserts, McLaughlin concluded that the tips of the funnels might be the sites of volcanoes whose ash had been carried by the winds and deposited in the patterns that form the maria. Since the winds bloning to the southern hemisphere are much stronger than those blowing to the northern hemisphere, the maria would thus be expected to form primarily south of the Martian equator. In fact, most of the maria are south of the equator.

Most astronomers, however. favour a vegetative hypothesis despite the difficulties it encounters. E. J. Öpik presented a crucial argument for this theory: the maria must have regenerative powers, or they would have been obliterated ages ago by the dust of the deserts.

4. Canals. — Discovery of the Martian markings designated as canals was made by the Italian observer G. V. Schiaparelli (*q.v.*) at the exceptionally close opposition of 1877. Schiaparelli described these markings as *canali* (channels or canals). Translated into English as canals, the word erroneously suggested that these channels were artificial waterways constructed by intelligent beings. In 1892, W. H. Pickering discovered a new feature of the canals which he called an oasis, a small round spot at the junction of several canals.

All observers agree that Mars shows a vast amount of fine detailed markings so complex as to be impossible to represent properly in a drawing. The markings come and go so rapidly with fluctuations in the seeing that even the best photographs fail to show the fine details that can be glimpsed by the eye.

Most astronomers have never been able to see canals on Mars and hence are naturally skeptical of their existence, a fact which is quite understandable when it is realized that most astronomers seldom give Mars more than a casual glance.

Judging from the maps which Schiaparelli made at the six oppositions from 1877 to 1888. the canals must have appeared to him as narrow dark lines extending across the deserts. Lowell in 1894 described them as a "network of fine straight, dark lines . . . either absolutely straight from one end to the other, or curved in an equally uniform manner."

E. M. Antoniadi stated that in good seeing the canals appeared to him as continuous lines, but in moments of the very finest seeing they broke up into a discontinuous series of lines and dots.

R. J. Trumpler's remarks about the canals (on the basis of observations made in 1924 and 1926 with the 36-in. refractor at Lick observatory) are of value, as representing the views of a careful and conservative observer:

> The network lines, the so-called canals, are not a well-defined class of similar objects, but vary greatly in visibility, width, and definition. Some of them like *Nectar, Cerberus, Thoth, Nepenthes,* are temporarily so wide as to resemble the dark areas. Practically every step of transition between these broad bands and the finest most difficult canals is represented.
>
> The canals as a rule, even the fainter ones, do not appear quite sharp but rather as diffuse hazy shadings. Sometimes they change in intensity along their course, and occasionally they even break off abruptly without reaching an endpoint. . . . In the dark areas the network is also present, but here the lines mostly become broad dark bands while the spots appear as diffuse condensations of shading. There are many reasons indicating that the iramework structure of the dark areas is of the same topographical character as the network (canal) svstem of the normal surface. . . . The network exhibits a great deal of irregularity and does not make the impression of artificiality. Although a certain tendency to straightness or directness oi line in the canals cannot be denied, it seems nevertheless possible to interpret the network by natural geological features of the crust of the planet. (R. J. Trumpler, "Visual and Photographic Observations of Mars Made at the Opposition of 1926," *Publications of the Astronomical Society of the Pacific,* vol. 39, p 103, 1927.)

In 1939, Edison Pettit began a series of drawings of Mars using a 6-in. Clark refractor. He undertook the work as a matter of self-education. with the intention of studying the seasonal changes. He had never been able to see the canals, and had concluded that they were visible only to a special type of eye. and that his eyes were of the great majority that could not see them.

Early one morning, while sketching the planet, a canal suddenly appeared and within a few seconds another. Within two hours he was able to see two more. sometimes all four being visible at once. On succeeding nights he was able to see the four canals again and some additional ones. In the following two months he made drawings of 40 canals, each identified three times before being put on a final drawing. On the best nights there were moments of "superseeing" when the whole canal pattern would flash out for a second or two. Very rarely was this interval as long as four or five seconds. The colour of the canals was an olive green, the same tint as the maria at that time.

On June 3, 1956, when Mars was at a distance of 75,000,000 mi., Robert S. Richardson observed Mars under very favourable seeing conditions with the 60-in. reflecting telescope on Mount Wilson. The canals appeared to be simply narrow extensions of the maria into the deserts, and were of the same colour as the maria. The markings did not have an artificial appearance, but gave the impression of being some natural surface feature.

On the other hand. Kuiper maintained. "I have never seen a long, narrow canal nor a network of 'fuzzy canals.' I am personally convinced that the objective evidence nhich has led to this concept has been misinterpreted and erroneously represented on drawings." (Gerard P. Kuiper. "On the Martian Surface Features," *Publications of the Astronomical Society of the Pacific,* vol. 67. no. 398, Oct. 1955.) Kuiper found that there was no evidence anywhere on the planet of a distinctly geometrical pattern; nor of a systematic streakiness in relation to the planetary coordinates (though in a given mare some streakiness may be observed). To him the dimensions of the patches appeared quite random and natural—and the representation of the many oases of roughly uniform size he considered definitely wrong.

An observation of Mars made by G. E. Hale and his associates at the 60-in. telescope on Mount Wilson on Nov. 3, 1909, has been quoted so often. and has come to be of such critical importance in the history of the canals. that it deserves comment. Mars was observed that night under excellent seeing conditions with a magnification of 800. Hale in a letter says: "So far as any of us could make out, there is not a trace of geometrical structure on the planet, nor any narrow straight canals."

All experienced observers of Mars are agreed that the visibility of the canals depends upon the Martian season. They first appear clearly in the southern hemisphere about early spring corresponding to April 1 (northern style season), and by the middle of June little is left of them.

Very few canals are visible in the southern hemisphere from late summer through winter. Hale's observation was made in Martian midsummer corresponding to terrestrial date July 23. It is therefore not surprising that he and his colleagues failed to see any canals that night.

V. LIFE ON MARS?

1. Plant Life.—Despite the daily extremes in Martian temperature, the absence of oxygen from the atmosphere and the low humidity, observational evidence from several different sources indicates the presence of life in the maria. Some interesting work on this subject of astrobotany was carried out by G. A. Tikhoff of the Academy of Science of the U.S.S.R. and his co-workers near the Arctic circle in the eastern Soviet Union, where conditions except for oxygen are scarcely less rigorous than those on Mars. The purpose of the project was to study plants growing under conditions resembling as nearly as possible those on Mars. The investigation proceeded from three basic assumptions: that the laws of life in the universe are identical in essence but differ in their manifestations; that the living organism is exceedingly adaptable to external conditions; and that plants possess optical adaptations to external conditions.

One of the objections to the presence of green plants on Mars is that the maria do not reflect light as chlorophyll does. Chlorophyll, the green colouring matter in plants, shows an absorption band at about $\lambda 6{,}700$, and reflects light strongly in the infrared beginning at about $\lambda 7{,}000$. But the maria reflect red and infrared equally well.

Tikhoff's group found that. as a general rule, plants growing under conditions of extreme cold do not reflect as much light as those growing in milder climates. Evergreens, for example, were found to reflect about half as much of the red rays in winter as in summer. About half the radiant energy from the sun is contained in the infrared region of the spectrum Ordinarily green plants reflect these rays strongly. But in an extremely cold climate the plants protect themselves from the cold by absorbing as much as possible of the radiant energy from the sun. They not only absorb much of the infrared radiation of the sun but a considerable portion of the red. orange and yellow light as well. Therefore, plants growing in excessively cold climates do not show the characteristic absorption band of chlorophyll in the red simply because the radiation throughout this whole region is absorbed. Plants growing in the arctic usually appear darker or "bluer" than plants growing in a warmer climate because they reflect principally violet. blue and green light; whereas plants growing in warmer climates reflect yellow and some orange light. From their observations on the Pamir plateau in the arctic, the climate of which is hardly less severe than that of Mars, Tikhoff and his colleagues concluded that the low Martian temperatures would not necessarily be fatal to plant life.

During the year the range in temperature of the surface soil, which supports such plants as blue wormwood, blue oxytrope and certain violets, is 102° C., and daily fluctuations amount to 60° C. The low temperatures experienced at night apparently harden a plant and make it more cold resistant. The ability of plants to withstand low temperatures is remarkable. For example, the flower buds of the scurvy grass on the Siberian shores of the Arctic ocean stand frosts of −46° C., sometimes even without a covering of snow, and still open and blossom in the summer. Furthermore, the atmosphere of Mars cannot be much drier than that of the Pamirs. which contains only an insignificant amount of moisture (at midday the relative humidity is practically zero).

There still remained the difficulty regarding oxygen. Although Tikhoff's research was carried out at a high altitude where the air is very thin, oxygen mas still abundant compared with the most that can be assumed to be present on Mars. The astrobotanists did not attempt to give a definite ansaer to this question, but pointed out that plants may conserve oxygen, both in their parts above ground and in their roots. Thus most bog and aquatic plants have become adapted to their environment by storing considerable stocks of oxygen in their bodies in wide intercellular spaces, and by developing respiratory root systems. This is only one way by which plants are known to adapt themselves to environments all but lacking in oxygen—Martian plants would conceivably have acquired quite different methods.

From considerations of the maria Salisbury concluded that life as it is known on Earth could not survive the rigours of the Martian climate. But he offered two biological possibilities: that life forms, essentially similar to those known on Earth, have become adapted to the rigours of the Martian climate; or that some other form of life, a parabiology, accounts for the markings on Mars.

2. Animal Life.—Existence of animal life on Mars is much less likely than plant life. It is unlikely that higher forms of animal life could exist in such a cold, arid and oxygenless world. Only the lowest types of animals, with little need of oxygen or water, would be able to survive. Experiments in this connection were made at the U.S. air force's School of Aviation Medicine (Randolph Air Force Base, Texas) by J. A. Kooistra, Jr., R. B. Mitchell and Hubertus Strughold. Four types of soil obtained from different geographic areas, with their inherent microflora, were exposed to environmental conditions simulating those on Mars.

Each soil type was pulverized and then mixed until homogeneous. A portion of the soil type was then sterilized and dried to constant weight to serve as a medium, while unsterilized portions of the soil served as inoculum. The soil media were mixed with the soil inoculum plus water to obtain the desired moisture level of 1%. This mixture was added to a Brewer anaerobic (oxygenless) jar which served as the simulator chamber. After base-line counts were made, the soil types were subjected to the combination of Martian environmental conditions.

Results obtained over a period of three months indicated that the micropopulation of the soil samples changed to accommodate organisms capable of surviving and multiplying under the simulated Martian conditions. The majority of the organisms that survived were facultative anaerobes of a gram-negative character. The experiments shoned that these low organisms at least could grow and multiply under conditions practically identical with those on Mars.

For information about these organisms *see* BACTERIOLOGY: *Conditions Affecting the Growth of Bacteria: Relation to Oxygen.*

3. Human Habitability of Mars.—With careful preparation a man could undoubtedly survive on Mars. The atmospheric pressure is probably sufficient so that only a simplified pressure suit with oxygen equipment and a helmet to preserve adequate pressure for breathing would be necessary. But, he could do nothing in the open that required free oxygen; he could not. for example, light a fire or smoke a pipe. Electrically generated heat would soon set a pot of water boiling but the pressure is so low it would be only lukewarm. A source of water supply could be established around the poles. Evaporation would be held down by the low temperature, but increased by the low pressure. A supply of oxygen might be obtained from water by electrolysis.

A visitor to Mars would probably find a cold, inert world monotonously uniform in aspect—a flat expanse of dry brownish soil as far as the eye could see and a gray-blue sky above. No mountain ranges or canyons would break a monotony of surface outline, similar to that of certain desert regions of the American southwest.

(R. S. RN.)

VI. SATELLITES

At the opposition of Mars which occurred in Aug. 1877, the planet was unusually near the Earth. Asaph Hall, then in charge of the 26-in. telescope at the Naval observatory in Washington, D.C., took advantage of this favourable circumstance to make a careful search for a visible satellite of the planet. On the night of Aug. 11. he found a faint object near the planet. Cloudy weather intervened, and the object was not again seen until the 16th. when it was found to be moving with the planet, leaving no doubt as to its being a satellite. On the following night an inner satellite much nearer the planet was observed. This discovery,

TABLE 11.—Data on Satellites of Mars

	Phobus	Deimos
Discoverer and date	A. a——, 1877	Hall, 1877
Mean distance from planet	5,825 mi.	14,580 mi.
Sidereal period	7 hr. 39 min.	1 da. 6 hr. 18 min.
Visual magnitude at opposition	+12	+13
Eccentricity	0.0170	0.0031
Diameter	10 mi.	10 mi.
Direction of revolution	direct	A. direct

apart from its intrinsic interest, is also noteworthy as the first of a series of discoveries of satellites of the outer planets. Hall named the outer satellite Deimos (Terror) and the inner Phobos (Fear), from the horses that drew the chariot of the god Mars. A remarkable feature of the orbit of Phobos is that it is so near the planet as to perform a revolution in less than one-third that of the diurnal rotation of Mars. *(See* Table II.) The result is that to an inhabitant of Mars this satellite would rise in the west and set in the east, making two apparent diurnal revolutions every day. The period of Deimos is only six hours greater than that of a Martian day; consequently its apparent motion around the planet would be so slow that more than two days elapse between rising and setting, and again between setting and rising. Lowell estimated the diameter of Deimos to be about 10 mi. and that of Phobos slightly more.

Long and careful series of observations have been made upon these bodies by other observers. At the very favourable oppositions of 1892 and 1894, observations were made at Pulkovo by Hermann Struve, who later subjected all the data up to 1909 to a very careful discussion. He showed that the inclination of the planes of the orbits to the equator of the planet is quite small, thus making it certain that these two planes can never wander far from each other. The relations of the several planes can be best conceived by considering the points at which lines perpendicular to them, or their poles, meet the celestial sphere. By theory, the pole of the orbital plane of each satellite revolves around the pole of a certain fixed plane, differing less from the plane of the equator of Mars the nearer the satellite is to Mars. *See* also Index references under "Mars" in vol. 24.

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MARSALA, seaport, Sicily, province of Trapani, 19 mi, by rail S. of Trapani. Pop. (1951) 30,743. It is situated on the low westernmost point of the island. The cathedral, dedicated to St. Thomas of Canterbury, contains 16 grey marble columns. The town trades in Marsala wine.

Marsala occupies the site of Lilybaeum, the principal Carthaginian stronghold in Sicily, founded by Himilco after the abandonment of Motya. Neither Pyrrhus nor the Romans were able to reduce it by siege, but it was surrendered to the latter in 241 B.C. In the later wars it was a starting point for the Roman expeditions against Carthage. The Saracens named it *Marsa Ali,* port of Ali. The harbour on the northeast was destroyed by Charles V to prevent its occupation by pirates. The modern harbour lies to the southeast. In 1860 Garibaldi landed at Marsala with 1,000 men and began his campaign in Sicily. Scanty remains of the ancient Lilybaeum, including fragments of the city walls, are visible. During World War II Marsala was heavily bombed by the Allies.

MARSCHALL VON BIEBERSTEIN, BARON ADOLF VON (1842–1912), German diplomatist, was born at Neuershausen, Baden, on Oct. 12, 1842. His grandfather, Karl Wilhelm, Baron Marschall von Bieberstein, ambassador of Baden in Stuttgart, represented Baden at the Congress of Vienna in 1815. Adolf was educated at Frankfort-on-Main, and at the universities of Heidelberg and Berlin. He held various administrative offices in the grand duchy of Baden, sitting from 1875–83 in the upper chamber of the Baden diet. In 1883 he was sent to Berlin as minister for Baden in the Federal council, and from 1884–90 he represented the council in the imperial insurance office. In 1890 he entered the imperial service, and succeeded Count Herbert Bismarck as state secretary for foreign affairs under Caprivi, continuing in that office under Prince von Hohenlohe; but he had incurred the enmity of Prince Bismarck by refusing his advice and the result was a fierce press campaign against him which finally obliged him to speak out when he appeared as witness at the trial of certain journalists in 1896 for *lèse-majesté.* He was opposed by the Agrarians for advocating the reduction of corn duties, and in 1897 resigned office, being appointed German ambassador in Constantinople, where he remained for nearly 15 years. He created a commanding position for himself and a growing ascendancy in Turkish affairs for his government. To him was largely due the promotion of the Baghdad railway. During his foreign secretaryship he took a strongly imperialist attitude. After the Krüger telegram, in the drafting of which Baron Marschall bore a leading part, it was he who declared in the reichstag that the maintenance of the independence of the Boer republics was a "German interest." He was an advocate of a strong naval policy for Germany. In 1907 he was principal German delegate in The Hague conference, and was the exponent of Germany's resolute and successful opposition to any practical discussion of the question of restriction of armaments. In May 1912 he succeeded Count Wolff-Metternich as ambassador to Great Britain, but his health broke down after a short time, and he died at Badenweiler on Sept. 24, 1912.

MARSCHNER, HEINRICH AUGUST (1795–1861), German composer and director, was born at Zittau, Saxony on Aug. 16, 1795. He studied music under Schicht at Leipzig, and in 1816 travelled to Pressburg and Vienna where he became acquainted with Košeluh and Beethoven. Weber produced his *Heinrich IV und Aubignk* at Dresden in 1820 and in 1824 Marschner was made musikdirector of the opera in that city. In 1827 he was appointed kapellmeister of the theatre in Leipzig, where he produced his highly successful romantic opera *Der Vampyr* in 1828, and in the following year his *Der Templer und die Judin.* In 1831 he became kapellmeister of the court at Hanover, and in May 1833, produced at Berlin his best and most successful opera, *Hans Heiling.* As a result of the performance of this work under his direction at Copenhagen in 1836, he was offered the position of musikdirector in Denmark. Marschner, however, returned to Hanover where, in 1859, he was given a pension and, after his death on Dec. 14, 1861, a monument was dedicated to his memory.

MARSDEN, WILLIAM (1754–1836), English orientalist, the son of a Dublin merchant, was born at Verval, Co. Wicklow, on Nov. 16, 1754. He was educated in Dublin, and having obtained an appointment in the civil service of the East India company went to Renkulen, Sumatra, in 1771. There he soon rose to the office of principal secretary to the government, and acquired a knowledge of the Malay language and country. Returning to England in 1779 with a pension, he wrote his Htstory of *Sumatra,* published in 1783. In 1795 Marsden was appointed second secretary and afterwards first secretary to the admiralty. In 1807 he retired and published. in 1812, his *Grammar* and *Dictionary* of the Malay *Language,* followed in 1818 by his translation of the Travels of *Marco* Polo. He died on Oct 6, 1836.

MARSEILLAISE, LA, the French national anthem, of a curiously fortuitous origin. It was composed—almost, it might be said, improvised — as to both words and music, in one night (April 24, 1792) by Claude Joseph Rouget de Lisle, a French captain of engineers who happened also to be a musical amateur. The need of a marching song for the French had been expressed by the mayor of Strasbourg, where de Lisle was then quartered, and the world-famous hymn was his patriotic response. It derived its name subsequently from the fact of its having been sung with indescribable enthusiasm by the troops on setting out from hfarseille for Paris. Rouget de Lisle's actual authorship of the music was long disputed but may now be taken as established beyond dispute although his work undoubtedly underwent certain improvements at the hands of various composers (including Grétry and Gossec) before it reached its existing form

MARSEILLES (Fr. **MARSEILLE),** a city of southern France, the chief seaport of France and of the Mediterranean and the capital of the department of Bouches-du-Rhône, lies 219 mi. S. by E. of Lyons and 534 mi. S.S.E. of Paris by the P.L.M. railway. Pop. (1954) 605,577.

History. — The Greek colony of Massilia (Massalia) was founded by the mariners of Phocaea in Asia Minor, about 600 B C.; probably Phoenicians settled at Marseilles before the Greek period. In 542 B C the fall of the Phocaean cities before the Persians probably sent new settlers to the Ligurian coast and cut off Massilia from close connection with the mother country. Isolated amid alien populations, the Massiliots made their way by prudence and by vigilant administration of their oligarchical government. Their colonies spread east and west along the coast from Monaco to Cape St. Martin in Spain, carrying with them the worship of Artemis. The inland trade, in which wine was an important element, can be traced by finds of Massilian coins across Gaul and through the Alps as far as Tirol. In the 4th century B.C. the Massiliot Pytheas visited the coasts of Gaul. Britain and Germany; and Euthymenes is said to have sailed donn the west coast of Africa as far as Senegal. The great rival of Massilian trade was Carthage, and in the Punic Wars the city took the side of Rome, and was rewarded by Roman assistance in the subjugation of the native tribes of Liguria In the war between Caesar and Pompey, Massilia took Pompey's side and in 49 B C. offereda vain resistance to Caesar's lieutenant Trebonius. In memory of its ancient services the city was left as a *civitas libera,* ("free city") but its power was broken and most of its dependencies taken from it. Thereafter Massilia has little place in Roman history; it became for a time an important school of letters and medicine, but its commercial and intellectual significance declined. The town appears to have been Christianized before the end of the 3rd century. Its reputation partly revived through the names of Gennadius and Cassianus (q v). which give it prominence in the history of semi-Pelagianism and the foundation of western monarchism.

After the ravages of successive invaders, Marseilles was repeopled in the 10th century under the protection of its viscounts. The town gradually bought up their rights, and at the beginning of the 13th century was formed into a republic, governed by a podestat, appointed for a term of one year, and renewable, who exercised his office in conjunction with 3 notables and a municipal council, composed of 80 citizens, 3 clerics and 6 principal tradesmen. The higher town was governed by the bishop, and had its harbour at the creek of La Joliette which at that period ran inland to the north of the old to n. The southern suburb was governed by the abbot of St Victor, and owned the Port des Catalans Situated between the two, the lower town, the republic, retained the Vieux-Port (old harbour), and was the most powerful of the three divisions. In 1245 and 1256 Charles of Anjou, count of Provence, whose predecessors had left the citizens a large measure of independence. established his authority above that of the republic. In 1423 Alphonso V of Aragon sacked the town. King René, who had made it his minter residence. however, caused trade, arts and manufactures to flourish again. On the incorporation of Provence in the kingdom of France in 1481, hfarseilles preserved a separate administration directed by royal officials. Under Francis I. Charles de Bourbon vainly besieged the town with the imperial forces in 1524 and 1536. During the wars of religion, Marseilles took part against the Protestants. and long refused to acknowledge Henry IV. The loss of the ancient liberties of the town brought new disturbances under the Fronde, which Louis XIV came in person to suppress He entered the town by a breach in the walls and afterward had Fort St. Nicolas constructed. Marseilles repeatedly suffered from the plague, notably in 1720–21.

During the Revolution the people rose against the ruling aristocracy. In the Terror they rebelled against the Convention but were promptly subdued. The wars of the empire, by dealing a blow to their maritime commerce. excited the hatred of the inhabitants against Napoleon, and they hailed the return of the Bourbons and the defeat of Waterloo. The prosperity of the city received a considerable impulse from the conquest of Algeria and from the opening of the Suez canal. During World War I part of the harbour became a British base, and many Indian, Australian and African troops passed through, and, after the armistice, an American embarkation camp was established. In World War II Marseilles was occupied by the Germans from Nov. 1942 until it was liberated in Aug. 1944 by the French 3rd infantry division under Gen. Goislard de Montsabert. To spare the population, he besieged the city without bombing it. When U S. soldiers returned home, in 1946, more than 1,000,000 embarked from Marseilles

The Town. — Marseilles is situated on the Gulf of Lyons on the eastern shore of a bay protected to the south by Cape Croisette but open toward the west. The city is built on undulating ground and the southnestern and most aristocratic quarter covers the slopes of the ridge crowned by a fort and the church of Notre-Dame-de-la-Garde and projecting westward into the bay to form a protection for the harbour. The newest portion lies on the southeastern slope of the ridge, which is better protected than most of the other quarters from the mistral and where in summer the temperature is always a little lower than in the centre of the town. From the old harbour, nhich opens on the west to the Gulf of Lyons, the famous La Canebière, the artery of the city's life, leads east-northeast.

The old town of Marseilles is bounded on the west by the Joliette basin and the sea, east by the Cours Belsunce, south by the northern quay of the old port, and north by the Boulevard des Dames. It consisted of a labyrinth of steep, dark and narrow streets inhabited by a seafaring population. On Jan. 24. 1943, the Germans evacuated the entire district on the edge of the port and destroyed it with explosives. Subsequently a new residential district was built there.

The entrance to the old harbour is defended by Fort St. Jean on the north and Fort St. Nicolas on the south. Behind the latter is the Anse (bay) de la Réserve. Beyond this again, situated in succession along the shore, come the Château du Pharo, which was given by the empress Eugénie to the town, the Anse du Pharo and the Anse des Catalans. In the roads to the southwest of the port lie the islands of Ratonneau and Pomegue. united by a jetty formerly forming a quarantine port but today abandoned Between them and the mainland is the islet of Château d'If, in which the scene of part of Dumas' Le Comte de *Monte-Cristo* is laid.

Marseilles possesses few remains of either the Greek or the Roman periods of occupation and is poor in medieval buildings. In the Place de la Major. the old cathedral of La Major (Sainte-Marie-Majeure), dating chiefly from the 12th century and built on the ruins of a temple of Diana, is poorly preserved; the chapel of St. Lazare in the left aisle is early Renaissance Beside this church and alongside the Joliette basin is the church begun in 1852, which has taken the place of the old cathedral.

On the south side of the old harbour near the Fort St. Nicolas stands the church of St. Victor, built in the 13th century and once attached to an abbey founded about 413. With its lofty crenelated walls and square towers built of large blocks of uncemented stone, it resembles a fortress. St. Victor is built above crypts dating mainly from the 11th century but also embodying architecture of the Carolingian period and of the early centuries of the Christian era. The spire of the ancient church of Accoules, and its only relic, marks the centre of Old Marseilles. Notre-Dame du Mont Carmel, also in the old town, occupies the place of what was the citadel of the Massiliots when they were besieged by Julius Caesar. The celebrated Notre-Dame-de-la-Garde, the steeple of which is surmounted by a gilded statue of the Virgin, 30 ft. in height, rises 150 ft. above the summit of the hill on which it stands.

Of the civil buildings of the city, the prefecture, one of the finest in France, the Palais de Justice and the Exchange all date from the latter half of the 19th century. The Hôtel de Ville (1673) stands on the northern quay of the old harbour. The Palais Longchamp (1862–69) is a museum and art gallery. The museum of antiquities, established in the Château Borély (1766–78) includes a Phoenician collection (containing the remains that support the hypothesis of the Phoenician origin of Marseilles). The city also has a colonial museum and a laboratory of marine zoology. The triumphal arch of Aix, originally dedicated to the victors of the Trocadéro, was in 1830 appropriated to the conquests of the empire.

The *canal de Marseille,* built between 1837 and 1848, which has transformed the town and its arid surroundings by bringing to them the waters of the Durance. leaves the river opposite Pertuis. It has a length of 97 mi. (including its four main branches) of which 13 mi. are underground. and irrigates some 7,500 ac. After crossing the valley of the Arc, between Aix and Rognac. by the magnificent aqueduct of Roquefavour, its waters are purified in the reservoirs of Realtort. It draws about 2,200 gal. of water per second from the Durance, supplies 2,450 h.p. to works in the vicinity of Marseilles. and insures a good water supply and efficient sanitation to the city.

hfarseilles is the seat of an archbishop and a prefect. It has tribunals of first instance and of commerce, a chamber of commerce and a board of trade arbitration. The educational institutions include a school of navigation and faculties of science, medicine and pharmacy; these two faculties form part of the university of Aix-Marseilles.

The Port, Trade and Industry.—The surface area of the Vieux-Port was doubled toward the north in 1846 by the creation of the new port of La Joliette; it was afterward extended farther north by eight wet docks. The port facilities, which were destroyed by the Germans in 1944, have been rebuilt and perfected. The new port is connected by the Rove tunnel to the Étang de Berre, which opens to the sea, and by the canal which is destined to go from Marseilles to the Rhône; the portion from Étang de Berre to the river was not completed by the late-1950s. There is an old canal from Port-de-Bouc at the mouth of the estuary to Arles, on the Rhône, but it is not deep enough to permit the passage of modern ships. A new port, Lavéra, has been built in the inner harbour of Port-de-Bouc which can receive nine tankers at once without the entry being blocked. Together with the refineries which line the banks of the Btang de Berre, Lavéra is a port annex of great importance to Marseilles. The airport of Marignane is on the south bank, $17\frac{1}{2}$ mi. from the centre of the city.

When they left in 1944, the Germans destroyed the fleet. By the late 1950s it had been rebuilt to a capacity of 915,000 tons distributed between passenger and cargo ships. Many lines are based here which send ships to the eastern Mediterranean, the east coast of Africa, Australia, India, Indochina, Algeria, Tunisia, Malta, Morocco and the Antilles, as well as Great Britain and the ports on the west coast of France. In addition, many of the big foreign lines call at the port, which is mainly a transhipment and industrial port instead of, as formerly, an entrepôt.

Marseilles is the western emporium for trade with the Levant and it is the French gate of the far east. It suffers from competition with Genoa for trade with Switzerland and from lack of communication with the inland waterways of France. It was hoped in the late 1950s that improved navigation on the Rhône and the construction of one new canal from Bouc to Arles, or to Saint-Louis, would make the city of Marseilles the national outlet from the rich basin in which it lies.

In order of importance, the imports are crude petroleum, grains, out of season fruits and vegetables, carbon, sugar. peanuts. chrome, phosphates, vegetable oils and greases, cotton, rubber, wine, copra, sulfur, coffee, Indian corn, skins and leathers. bananas, dates and dried fruits, manganese and nonferrous metals. Less important are meats, dried vegetables, cocoa, leaf tobacco, exotic woods, cork, paper and cardboard, wool, iron and steel.

The major export is petroleum. After that, successively, come construction materials, machines, chemical products, sugar, carbon, metalwork, farina, automobiles, lumber, fresh vegetables, cloth, beer, tobacco, wine. soap and vegetable oils.

The industry of Marseilles is closely connected with its imports, from which are taken most of the raw materials processed there. At mid-20th century, the most important industry was based on the pact of San Remo (1920) which gave France one-fourth of Iraq's production of petroleum of which a large part is refined at Berre.

The oldest and best known industry, founded in the 15th century, is that of soap. It retains its importance despite a decrease of 35% since 1935. The production of sugar has decreased similarly since 1920. Even though the oil refineries represent half the production of France, drastically reduced in the late 1950s, their production is 50% of what it was formerly. Marseilles is the largest producer of semolina in France; and is the fourth largest producer of *pasta* which is made from semolina. The building materials made—quicklime, cement, plaster. bricks and tiles—are a significant part of France's total. The manufacture of glass is still a major industry. Metallurgy and smelting have grown in importance since World War II and Marseilles has developed a very large chemical industry (sulfuric acid, superphosphates, hydrochloric acid, refined sulfur and copper sulfate), partly owing to the needs of the vine-growing region around the city. (J. BD.)

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MARSH, ADAM (ADAM DE MARISCO) (d. *c.* 1258), English Franciscan, scholar and theologian, was born about 1200 in the diocese of Bath. and educated at Oxford under Grosseteste. Before 1226 Adam received the benefice of Wearmouth from his uncle, Richard Marsh, bishop of Durham; but between that year and 1230 he entered the Franciscan order. About 1238 he became the lecturer of the Franciscan house at Oxford. Roger Bacon, his pupil, speaks highly of his attainments in theology and mathematics. Consulted as a friend by Grosseteste, as a spiritual director by Simon de Montfort. the countess of Leicester and the queen, as an expert lawyer and theologian by the primate, Boniface of Savoy, he did much to guide the policy both of the opposition and of the court party in all matters affecting the interests of the Church. He shrank from office, and never became provincial minister of the English Franciscans, though constantly charged with responsible commissions. Henry III and Archbishop Boniface unsuccessfully endeavoured to secure for him the see of Ely in 12 j6. In 1257 Adam's health was failing, and he appears to have died in the following year. He sympathized with Montfort as with a friend of the Church and an unjustly treated man; but on the eve of the baronial revolution he was on friendly terms with the king. He rebuked both parties in the state for their shortcomings, but he did not break with either.

See the biographical notice in A. G. Little's *Grey Friars in Oxford* (Oxford, 1892), where all the references are collected (H. W. C. D.)

MARSH, GEORGE PERKINS (1801–1882), American diplomatist and philologist, was born at Woodstock, Vt., on March 15, 1801. He graduated at Dartmouth college in 1820, was admitted to the bar in 1825, and practised law at Burlington, Vt., devoting himself also to philological studies. From 1843 to 1849 he was a Whig representative in Congress. In 1849 he was made United States minister resident in Turkey, returning to Vermont


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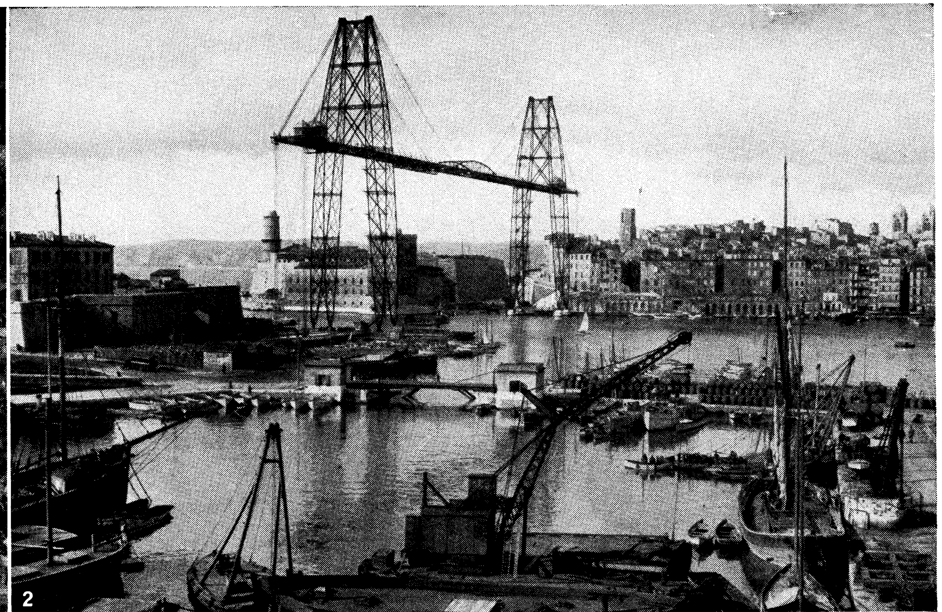
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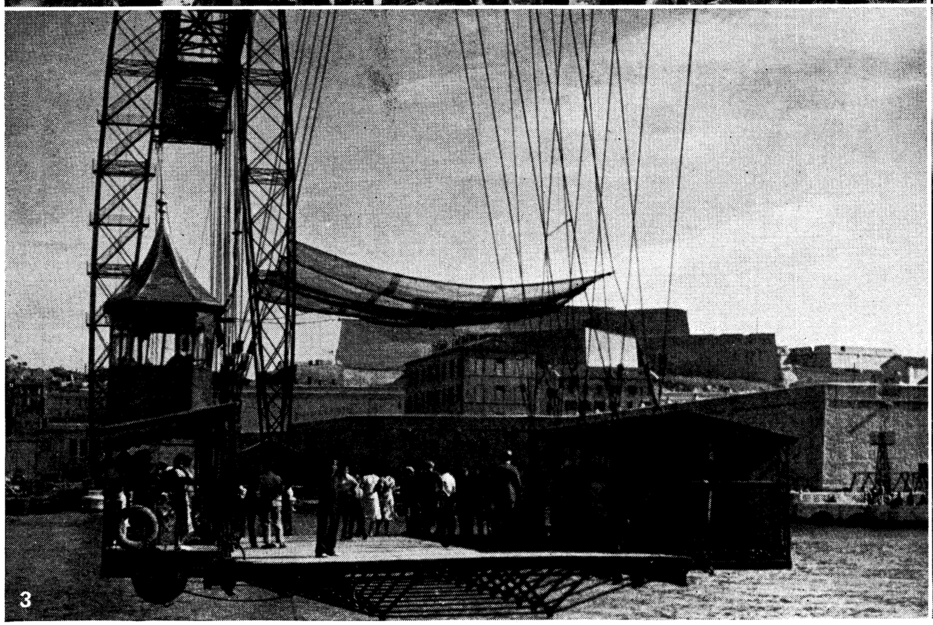
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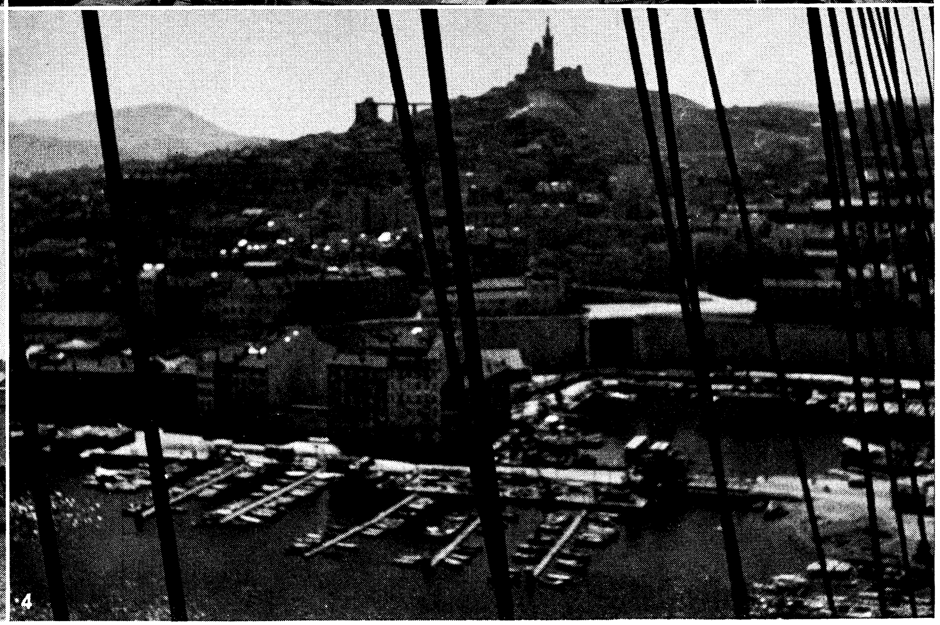
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PHOTOGRAPHS, (1) SIR ALAN COBHAM FROM EWING GALLOWAY, (2) EWING GALLOWAY, (3) PIX, (4) SCHALL-PIX

VIEWS OF THE HARBOUR OF MARSEILLES

1. Air view of Marseilles, showing the Old Harbour (Vieux Port) at the left centre, and the new harbours at the upper right

2. The Old Harbour, with the Pont Transbordeur (Transportation bridge) at the mouth. This area was ruined in World War II

3. Close-up view of the Pont Transbordeur

4. A view of the hill of Notre-Dame de la Garde, taken from the upper level of the Pont Transbordeur

in 1854. In 1861 he became the first United States minister to the kingdom of Italy, and died in that office at Vallombrosa on July 23, 1882. Marsh was an able linguist, a scholar of great breadth, and a remarkable philologist for his day. His chief published works are: *A Compendious Grammar of the Old Northern or Icelandic Language* (1838); *The Camel, his Organization, Habits, and Uses, with Reference to his Introduction into the United States* (1856); *Lectures on the English Language* (1860); *The Origin and History of the English Language* (1862; revised ed., 1885); *Man and Nature* (1864); *The Earth as Modified by Human Action* (1874, 1885); and *Mediaeval and Modern Saints and Miracles* (1876).

See Mrs. C. Marsh's ***Life*** and ***Letters of George Perkins Marsh (1888).***

MARSH, OTHNIEL CHARLES (1831–1899), U.S. paleontologist whose discoveries and scholarly descriptions of numerous fossils won him his scientific reputation. was born in Lockport, N.Y., on Oct 29, 1831. He graduated at Tale college in 1860, and studied geology and mineralogy in the Sheffield Scientific school there. Becoming interested in vertebrate paleontology, he studied abroad and on his return to Yale in 1866 was appointed professor of vertebrate paleontology. He was aided by a private fortune from his uncle, George Peabody, whom he induced to establish the Peabody Museum of Natural History in the college. With this backing, he sent out numerous exploring parties to Wyoming and other western states almost annually for the next three decades. In his publications on fossil finds he utilized the studies of such scientists as Samuel Wendell Williston, Oscar Harger, Max Schlosser and George Baur; these men were not generally permitted to publish themselves on vertebrate paleontology while in Marsh's employ. A host of short papers by Marsh appeared in the *American Journal of Science;* his major published works, however, were quarto volumes on toothed birds, the Dinocerata (archaic horned mammals). and North American dinosaurs. Marsh was prominent in national scientific affairs. and was president of the National Academy of Sciences for 12 years. His rival in the exploration of the western fossil beds nas Edward Drinker Cope (*q.v*) of Philadelphia; their rivalry developed into a bitter feud which somewhat clouded the reputations of both. Early government geological exploration of the west had been made by several independent surveys; they were combined in 1881 to form the United States Geological survey. Marsh was put in charge of its work in vertebrate paleontology and given liberal support.

Marsh's last years were saddened by financial reverses, loss of government support, and demand that fossils collected under government auspices be sent to the National museum. He died in New Haven on March 18, 1899.

See Charles Schuchert and Clara Mae LeVene, *O. C. Marsh: Pioneer in Paleontology* (1940). (A. S. Rr.)

MARSH, an area of low, flat-lying, wet ground subject to daily, seasonal or perennial flooding. In popular usage the term is applied interchangeably with swamp (*q.v.*). Technically marshes have many physical features common to swamps; they differchiefly in having vegetation composed dominantly of grasses and such grasslike plants as sedges and rushes. Characteristic marsh plants include cord and salt reed grass in salt water, saw grass and reeds in brackish to fresh water, and Indian rice and giant cane in fresh water.

Salt- and brackish-water marshes are common along low seacoasts, inside barrier bars and beaches, in estuaries and on deltas, and are often extensive in deserts. Maritime marshes often extend many miles inland and are variably subjected to tidal action. Fresh-water marshes are found frequently on mineral substrates of alluvial and lacustrine origin and are both numerous and extensive on upland areas with impeded drainage, particularly those, such as the most recently glaciated areas of North America. with underdeveloped drainage. Marshes were ubiquitous in the prairie of the midwestern United States, but their value as agricultural scils resulted in early drainage and cultivation. As wildlife refuges they provide a valuable economic and recreational resource.

Notable marshes in the United States are the Everglades of Florida, the tule marshes of the Sacramento and San Joaquin valleys of California and the Humboldt Salt marsh of Nevada. The vast Pinsk marshes of the Pripet river drainage in the Soviet Union and the Pontine marshes of Rome are of particular historical interest. (M. E. B.)

MARSHAL, a title given in various countries to certain military and civil officers, usually of high rank. The origin and development of the meaning of the designation is closely analogous with that of constable (*q.v.*). Just as the title of constable is traceable to the style and functions of the Byzantine count of the stable, so that of marshal was evolved from the title of the *marescalci,* or masters of the horse, of the early Frankish kings. In this original sense the word survived down to the close of the Holy Roman empire in the titular office of *Erz-Marschalk* (arch-marshal), borne by the electors of Saxony. Elsewhere the meaning of office and title was modified. The importance of cavalry in mediaeval warfare led to the marshalship being associated with military command; this again led to the duty of keeping order in court and camp, of deciding questions of chivalry, and to the assumption of judicial and executive functions. The marshal, as a military leader, was originally a subordinate officer, the chief command under the king being held by the constable; but in the 12th century, though still nominally second to the constable, the marshal has come to the forefront as commander of the royal forces and a great officer of State. In England after the Conquest the marshalship was hereditary in the family which derived its surname from the office, and the hereditary title of earl-marshal originated in the marriage of William Marshal with the heiress of the earldom of Pembroke (*see* EARL MARSHAL). Similarly, in Scotland, the office of marischal (from the French *mare'chal),* probably introduced under David I., became in the 14th century hereditary in the house of Keith. In 1485 the Scottish marischal became an earl under the designation of earl-marischal, the dignity coming to an end by the attainder of George, 10th earl-marischal, in 1716. In France, on the other hand, though under Philip Augustus the marshal of France *(marescalcus Franciae)* appears as commander-in-chief of the forces, care was taken not to allow the office to become descendible; under Francis I. the number of marshals of France was raised to two, under Henry III. to four, and under Louis XIV. to 20. Revived by Napoleon, the title fell into abeyance with the downfall of the Second empire.

In England the use of the word marshal in the sense of commander of an army appears very early; so Matthew Paris records that in 1214 King John constituted William, earl of Salisbury, *marescalcus* of his forces. The modem military title of field marshal, imported from Germany by King George II. in 1736, is derived from the high dignity of the *marescalcus* in a roundabout way. The *marescalcus campi,* or *mare'ckal des champs,* was originally one of a number of officials to whom the name, with certain of the functions, of the marshal was given. The marshal, being responsible for order in court and camp, had to employ subordinates, who developed into officials often but nominally dependent upon him. On military expeditions it was usual for two such marshals to precede the army, select the site of the camp and assign to the lords and knights their places in it. In time of peace they preceded the king on a journey and arranged for his lodging and maintenance. In France *mare'chal des logis* is the title of superior non-commissioned officers in the cavalry.

Similarly at the king's court the *marescalcus aulae* or *intrinsecus* was responsible for order, the admission or exclusion of those seeking access, ceremonial arrangements, etc. Such "marshals" were maintained, not only by the king, but by great lords and ecclesiastics. The more dignified of their functions, together with the title, survive in the various German courts, where the court marshal (*Hofmarschall*) is equivalent to the English lord chamberlain. Just as the *marescalcus intrinsecus* acted as the vicar of the marshal for duties "within" the court, so the *marescalcus forinsecus* was deputed to perform those acts of serjeanty due from the marshal to the Crown "without." Similarly there appears in the statute 5 Edw. III. cap. 8, a *marescalcus banci regii,* or marshal of the king's bench, who presided over the Marshalsea court, and was responsible for the safe custody of prisoners bestowed in the Marshalsea prison. The office of marshal of the queen's bench survived till 1849 (see LORD STEWARD; and MARSHALSEA). The official known as a judge's marshal, nhose office is of considerable antiquity. and whose duties consisted of making abstracts of indictments and pleadings for the use of the judge, still survives, but no longer exercises the above functions. He accompanies a judge of assize on circuit and is appointed by him at the beginning of each circuit. His travelling and other expenses are paid by the judge, and he receives an allowance of two guineas a day, which is paid through the Treasury. He introduces the high sheriff of the county to the judge of assize on his arrival. and swears in the grand jury. For the French *maréchaussée* see FRENCH LAW AND INSTITUTIONS.

In the sense of executive legal officer the title marshal survives in the United States of America in two senses. The United States marshal is the executive officer of the Federal courts. one being appointed for each district, or exceptionally, one for two districts. His duties are to open and close the sessions of the district and circuit courts, serve narrants and execute throughout the district the orders of the court. There are United States marshals also in Alaska, Hawaii and Puerto Rico They are appointed by the president of the U.S., nith the advice and consent of the Senate, for a term of four years. and, besides their duties in connection with the courts. are employed in the service of the internal revenue, public lands, post office, etc. The temporary police sworn in to maintain order in times of disturbance. known in England as special constables, are also termed marshals in the United States. In some of the southern and aestern States of the Union the title marshal has sunk to that of the village policeman, as distinct from the county officers known as sheriffs and those of the justices' courts called constables.

In England the title of marshal, as applied to an executive officer, survives only in the army. where the provost marshal is chief of the military police in large garrisons and in field forces. Office and title were borrowed from the French *prévôt des maréchaux*, the modern equivalent of the mediaeval *praepositus marescalcorum* or *guerrarum*.

MARSHALL, ALFRED (1842–1924), British economist who, through the influence of his work, was one of the chief founders of the school of neoclassical economists, was born in London on July 26, 1842. Educated at Merchant Taylors' school and at St. John's college, Cambridge, in 1877 he became the first principal of University college, Bristol, but resigned in 1881 because of ill health. He was a fellow and lecturer in political economy at Balliol college, Oxford, from 1883 to 1885, when he returned to Cambridge as professor of political economy in succession to Henry Fawcett. He was a member of the royal commission on labour from 1891 to 1894 and subsequently served in several government inquiries. In 1903, after years of struggle, he succeeded in establishing an economics tripos at Cambridge, separate frorn the moral sciences tripos. He retired from the chair of political economy in 1908 and thenceforward devoted himself to his writings until his death at Cambridge on July 13, 1924.

Marshall's first big work, *Principles of Economics* (1890), was in many ways his most important contribution to economic literature. His next volume: *Industry and Trade*, a realistic study of industrial organization, did not appear until 1919, but in the meanwhile he had devoted much time and energy to bringing out successive editions of his *Principles*. In 1923 he published his last volume, *Money, Credit and Commerce*. Marshall may be said to have been in the lineal descent of the great English economists—Adam Smith, Ricardo and J. S. Mill. His *Principles of Economics* was distinguished by its profound and systematic methods of analysis and by the introduction of a number of new concepts, such as elasticity of demand, consumer's surplus, quasi rent! the representative firm, etc., which played a great role in the subsequent development of economics. Writing at a time when the economic world was deeply divided on the theory of value, he succeeded, largely by introducing the element of time as a factor in analysis, in reconciling the classical cost of production principle with the marginal utility principle formulated by William Jevons (*q.v.*) and the Austrian school. He did much to rescue economics from rigid dogmatism by insisting that economic reasoning and laws were not themselves a body of concrete truth but an engine for the discovery of concrete truth. (C. W. G.; X.)

MARSHALL, GEORGE CATLETT (1880–1959), U S. army officer aho directed the organization and training of U.S. land and air forces during World War II, served as secretary of state and of defense. was author of the Marshall plan for European recovery and was winner of the Nobel peace prize (1953). He was born at Uniontown, Pa., on Dec. 31, 1880, and graduated from the Virginia Military institute, Lexington in 1901. Commissioned as a second lieutenant in February 1902, with date of rank from February 1901, his first service mas in the Philippines (1902–03). He was advanced through the grades to general of the army in Dec. 1944. As a five-star general he mas still on active duty and the highest ranking officer of the army at the time of his death.

In World War I he served as chief of operations of the 1st army and chief of staff of the 8th army corps. He drafted plans for the St Mihiel operation and later nas assigned the problem of transferring more than 500,000 men and 2.700 guns to the Argonne front for the Meuse-Argonne battle.

After World War I. he was an aide to Gen John J. Pershing from 1919 to 1924 and served with the 15th infantry regiment in Tientsin, China (1924–27). As assistant commandant in charge of instruction (1927–32) at the infantry school. Ft Benning he strongly influenced army doctrine and such later wartime leaders as Bradley. Collins, Ridgway, Stilwell, Bedell Smith. Hodges and Bolté. He was saorn in as chief of staff of the army on Sept 1, 1939 the day World War II began with the invasion of Poland by German troops For the next six years. Marshall directed the raising of new divisions, training of troops. development of new weapons and equipment, and selection of top commanders. He was chief of staff of the army at the time of Pearl Harbor. As an adviser to Pres. Franklin D. Roosevelt on strategy, he attended the conferences at Casablanca. Quebec, Tehran. Yalta and Potsdam.

Marshall resigned as chief of staff Nov 21, 1945. A few days later he was appointed special representative of Pres. Harry S. Truman to China with rank of ambassador. He was unsuccessful in his efforts to mediate the Chinese civil war.

Appointed secretary of state by President Truman on Jan. 21, 1947, he headed—during the next two years—U S. delegations to international conferences at Moscow, Rio de Janeiro, Bogotá, Paris, London and New York. On June 5, 1947, at Harvard university he proposed a European Recovery program nhich, knonn as the Marshall plan (*q.v.*), was enacted into law in April 1948 The Greek and Turkish aid programs, recognition of Israel and the initial discussions of the North Atlantic Treaty organization (NATO) agreements came during his secretaryship. He resigned on Jan 21, 1949 In the course of the year he was named chairman of the American Battle Monuments commission and president of the American Red Cross.

Marshall nas secretary of defense under Truman from Sept 21, 1950. to Sept. 12, 1951. In this post he helped implement the NATO agreements. He pressed vigorously for increases in man power and production of matériel to strengthen U S. forces in Korea, and urged the establishment of a universal military training program.

He represented Pres. Dwight D. Eisenhouer at the coronation of Elizabeth II in 1953. Later in the same year he was awarded the Nobel peace prize in recognition of his contributions to the economic rehabilitation of Europe after World War II and his efforts to promote international peace and understanding. He died in Washington, Oct. 16, 1959, and was buried in Arlington National cemetery (F.C. PE.)

MARSHALL, JOHN (1755–1835), fourth chief justice of the United States nhose constitutional decisions gave shape and definition to the structure of the federal government, was born on Sept 24. 1755, near a settlement then called Germantown (now Midland), Va. the eldest of 15 children of Thomas Marshall (1730–1802) and Mary Keith Marshall. His childhood and youth were spent in the near-frontier region nhich in 1759 became Fauquier county. first in the forested area of southern Fauquier in which he had been born. later on in the more extensive properties his father acquired in the Blue Ridge mountain area north and west of Warrenton. His education appears to have been largely the product of his parents' efforts, supplemented only by the instruction afforded by a visiting clergyman who lived with the family for about a year, and by a few months of slightly more formal training at an academy in Westmoreland county. Thomas and Mary Marshall, however, had more learning and wider experience to transmit to their children than was common among the farmers and hunters of the back country of northern Virginia. Mary Keith Marshall was the daughter of a college-trained Scottish clergyman who had migrated to Virginia. Thomas Marshall brought to the family circle a continually broadening experience. A friend of George Washington, he had been his assistant in surveying the extensive estates of Lord Fairfax. Soon after Fauquier county was established he was elected its representative in Virginia's house of burgesses. His career of officeholding next included service as sheriff of Fauquier county, a return to the house of burgesses, appointment as clerk of Dunmore county, followed once again by service in the house of burgesses. This was the period when the differences between the upland counties and the tidewater aristocracy grew sharp and were paralleled by an increasing sentiment for colonial autonomy and finally for independence among the back-country residents whom Thomas Marshall represented.

When political debate with England was followed by armed clashes in 1775. John Marshall. as lieutenant. joined his father in a Virginia regiment of minutemen and participated in the first fighting in that colony. Joining the Continental army in 1776. he served under Washington for three years in New Jersey, New York and Pennsylvania, including in this service the harsh winter of 1777–78 at Valley Forge. When the term of service of his Virginia troops expired in 1779, Marshall returned to Virginia and thereafter saw little active service prior to his discharge in 1781.

Marshall's career in law dates from 1780. His only formal training was a brief course of lectures given by George Wythe which he attended at William and Mary college early in that year. Licensed to practise in Aug. 1780, he returned to Fauquier county and was elected to the Virginia house of delegates in 1782 and 1784. Attending the sessions of the legislature in the capitol at Richmond. he established there both a lam practice and a home after marriage to Miss Mary Ambler in Jan. 1783.

For the next 15 years Marshall's career was marked by increasing stature at the brilliant bar of Virginia. He had not, in 1787, achieved a public position which would have sent him as a delegate to the Constitutional Convention in Philadelphia, but he was an active, if junior, proponent of the constitution in the closely contested fight for ratification. Virginia was then the largest and most populous of the states. Its ratification was not only essential to the success of the proposed constitution but was also among the most doubtful. Marshall was elected to the legislature which took the first step toward ratification by issuing a call for a convention to consider ratifying; he was also elected a delegate to the convention. On the floor of that convention the contest on behalf of the constitution was led by men senior to Marshall—James Madison. Edmund Randolph, Edmund Pendleton and Wilson Cary Nicholas; Patrick Henry and George Mason led the opposition. Jlarshall made one address in reply to a general attack by Henry. His principal effort on the floor was, perhaps prophetically, a defense of the judiciary article. It can only be assumed that his acknowledged popularity was employed with at least equal effectiveness off the floor to gain or hold the narrow margin by which Virginia's ratification was won.

With the new government under the constitution installed, President Washington offered Marshall appointment as United States attorney for Virginia. Marshall declined. In 1789. however, he sought and obtained a further term in Virginia's house of delegates as a supporter of the national government. As party lines emerged and became defined in the 1790s, Marshall became recognized as one of the leaders of the Federalist party (*q.v.*) in Virginia. In 1795, Washington tendered him an appointment as attorney general. This, too. was declined. but Marshall returned to the state legislature as a Federalist leader. His first federal service came when Pres. John Adams appointed him member of a commission, with Elbridge Gerry and Charles C. Pinckney, to seek improved relations with the government of the French republic. The mission was unsuccessful. But when its reports were published disclosing the approach of intermediaries, the shadowy figures of "X, Y and Z," who informed the commissioners that they would not be received by the French government unless they first paid large bribes, and the rebuff of these advances in a memorial which Marshall had prepared, Marshall became a popular figure and the conduct of his mission was applauded by one of the earliest American patriotic slogans, "Millions for defense, but not one cent for tribute" (*see* XYZ CORRESPONDENCE).

Returned from France. Marshall declined appointment to the supreme court to succeed Justice James Wilson but was persuaded by Washington to run for congress. He was elected in 1799 as a Federalist from the Richmond district, though not until he had expressed opposition to the unpopular alien and sedition laws which the Adams administration had sponsored (*see* UNITED STATES: *History: Struggle for National Government, 1783–1865*). His service in the house of representatives was brief. His chief accomplishment there appears to have been the effective defense of the president against a Republican attack for having honoured a British request under the extradition treaty for the surrender of a seaman charged with murder on a British warship on the high seas. In May 1800, President Adams requested the resignation of his secretary of war and offered the post to Marshall. Marshall declined. The president next dismissed his secretary of state and tendered the vacant place in his cabinet to Marshall. In an administration harassed by dissension and with uncertain prospects in the forthcoming election, the appeal of the invitation must have been addressed principally to Marshall's loyalty. After some hesitation he accepted and almost immediately became the effective head of government when the president retired to his home in Massachusetts for a stay of a few months. In the autumn of 1800, Chief Justice Oliver Ellsworth resigned owing to ill health. Adams, defeated in the election of November, tendered reappointment to John Jay, the first chief justice. Jay declined. The president then turned to his secretary of state and in Jan. 1801, sent to the senate the nomination of John Marshall to be chief justice of the United States. The last Federalist senate confirmed the nomination on Jan. 27, 1801. On Feb. 4, Marshall accepted the appointment but, at the president's request, continued to act as secretary of state for the last month of the Adams administration.

It fell to Marshall, and to the supreme court under and beginning with Marshall, to set forth with authority the main structural lines of the government of the United States. Whether the constitution had created a federation or a nation was not a matter on which universal agreement could have been won at the beginning of the 19th century. Though judicial decisions could not alone dispel differences of opinion. they could create a body of coherent, authoritative and disinterested doctrine around which opinion could mass and become effective. To the task of creating such a core of agreement bfarshall brought qualities which were admirably adapted for its accomplishment. His own mind had apparently a clear and well organized concept of the effective government which he believed mas needed and was provided by the constitution He wrote with a lucidity, a persuasiveness and a vigour which gave to his judicial opinions a quality of reasoned inevitability which more than offset nhat they sometimes lacked in precision of analysis. The 35 years of his magistracy gave opportunity for the development of a unified body of constitutional doctrine. It was the first aspect of Marshall's accomplishment that he and the court which he headed did not permit this opportunity to pass unrecognized.

Prior to Marshall's appointment, it had been the custom of the supreme court, as it was in England, that each justice deliver an opinion in each significant case. This method may be effective where a court is dealing nith an organized and existing body of law. With a new court and a largely unexplored body of law. it created an impression of tentativeness. if not of contradiction, nhich lent authority neither to the court nor to the law it expounded. With Marshall's appointment, and presumably at Marshall's instance, this practice changed. Thereafter, for some years, it became the general rule that there was only a single opinion from the supreme court, and that delivered by the chief justice. This change of practice alone would have contributed to making the court a more effective institution. And when the opinions were cast in the mold of Marshall's clear and compelling statement. growth of the court's authority came as a result which might have been, and presumably mas, anticipated.

Marbury v. *Madison* (1803) mas the first of hlarshall's great cases and the case which established for the court its power to state and expound constitutional law in disregarding federal statutes which it found in conflict with the constitution. President Adams had appointed a number of justices of the peace for the District of Columbia shortly before his term expired. Their commissions had been signed and the seal of the United States affixed in the office of the secretary of state, but some of them, including that of William Marbury, remained undelivered. President Jefferson is believed to have ordered that some of them not be delivered. After unsuccessful application at the department of state, Marbury instituted suit in the supreme court against James Madison. the new secretary. Though the matter was not beyond question, the court found that congress had by statute authorized that such suits be started in the supreme court rather than in a lower court. But the supreme court, speaking through Marshall, held that art. iii of the constitution did not permit this, and that the court could not follow a statute which was in conflict with the constitution. It thereby confirmed for itself its most controversial power, the function of judicial review, of finding and expounding the law of the constitution.

Marshall's emphasis was put on the assertion that if the constitution was to be a lasting and controlling document, judges who were sworn to uphold it could not follow a law which conflicted with it. As Chief Justice John Bannister Gibson of the supreme court of Pennsylvania later pointed out, the problem was not so much whether the court should follow laws which conflicted with the constitution as it was who—court or congress—should determine whether the conflict existed, a matter often as uncertain as it was in Marbury's case. This great power of determining whether there was conflict between a law and the constitution was not explicitly given to the court. 4s early as 1796 it had held ineffective a state law which it found in conflict with federal law, and in the same year had considered a constitutional challenge to a federal tax, but had left without specific decision its power to disregard a federal statute. Marshall's was the first decision which asserted and acted upon this authority. Though the court's action has been questioned, and even termed usurpation, history lends strong support to Marshall's action. British judges had passed upon the question whether the acts of colonial legislature were consistent with their charters, so the function was not an unfamiliar one. There mas some history of state courts having done the same with respect to state laws and state constitutions. Most of the leaders of the Constitutional Convention and many of those in state ratifying conventions appear to have contemplated judicial review and to have assumed that it would be exercised. And the terms of the Judiciary act passed by the first congress in 1789 appear equally clearly to have contemplated that this function would be carried out by judges subject to ultimate review by the supreme court.

Once the power of judicial review had been established, Marshall and the court followed with decisions which assured that it would be exercised, and the whole body of federal law determined, in a unified judicial system with the supreme court at its head. In *Martin* v. *Hunter's Lessee* (1816) the court overruled the court of appeals of Virginia, which had held that the state courts were not subject to review by the supreme court, even in cases where federal questions were involved. Marshall did not participate in this case because the specific point at issue was ownership of the Fairfax estate in which he had a large interest. But in *Cohens* v. *Virginia* (1821), Marshall followed the same reasoning and went a step further in holding that even criminal cases in the state courts, in which a state itself was a party. were subject to review by the supreme court if a question under federal law arose in the case. This decision provoked vigorous opposition by Judge Spencer Roane of Virginia, but it is clear that a unified federal system could hardly have been maintained had Marshall's decision been otherwise, And in *United States* v. *Peters* (1809), Marshall closed another possible gap in federal authority by holding that once the federal courts had acted, not even a state legislature could interpose effective authority to nullify or set aside its order or judgment

After asserting the authority of federal judges to interpret and apply the constitution, Marshall's most important decision in the exercise of this function was in *McCulloch* v. *Maryland* (1819) in nhich he upheld the authority of congress to create the Bank of the United States. Once again he was dealing uith a power not explicitly given. for the constitution did not in so many words emponer congress to create a corporation or establish a bank. But Marshall found that if congress determined that a corporation exercising banking poners would be a useful and appropriate means of accomplishing its purpose within the granted powers of regulating commerce, borrowing money, collecting taxes, paying and supporting troops, and the like, its action was authorized by the constitution. In nriting "[W]e must never forget that it is a *constitution* we are expounding . . . Let the end be legitimate, let it be within the scope of the constitution, and all means which are appropriate. which are plainly adapted to that end. which are not prohibited, but consist with the letter and spirit of the constitution, are constitutional," Marshall set a standard of judgment of congressional action which would validate the expanding federal legislation of later years. *McCulloch* v. *Maryland* uell illustrates that judicial revien may have an affirmative aspect as well as a negative. It may accord an authoritative legitimacy to contested government action no less significant than its restraint of prohibited or unauthorized action.

The constitution had been called into being as much by the need for restricting state legislation hostile to the commerce of other states as by any other single factor. It granted to congress the poner to "regulate commerce . . . among the several states." It left open the question nhether, or to what extent, state regulatory laws could be applied to interstate commerce. In order to encourage the development of the steamboat, New Tork had granted to Fulton and Livingston, and their licencees, a long-term monopoly of steam navigation on the waters of the state. In *Gibbons* v. *Ogden* (1824), the question was whether this New Tork statute could operate to exclude vessels propelled by steam and coming from another state. In dealing with the problem, Marshall first set forth the great scope of the power granted to congress by the commerce clause. There remained the dilemma whether this excluded state action in the field when congress had not acted. Marshall san that many state laws primarily of local concern would. be ineffective if they could not be applied to persons and goods from other states. At the same time many others could operate to evoke hostility and reprisals from other states. as indeed New York's steamboat monopoly was doing. In *Gibbons* v. *Ogden*, after an extensive survey of the problem nhich left it unanruered, Marshall resolved that particular case by invoking federal authority in the form of a federal coasting licence possessed by the New Jersey vessel to override New York's statutory monopoly. Yet in *Willson* v. *Black Bird Creek Marsh company* (1829), Marshall held in a brief and inexplicit opinion that a similar coasting licence could not justify destruction of a dam across a navigable stream which Delaware had authorized in order to drain a marsh. These apparently conflicting decisions showed not contradiction or indecision but rather a recognition that the problem was a complex one incapable of solution by any simple rule or formula. It remained for Marshall's successors to recognize explicitly what hlarshall's decisions had foreshadowed, that such problems could be dealt with only on the particularized basis of appraising the competing interests of the state and of a nationally open market in the circumstances of each case. When Maryland, however. imposed a special tax upon importers. thereby creating a hostile discrimination against foreign goods in the local market, Marshall had little difficulty in deciding, in *Brown* v. *Maryland* (1827), that this taxing statute was unconstitutional. Though the result of that decision was not questioned thereafter, hlarshall's opinion in *Brown* v. *Maryland* was not among his happiest. Instead of basing the decision upon the fact that the tax was discriminatory, Marshall held instead that for a time imports must be completely tax exempt. He suggested that this exemption existed during the time they remained in the original package and before the first sale. The opinion, rather than the result of the decision. posed for successor judges many difficult problems in enforcing general non-discriminatory state taxes insofar as they relate to imported goods.

Marshall's decisions dealing with the authority and organization of the federal government and with federal-state relationships created an organized structure upon which his successors have for the most part built and elaborated. His decisions dealing with the specific restraints upon government, chiefly involving the provision of art. i of the constitution that "No State shall . . . pass any . . . Law impairing the Obligation of Contracts" proved less enduring in establishing the uorking limits within which state governments must operate. Though *Fletcher* v. *Peck* (1810)—holding that a state could not legislatively revoke an executed sale of land uhich had subsequently been acquired by innocent purchasers—presumably remains effective (either by virtue of the 14th amendment or the contract clause), other decisions by Marshall under the contract clause have been modified. In *New Jersey* v. *Wilson* (1812), Marshall held that a legislative grant of tax exemption to land occupied by Indians remained effective and could not be denied by the state even after the land had been purchased by others. The construction which interpreted the grant in such sweeping terms was presumably qualified by Marshall himself in *Providence Bank* v. *Billings* (1830). The decision in *Trustees of Dartmouth College* v. *Woodward* (1819), that a grant of a corporate charter constituted a contract which was inviolate against subsequent amendment, was effectively lessened in scope both by more restrictive construction of such charters and by the subsequently developing practice of state legislatures in specifically reserving the power to amend. The decisions in *Sturges* v. *Crowninshield* (1819) and in *McMillan* v. *McNeill* (1819), holding that state laws could not grant a discharge to insolvent debtors. were modified by *Ogden* v. *Saunders* (1827) with respect to debts incurred after the passage of the state law. This decision was one of the few cases decided while Marshall was on the supreme court in nhich the majority did not agree with him, and in which he dissented. If it was true that Marshall's decisions attempting to mark out the scope of the constitution's specific prohibitions on government have been among his less enduring ones, the same has been no less true of his successors. It is in this area that judicial review has evoked its most vigorous critics.

For the first 30 years of his service as chief justice, Marshall's life was singularly happy. In the autumn of 1831, at the age of 76, he underwent the rigours of surgery for the removal of kidney stones and appeared to make a rapid and complete recovery But the death of his aife on Christmas of that year was a blow from nhich his spirits did not so readily recover. In 1835 his health declined rapidly and on July 6 of that year he died in Philadelphia. He lies buried in Richmond, where he had maintained a home for many years. It was said of him by Justice Holmes. "When we celebrate Marshall we celebrate at the same time and indivisibly the inevitable fact that the oneness of the nation and the supremacy of the national Constitution were declared to govern the dealings of man nith man by the judgments and decrees of the most august of courts." It is his lasting memorial that when the phrase "the great chief justice" is used, the reference is unmistakably to John Marshall.

See also CONSTITUTION AND CONSTITUTIONAL LAW: *Cnited States;* and SUPREME COURT OF THE UNITED STATES. THE.

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MARSHALL, LOUIS (1856–1929), U.S. lawyer and Jewish community leader best known for his efforts to extend religious, cultural and political freedom to all racial, religious and linguistic minorities. was born in Syracuse, N.Y., on Dec. 14. 1856 He achieved eminence as an appellate lanyer, and made many important contributions to legal and constitutional reforms. At the Paris peace conference of 1919 he successfully advocated treaties signed by a number of eastern European countries intended to protect minority rights (*see* MINORITIES). His opposition to Henry Ford's *Dearborn Independent,* and particularly to its circulation of the forged "Protocols of the Elders of Zion," helped bring about the discontinuance of this publication. He helped develop many religious and philanthropic Jewish organizations of national and international scope. He died at Zurich, Switz., on Sept. 11, 1929. His writings are collected in *Louis Marshall: Champion of Liberty,* edited by Charles Reznikoff (1957). (A. EN.)

MARSHALL, STEPHEN (*c.* 1594–1655), English Presbyterian clergyman, was born at Godmanchester in Huntingdonshire, and was educated at Emmanuel college, Cambridge (M.A. 1622, B.D. 1629). After holding the living of Wethersfield in Essex he became vicar of Finchingfield in the same county, and in 1636 was reported for "want of conformity." He was a preacher of great power, and influenced the elections for the Short parliament of 1640. Clarendon esteemed his influence on the parliamentary side greater than that of Laud on the royalist. In 1642 he was appointed lecturer at St. Margaret's, Westminster, and delivered a series of addresses to the Commons in which he advocated episcopal and liturgical reform. He had a share in writing *Smectymnuus,* was appointed chaplain to the earl of Essex's regiment in 1642, and a member of the Westminster assembly in 1643. He represented the English parliament in Scotland in 1643, and attended the parliamentary commissions at the Uxbridge conference in 1645. He waited on Archbishop Laud before his execution, and was chaplain to Charles I at Holmby house and at Carisbrooke. A moderate and judicious Presbyterian, he prepared with others the "Shorter Catechism" in 1647, and was one of the "Triers" 1654. He died in November 16jj and was buried in Westminster abbey, but his body was exhumed at the Restoration.

MARSHALL, THOMAS RILEY (1854–1925), 28th vice-president of the United States, was born in North hlanchester, Ind.. on March 14, 1854. He attended the public schools of that community and graduated from Wabash college, Crawfordsville, Ind. He studied law in the office of Judge Walter Olds, in Fort Wayne, and was admitted to the bar on his 21st birthday. Betneen 1875 and 1909 he practised law in Columbia City, Ind. Marshall gained a state-wide reputation as a forceful and entertaining speaker and was elected governor in 1908. He was nominated for vice-president on the Democratic ticket at Baltimore in 1912, following the stormy proceedings in which Woodrow Wilson was finally nominated for president. hlarshall nas elected that year and re-elected in 1916, the first vice-president to succeed himself in almost a century.

Marshall presided over the senate with fairness, tact and poise. His personal influence on legislation was a ponerful aid to the administration. For almost two years folloning the outbreak of World War I he advocated strict neutrality. a stand he later regretted. Folloning the war. he proved a strong advocate of the League of Nations, and opposed women's suffrage. He won friends nith his kindliness, tolerance and nhimsical humour. During a tedious debate in the senate on the needs of the country he was heard to comment: "What this country needs is a really good five-cent cigar." His homespun philosophy and love of fun are preserved in his book *Recollections of Thomas R. Marshall: a Hoosier Salad* (1925). He served on the U.S. Coal commission in 1922 and died in Washington, D.C , on June 1. 1925.

See C. M. Thomas, *Thomas Riley Marshall, a Hoosier Statesman* (1939). (H. F. TT)

MARSHALL, a city of eastern Texas, U.S., seat of Harrison county, is 38 mi. W. of Shreveport. It is a historic community, settled in 1839. named for U.S. Chief Justice John Marshall, incorporated in 1843 and chartered in 1848. It adopted the council-manager form of municipal government in 1909. Situated on the Texas and Pacific railway, Marshall is the centre of a farming area (cotton, sweet potatoes. peas, cattle) with considerable oil production. It has large railroad repair shops, and manufactures include steel products, bricks and foundry items.

Marshall is the seat of the East Texas Baptist college (chartered 1917) and two colleges for Negroes, Bishop college (1881) and Wiley college (1873). The city served for a time as secession capital of Missouri during the American Civil War. Considerable tourist trade is derived from nearby Caddo lake, a popular vacation spot. For comparative population figures see table in TEXAS: *Population.* (N. McG.)

MARSHALL ISLANDS are the easternmost group of islands in Micronesia (*q.v.*) and the eastern district of the United States Trust Territory of the Pacific Islands. Two of the atolls. Kwajalein and Eniwetok, were the scenes of heavy fighting during World War II. Later Bikini and Eniwetok became centres for atomic bomb experiments. outside the jurisdiction of the Trust administration. (The islanders were transferred to other atolls by the U.S. navy, and in 1957 were paid $500,000 in reparations.) The administrative centre of the Marshall Islands district is located on Majuro. The islands extend roughly from latitude 3° to 15° N. and from longitude 161° to 172° E. Their land area is 61 sq.mi., and the lagoon area is about 4,500 sq.mi. A reef-enclosed lagoon 70 mi. long with an area of 840 sq.mi. makes Kwajalein the largest atoll in the world. The population increase (from 10.553 in 1948 to 14,163 in 1958) in the face of limited natural resources threatened the economy after mid-century.

The Marshall Islands are arranged in two parallel rows: the Ratak chain to the east and the Ralik chain to the west. These islands are coral caps on great dome volcanoes which rise 18,000 ft, from the floor of the ocean. Cores have been drilled on Eniwetok to depths of 4,222 and 4,610 ft. through coral limestone before reaching the volcanic stone base of olivine basalt. The fossil evidence so obtained indicates that the islands have been sinking slowly since Eocene times. Drills and soundings made on other islands indicate a similar origin. The dome volcanoes have formed in two rows which correspond to lines of weakness in the ocean floor. Most of the Marshall Islands are true atolls with central lagoons enclosed by coral reefs on which storms have piled small islets. Since these islets seldom rise more than 20 ft. above high tide they are easily flooded during storms, typhoons and tidal waves. A few of the islands have undergone recent uplift which has left shallow lagoons or none at all.

Although various Spanish expeditions of the 16th century passed through the Marshall Islands, the lack of wealth discouraged further exploration and mapping. Captain Marshall partially explored them in 1788 but much of the mapping was done by Russian expeditions under Adam Ivan Krusenstern in 1803 and Otto von Kotzebue in 1815 and 1823. Spain's claims to the islands were recognized in 1886. After the Spanish-American War, Spain sold the Marshalls to Germany. Japan seized the islands in 1914 and later administrated them as a mandate from the League of Nations. The United States administration was made a formal United Nations trusteeship. July 18, 1947. See also PACIFIC ISLANDS. (C. A. MR.)

MARSHALL PLAN, also known as the European Recovery program (ERP), a program of U.S. economic aid to Europe in the post-World War II period. On June 5, 1947, in an address at Harvard university, George C. blarshall, the C.S. secretary of state, advanced the idea of a program of European economic self-help supported by U.S. assistance. On the basis of a unified plan for western European economic reconstruction presented by a committee representing various European powers, the U.S. congress in Dec. 1947 authorized establishment of ERP. It was administered by the U.S. Economic Cooperation administration (ECA) and the Organization for European Economic Cooperation (O.E.E.C.), the European co-ordinating body. See FOREIGN AID PROGRAMS.

MARSHALLTOWN, a city located near the geographical centre of Iowa, U.S., the seat of Marshall county. is on the Iowa river about 50 mi. N.E. of Des Moines. Large wholesale businesses and diversified industries have been developed, including the manufacture of furnaces, pressure valves, governors, die castings and canned goods. It was named for Marshall, Mich., in 1851 by the first settler, Henry Xnson. Marshalltown became the county seat in 1859 and was incorporated as a city in 1863. When hospitalization of Civil War veterans became a matter of state concern, the town donated 128 ac. which became the site of the Iowa Soldiers' home, now a state residence for disabled and aging Iowa veterans of all wars. Its community school district supports a junior college (1927). For comparative population figures see table in IOWA: Population. (J. F. WA.)

MARSHALSEA, a prison formerly existing in Southwark and attached to the court of that name held by the steward and marshal of the king's house (see LORD STEWARD AND MARSHAL). It existed as early as the reign of Edward III. It was consolidated in 1842 with the queen's bench and the Fleet, and was then described as "a prison for debtors and for persons charged with contempt of Her Majesty's courts of the Marshalsea, the court of the queen's palace of Westminster, and the high court of admiralty, and also for admiralty prisoners under sentence of courts martial."

The Marshalsea prison was abolished in 1849. It is described in Charles Dickens' Little Dorrit.

MARSH MALLOW (Althaea *officinalis*), a European plant allied to the hollyhock (*q.v.*), found in Great Britain and sparingly naturalized in the eastern U.S. It grows in marshes, especially near the sea. Sweetmeats were formerly made irom the root, and both roots and leaves are used in medicine as demulcents.

In the United States a marshmallow is a confection of sugar, sirup, starch and gelatin.

MARSHMAN, JOSHUA (1768–1837). English Baptist missionary and orientalist, was born on April 20, 1768. at Westbury Leigh, in Wiltshire. In 1799 he was sent by the Baptist Missionary society to join its mission at Serampore. There he translated the Bible into various dialects and, aided by his son, established newspapers and founded Serampore college. He received the degree of D.D. from Brown university, Providence, R.I., in 1810. He died at Serampore on Dec. 5, 1837. Marshman translated into Chinese the book of Genesis, the Gospels. Romans and Corinthians; in 1809 he published The Works of Confucius and in 1814 his *Clavis Sinica*.

See J. C. Marshman, Life and Times of Carey, Marshman, and Ward, Embracing the History of the Serampore Mission, 2 vol. (1859).

MARSH MARIGOLD (Caltha *palustris*), a plant of the buttercup family (Ranunculaceae), the "winking Mary-buds" of Shakespeare (Cymbeline, act ii, scene 3), common in wet places on both sides of the Atlantic. In the U.S. it is usually called cowslip, and is often known as kingcup in Great Britain. The stem is thick and hollow; the leaves are shining and kidney-shaped; and the flowers, which bloom in March or April, have five yellow sepals. The early shoots and leaves are used like spinach and the flower buds preserved in salted vinegar form a substitute for capers. A double-flowered variety is often cultivated and is occasionally found wild. C. natus, a large species nith white or pink flowers, occurs in ponds from Minnesota north. *C. leptosepala,* with white or bluish. usually solitary flowers, native to the Rocky Mountain region from Alaska to New Mexico, is an excellent potherb. The genus contains 20 species, confined to temperate climates.

See RANUNCULACEAE.

MARSI, an ancient people of Italy, whose chief centre was Marruvium, on the eastern shore of Lake Fucinus. They are first mentioned as members of a confederacy with the Vestini, Paeligni and Marrucini (Liv., viii, 29, cf. viii, 6, and Polyb., ii, 24, 12). They joined the Samnites in 308 B.C. (Liv., ix, 41), and became allies of Rome in 304 B.C. (Liv., ix, 45).

After a short-lived revolt two years later, for which they were punished by loss of territory (Liv., x, 3), they were readmitted to the Roman alliance and remained faithful down to the social war, their contingent (*e.g.,* Liv., xliv, 46) being always regarded as the flower of the Italian forces (*e.g.,* Hor., Od., ii, 20, 18). In this war, which, because of the prominence of the Marsian rebels became known as the Marsic War, they fought bravely against odds under their leader, Q. Pompaedius Silo, and, though they were frequently defeated, the result of the war was the enfranchisement of the allies. The Marsi were also renowned for their magicians, nho had strange remedies for various diseases.

The Latin colony of Alba Fucens near the northwest corner of the lake was founded in the adjoining Aequian territory in 303 B.C., so that from the beginning of the 3rd century the Marsians were in touch with a Latin-speaking community, to say nothing of the Latin colony of Carsioli (298 B.C.) farther west. The earliest pure Latin inscriptions of the district seem to be *C.I.L.*, ix, 3827 and 3848, from the neighbourhood of Supinum; their character generally is of the Gracchan period, though it might be somewhat earlier.

Mommsen *(Unteritalische Dialekten,* p. 345) pointed out that in the social war all the coins of Pompaedius Silo have the Latin legend "Italia," while the other leaders in all but one case used Oscan.

The chief record of the dialect or patois is owed to the goddess Angitia, whose chief temple and grove stood at the southwest corner of Lake Fucinus, near the modern village of Luco. She (or they, for the name is in the plural in the Latin inscription next cited) was widely worshiped in the central highlands (Sulmo, *C.I.L.*, ix, 3074, Furfo Vestinorum, *ibid.*, 3515) as a goddess of healing, especially skilled to cure serpent bites by charms and the herbs of the Marsian woods. Her worshipers naturally practised the same arts—as their descendants do *(see* A. de Nino's collection of *Usi e costumi abruzzesi*), their country being in Rome counted the home of witchcraft; *see* Hor., *Sat.*, 1, 9, 29, *Epod.*, 17, 28, etc.

The earliest local inscriptions date from about 300 to 150 B.C. and include the bronze of Lake Fucinus, which seems to record a votive offering to Angitia. The language of these inscriptions differs very slightly from Roman Latin of that date. The older form of the name of the tribe (dat. plur. *Martses* = Lat. *Martiis*) shows its derivation and exhibits the assibilation of *-tio-* into *-tso-* proper to many Oscan dialects (*see* OSCAN), but strange to classical Latin.

See R. S. Conway, *The Italic Dialects* (1897).

MARSIGLI (MARSILIUS), **LUIGI FERDINANDO,** COUNT (1658–1730), Italian soldier and scientific writer, was born at Bologna on July 10, 1658. After a course of scientific studies in his native city he traveled through Turkey collecting data on the military organization and natural history. On his return he entered the service of the emperor Leopold (1682) and fought with distinction against the Turks, by whom he was wounded and captured in an action on the river Raab, and sold to a pasha whom he accompanied to the siege of Vienna. His release was purchased in 1684 and he afterward took part in the War of the Spanish Succession. In 1703 he was appointed second in command under Count Arco in the defense of Alt-Breisach. The fortress surrendered to the duke of Burgundy, and both Arco and Marsigli were court-martialed; the former was condemned to death and the latter cashiered, although acquitted of blame by public opinion. Marsigli devoted the rest of his life to scientific investigations, in the pursuit of which he made many journeys through Europe, spending a considerable time at Marseilles, France, to study the nature of the sea. In 1712 he presented his collections to his native city, where they formed the nucleus of the Bologna Institute of Science and Art.

He died at Bologna on Nov. 1, 1730.

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MARSILEACEAE, the water clover family, a group of aquatic or marsh ferns having four-parted cloverlike leaves in the major genus. This family along with the salvinia family (Salviniaceae) comprises the fern order Hydropteridales. The Marsileaceae contains three genera and about 72 species. *Marsilea,* commonly known as water clover or pepperwort, has about 65 species of wide distribution in tropical and temperate regions; the plants are submersed or emersed aquatics with leaf blades often floating on the water's surface. *Pilularia,* which occurs from Australia and New Zealand to Chile, North America and Europe, has grasslike leaves; and *Regnellidium,* known only from southern Brazil, has leaves with two opposite leaflets terminating the leaf stalk. *Marsilea* is grown in greenhouses; M. *quadrifolia* is grown in pools and aquariums. (J. M. BL.; X.)

MARSILIUS OF PADCA (*c.* 127j–C. 1342), Italian political philosopher, was the author of the *Defensor pacis,* one of the most original treatises on political theory produced during the middle ages. Born at Padua. he was educated at the university there and at first studied medicine. He is known to have been rector of the University of Paris on March 12, 1313. While at Paris he met John of Jandun, who assisted him in writing the *Defensor pacis.* This treatise, which was completed on June 24, 1324, had a direct bearing on the controversy between Pope John XXII and Louis of Bavaria (*see* LOUIS IV, Holy Roman emperor), to whose court Marsilius went in 1326. In the following year, when he was condemned as a heretic, Marsilius accompanied Louis on his Italian expedition, which gave practical expression to many of the ideas advanced in the *Defensor pacis.* When Louis entered Rome in Jan. 1328, Marsilius was rewarded by being appointed imperial vicar of the city. After the withdrawal of the imperial forces from Italy, Marsilius spent the remainder of his life in Bavaria, where he died, probably in 1342 and certainly before April 10, 1343. In 1342 Marsilius produced the *Defensor minor,* a brief summary of his earlier work.

Defensor Pacis.—The part played by John of Jandun in the writing of the *Defensor pacis* is a matter in dispute, but most modern scholars hold that Marsilius was almost solely responsible for writing the work.

Marsilius believed that the constant wars which devastated northern Italy were the direct result of the papal policy in furthering its temporal claims. Hence the treatise commences in line with the *De Monarchia* of Dante by affirming that the object of government is the maintenance of peace, but Marsilius went much further than Dante in his Erastian doctrine. He quotes Aristotle to the effect that the state exists for the sake of the good life, but departing from the harmony of church and state which St. Thomas Aquinas had emphasized, Marsilius claims that the church is really part of the state. Although Marsilius did not completely reject the Thomist conception of natural law, he made very little use of it. The law about which he was concerned was the positive law of the state which he averred to be supreme. Implicit in his thought was the distinction between what is legally and what is morally right. Positive law implies a legislator, and Marsilius makes it clear that this is the whole citizen body or the more weighty part of it. He realized, however, that it would be difficult in practice for the whole body of the citizens to legislate and that a more effective method would be to hand over the task of framing laws to a committee who would submit their work to them.

Marsilius thought it essential that the ruler be chosen by the citizens and that the armed forces placed at his disposal be sufficient for maintaining order but not so large that he could make himself a tyrant. The ruler was to be responsible to his subjects and if he betrayed his trust he could be deposed or punished. The state could carry out its proper function only in an atmosphere of peace and tranquility, but the church by interfering with the rights of the emperor had been an aggressor and a disturber of the peace. Marsilius argued that since Christ taught submission to the civil power, the temporal claims of the papacy were completely invalid. He denied, not only to the pope but to all bishops, the right of excommunication and the imposition of an interdict on their own authority. Heretics might be punished, but the right to inflict the penalty mas the prerogative of the civil power. All ecclesiastical appointments ought to be made by the state. The power of the clergy should be restricted to spiritual matters and the supreme power in the church should rest in a general council summoned hy the ruler in which both clergy and laity should be represented. The council. because it would speak with the will of the whole community. spiritual and temporal, should have power to depose or punish the pope. He believed that the church should return to the holy poverty of the apostolic age. Tithes should be abolished and the state should take over a considerable part of the property held by ecclesiastics.

Condemned by the church in 1327 and in 1378, the treatise was known to Wycliffe and Luther and had some influence at the time of the Reformation. The first printed edition (1517) was studied by both Thomas Cranmer and Richard Hooker (*qq.v.*).

There are editions of the *Defensor pacis* by C. W. Previté-Orton (1928) and by R. Scholz, 2 vol. (1932–33). For an English translation *see* A. Gewirth, *Marsilius of Padua: the Defender of Peace,* vol. ii (1955).

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MARSIVAN or MERZIFON (anc. Phazemon?), a town in the Amasya *il* (province) of Turkey, situated at the foot of the Tavshan Dagh. Pop. (1960) 22,173. Before World War I, it was best known as a centre of American missionary and educational enterprise, and the seat of Anatolia college, a theological seminary. and schools.

MARSMAN, HENDRIK (1899–1940), one of the most outstanding Dutch poets and critics between the wars, was born at Zeist near Utrecht, Neth., Sept. 30, 1899. He studied law and practised in Utrecht, but after 1933 was entirely occupied with literature and journalism. After traveling in southern Europe, he settled in France. On June 21, 1940, he was drowned when the ship on which he was trying to reach England was torpedoed in the English channel.

Under the influence of the German expressionists, Marsman made his literary debut in about 1920 with rhythmic free verse which attracted notice for its almost aggressive independence. The collection *Verzen* (1923) expresses a paganism which the poet later described as representing the "vitalist" period of his career. As editor of the periodical *De Vrije Bladen,* he became in 1925 the foremost critic of the younger generation. His next collection of verse appeared in 1927 with the English title *Paradise Regained* and was greeted as a major artistic achievement. Another cycle. *Porta Nigra,* dominated by the idea of death, appeared in 1934. His last book of verse *Tempel en Kruis* (1940) opposes to prevalent pessimism and sense of disintegration the humanistic ideal of the creative spirit, symbolized by the Greek temple. Marsman wrote also several modernistic tales and a short novel, *De dood van Angèle Degroux* (1934), the action of which takes place in the artistic milieu of Paris and serves as a background to discussions on the attitude to life of the individual striving for independence. His *Verzameld Werk* appeared in 1947.

See W. L. M. E. van Leeuwen, *Drie Vrienden* (1947); A. Lehning, *De vriend van mijn jeogd* (1957). (GD. W. Hs.)

MARSTON, JOHN (c. 1575–1634), English dramatist and satirist, eldest son of John Marston of Coventry, at one time lecturer of the Middle Temple, was born in 1575 or early in 1576. His mother was the daughter of an Italian physician, Andrew Guarsi. He entered Brasenose College, Oxford, in 1592, taking his B A. degree in 1594. He married Mary Wilkes, daughter of one of the royal chaplains, and Ben Jonson said that "Marston wrote his father-in-law's preachings, and his father-in-law his sermons." His first work was *The Metamorphosis of Pigmalions Image, and certnine Satyres* (1598). "Pigmalion" is an erotic poem in the metre of *Venus and Adonis,* and Joseph Hall attached a rather clumsy epigram to every copy that was exposed for sale in Cambridge. In the same year Marston published, under the pseudonym of W. Kinsayder, already employed in the earlier volume, his *Scourge of Villanie,* eleven satires, in the sixth of which he asserted that Pigmalion was intended to parody the amorous poetry of the time. Both this volume and its predecessor ,were burnt by order of the archbishop of Canterbury.

The satires, in which Marston avowedly took Persius as his model, are coarse and vigorous. In addition to a general attack on the vices of his age he avenges himself on Joseph Hall who had assailed him in *Virgidemiae.* He had a great reputation among his contemporaries. John Weever couples his name with Ben Jonson's in an epigram; Francis Meres in *Palladis Tamia* (1598) mentions him among the satirists; a long passage is devoted to "Monsieur Kinsayder" in the *Return from Parnassus* (1606), and Dr. Brinsley Nicholson has suggested that *Furor poeticus* in that piece may be a satirical portrait of him.

On Sept. 28, 1599, Henslowe notices in his diary that he lent "unto Mr. Maxton, the new poete, the sum of forty shillings," as an advance on a play which is not named. Another hand has amended "Maxton" to "Mastone." The earliest plays to which Marston's name is attached are *The History of Antonio and Mellida. The First Part;* and *Antonio's Revenge. The Second Part* (both entered at Stationers' Hall in 1601 and printed 1602). These were written for the Paul's Boys, for whom he also probably revised the anonymous *Histriomastix,* and finally wrote *What you Will* (which was certainly written before 1607), while he was doubtless part author of *Jacke Drums Entertainment* (1600).

The melodrama and the exaggerated expression of these two plays offered an opportunity to Ben Jonson, who had already twice ridiculed Marston, and now pilloried him as Crispinus in *The Poetaster* (1601). The quarrel was patched up, for Marston dedicated his *Malcontent* (1604) to Jonson, and in the next year he prefixed commendatory verses to *Sejanus.* Far greater restraint is shown in *The Malcontent* than in the earlier plays. It was printed twice in 1604, the second time with additions by John Webster. *The Dutch Courtezan* (1605) and *Parasitaster, or the Fawne* (1606) followed. In 1605 *Eastward Hoe,* a gay comedy of London life, which gave offence to the king's Scottish friends, caused persons concerned in its production—Marston with others—to be imprisoned. *(See* JONSON, BEN.) In the preface to *The Wonder of Women, or the Tragedie of Sophonisba* (1606), Marston mocks at those authors who make a parade of their authorities and their learning. and the next play, *What you It'ill* (printed 1607; but probably written much earlier), contains a further attack on Jonson. Marston's undoubted dramatic work was completed in 1607. It is uncertain at what time he exchanged professions, but in 1616 he was presented to the living of Christchurch, Hampshire. He formally resigned his charge in 1631, and when his works were collected in 1633 the publisher, William Sheares, stated that the author "in his autumn and declining age" was living "far distant from this place." Nevertheless he died in London, in the parish of Aldermanbury, on June 25, 1634. He was buried in the Temple Church.

Marston's works were first published in 1633. once anonymously as *Tragedies and Comedies,* and then in the same year as *Workes of Mr. John Marston. The Works of John Marston* (3 vol.) were reprinted by J. O. Halliwell (Phillipps) (1856) and by A. Bullen, 3 vol. (1887). His *Poems* (2 vol.) were edited by A. Grosart in 1879.

For an account of the quarrel of Dekker and Marston with Ben Jonson *see* R. A. Small, *The Stage Quarrel Between Bert Jonson and the So-called Poetasters. See* also M. S. Allen, *The Satire of John Marston* (1920).

MARSTON MOOR, BATTLE OF, was fought on July 2, 1644, on a moor (now enclosed) 7 mi. W. of York, between the Royalist army under Prince Rupert and the Parliamentary and Scottish armies under the earl of Manchester. Lord Fairfax and Lord Leven. For the operations that preceded the battle *see* CIVIL WAR, ENGLISH. Rupert had relieved York and had joined forces with the marquess of Newcastle's army that had defended that city, and the Parliamentarians and Scots who had besieged it had drawn off south-westward followed by the Royalists. On the morning of July 2, however, Rupert's attack on their rearguard forced them to halt and deploy on rising ground on the south edge of the moor, their position being defined on the right and left by Long Marston and Tockwith and divided from the Royalist army on the moor by a lane connecting these two villages. The respective forces were—Royalists about 18,000, Parliamentarians and Scots about 27,000. The armies stood front to front. On the Royalist right was half the cavalry under Rupert; the infantry was in the centre in two lines and the left wing of cavalry was under General (Lord) Goring. The lane along the front was held by skirmishers. On the other side the cavalry of the Eastern Association under Lieut.-General Cromwell and that of the Scots under Major-General Leslie formed the left; the infantry of the Eastern Association under Major-General Crawford, of the Scots under Lord Leven, and of the Yorkshire Parliamentarians under Lord Fairfax was in the centre; and the Yorkshire cavalry under Sir Thomas Fairfax was on the right wing.

During the afternoon there was a desultory cannonade, but neither side advanced. At last, concluding from movements in the enemy's lines that there would be no fighting that day, Rupert and Newcastle strolled away to their coaches and their soldiers dismounted and lay down to rest. But seeing this Cromwell instantly advanced his wing to the attack (5 P.M.). His dragoons drove aaay the skirmishers along the lane, and the line cavalry crossed into the moor. The general forward movement spread along the Parliamentary line from left to right, the Eastern Association infantry being the first to cross the road. In Rupert's momentary absence, the surprised Royalist cavalry could make no head against Cromwell's charge, although the latter was only made piecemeal as each unit crossed the lane and formed to the front. Rupert soon galloped up with his fresh second line and drove back Cromwell's men, Cromwell himself being wounded, but Leslie and the Scots Cavalry, taking ground to their left, swung in upon Rupert's flank, and after a hard struggle the hitherto unconquered cavalry of the prince was broken and routed. Then, being unlike other cavalry of the time, a thoroughly disciplined force, the Eastern Association cavalry rallied, leaving the pursuit to the Scots light horse. On the Parliamentary right, Goring had swept away the Yorkshire horse, and although most of his troopers had followed in disorderly pursuit, Sir Charles Lucas with some squadrons was attacking the exposed right of Leven's infantry. At the same time the Parliamentary infantry had mostly crossed the lane and was fighting at close quarters and suffering severely, Newcastle's north-country "White-Coat" brigade driving back and finally penetrating their centre. Lord Leven gave up the battle as lost and rode away to Tadcaster. But the Scots on the right of the foot held firm against Lucas's attacks, and Cromwell and Leslie with their cavalry passed along the rear of the Royal army, guided by Sir Thomas Fairfax (who though wounded in the rout of his Yorkshire horse had made his way to the other flank). Then, on the ground where Goring had routed Fairfax, Cromwell and Leslie won an easy victory over Goring's scattered and disordered horsemen. The Eastern Association infantry had followed the horse and was now in rear of the Royalists. The original Parliamentary centre of foot, a remnant, but one containing only the bravest and steadiest men, held fast, and soon the Royalist infantry was broken up into isolated regiments and surrounded by the victorious horse and foot of the enemy. The White-Coats retreated into an enclosure and there defended themselves to the last man. The rest were cut down on the field or scattered in the pursuit and at nightfall the Royalist army had ceased to exist. Some of Rupert's foot regiments made their way to York, but the dispirited garrison only held out for a fortnight. Rupert rallied some six thousand of the men and escaped over the hills into Lancashire, thence rejoining King Charles in the south. But the Northern army, the main hope of the Royalist cause, was destroyed.

MARSUPIALIA, a subclass of Mammalia (*q.v.*) in which (with some exceptions) the young for some time after birth are kept in a pouch (marsupium) or bag of skin on the under side of the body of the female. Outstanding examples of the group are the kangaroos of Australia and the opossums of America, The marsupials are exceptionally important and interesting to the student of evolution for reasons which will appear later.

Discovery.—The South American opossums were seen and described by the first explorers of the New World, the Pinzons having taken a live one in Brazil in 1500, which was exhibited in Granada and described in a work by Trivigiano published in 1504. As to the North American opossums, Captain John Smith in his Description of *Virginia* (1612) states that: "An opossum hath a head like a Swine, and a taile like a Rat, and is of the bignesse of a Cat." Apart from the description by a Dutch voyager Pelsart (1629) of wallabies seen on islands off western Australia, the Australian marsupials remained practically unknown until Captain J. Cook's voyage. In 1770 Captain Cook saw kangaroos in the region now known as North Queensland. The kangaroo was at first regarded as a gigantic leaping rodent. The discovery of other Australian marsupials such as the marmot-like wombat, the rabbit-like bandicoot. the wolf-like thylacine, at first brought confusion into the gradual process of classifying the mammals of the world. Even Baron Cuvier did not at first realize that the marsupials formed an independent series. having only a general and superficial resemblance to the carnivorous, insectivorous and gnawing animals of the northern world. and separated from them by profound differences in the mode of reproduction. It remained for Henri M. D. De Blainville in 1816 and 1834 to take the steps of putting the marsupials by themselves in a subclass of mammals which he named Didelphia, co-ordinate in rank with the Ornithodelphia (the egg-laying mammals or monotremes) and with the Monodelphia, which are the placentals or ordinary mammals of the northern world.

Reproduction. — The most famous character of typical marsupials is the pouch in which the females carry their young. In its extreme form, as in the kangaroo, the pouch consists of a capacious elastic bag, lined with fur. The fold which grows up to form the pouch may be compared to a gigantic teat surrounding the entire mammary field. In some Australian dasyures the pouch-fold arises only around the front end of the mammary field; the presence of a scrotal pouch in the male thylacine shows how easily the abdominal wall sinks in. In its complete form the pouch has a circular aperture opening downward. As the number of nipples increases the mammary field becomes an elongate oval and the pouch gives place to low longitudinal ridges and finally disappears. It has been suggested that the lack of a pouch is really a primitive character and that we can trace many stages in the evolution of the pouch among living members of the group. Since the pouch is reduced or wanting in members of different families of marsupials, the foregoing hypothesis must assume also that when it is present the pouch has arisen independently in different families. However, before such an hypothesis can be seriously considered it would be necessary to disprove the older view that marsupials, like all other mammals. are subject to the occasional degeneration or loss of even highly evolved structures, that the pouch is normally an important part of the marsupial mode of caring for the young but that in special circumstances, such as a marked increase either in the number of young at a birth or in their size, the pouch becomes unnecessary and is reduced or eliminated. The nen-er view seems to rest in part also on the erroneous assumption that the banded anteater (*Myrmecobius*) is a little modified survivor of the Mesozoic mammals. In the marsupials of the polyprotodont division (see below) the pouch frequently opens downward or backward but in the kangaroos and phalangers, which rest in a sitting position, the pouch opens forward or upward.

Hardly less striking in appearance than the pouch are the pair of flat rod-like bones called the epipubic or marsupial bones, which lie in the deepest part of the muscular abdominal wall and are attached to the front or pubic border of the pelvis. These marsupial bones are present in both sexes and therefore are not exclusively related to the support of the female's pouch but seem rather to be remnants of the skeletal floor of the abdomen, which in primitive reptiles extends from the pubis to the sternum. Similar epipubic bones are found in the monotremes or egg-laying mammals. In some marsupials (including the thylacine or marsupial wolf) the epipubic bones are reduced to vestiges or completely lost.

At least in the larger marsupials the new-born animals are very small and in general poorly developed but it is remarkable that at this stage their fore-limbs are very large and tipped with strong claws, while the hind legs are hardly more than embryonic buds. In the case of the Virginia opossum, immediately after birth the young animal uses these large fore-limbs and claws in climbing along the under-side of the mother's body from the cloaca to the mammary field, where it attaches itself to one of the teats. The teat then swells and becomes fastened firmly in the mouth of the young; the windpipe of the young becomes prolonged upward and forward to fit into the back part of the nasal tunnel; thus the milk is prevented from getting into the windpipe and the air is delivered directly to the lungs. The teats vary in number from two in certain diprotodonts to 27 in *Monodelphis*.

The large size of the maternal teat and the prolonged attachment of the young to it may have crowded the tooth-forming part of the jaws to such an extent that the milk teeth are delayed in formation, only the hinder upper and lower premolars, at the back of the jaw, having room to develop in most marsupials, while even these milk teeth become reduced in size in the marsupial wolf (*Thylacinus*) and completely eliminated in the dasyures, wombats, koalas and marsupial anteaters. In this connection it is interesting to note that tiny vestiges of deciduous incisors and premolars, which never break through the gum, have been found in some marsupials.

At birth the young of the large forms are about an inch in length, entirely naked, blind, the ears hardly visible, the hind limbs small and the fore limbs more robust and with well-developed claws. The period of gestation in large kangaroos is about three weeks. At parturition the female sits with her tail brought forward between her legs and spends some of her time scratching at her pouch with the fore-paws and licking it. When the young animal emerges from the cloaca of the female it climbs by its clawed fore-limbs into the pouch, reaching the teats, one of which it eventually seizes with its mouth, the more easily as the teats at this time are pointed and rather turgid.

Shortly after the teat is received in the mouth of the young animal, lactation begins and the teat becomes somewhat flaccid. The body of the little kangaroo increases in size but the mouth that holds the teat does not at this time enlarge. The tip of the teat expands within the mouth so that the young cannot be released without rupturing the sides of its mouth. Numerous striated muscle fibres pass between the lobes of the mammary gland, indicating that the milk is forcibly expressed from it.

By the end of the Australian winter, September or October, the young kangaroo has grown considerably and is ready to leave the pouch. For some time before finally leaving the pouch it has been free from the teat and has eaten vegetation that it reached by leaning from the pouch while its mother was feeding.

The female reproductive organs of marsupials differ markedly from those of higher or placental mammals in the following respects: the vaginal tubes of the right and left sides always have at least a kink or sharp bend, one on each side, just above the place where the ureters pass downward to open into the bladder. These kinks usually join in the mid-line and from the point of junction is developed a cul-de-sac of varying lengths, leading backward toward the cloaca or short passage to the exterior. In females that have never produced young the median cul-de-sac ends blindly at the lower end. After the egg has passed down from the ovary into the oviduct it is fertilized by some of the sperm which has been kept in the vaginal caecum or kink above described. During parturition (in members of several families) the embryo passes down into the median cul-de-sac, which becomes prolonged backward, forming a median canal. A hole is formed in the median canal and the young escapes into the cloaca without going through the lateral canals. Thus the typical marsupials have a contorted vaginal canal with one median and two lateral passages, the median one being formed from the coalescence of part of the two laterals. In placental mammals, on the other hand, no traces of the three-way vaginal canal or of the kinks in the vaginal canals are ever formed but the lower part of the right and left oviducts tend to unite in a single median uterus. It is therefore inferred that the marsupial arrangement is a peculiar specialization not developed in the common ancestors of marsupials and placentals.

Another remarkable feature of the reproductive system of marsupials is the peculiar relstion of the two sacks or outgrowths from the ventral wall of the embryo, either one of which forms the functional placenta or organ of contact of the embryo with the uterus. In certain marsupials a double contact with the uterine wall is formed both by the true or allantoic placenta and by the omphalopleure or yolk-sack wall. In the bandicoots the true or allantoic placenta forms an intimate relationship with the uterine wall, essentially like that in the true placental mammals. On the other hand, in *Dasyurus* the allantois is degenerate and the yolk-sack alone makes contact with the uterine wall. Essentially similar conditions are found in the American opossum (*Didelphis*). In the higher placental mammals, on the other hand, only the true placenta is of functional importance in supplying the growing embryo with maternal nutriment. Thus the marsupials specialized in the early and brief internal development of the embryo, which depends for food chiefly upon its own yolk-sack and which completes its development after birth while attached to the teat. The higher or placental mammals gave the young a longer and better uterine development and a more flexible system of nursing, with greater maternal responsibility.

EVOLUTION AND CLASSIFICATION

As the existing monotremes in many respects represent a specialized side-group of the earliest mammals, the marsupials, on the whole, are the most central group of the mammalian class; consequently the problem of the origin of the marsupials largely resolves itself into the problem of the origin of the mammals, which is treated more fully under MAMMALIA. Nevertheless we present here a short review of the palaeontologic data bearing on the possible relationships of the marsupials to the several Mesozoic orders with which they have been thought to be connected.

Origin of **the** Marsupials.—The cynodont reptiles, whose fossil skeletons have been found in the Permian formations of Russia and the Triassic of South Africa, may not have been in the direct line of mammalian ascent but hey were certainly progressing in that direction and some of them, such as the smaller cynodonts of the family Galesauridae were approaching the carnivorous marsupials in the general appearance of the skull and jaws. The two minute fossil jaws from the Upper Triassic of Carolina named *Dromotherium* and *Microconodon*, which were regarded as basic Mammalia by H. F. Osborn are referred by G. G. Simpson, after careful study of the originals, to the group of cynodont reptiles.

The multituberculate or allotherian mammals (*see* MULTITUBERCULATA), which range in time from the Upper Triassic to the Lower Eocene, appear to have been a side branch of the primitive mammalian stock, paralleling the monotremes on the one hand and the diprotodont marsupials on the other but not closely related to either.

The fossil mammals called triconodonts from the Jurassic of England and Wyoming have usually been referred to the marsupials, but according to the recent studies by Simpson the triconodonts formed a special group of their own, with no valid claims to relationship with the marsupials. These were small predatory mammals, the largest about the size of a cat, with jagged cheek teeth, each molar crown comprising three cusps arranged in a longitudinal line. A braincase of *Triconodon* reveals an extremely primitive stage with large olfactory lobes and unexpanded forebrain. On the whole, the triconodonts stand on a lower level of evolution than any true marsupials.

Another Jurassic group, the Trituberculata, includes various small lower jaws, of which the most widely known has received the name *Amphitherium prevostii*. One of these jaws from Oxford was examined by Cuvier, who noted its resemblance to the jaw of the opossums but also noted that it had ten teeth on each side behind the canine, a greater number than that of any carnivorous marsupial. In 1888 H. F. Osborn pointed out that the lower molar teeth of *Amphitherium* consisted of two moieties: in front an elevated triangle of sharp cusps and behind a low heel or talonid; here clearly was a distinct prophecy of the famous "tuberculo-sectorial" lower molars of Eocene mammals. Whatever its precise relationships, the lower jaw of *Amphitherium* could be changed into that of a primitive marsupial by the inturning of the angular process, by the reduction in the number of the cheek teeth from ten to seven; and by the further development of the heel of the lower molars. Even less change would be required to transform it into the jaw of a generalized placental mammal, in which the angular process is not inflected.

The American Opossums.—The oldest known fossil which may be referred nithout any doubt to the group of marsupials is a fragmentary skull and lower jaw from the Upper Cretaceous of Montana, described by W. D. Matthew in 1916 as *Eodelphis browni;* this was discovered by Barnum Brown in association with the skull of a Cretaceous dinosaur. As Matthew pointed out, the pieces of the skull and the lower jaw match closely the corresponding parts of existing opossums, which thus take their place among the most primitive known mammals. Matthew has also traced the fossil history of the opossum family through several Eocene formations of Wyoming into the genus *Peratherium,* which is found in the Oligocene formations of western North America and France. In South America fossil opossums of the genera *Microbiotherium* and *Proteodidelphys,* date from the Lower Miocene and earlier formations. From these and similar facts Matthew has pointed out that the family of the opossums, like that of many other families of mammals, appears to have originated in North America and then to have spread on the one hand into Europe and on the other into South America. Possibly the common Virginia opossum, together with related genera in Mexico and Central America, may represent a reflux wave of immigrants coming from South America in Pliocene times.

T. H. Huxley, Dollo and R. A. Bensley have adduced much evidence tending to show that the common opossum (*Didelphis virginiana*) embodies nearly all the characters one might reasonably expect to find in the remote common ancestors of all the higher marsupials, since it retains all their primitive characters but has assumed few specializations of its own. This is not equivalent to saying, however, that American opossums are ancestral to the Australian marsupials. It probably means only that the American opossums are the survivors of an ancient and diversified group, which in some earlier geological epoch was spread perhaps as far east as Asia and which gave rise on the one hand to the American marsupials and on the other to the Australian carnivorous marsupials and later groups.

The tree-climbing habits of the opossum are expressed in its muscular prehensile tail and especially in the grasping power of its hands and feet, each with five fully developed toes; the "friction pads" on the sole of the foot also are well developed. The forearm can be freely twisted on the upper arm and the collarbones (clavicles) are well developed, as in most climbing mammals. In the hind-limbs the great toe is set off widely from the others, the feet are plantigrade and capable of being freely turned inward.

The braincase of a large opossum is relatively small and unexpanded in keeping with its low type of brain. The muzzle is large and in its interior the delicate bones that support the membranes of the sense of smell are well-developed; the bony orbits or sockets for the eyes are rather small, as are the eyes themselves; the inner ear-bones are relatively small and the same is true of the resonating chamber of the middle ear. All these and many similar facts suggest that the opossum is not an intelligent animal, that it pursues its prey chiefly by the sense of smell, and depends for safety upon hiding in the daytime and prowling about at night.

In conformity with its carnivorous-omnivorous habits, the skull of a large opossum recalls those of other carnivorous mammals in its stout cheek arches and in its high median and occipital crest, all for the support of the stout jaw muscles. The dentition also tells plainly that the opossum is primarily a flesh-eating animal, which however has not acquired highly specialized shearing teeth like those of a cat but has retained certain primitive features. The general outline of an upper molar cronn of an opossum is that of a scalene triangle with the apex on the inner side, the shorter leg being in front, the longer one behind. From the general surface of this triangle two small, V-shaped cusps project: a very small one in front (the paracone) and a much larger one behind (the metacone). Between any two adjacent upper molars are empty embrasures or openings, each like an inverted V with the tip pointing outward. Into these embrasures fit the elevated V-shaped forepart of the lower molars, surmounted by three blade-like cusps, the apex of this V pointing outward. The inverted V of a lower molar shears past the large V of an upper molar; while the inwardly projecting apex of an upper molar fits into a concave projection constituting the rear half of a lower molar. Thus the upper and lover molars of the opossum present fundamentally the same combination of shearing V's and piercing projections and sockets which is to be found in the most primitive mammals of the Cretaceous and Eocene ages.

In the opossum, as in all primitive marsupials, there are on each side four upper molars and four lower, also three upper premolars and three lower premolars. The upper premolar crowns hale a single high tip, equivalent to the highest cusp on the crown of the molars. Thus there are in all seven teeth on each side, above and below, behind the canines The same number of postcanine teeth is to be found in primitive placental mammals, but in the latter there are four premolars and three molars. The canine teeth, both upper and lower, of the opossum have long-curved, sharp-tipped crowns, well fitted for fighting and killing The incisor teeth are small and numerous with simple crowns, five on each side in the upper jaw and four in the lower jaw: of these the first upper incisors are somewhat larger and have downwardly directed points, while the first lower incisors are somemhat inclined forward. Here then is the first hint of the nipping or prehensile development of the incisors which becomes pronounced in the diprotodont group of marsupials. Accordingly the dental formula, shoning the number of different kinds of teeth in the upper and lower jaws of the common opossum may be written as follows: (incisors $\frac{5}{4}$ canines $\frac{1}{1}$ premolars $\frac{3}{3}$ molars $\frac{4}{4}$) X a = 50. From this as a starting-point the dental formulae of all other marsupials appear to have been derived either by reduction and loss of teeth or, in the case of *Myrmecobius,* by the secondary increase in number of the molar teeth. As in all typical marsupials, only the hinder or third premolars of the adult dentition are preceded by deciduous teeth.

The precise arrangement of the lateral and median vaginal canals varies widely in diiferent individuals and species of the opossum family. In some, the lateral canals are completely separate and there is hardly a beginning of the median cul-de-sac; in other species, however, it is very well developed and in still others transitional conditions are found. The attachment of the embryo to the wall of the uterus is by the yolk-sack, there being no true placenta.

Some of the smaller species of opossums have a large number of young at a birth, together with a large number of teats (rarely, as many as 27) and a reduction or loss of the pouch It is very doubtful, however, whether these are primitive characters; they seem more like retrogressive specializations nithin the family.

The common opossum (*Didelphis virginiana*) may reach a total length of 37 inches, the head and body being 22 inches long, while at the other extreme in the shrew-opossum of Brazil (*Monodelphis*) the length of the head and body is less than 3 inches. The murine opossum (*Marmosa*) of Central America and Brazil includes mouse-like insectivorous forms in which the pouch is absent. The water opossum or yapok (*Chironectes*) of Panama and Guiana is the only knonn marsupial adapted to a partly aquatic life. The toes of the hind feet are webbed and it resembles an otter in habits. The pouch is present.

The Australian Dasyuroids.—Under the name dasyuroicls we may include a series of Australian forms ranging from the tiny "pouched mice" to the wolf-like *Thylacinus.* They are frequently referred to collectively as "carnivorous marsupials." The ordinary "pouched mice" of the genus *Phascogale* are extremely active little animals with the blood-thirsty habits of shrews. They live mostly in the bush or forest. They differ profoundly from true mice not only in their internal anatomy but especially in their dentition, which is of the carnivorous-insectivorous type. In his excellent work *The Mammals of South Australia* F. Wood Jones writes: "The Yellow-footed Pouched Mouse is an animal of great interest from a zoological point of view, since in the whole of its anatomy it shows itself to be a remarkably generalized animal. It represents a marsupial base form, its general anatomy being but little modified from a basal mammalian plan, and it stereotypes the simple creature that could be considered ancestral to most of the marsupial radiations." Although too specialized in certain details. such as the reduction of the first toe of the hind foot and the loss of the caecum of the intestine: to be the direct ancestors of the diprotodont or herbivorous marsupials, the pouched mice of the genus *Phascogale* are at least structurally near to the diverging lines leading to the jumping pouched mice, to the dasyures, to the Tasmanian devil and other peculiar forms.

In the fat-tailed pouched mouse (*Sminthopsis crassicaudata*) the hind foot is much elongated and this feature is carried to an extreme in the jerboa pouched mouse (*Antechinomys*), which shows a maximum adaptation to the jumping habit, including a complete loss of the first digit of the hind foot. As in many other desert-living animals, the ears are very large and the bony shells covering the chambers of the middle ears are greatly enlarged. The animal is insectivorous and probably leaps after insects.

One of the most remarkable members of the pouched-mouse group is the mulgara, or crest-tailed pouched mouse (*Dasycercus cristicauda*), of South Australia. This sturdily built, short-limbed little animal is a typical desert form, which has multiplied in an astonishing manner during the passage of a mouse plague across cultivated districts, and is a fearless predatory animal.

The carnivorous adaptations of the mulgara are carried further in the so-called native cats. or dasyures, which are about as large as true cats but have pointed muzzles. The blades on the upper molars are relatively longer and more obliquely directed than in the mulgara and the third upper premolar is now completely eliminated. The skull bears heavy crests and well-developed cheek arches for the support of the powerful muscles. The general form of body is like that of a marten. In the spotted-tailed native cat (*Dasyurus maculatus*) the first digit of the hind foot is retained and the foot pads are striated in conformity with its tree-climbing habits; but in the common native cat (*Dasyurus viverrinus*) the first digit of the hind foot is lost and the foot pads are granular. It formerly inhabited treeless rocky country as well as cultivated districts and was a fearless predatory animal.

The Tasmanian devil (*Sarcophilus ursinus*) is a short-bodied, burly dasyurid with a broad muzzle: an enormous, broad and massive skull and most powerful jaws. There are strongly developed blades on the upper and lower molar teeth, which resemble those of such extinct placental carnivores as *Oxyaena*. The inner projections of the upper molar crowns are reduced and the planes of the inner surfaces of these blades now point more obliquely backward than those in the more primitive pouched mice.

In the, marsupial wolf or tiger (*Thylacinus*) the general habitus is somewhat wolflike, except that the feet are shorter and the hinder part of the body gradually tapers into the tail. Broad, transverse, black stripes over the back and tail give the animal its common name of "tiger." The thylacine (*q.v.*) is a wolflike derivative of the dasyuroid stock specialized for long-distance running. Its skull is elongate. in contrast with the very broad short skull of *Sarcophilus*. The molar teeth, although adapted for shearing flesh, differ markedly from those of the dasyures and *Sarcophilus*. The upper molars have lost the accessory cusps on the outer side of the crown, the internal spurs of the upper molars are subcircular, the two main external cusps are more or less approximated. In the lower molars the hinder spur or talonid is reduced, while the front part consists of two large bladelike cusps, the metaconid or hinder inner cusp being totally wanting. The nearest resemblances in dentition and skull are found not in any other Australian forms but among the extinct borhyaenids of the Patagonian Miocene. On the other hand, *Thylacinus* agrees closely with the Australian dasyuroids in many important details, so that there seems little doubt of its derivation from an Australian dasyuroid stock. The further significacce of these facts will be discussed below. The thylacine formerly inhabited the mainland of Australia, its fossil remains having been found in caves; but during historic times it has lived only in Tasmania. Since it was destructive to sheep it has been almost exterminated and survives only in the mountains.

Under the Australian dasyuroid series we include the banded anteater (*Myrmecobius*), or wombat, of South and Western Australia. This rare animal is now almost extinct. In general appearance it strongly recalls other small dasyuroids, having a long pointed muzzle and long ears, somewhat like *Antechinomys*, a transversely striped back. recalling *Thylacinus* and certain bandicoots, a bushy tail. like that of the brush-tailed pouched mouse. Moreover it is pouchless and the large foetuses are carried on the nipples, exposed as in *Dasycercus*. The high number of molars (sometimes rising to five in the upper and six in the lower jaws) may be regarded as a secondary increase in number correlated with reduction in size and spreading out of the teeth, in connection with an elongate, cylindrical, extensible tongue, and a backwardly prolonged palate. A comparative study of the entire skeleton of *Myrmecobius* leads to the conclusion that it is thoroughly dasyuroid in type. A fossil lower jaw from the basal Eocene of Montana, named *Myrmecoboides montanensis*, helps us to visualize the process by which more normal insectivorous lower molars could readily be modified into the *Myrmecobius* type by suppression of the main outer cusps on the lower molars and of the inner cusps of the upper molars! this producing what I. W. Gidley has well named a "pseudotriconodont" type. The fossil jam itself, however, is probably not at all related to *Myrmecobius*, since it agrees with the extinct placental insectivores of the family Lepticitidæ in its dental formula and in the family characters of the teeth.

A most highly aberrant dasyuroid is the pouched mole (*Notoryctes*) of South and Western Australia. The general appearance is like that of the African golden mole (*Chrysochloris*) In adaptation to its digging habits the conical head ends in front in a horny shield over the nose and evidently the head must be pushed into the soil. The neck vertebrae are fused to give it a firm support. The hands are provided with two enormous claws on the third and fourth fingers; the first and second fingers bearing much smaller claws which are opposable to the inner surfaces of the large outer claws. The fifth finger is very short and capped with a horny boss. The body is thick and cylindrical and the tail very short and covered with horny rings. The hind feet are short and spreading, with long digging claws. The eyes are degenerate, almost vestigial, and there are no external ears. The upper molar crowns, like those of the Cape golden mole, consist of very narrow V's, probably derived by degeneration from a more normal, less compressed type; in the lower molars the talonids or hinder spurs are lost. A pouch is present and opens backward. A comparative study of the skeleton has shown that the marsupial mole resembles the Cape golden moles, which are true placental mammals, only in its "habitus," while its "heritage" is unmistakably that of other marsupials.

The Australian Bandicoots. — The largest of these animals somewhat resemble rabbits both in appearance and habits, since they hare large ears and dig holes in the ground. They are therefore often called "native rabbits." But they are none the less true marsupials.

The hind feet are remarkably like those of kangaroos and have what was originally the fourth toe much elongated; the first toe, if present, is small; all the remaining toes have large pointed claws for scratching and digging. The hind foot also resembles those of kangaroos and other herbivorous marsupials in that the toes corresponding to the second and third of the normal mammalian foot are very slender, much smaller than the fourth toe, and so closely appressed to each other that they appear to be united at their bases. Each, however, is a complete digit with its own claw and separate muscles. These two digits serve as a comb by which the animal removes from its fur biting lice or other unwelcome objects.

This peculiar syndactylous specialization of the hind feet is found also throughout the series of diprotodont or herbivorous marsupials of Australia but not in any of the polyprotodont families (American opossums, Australian dasyuroids, etc.).

The bandicoots have front teeth of the carnivorous-insectivorous or polyprotodont type, essentially like those of the American opossums and the dasyuroids. while their molar teeth, although peculiar, show traces of derivation from some form in which the accessory cusps on the outer sides of the molar were strongly developed. The bandicoots, while chiefly insectivorous, frequently have the molar teeth much ground down by wear, which may indicate that their food gets mixed with a certain amount of grit Apparently in adaptation to this condition, the molar teeth tend to acquire high crowns, like those of many rodents. Bandicoots are pugnacious little animals which leap up in the air and strike each other with their long-clawed hind-feet. In the forms with very long hind-feet this extraordinary leaping ability is probably useful not only in escaping enemies but in capturing insects. All the species are now rapidly becoming rare. The family (Peramelidae) ranges from New Guinea and adjacent islands on the north to Tasmania on the south.

The Australian **Diprotodonts.**—Under the term Diprotodontia are generally included all the primarily herbivorous marsupials of Australia, in which the median pair of lower incisor teeth are more or less enlarged and inclined forward, so as to oppose one or more pairs of upper incisors, thereby functioning either as nippers or cutters. All known diprotodonts have the syndactylous relations of the second and third toes described above in the bandicoots. The diprotodont division includes a large number of species of highly diversified size and form, from the tiny dormouse phalanger to the almost elephantine extinct *Diprotodon,* and from the most agile pygmy "flying-squirrel" to the powerful and clumsy wombat,

Australians usually call the phalangers "opossums," but they are not closely related to the American animals. This mistake arises from the facts that both animals are pouched mammals, both live in trees, both have pointed muzzles and strongly grasping hands and feet and prehensile tails. But in many other important characters the American opossum and the Australian "opossum" differ widely. The former belongs to the polyprotodont division, having the incisors and canines disposed as in other carnivorous mammals, the latter have diprotodont front teeth, adapted for cutting vegetable fibre, and crested molar teeth adapted for grinding. Very striking is the contrast in the dental formulae of the two animals:

American opossum (*Didelphis*): $(\text{i.}\frac{5}{4}\ \text{c.}\frac{1}{1}\ \text{p.}\frac{3}{3}\ \text{m.}\frac{4}{4}) \times 2 = 50$

Australian "opossum" (*Trichosurus*): $(\text{i.}\frac{3}{2}\ c.\frac{1}{0}\ \text{p.}\frac{2}{2}\text{m.}\ \frac{4}{4}) \times 2 = 36$ (or less)

The polyprotodont American opossums have no trace of the syndactylous specialization of the hind feet which, as described above, is so characteristic of the Australian "opossum" and there are many striking differences in the skulls and other parts of the anatomy. The Australian phalangers as a group live in close ecologic relations with the eucalyptus trees that dominate the landscape in all but the dryest regions of the interior. Many eat eucalyptus leaves and the "native bear" (*Phascolarctos*) normally lives on nothing else. To overcome the aromatic essence of these leaves and extract nutriment from this highly indigestible material the phalangers have a long intestine and a greatly enlarged caecum. In locomotor habits the phalangers range from the sloth-like native bear, which clings tenaciously to the branches with its large hands and feet, to the highly active flying phalangers, including several quite difierent genera, which have a skimming membrane on the sides of the body and between the limbs. In one division of the family, including *Pseudochirus* and *Phascolarctos,* the upper molar teeth each bear two sharp V's or crescents. In another subfamily, which includes the Australian "opossum" (*Trichosurus*), the two V's of the upper molars are modified into cross-crests. The last lower premolar of the typical phalangers has a compressed cutting crown, with more or fewer vertical grooves and ridges In the phalangers, however, these cutting premolars are not as elongate as they are in the smaller kangaroos. These cutting premolars, both in the upper and lower jaws, became greatly enlarged in the extinct "marsupial lion" (*Thylacoleo*), in which the molars were reduced and the front teeth became enlarged and piercing. Sir Richard Owen was of the opinion that *Thylacoleo* was a fierce carnivorous creature but others have demurred from this opinion on various grounds and think the animal sheared some unknown kind of fruit. In widest contrast to the shearing-toothed *Thylacoleo* is the tiny long-snouted phalanger *(Tarsipes)* of West Australia, which is said to live on the honey and insects found in long-tubed flowers, into which it sticks its long muzzle and extensile tongue.

The kangaroos doubtless represent a ground-living group descended from arboreal ancestors; in the most primitive living type, the musk-kangaroo (*Hypsiprymnus*), the hind-foot still bears the stamp of the foot of the tree-living phalanger, in which the fourth digit is much enlarged, the second and third digits are reduced and syndactylous, the first digit is still present, and separate friction pads are retained under the digits. In the more advanced kangaroos the first digit is lost and so are the friction pads. For further evolution of this family *see* KANGAROO

The wombats *(Vomhatus)* are sometimes called "native badgers" on account of their robustness and burrowing habits, but they far excel the true or placental badgers in strength and in ability to dig deep tunnels with great rapidity. Their skulls are rodent-like in so far as they have only a single pair of long curved incisors in the upper jaw as well as in the lower; their molar teeth also have long-curved crowns and widely open roots. Each upper molar crown consists essentially of a pair of V's in tandem and this arrangement appears to be derivable from the double-V molars of the Koala (*Phascolarctos*) with which the wombats are in many ways rather closely related.

Fossil Marsupials of Australia. — During the Pleistocene or glacial epoch when northern Europe and northern North America were repeatedly covered by continental glaciers, Australia remained free of glaciers except in the vicinity of its highest mountains. While the mastodon, the mammoth, the cave-bear and other animals dominated Europe, Australia had her own peculiar mammalian fauna which has left its bones in cave deposits of eastern Australia and in ancient lake basins of the interior In the cave fauna are the scattered bones of giant kangaroos of many extinct species, of the lion-like *Thylacoleo,* of the marsupial wolf and many others. Around the margins of the lakes, however, lived still stranger beasts, the clumsy diprotodonts and notothcres. In general body form these resembled huge rodents; the name "marsupial rhinoceros" applied to one notothere seems highly inappropriate even if the animal did have a hump on its nasal bones In general the molar teeth of the diprotodonts each bear two sharp cross-crests, not unlike those of the extinct proboscidean *Dinotherium.* They appear to be an offshoot of the phalanger stock, distantly related to the kangaroos, wombats and native bears. The fossil diprotodont *Wynyardia,* described by Sir Baldwin Spencer from the Tertiary beds of Table Cape, Tasmania, was formerly regarded as of Oligocene age but is now known to be much younger (Pliocene). The skull is thoroughly phalangerid in type.

Fossil Marsupials of South **America.**—We have already noted that the family of American opossums, appearing late in the Cretaceous in North America, and continuing there well into Oligocene, somehow found its way into South America at least by Lower Miocene and possibly earlier. But along with these purely American fossils there have been found in the Santa Cruz (Lower Miocene) formation of Patagonia the fossil representatives of two families that have a strangely Australian appearance.

The first are unquestionably carnivorous marsupials, the several genera ranging from the size of a large opossum to that of a hyaena. Of these the largest and most famous form, called *Borhyaena,* figured in scientific literature as a kind of link between the extinct creodonts of the Eocene epoch of North America and the existing marsupial wolf of Australia But in every fundamental feature they are true carnivorous marsupials W. D. Matthew even holds that the special resemblances between the Patagonian borhyaenids and the Australian carnivorous marsupials are likewise due in part to parallel evolution, the borhyaenids being predatory derivatives of the American opossum stock, the Australian thylacines of the related Australian dasyurid stock, both derived ultimately from Cretaceous opossums of the northern hemisphere. But H. E. Wood has shown that, apart from the rather close resemblances in the borhyaenid dentitiop to that of the Australian thylacines, there are several curious resemblances in the backbone, pelvis and limbs, which tend to link borhyaenids with thylacines and contrast them both with opossums, so that to attribute this all to parallelism, plus descent from a common didelphid ancestor, seems to be essentially a *petitio principii*, especially as the now rather numerous known opossums from Cretaceous to Recent times show not the slightest tendency to vary in the borhyaenid-thylacine direction.

The second family of South American marsupials which seem to have a distinctly Australian appearance are the caenolestids. These little animals were long known from a few fragmentary fossils (*Epanorthus*, *Abderites*, etc). In 1895 Oldfield Thomas announced that this supposedly extinct family was actually represented in the living mammalian fauna of Ecuador and Bolivia by a small shrew-like animal, which he called *Caenolestes* and pointed out that it resembled certain of the extinct Patagonian epanorthids in its dentition, also that it resembled in other respects certain of the Australian phalangers, with the important exception that its hind feet were devoid of the syndactyl specialization of the second and third toes. Since that time a number of species of *Caenolestes* have been found in the mountains of the Andean parts of South America and the anatomy of the animal has been thoroughly studied, especially in the recent monograph by W. H. Osgood. From all this it appears that *Caenolestes* exhibits a highly confusing mixture of resemblances with the Austraiian bandicoots and diprotodonts, but that it contrasts widely with the opossums except in a few details, such as the construction of Jacobson's organ in the interior of the nose; in this it shows strong resemblances both to the opossums and the bandicoots. The general impression left by a careful consideration of the evidence is that, in spite of the somewhat phalanger-like features of its dentition, *Caenolestes* is not a true diprotodant but merely a phalanger-iike offshoot of a primitive marsupial stock that was perhaps more nearly allied with the bandicoots than with the American opossums.

How then did the extinct borhyaenids and the extinct and recent caenolestids, both apparently more nearly related to Australian stocks than to the American opossums, ever get into South America? Are they derived from two as yet undiscovered northern ancestral stocks which also gave rise respectively to the Australian dasyuroids and to the Austrnlian bandicoots and diprotodonts, or did they come into Patagonia from the south, after crossing some long-sunken archipelago connecting Patagonia with the once flourishing continent of Antarctica? Matthew has shown that in a great many other cases relict forms of the southern land masses have been derived from northern ancestors and this may eventually prove true in the case of the borhyaenids and caenolestids. Nevertheless, the more direct evidence so far brought forward by recent authors leaves the impression that the American opossums are not closely related either to the borhyaenids or to the caenolestids and that the latter two are more nearly related respectively with the dasyuroid and perameloid stocks of Australia in spite of their wide geographic separation.

Classification of Families. — The famous classification of the marsupials into two suborders, Polyprotodontia and Diprotodontia, based upon the numher and arrangement of the front teeth, seems at the present time to be a rather misleading simplification of a complex situation. The "polyprotodont" bandicoots, for example, appear to be more nearly related to the Australian true diprotodonts than to the American polyprotodont opossums, while the functionally "diprotodont" caenolestids appear to be more nearly related to the polyprotodont bantlicoots than to the true diprotodonts. No less objectionable is the old grouping into Diadactyla and Syndactyla recently revived by Wood Jones, which is based solely upon the presence or absence of the syndactylous specialization of the second and third toes of the hind foot. However, the bandicoots, which resemble the kangaroos in posscssing the syndactylous type of foot, differ profoundly from them in many other respects. From a comparative study of the dentition we may even affirm with B. A. Bensley that both bandicoots and kangaroos, along with all other Australian families, must be derived from primitive Australian polyprotodonts much resembling the pouched mice *(Phascogale)*. In short, in the present state of knowledge it seems advisable to abandon the old larger groups and to group the families into the following series of superfamilies:

1. Superfamily Didelphoidea. North America, Cretaceous to Recent; Europe, Oligocene; South America, Oligocene to Recent. Primarily arboreal with strongly grasping hind feet, the great toe (hallux) large and divergent. Second and third digits not syndactylous. Snout pointed. Insectivorous-carnivorous, with unreduced dentition; polyprotodont. Dental formula typically $i.\frac{5}{4}\ c.\frac{1}{1}\ p.\frac{3}{3}\ m.\frac{3}{3}$, seldbm reduced. Upper molars triangular, with strongly developed metacones (main posteroexternal cusps) and various developed accessory marginal cusps; internal cusps large. Lower molars primitive, tuberculo-sectorial. Auditory process of alisphenoid small or moderate, not covering tympanic cavity below. Jacobson's organ well developed. Nipples numerous (5–27). Pouch variable, if present opening forward or downward. Paired vaginal canals separate or partly united in a variable median cul-de-sac. Allantoic sack abortive, not forming a placenta.

Family Didelphiidae. North America, Cretaceous to Oligocene, Recent; South America, Oligocene (?), Lower Miocene, Recent.

2. Superfamily Dasyuroidea. Australian Region,-Pliocene to Recent; One family in South America,-Miocene. Terrestrial or slightly arboreal, with narrow or variously elongated hind feet, the hallux more or less reduced. Snout pointed to blunt. Insectivorous to extremely carnivorous dentition, polyprotodont, often with reduced premolars. Upper molars triangular to shearing. Internal cusps often small. Lower molars tuberculo-sectorial to shearing. Auditory process of alisphenoid much inflated. Nipples usually numerous (4–10). Pouch variable, often reduced or absent; if present, marsupial bones sometimes absent; typically opening backward. Median vaginal canal temporarily pierced at parturition. Allantoic sack abortive.

Family Dasyuridae. Australia, Pleistocene and Recent. Pouched mice, native cats, Tasmanian devil, Tasmanian wolf.

Family Borhyaenidae. Patagonia, South America, Lower Miocene.

Family Myrmecobiidae. Australia, Recent. Banded anteater.

Family Notoryctidae. Australia, Recent. Marsupial mole.

3. Superfamily Perameloidea. Australian Region. Terrestrial, with kangaroo-like hind limbs, longer than fore limbs, adapted for scratching, digging and leaping. Hallux reduced, fourth digit much enlarged, second and third syndactylous. Snout very long, projecting, pointed. Dentition insectivorous-omnivorous, polyprotodont. Dental formula: $(i.\frac{5\ \text{or}\ 4}{3}\ c.\frac{1}{1}\ p.\#\ m.\frac{4}{4})\times 2=48$ or 46. Incisor teeth with flattened, not pointed, crowns. Upper molars more or less quadrangular, long-crowned, main outer cusps probably representing much enlarged marginal cusps of primitive dasyuroids. Auditory process of alisphenoid inflated. Jacobson's organ well developed. Nipples six to eight. Pouch present, opening downward and somewhat backward. Median vaginal cul-de-sac moderately developed, young at least occasionally delivered *via* lateral vaginal canals. Allantoic placenta well developed.

Family Peramelidae. Australia and New Guinea, Pleistocene, Recent. Bandicoots.

4. Superfamily Caenolestoidea. Andean South America, Miocene to Recent. Terrestrial shrew-like forms with narrow non-syndactylous hind feet with slender hallux. Snout elongate. Insectivorous, functionally more or less diprotodont but with polyprotodont. Dental formula: $(i.\frac{4}{3\ \text{or}\ 4}\ c.\frac{1}{1}\ p.\$\ m.\frac{4}{4})\times 2=46$ or 48. First and second upper molars more or less quadrangular, short crowned; lower molars modified tuberculo-sectorial with large talonids. Last lower premolars sometimes compressed, grooved *(Abderites)*. Auditory process of alisphenoid moderate. Jacobson's organ very well developed, essentially as in polyprotodonts. Teats four. Pouch absent in adults. Marsupial bones well developed. Median vaginal canal essentially as in Didelphiidae.

Family Caenolestidae. Patagonia, Miocene to Recent.

5. Superfamily Phalangeroidea. Australian region, Pliocene to Recent. Primarily arboreal, secondarily terrestrial and derived

forms; the primitive arboreal type with strongly grasping hind feet, the hallux large and divergent, second and third digits markedly syndactylous. Snout typically rather short and thick. Dentition primarily herbivorous, diprotodont; dental formula reduced, typically (i. $\frac{3}{2}$ c. $\frac{1}{0}$ p. $\frac{2}{2}$ m. $\frac{4}{4}$) $\times 2 = 36$. Upper and lower molars typically bicrescentic or bilophodont. Last premolars compressed. in primitive forms grooved. Auditory process of alisphenoid usually well inflated, typically bridging petrous bone below and joining paroccipital process. Nipples usually four, rarely two. Pouch well developed, opening forward. Marsupial bones well developed. Median vaginal canal well developed, the young delivered through a temporary pseudovaginal opening. Allantois not forming a placenta.

Family Phalangeridae. Australian region, Pliocene to Recent. Phalangers, native bears.

Family Thylacoleontidae. Australia, Pleistocene.

Family Macropodidae. Australia, Pliocene to Pleistocene. Kangaroos.

Family Diprotodontidae. Australia, Pliocene to Recent.

Family Vombatidae. Australia, Pliocene to Recent. Wombats,

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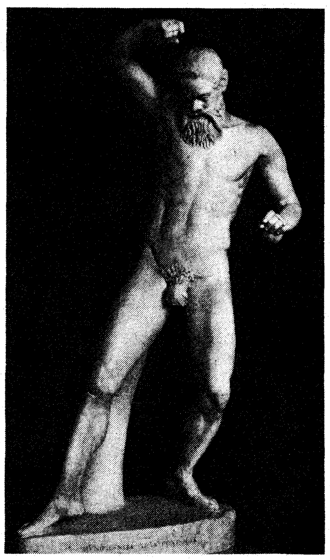
MARSUPIAL MOLE (*Notoryctes typhlops*), a small burrowing animal from central South Australia, constituting a family, Notoryctidae, of the pouched mammals or marsupials (see MARSUPIALIA). It resembles the true mole, family Talpidae, in size and appearance but is not a relative (see MOLE). Seither ear conches nor eyes are visible externally. Except for the horny skin on the nose and on the stumpy leathery tail, the body is covered with long, silky, golden-yellotv hair. When awake, the marsupial mole, as all moles. is extremely active, searching almost continuously for worms, insects! etc. It feverishly devours its food and abruptly falls asleep, only to awaken shortly and resume its frenetic search. The forefeet are wonderfully adapted to burrowing, the third and fourth toes being armed with enormous claws.

MARSUPIAL MOUSE, a small member of the family Dasyuridae (see MARSUPIALIA); most belong to the genus Phascogale. There are more than 12 species, none larger than a rat. Females of several species have pouches, but there are folds of skin only around the mammae in other forms. Marsupial mice are found throughout Australia, Tasmania, New Guinea and Aru Islands.

MARSUPIAL WOLF (Thylacinus cynocephalus), the largest carnivorous marsupial, resembling a wolf but smaller. Now confined to Tasmania, fossils show it was on the Australian mainland in the Pleistocene. Its face is sharp and foxlike. Grayish bronn, its entire back is marked with transverse, blackish-bronn bars. The pouch opens backuards; it bears two to four young. carrying them for about three months. It feeds on wallabies. small mammals and birds. When sheep were introduced, it preyed on them and was nearly exterminated. See also MARSUPIALIA (J. E HL; X.)

MARSYAS, a legendary Greek figure of Anatolian origin. According to the Greek legend Athena had invented the oboe and threw it anay in disgust because it distorted the features. Marsyas found it and, having acquired great skill in playing the instrument. challenged Apollo to a contest with his lyre. Midas, king of Phrygia who had been appointed judge, declared in favour of Marsyas, and Apollo punished Midas by changing his ears into ass's ears. In another version, the Muses were the judges, and they awarded the victory to Apollo, who tied Marsyas to a tree and flayed him alive. In Rome a statue of Marsyas, a favourite art subject, stood in the Forum, and this was imitated by Roman colonies and came to be considered a symbol of autonomy.



ALINARI

MARSYAS, FROM A COPY OF MYRON'S GROUP. ABOUT 450 B C. IN THE LATERAN MUSEUM. ROME

MARTELLO TOWER, a defensive work whose name is a corruption of that of Cape Mortella in Corsica, where a circular toner of this kind was captured only with great difficulty in 1794 by British forces supporting Corsican insurgents against the French. With the threat to England of invasion by Napoleon Bonaparte in 1803, the duke of York, as commander in chief, recommended this type of tower for coast defense, and 74 Martello towers were therefore erected on the most vulnerable stretch of the English channel coast. They were from 30 to 40 ft. high, with walls 9 ft. thick on the seaward side. and surrounded by a deep ditch. Entry was effected by a small; rear door at the head of a 20-ft. ladder. A platform held two howitzers and a swivel gun; a powder magazine and living quarters were below. The French built a few *tours modèles* of similar design, and others were built in the United States and Canada. Martello towers lost most of their value with the advent of powerful naval guns. (R. C. H.)

MARTEN, several species of the weasellike genus *Martes* of the mammalian carnivore family Mustelidae (see CARNIVORA). The American marten (*M.* americana) is similar to the pine marten (*M. martes*) of north and central Europe and the British Isles. The marten is a cat-sized animal with a long, somewhat bushy tail, and a lithe and slender body. The legs are short, the neck long and flexible and the ears short and rounded. The rich, dense and lustrous fur with stiff and shiny guard hairs, is highly valued. Martens are bloodthirsty and rapacious, feeding on small mammals, birds and occasionally bird eggs. They live in forests, especially in rocky areas: and climb trees as easily as a squirrel. Sexual maturity is reached at two years. Most species mate in late summer, one to five young being produced the following spring. In northern species the gestation period is prolonged (from 220 to 358 days according to species and locality). The gestation period may be markedly shortened by increasing the hours of light per day.

The pine marten is dark brown with a tawny throat. The dark sable (*M. zibellina*), which inhabits Siberia, has the most valuable fur. The beech or stone marten (M. foina), occurring from central and southern Europe to China, is a paler species. *M. melampus* is found in Japan. The large fisher or pekan (*M. pennanti*) occurs in North America. The large yellow-throated marten (*C. flavigula*), occurring from India and China to Java, belongs to the closely related genus *Charronia*. (K. R. KN.)

MARTENS, FËDOR FËDOROVICH (FRÉDÉRIC FROMMHOLD DE MARTENS; FRIEDRICH VON MARTENS) (1845–1909j, Russian jurist and author of works on the European penetration of Asia and Africa, was born at Parnu, in Livonia, Estonia, on Aug. 27, 184j. In 1868 he entered the Russian ministry of foreign affairs and in 1872 was made professor of public law in the Imperial School of Law and the Imperial Alexander lyceum, a post he held until 1905. In 1874 he started special juristic work for the Russian government. His work on the right of private property in war appeared in 1869. and that on the office of consul and consular jurisdiction in the east in 1873 (German trans., 1874). These were the first of a series of studies which won Martens a worldwide reputation and enhanced that of the Russian school of international jurisprudence.

Recueil des *traités* et *conventions conclus* par la *Russie avec* les *puissances étrangères* (15 vol., 1874–1909), edited by him, is the greatest of the series; published in Russian and French in parallel columns. it contains not only the texts of the treaties between Russia and other countries but also histories of the diplomatic conditions of which the treaties were the outcome, these being based upon unpublished Russian documents.

Martens' original work includes books on Russia and England in central Asia (1879). on Russia's conflict with China (1881), on the international law of civilized nations (1882), on the Egyptian question (1882) and on the African conference of Berlin and the colonial policy of modern states *(1887)*.

Repeatedly chosen to participate in international arbitrations: Martens acted in the disputes between Mexico and the United States — the first case to be determined by the permanent tribunal at The Hague — and that between Great Britain and France over Newfoundland in 1891. He played an important part in the negotiations between his own country and Japan which led to the peace of Portsmouth (Aug. 1905) and prepared the way for the Russo-Japanese convention. He was employed in laying the foundations for The Hague conferences and was one of the Russian plenipotentiaries at the first conference and president of the fourth committee — that on maritime law — at the second conference. He was judge of the Russian supreme prize court established to determine cases arising during the Russo-Japanese War of 1904–05. He died at Valga, in Livonia, on June 19, 1909.

See T. E. Holland in *Journal of the Society of Comparative Legislation* (Oct. 1909), where a list of writings of Martens appears. (E. H. Ld.; X.)

MARTENS, GEORG FRIEDRICH VON (1756–1821), German jurist and diplomat, the original editor of the principal printed collection of treaties of the world, was born at Hamburg on Feb. 22, 1756. He was educated at the universities of Gottingen. Regensburg and Vienna and became professor of jurisprudence at Gottingen in 1783 and was ennobled in 1789. In 1814 he was appointed privy cabinet councilor *(geheimer Kabinettsrat)* by the king of Hanover and in 1816 went as a representative of the king to the diet of the new German confederation at Frankfurt, where he died on Feb. 21, 1821.

Martens' major work. *Recueil des traités* from 1761, had been preceded by *Histoire diplomatique des traités,* covering the period from the end of the 16th century to the peace of Amiens (1577–1802). The first seven volumes of *Recueil des traités* were published 1791–1801 and were followed by four supplementary volumes partly edited by his nephew Karl von Martens. These were followed by *Nouveau recueil général des traités,* of treaties subsequent to 1808, in 16 vol. (1817–42) edited by G. F. von Martens, K. von Martens, F. Saalfeld and F. Murrhard; this last work was subsequently continued under other editors (2nd series, 20 vol., 1843–75; 3rd series, 35 vol., 1876–1908; 4th series, 41 vol., 1908–44).

Of Martens' other works the *Droit des gens,* first published in 1788, is probably the most famous. (E. H. Ld.)

MARTHA'S VINEYARD, an island off the southeastern coast of Massachusetts, about four miles across Vineyard sound from the mainland of Cape Cod. Long a leading fishing and whaling area, the island is nou almost entirely devoted to the summer tourist and recreation industries.

The island is nearly 20 mi, long, ranges from 2 to 10 mi. in width and represents largely the terminal moraine of a continental ice sheet. There is rolling to hilly country along the northeastern side, stretching out to nearly level plains in the south and east The highest point is only 311 ft. above sea level. The ocean has been very active in shaping the coast line, sealing off the many inlets along the south shore and building up long beaches and spits. The many-coloured clay bluffs at Gay Head are among the island's spectacular sights.

Martha's Vineyard probably was sighted by many early explorers, but the first known record was by Bartholomew Gosnold in 1602. Granted to Thomas Mayhew of Massachusetts, the island uas first occupied in 1642; it was under the jurisdiction of New York until 1692. There were early attempts at agriculture, salt evaporating, brickmaking and the smoking of fish. Fishing, which became an important source of revenue, led to the development of whaling and foreign trade, the two activities that eventually dominated the 18th and part of the 19th centuries. At one time the island boasted the world's largest sperm oil candle factory.

Advances in technology and a disadvantageous location terminated both of those trades, but the island's quaint old villages, Colonial architecture, scenic beauty and sandy beaches, as well as its protective coves for yachts and sailboats made Martha's Vineyard nearly ideal for summer vacationers and visitors.

The island itself contains six small towns: Tisbury, Oak Bluffs, Edgartown, West Tisbury, Chilmark and Gay Head, the latter occupied almost entirely by Indians. Together with the adjacent Elizabeth Islands and No Rlans Land, the island forms Dukes county, Mass. (G. K. L.)

MARTIAL (MARCUS VALERIUS MARTIALIS) (*c.* A.D. 40–*c.* A.D. 104), Roman epigrammatist. brought the Latin epigram to perfection and provided in his poems a picture of Roman society under the early empire which is remarkable both for its completeness and for its accurate portrayal of human foibles. His birthplace was Bilbilis. in Hispania Tarraconensis. of which he writes (in i, 61. 11–12): *te, Liciniane, gloriabitur nostra/nec me tncebit Bilbilis* ("of thee. Licinianus. our Bilbilis shall boast. nor will she keep silent about me"). His birthday was March 1. *Martem mearum principem Kalendarum* (x, 92, 10). Martial made much use of the mordant epigram bearing a sting in its tail. Frequently this sting consists merely of a single unexpected word. Poems of this kind exercised a great influence on the history of the genre in the literature of England. France. Spain and Italy. Though some of the poems are devoted to scenic descriptions. most are about people — emperors. public officials. writers. philosophers. lawyers, teachers. doctors. fops. gladiators. slaves, undertakers, gourmets, spongers, senile lovers and revolting debauchees.

Life at Rome. — In A.D. 64 he came to Rome, where. apart from a brief visit to Cisalpine Gaul in 88. he made his home for 34 years. There he sought the protection of his fellow Spaniards. the Senecas and Lucan. but. as they were involved in the Pisonian plot of 6j. this attachment was of short duration. Virtually nothing is known of his career during the next 1j years. In 80 was published the *Liber Spectaculorum,* containing 33 epigrams celebrating the shows held in the Colosseum, an amphitheatre in the middle of the city begun by Vespasian and completed by Titus in 79. Living at first in rather humble circumstances (i, 117, 7: *scalis habito tribus sed altis,* "I live up three staircases. and high ones too"), he gradually made headway and was able to have. in addition to his town house on the Quirinal (x, 58, 10: *vicinosque tibi, sancte Quirine, lares,* "And my house near to you, sacred Quirinus"), a small country place at Nomentum, in the Sabine territory (vi, 43, 3–4: *me Nomentani confirmant otia ruris/et casa iugeribus non onerosa suis,* "leisure in the Nomentan countryside restores me and a cottage not too big for its acres"). He won the ear of the court and received from Titus and Domitian. though he was not a father, the *ius trium liberorum* (the rights of a father of three children), a privilege which allowed a person to hold a public office before his 25th year and to be exempted from public burdens. *Rumpitur invidia tribuit quod Caesar uterque/ius mihi natorum* ("he is consumed with envy because both Caesars have granted me a father's rights"), he wrote in ix, 97, 5–6. He also, probably without having served in the army, obtained a military tribuneship and, despite his lack of means. the dignities of an *eques Romanus* ("Roman knight"). In 84 or 85 appeared two books of epigrams (in modern editions, books xiii and xiv) entitled *Xenia* and *Apophoreta,* two-line mottoes for presents distributed at the festival of the Saturnalia, in December. In 86 were issued books i and ii of the *Epigrams.* Between 86 and 98. when Martial returned to Spain. new books of the *Epigrams* were brought out more or less at yearly intervals. When the poet left Rome for his birthplace (xii, 18. 7–9: *multos repetita post Decembres . . . Bilbilis,* "Bilbilis sought again after many Decembers") he lived on an estate presented to him by his friend Marcella, a Spanish lady of whom he writes warmly in xii, 21 and 31. There he wrote and published the 12th and last book of his *Epigrams* and soon after died. Pliny the Younger. in a letter of 104, describes his feelings on hearing of the poet's death: "I hear that Valerius Martialis has died and I am grieved. He was a man of ability, sagacity and ardour. whose writing displayed wit, acrimony and no less good-nature. When he was leaving Rome I presented him with a parting gift, a tribute both to his friendship and to the lines he wrote about me." The poem referred to is x, 19, and Pliny quotes the last ten lines (12–21).

Literary Friendships. — At Rome, Martial seems to have enjoyed the friendship of the leading literary men of his time. Pliny, Lucan and the Senecas have already been mentioned.

Lucan is eulogized in vii, 22; vii. 21 and 23 are addressed to Polla Argentaria. Lucan's widow. The loyalty of Maximus Caesonius to the exiled Seneca is recorded in vii. 44 and 45. Quintilian is addressed in ii, 90, a poem which seems to express the poet's attitude to life:

Quintilian, distinguished trainer of our wayward youth, Quintilian, glory of the Roman gown, pardon me if I, though still poor, yet not made useless by the years, am quick to enjoy life. No man is quick enough really to enjoy life. If a man is eager to surpass his father's income, if he wants to crowd his halls with iamily busts, let him put off the job of living. My delight comes from the hearth and the roof-tree that does not object to sooty smoke, from a living spring and an untrained grass-plot. Give me a well-ied home-born servant, a wife who is no bluestocking, nights blessed with sleep and days innocent of litigation.

Silius Italicus, addressed in iv, 14. 1 as "pride of the Muses' sisterhood." is mentioned also in vi, 64. 10; vii. 63, 1–2; ix, 86. 1–2; and xi, 48 and 49. To Valerius Flaccus. another epic poet, there are references in i, 61. 4; i, 76; and iv. 42 and 49. For his relations with his true friend Juvenal see vii. 24 and 91; xii, 18. Martial never speaks of Statius, nor Statius of Martial. J. Wight Duff has suggested that "incompatibility of temperament" may explain this strange silence.

Form of the Epigram. — Martial wrote 1.561 epigrams in all. Of these 1,235 are in elegiacs. 238 in hendecasyllables and 77 in scazons or "limping iambics.!' The remainder includes pure hexameters (*e.g.*, i, 53), pure iambic trimeters (*e.g.*, vi, 12), iambic trimeter alternating with iambic dimeter (*e.g.*, i. 49) and scazons alternating with iambic dimeters (*e.g.*, i. 61). Occasionally Martial's epigrams are much longer than those of the Greek anthology (see ANTHOLOGY): 51 scazons make up iii. j8. while vi, 64 consists of 32 hexameters.

The elegiacs owe much to Ovid, though Catullian influence is probably to be discerned in the polysyllabic endings of pentameters. On Catullus also are based the hendecasyllables and scazons; but Martial's scazons begin more rigidly with a spondee. "Echoing verses" and involved patterns of various kinds are not uncommon (*cf.*, i, 32, 67. 77, 79; ii, 6, 33, 41, etc.). Puns. parodies, Greek quotations and ingenious ambiguities enliven Martial's pages. A type of epigram familiar to all is illustrated by i, 28. where the apparent contradiction of an insult masks an 'insult far more subtle: "If you think Acerra reeks of yesterday's wine. you are mistaken. He invariably drinks till morning."

Servility and Adulation. — Many readers of Martial are repelled by his flattery of any. especially the rich and powerful! who could fill his stomach or his purse. His frequent pleas for more and better presents from patrons and above all his use of the official title "Lord and God" toward Domitian cause a disgust not entirely warranted by the facts of history. For Martial. a poet known to the imperial court, to refuse extravagant homage might well have been suicidal. As for his begging verses. objectionable though they are. they must have paid dividends or the practice would have been abandoned. The poems on Domitian, disfigured by grotesque mythological conceits, are utterly foreign to Martial's usual direct style and are among his worst efforts.

Obscenity. — Byron asked, "What proper person can be partial1 To all those nauseous epigrams of Martial?" The Delphin editor abstracted the foulest verses and lumped them together at the end of the book. Opinions are bound to vary on the proportion of the indescribably salacious to the tolerably wholesome: it is certainly more than a tenth and considerably less than a quarter. Martial repeatedly warns his readers that his poems are not for the squeamish. He protests that though his page is licentious, his life is decent: lasciva est *nobis pagina*, vita *proba*, "though wanton my page, my life is good" (i. 4, 8). Catullus and Ovid had made similar distinctions before him: Apuleius and Ausonius were to do so in later generations. Martial hints more than once that he is far from being the worst of offenders.

Sentiment in **Martial.**—A genuine love of natural scenic beauty is seen in iv. 44 (lament for the devastation caused by the eruption of Vesuvius, A.D. 79); iv, 64 (view of Rome from a friend's estate); and x, 30 (seashore at Formiae). Tenderness toward slaves. inherited perhaps from the precept and practice of Seneca and Pliny. marks i. 88 and 101, both of which are funeral epigrams. Other sepulchral poems include v. 34 (on Erotion, a girl not yet six); vi, 85 (on Camonius Rufus. a lad of 20); and xi. 13 (on Paris. a celebrated actor, put to death by Domitian). The warmth of his friendship is to be seen in three famous epigrams, all addressed to Julius Martialis (i, 15; v, 20; and x, 47). The first ends with the advice — sera *nimis vita* est crastina: vive *hodie*, "live for to-day: tomorrow is too late." The second contains the sundial motto about the fleeting hours—*pereunt* et *imputantur*, "they perish and are scored against us." The third, which has been translated by a dozen English poets, consists of a comfortable recipe for happiness. Another, iv, 13, is a charming little epithalamium, while x, 23 is a serene picture of the peaceful old age of one who, by reliving his well-spent days, doubles his life's span.

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MARTIAL LAW. This term is one of rather doubtful significance in the English legal system. but is fairly well defined in the United States. It can be argued plausibly, but scarcely with conviction, that the English legal system does not know of, and makes no provision for, martial law, and that it is merely a term relating the common law right to resist force by force to a state of war, whether civil or external. This view seems to be implicit in a dictum of Chief Justice Thomas Molony in R. v. *Strickland* (1921 2 Irish Reports 334) that "the term 'execution of Martial Law' is now nothing more than a convenient label for the state of affairs which exists when the military take exceptional measures to suppress an insurrection." In the words of Sir Frederick Pollock, "So-called 'martial law,' as distinct from military law, Is an unlucky name for the justification by the common law of acts done by necessity for the defence of the Commonwealth when there is war within the realm.!'

On the other hand, the learned editors of D. L. Keir and F. H. Lawson's Cases in Constitutional Law express the view that the military authorities "have the right not to be interfered with *durante bello*, and this right belongs, it is to be conceived, exclusively to the regularly constituted military forces." If this argument be correct. and this right does indeed belong exclusively to the lawfully constituted military authorities, then martial law is something more than a "convenient label." Indeed, Chief Justice Molony himself, in the case referred to above, gives the most forcible answer to his own definition, for he stated elsewhere in his judgment that "We hold that when a state of things does exist which justifies the 'execution of martial law,' and is proved to our satisfaction, our hands are tied . . . the courts have recognized frankly that when a state of war exists — and they have not relinquished the right of adjudicating on that point — they must 'accept the consequences.'" It may be that martial law can be defined as a stage intermediate between law and anarchy, in which, the normal administration of the law having broken down, the authority appointed in accordance with law maintains order by summary methods.

In any event, martial lam must be sharply distinguished from military law, which is the law governing the armed forces whether in war or peace; confusion has been caused by the fact that some of the older writers, for instance, Sir Matthew Hale in his History *of* the *Common* Law, used the term "martial law" in relation to what is now called "military law."

Martial law, in the modern sense, seems to have three different aspects in the relationship of the military authorities to (1) subjects and nonenemy aliens, (2) enemy aliens at home and (3) enemy aliens abroad. No very serious problems are presented by (2) and (3). As for (2), it is difficult, as Sir W. Holdsmorth has observed, to see by what authority these could be tried by English courts! though in practice: and on the authorities, it would appear that. once the ordinary courts were satisfied that a state of war existed at the relevant time: they would not inquire into any acts done by the military authority, at any rate unless it could be established that they were done in ill faith. As for (3), the crown has an "absolutely free hand," though in the light of the Nürnberg trial and the trials of lesser war criminals, the duke of Wellington's remark that martial law merely means "the will of the general who commands the army" requires some qualification: that n-ill must he exercised in accordance with international law and the conventions of civilized warfare—however these may be' interpreted from time to time.

Constitutionally and historically, the first aspect, namely the relationship of the military authorities in whom the execution of martial law is vested. toward the subjects and nonenemy aliens who are entitled to the protection of the crown. is the most important. It gives rise to three main questions: (1) What are the circumstances. if any. that lawfully give rise to the suspension of normal civil rights? (2) In what circumstances, if any, will the normal courts review the decisions of tribunals set up by the military authorities to help them in the exercise of their powers? (3) \\'hat remedies, if any, has the subject against abuse or excess of their powers on the part of the military authorities?

Circumstances Giving Rise to Martial **Law.**—As Chief Justice Molony pointed out in the Irish judgment referred to above, the courts have not relinquished the right of adjudicating on the question whether a state of war exists. In older authorities. the test that was applied seems to have been the simple one of whether the ordinary courts were sitting or not; if they were, for this purpose a state of peace was deemed to exist, and there was therefore no room for the declaration or execution of martial law. This rule, if it can be so termed, appears definitely to have been abrogated by the decisions of the judicial committee of the privy council in *Elphinstone* v. *Bedreechund* (1 Knapp. P.C. 316) and D. F. *Marais* v. *The General Officer Commanding the Lines of Communication of the Colony* (*i.e.*, the Cape of Good Hope) (1902 Appeal Cases 109). In the latter case martial law had been proclaimed both in the district in which the petitioner, Marais. had been arrested. and in that to which he had been moved. In giving the judgment of the judicial committee, Lord Halsbury, the lord chancellor, said that they were "of opinion that where war is raging acts done by the military authorities are not justiciable by the ordinary tribunals) and that war in this case was actually raging... is sufficiently evidenced by the facts disclosed by the petitioner's own petition and affidavit . . . The fact that for some purposes some tribunals had been permitted to pursue their ordinary course is not conclusive that war was not raging." The conclusion Lord Halsbury drew was that: "The truth is that no doubt has ever existed that where war actually prevails the ordinary courts have no jurisdiction over the action of the rnilitary authorities," but that "doubtless cases of difficulty arise when the fact of a state of rebellion or insurrection is not clearly established."

These statements in Marais's case probably represent the high-water mark of the doctrine of the immunity of the military authorities from control by the civil power. But it may be remarked that even here. where the simple test of whether or not the ordinary courts are sitting was discarded probably once and for all, the right of the judiciary to consider whether, as a matter of fact. war was actually raging was vindicated by Lord Halsbury as it has been by other judges both before and since. On what criteria the courts would come to a decision today there does not seem to be much positive guidance. The test of an immediate local emergency seems to have been discarded. On the other hand, the decision of the house of lords in *Johnstone* v. *Pedlar* (1921 2 Appeal Cases 262) that it was "not a good defence to an action of tort brought by a friendly alien resident in the United Kingdom against an officer of the Crown in respect of the wrongful seizure and detention of the alien's property that the seizure and detention have been adopted and ratified by the Crown as an act of State" would seem, in spite of the rather special character of the facts, to warrant the conclusion that a mere state of general war, not involving a suspension of the normal machinery for the maintenance of order and the execution of justice. does not suffice to justify an arbitrary act done under colour of emergency.

Jurisdiction of the Courts Over Tribunals.— It seems to be well established that the normal courts will not review the decisions of tribunals set up by the military authorities to help them in the exercise of their powers because they do not recognize these tribunals as courts of law. Historically, the reason seems to be that acts done in pursuance of martial law were, in the words of Keir and Lawson, "withdrawn from the cognizance of the common law:" and in consequence, although the crown's "executive acts escaped the interference of the judges, its power to do them did not in all cases receive judicial acknowledgment. It would accordingly be difficult at the present date to find authority for the view that such acts can legally be done under the Royal Prerogative." The leading authority in this field is the decision of the house of lords in *In re Clifford and O'Sullivan* (1921 2 Appeal Cases 570). In Dec. 1920 the commander in chief in Ireland declared the unauthorized carrying of arms to be punishable by death, and he authorized the general officer commanding in Cork to issue orders for the holding of military courts as might be necessary. In May 1921 Clifford and O'Sullivan, who were civilians. were tried by a military court on a charge of improperly carrying arms, and were convicted and sentenced to death, subject to confirmation; they applied in the chancery division in Ireland for a writ of prohibition against the military court. the commander in chief and the general commanding in Cork on the ground that the court was illegal and had no jurisdiction to deal with the matter. On appeal to the house of lords the application was dismissed, on the ground, among others, that prohibition did not lie. because the officers constituting the court did not claim to act as a judicial tribunal in any legal sense.

Remedies of the Subject.— The question of remedies against the abuse or excess of their powers on the part of the military authorities is one on which there is very little authority. Granted that. as the 16th-century judges declared, "in time of war a man may justify making fortifications on another's lands without licence" (1 Dyer 36 b), what is the position if he does so not for the purposes of defense but to gratify a private spite against the landowner? Keir and Lawson have no doubt but that "evidently the Commander-in-Chief would be liable for acts done *mala fide* and not solely with a view to suppressing insurrection." This view is eminently sensible and accords with the common-law doctrine of using the minimum degree of force that is necessary to repel force. Then there is the question of the character of the necessity. Of this Keir and Lawson say that "Dicey's doctrine, that he [*i.e.*, the military commander] must prove an immediate necessity for every act, is obviously too hard . . . ." This view is not only sensible but accords with the decision in Marais' case that the emergency need not be for these purposes an immediate or local one.

The modern practice of taking emergency powers by statute makes the likelihood of these questions assuming importance in the future somewhat doubtful. But in the past they certainly had considerable importance.

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United States.— In the United States, martial law is the temporary rule by military authority of a designated domestic area in time of an emergency when the civil authorities are unable to function or their attempt to continue functioning for the time being might endanger the state. It may be declared by a proclamation of the president or the governor of a state, but such a proclamation is not necessary. Martial law becomes effective when military authorities supplant the civil authorities. Although neither mentioned in the constitution nor defined by statute. martial law long has been recognized in the United States. Civil courts many times have been called upon to pass upon the validity of acts taken in pursuance of martial law, but they have not precisely defined its limitations.

Martial law, as noted above, is to be distinguished from *militavy law*, which is the law governing those in the military service; from *military government*, which is the military rule of conquered territories; and from situations in which military forces are called upon to assist the civil authorities in maintaining public order without the existence of martial law. Where the military forces are called upon only to assist, the civil courts continue to function. and members of the civilian population may be punished only for violations of the civil law, not for violations of military orders other than those in implementation of civil law. *See* also MILITARY *GOVERNMENT*.

The use of federal or state military forces to quell a domestic disturbance or to assist in the maintenance of order during a disaster, such as a flood or a tornado, does not of itself bring about a state of martial law. In sending federal troops into Pennsylvania in 1794 to put down the Whiskey Rebellion. Pres. Washington specifically admonished the commander of the troops to enforce the law and deliver the insurgents to the regular courts for trial. During the labor trouble in the Coeur-d'Alene area of Idaho in 1899, the president sent federal troops to assist in the maintenance of order but directed that they support the civil authorities in the preservation of peace. Within a few hours after the initial shocks of the San Francisco earthquake of 1906, federal troops from a local garrison were assisting the civil authorities in maintaining order.

There have been cases in which governors of states hare improperly declared martial law in order to accomplish political purposes. Such was the case in Texas in 1931 when the governor declared martial law to permit enforcement of a limitation upon the production of oil; his act was declared invalid by the United States supreme court in the case of *Sterling* v. *Constantin.* Two other examples occurred in the 1930s. In South Carolina the governor declared a state of "rebellion, insurrection, resistance and insurgency" in an attempt to depose state highway commissioners; in Oklahoma the governor sought to prevent further constructiori of a dam until demands of the state highway commission for reimbursement for the closing of roads were met. In both cases, the courts declared the acts of the governors invalid.

The justification for martial law is that civil authorities are unable to function, or that because of impending grave danger, it would be unsafe for them to function. The question as to the continued functioning of the civil courts is particularly important. In' an area of active military hostilities. it is a practical impossibility for the civil courts to function. Where it is felt that their functioning should be suspended because of impending danger, a doubt may exist as to the necessity of the suspension. Immediately following the bombing of Pearl Harbor in 1941, for example, martial law was declared in Hawaii, the civil courts were closed and trials were by military courts. Although civil courts later were permitted to operate to a limited extent, martial law was not finally removed until late in 1944. In the case of *Duncan* v. *Kahanamoku,* which involved civilians tried by military courts in Hawaii, the U.S. supreme court found that there was no justification for suspension of the civil court functions at the time the accused civilians were convicted, but did not state the limit of martial law which the court would have found proper.

The U.S. constitution specifically recognizes that the privilege of the writ of habeas corpus may be suspended when in cases of rebellion or invasion the public safety may require it. This privilege requires that a person who is in confinement must be, upon his demand, brought before a court to determine the legality of his confinement. The privilege is suspended as an incident to martial law. During the period of martial law, the military commander rather than a civil court determines the propriety of the confinement. Thus a person believed dangerous to the state may be confined upon mere suspicion. without trial until the termination of martial law. During the Civil War, Pres. Lincoln suspended the privilege in various localities, particularly in the vicinity of the nation's capital.

While martial law is in effect! persons charged with violations of either civil law or military orders may be tried by military courts commonly known as provost courts. The sentences adjudged by such courts are no longer effective after the termination of martial law.

The authority of the military commander, during a period of martial law, is virtually unlimited, but the commander later may be called upon to justify his actions. He may be personally liable to pay damages for acts which do not appear to have been reasonably believed necessary at the time the acts were undertaken. However, the commander is judged according to the facts as they appeared at the time rather than according to the way they appeared in the light of later developments.

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MARTIGNAC, JEAN BAPTISTE SYLVÈRE GAY, VICOMTE DE (1778–1832), French statesman, was born at Bordeaux on June 20, 1778. In 1798 he acted as secretary to Sieyès; then. after serving for a while in the army, he turned to literature, producing several light plays. Under the empire he practised with success as an advocate at Bordeaux, where in 1818 he became advocate general of the *cour royale.* In 1819 he was appointed *procureur général* at Limoges and in 1821 was returned for Marmande to the chamber of deputies. where he supported the policy of Villèle. In 1822 he was appointed councilor of state; in 1823 he accompanied the duc d'Angoulême to Spain as civil commissary; in 1824 he was created a viscount and appointed director general of registration. In contact with practical politics his ultraroyalist views were gradually modified in the direction of the Doctrinaires, and on the fall of Villèle he was selected by Charles X to carry out the new policy of compromise. On Jan. 4, 1828, he was appointed minister of the interior and, though not bearing the title of president. became the virtual head of the cabinet,. He succeeded in passing the act abolishing the press censorship and in persuading the king to sign the ordinances of June 16. 1828, on the Jesuits and the little seminaries. He was exposed to attack from both the extreme left and the extreme right, and, when in April 1829 a coalition of these groups defeated him in the chamber, Charles X, who had never believed in the policy he represented, replaced him by the prince de Polignac. His last public appearance was in defense of Polignac in the chamber of peers in Dec. 1830. He died April 3, 1832.

MARTEN, SAINT (*c.* 330–397), bishop of Tours, missionary and father of monasticism in Gaul, and one of the most revered saints of western Europe, was born at Sabaria in Pannonia (now Szombathely, Hung.), of pagan parents. but became a catechumen at an early age. As a youth he had to serve in the Roman army. His disciple arid biographer, Sulpicius Severus, tells the famous story. often depicted in art. of how Martin divided his military cloak with a naked beggar at Amiens. In a dream that night he saw Christ wearing the half cloak, and shortly afterward he received baptism. Later. he asked to be released from the army because "I am Christ's soldier: I am not allowed to fight." When taxed with cowardice he offered to stand in front of the battle line armed only with the sign of the cross. but the immediate surrender of the enemy made this superfluous.

On leaving the army Martin settled at Poitiers, where he was made an exorcist by the bishop St. Hilary. Later he lived in retirement, first at Milan, then on the island of Gallinaria, off Albenga. On Hilary's return from exile in 360 Martin also returned and founded a community of hermits at Ligugé, south of Poitiers, the first monastery in Gaul. Later he founded another, Marmoutier, outside Tours: to which he withdrew whenever possible after becoming bishop of 'Tours in 372, an office which he accepted unwillingly.

As bishop, Martin was an active missionary in Touraine and beyond. Christianity had scarcely penetrated yet into the country districts, where Martin went round preaching, visiting each of his outlying settlements every year and encouraging monasticism. His fame brought him into contact with the imperial court at Trier, where he took part in a conflict between church and state. He protested to the emperor Maximus, who was being induced to condemn the Spanish heretic Priscillian to death, against the killing of heretics and against civil interference in ecclesiastical matters. Priscillian was nevertheless executed, and Martin's continued protests together with his intercession for Priscillian's followers involved him in difficulties with the Spanish bishops.

Martin died at Candes on Nov. 8, 397. He had acquired a great reputation of working miracles, and was one of the first persons not a martyr to be publicly venerated as a saint. His feast day is Nov. 11, and his popularity in medieval England is attested by calendars and church dedications. See SEVERUS, SCLPICIUS.

See I. Costanza, *La leggenda di San Martino nel medioevo* (1921). (D. AR.)

MARTIN (MARTINUS), the name of three popes, Martin I, Martin IV and Martin V. In the 13th century the papal chancery misread the names of the two popes Marinus (*q.v.*) as Martin, and as a result of this error Simon of Brion in 1281 assumed the name of Martin IV instead of Martin II.

ST. MARTIN I (d. 655), pope from 649 to 655, succeeded Theodore I in June or July 649. He presided over the Lateran synod which condemned the Monothelite heresy. Thereupon by order of the emperor Constans II Martin was arrested, taken to Constantinople (Sept. 17. 654), publicly humiliated and banished to Cherson in May 6j5. He died there the following September. He is honoured as a martyr by the church both in the east (feast day Sept. 16 or the middle of April) and in the west (Nov. 12). (C. P. L.)

MARTIN IV (Simon of Brie, or Brion) (1210/20–1285), pope from 1281 to 1285, was born between 1210 and 1220 as the scion of a French noble family of Brie. St. Louis IX of France made him a member of his council and, in 1260, chancellor and keeper of the great seal. About a year later the French pope Urban IV elevated Simon to the dignity of cardinal priest of St. Cecilia. He was elected pope on Feb. 22, 1281.

Soon after his coronation at Orvieto on March 23, 1281, Martin IV began to reverse the policy of his great predecessor Nicholas III by restoring Charles of Anjou, king of Sicily, as Roman senator and by favouring his interests in every possible way, even at the expense of the union with the Greeks. Charles apparently convinced the pope that the only guarantee of a permanent union was the conquest of the Byzantine empire by himself, and Martin excommunicated the emperor Michael VIII for lack of sincerity in the cause of the union shortly before the latter's death on Dec. 12, 1282; this led to a new formal break between the churches of Constantinople and Rome under the emperor Andronicus II (1283). After the Sicilian Vespers (*q.v.*) of March 1282 had deprived Charles of Anjou of the island of Sicily, and the Sicilians had chosen Peter III of Aragon as their new ruler: Martin spent the remainder of his pontificate in vain attempts to dislodge him and to reinstate Charles. He excommunicated Peter III, called for a Sicilian "crusade," and declared that Peter had forfeited the kingdom of Aragon, which was a fief of the Holy See since the eleventh century; Philip III of France, Charles of Xnjou's nephew, was invited by the pope to take over Aragon for his youngest son Charles of Valois. However, a Roman uprising against Charles of Anjou cost him his senatorial dignity; a great sea battle between the Aragonese and Angevin fleets resulted in utter defeat of the latter and in the capture of Charles of Anjou's son, the future king Charles II of Naples; while Philip III's campaign in Aragon was likewise to end in disaster in the very year in which the pope died (March 28, 1285) at Perugia. His francophile policy had foreshadowed the Avignonese period of the papacy. Martin IV's successor was the Roman Honorius IV.

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MARTIN V (Oddone Colonna) (1368–1431), pope from 1417 to 1431, was born at Genazzano. He was unanimously elected pope on Nov. 11, 1417, in a conclave held during the Council of Constance. which had been called to end the Great Schism (1378–1417j. Martin, a mild and gentle man, was at the time a cardinal-subdeacon who had helped organize the Council of Pisa.

As pope he faced enormous difficulties. As soon as the council was over he condemned the widely held conciliar theory which would make the pope subject to a council and forbade any appeal from papal judgment on matters of faith. Then he returned to Rome, which he found in ruins. He restored some of its churches and fortifications and tried to recover control of the Papal States. He norked hard to mediate the Hundred Years' War between France and England and to organize crusades against the Hussites in Bohemia.

Although he always had a dread of councils lest they try to revive the conciliar theory. Martin called the Council of Pisa in 1423 as prescribed by the Council of Constance. When a plague struck Pavia he moved the council to Siena. Martin's legates dissolved it when it dragged on in futile discussion of the conciliar theory. Martin neglected the great opportunity offered by church councils to reform the church; his efforts to meet the crying need for reform nere halfhearted and proved ineffective. He died on Feb. 20, 1431, shortly after calling the Council of Basel.

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MARTIN, ARCHER JOHN PORTER (1910–), British biochemist, was awarded the Nobel prize in chemistry jointly with R. L. M. Synge in 1952 for the invention of partition chromatography. This effected the partition of a substance between two liquids by very simple means instead of by a series of intricate chemical operations and was subsequently so widely applied in chemical, biological and medical research as to constitute almost a new scientific tool. Martin was born in London on March 1, 1910, and was educated at Bedford school and Cambridge university, where he graduated in 1932. He worked in the Dunn Nutritional laboratory on problems relating to vitamin E from 1933 until 1938 when he was engaged with the Wool Industries Research association at Leeds in a study of the felting of wool. In 1946 he became head of the biochemistry division in the research department of Boots Pure Drug Co., Nottingham, and held the post until 1948 when he was appointed to the staff of the Medical Research council, working first at the Lister Institute of Preventive Medicine and then at the National Institute for Medical Research, where he later became head of the division of physical chemistry. He was elected a fellow of the Royal society in 1950, and he received the Berzelius gold medal in 1951. (D. McK.)

MARTIN, GLENN LUTHER (1886–1955), U.S. aircraft designer, held the unique distinction of being the only pioneering airplane inventor and pilot to have remained at the head of his own manufacturing organization during his entire business career. Born Jan. 17, 1886, at Macksburg, Ia., Martin later m s taken by his family to Liberal, Kan., where his "aircraft" business started when Glenn, aged 8, built kites in his mother's kitchen and sold them to his contemporaries. Later, in Santa Ana, Calif., Martin designed his first powered airplane and leased an abandoned church as his first factory. He became one of the outstanding "barnstormers" in the 1910–14 period, and from that experience developed several successful types of military aircraft. The first Martin bomber appeared in 1918–19, too late for active use in World War I, but its success established Martin as one of the leading military airplane manufacturers of the United States. He built a factory in Cleveland, O., and in 1929 moved his manufacturing facilities to Middle River, Md., near Baltimore. Martin bombers and flying boats played important roles all over the world in World War II. At peak, Martin's Baltimore plant employed over 50,000 people. Toward the end of his life Martin took great interest in civic affairs, education and wildlife conservation. He gave large sums to support the engineering schools in the University of Maryland. Martin died at Baltimore, Md., Dec. 4, 1955. (S. P. J.)

MARTIN, (BON LOUIS) HENRI (1810–1883), French historian. author of a famous history of France. was born on Feb. 20. 1810. at St. Quentin. With Paul Lacroix ("le Bibliophile Jacob") he planned a history of France, to consist of excerpts from the chief chroniclers and historians, with original matter filling up gaps in the continuity. His *Histoire de Fmnce,* 15 vol. (1833–36). was the result. This magnum opus, rewritten and further elaborated (4th ed., 16 vol. and index, 1861–65), gained for the author in 1856 the first prize of the Académie Française and in 1869 the grand biennial prize of 20,000 fr. A popular abridgment in seven volumes was published in 1867 (Eng. trans.; 1877–82). This, together with the continuation, *Histoire de France depuis 1789 jusqu'à nos jours* (6 vol., 1878–83), gave a complete history of France and superseded J. C. L. de Sismondi's *Histoire des Français.* A staunch republican, Martin sat in the *assemblée nationale* as deputy for Aisne in 1871 and was elected life senator in 1876, but he left no mark as a politician. He died in Paris on Dec. 14, 1883.

MARTIN, HOMER DODGE (1836–1897), U.S. painter, whose works have given him a place at the culmination of American landscape before Impressionism. was born in Albany, N.Y., Oct. 28. 1536. Martin studied briefly with James Hart, and his early work follows the tradition of the Hudson River school. He became a member of the National Academy of Design in 1874 and in 1877 was one of the founders of the Society of American Artists. The sombreness of his pictures prevented them from being sold, and so Martin's wife turned to journalism for support. Sent to England to make magazine illustrations; he later (1882–86) matured his style in France under Barbizon influence. His best works, such as "The Harp of the Winds:" "Ontario Sand Dunes" and "Westchester Hills," were done after his return to the United States; their spacious design and rich colour put them on a level with those of Alexander H. Wyant and George Inness. The artist's sight failed a few years before his death at St. Paul. Minn., Feb. 2. 1897. (Vl. B.)

MARTIN, LUTHER (*c.* 1748–1826), U.S. lawyer, a dissenting member of the Constitutional Convention of 1787 who thereafter became an ardent Federalist opposed to the philosophy of Thomas Jefferson. He was born near New Brunswick, N.J., probably in 1748. After graduating from the College of New Jersey (now Princeton university) in 1766, he taught school for a time and in 1771 was admitted to the Virginia bar. Shortly thereafter he settled in Maryland. He served as attorney general of Maryland from 1778 to 1805 and from 1813 to 1822 and during that entire period had an extensive and lucrative practice. private as well as public. He was leading counsel for the defense in two famous state trials of the Jeffersonian era, the impeachment of Justice Samuel Chase (*q.v.*) and the treason trial of Aaron Burr (*q.v.*), and was of counsel in many of the great constitutional cases of the formative years of tiie United States. His last and most famous was *McCulloch* v. *Maryland* (1819), involving the right of a state to tax an instrumentality of the federal government (the national bank). Martin, representing the state. abandoned federalism and reverted to his theory of the power of the states for which he had unsuccessfully contended in the Constitutional Convention. He was again unsuccessful.

After his paralysis in 1822 the Maryland legislature passed a unique act requiring each lawyer in the state to pay an annual licence fee to be used by trustees for the financial support of Martin, but he died in poverty on July 10, 1826, at the New York horne of his friend Aaron Burr. (A. Dm.)

MARTIN, PIERRE ÉMILE (1824–1915), French engineer noted as the inventor of the Siemens-Martin or open-hearth steel process (*q.v.*) for the manufacture of steel, was born at Bourges, Cher.. on Aug. 18, 1824, the son of Émile Martin, owner of the Sireuil ironworks in the Charente. While the chemistry of the steel-making process was aiready familiar. no means were available for artaining the high temperature required for its operation. On hearing of Sir William Siemens' development of the regenerative furnace about 1863, Martin obtained a licence to build such furnaces, starting with an experimental furnace of one-ton capacity. His steel products exhibited at the Paris exhibition of 1867 gained the exhibition's gold medal award. Nevertheless, his patents were challenged on the ground that he had merely made use of appliances and processes which were already known. and the development of his invention was delayed by proionged and costly litigation and by the rapid success of the Bessemer process. Martin was reduced to straitened circumstances but, in 1907, the Comité des Forges de France instituted a fund for his benefit and contributions were received from all the principal steel-making countries. In 1915 he was awarded the Ressemer gold medal of the Iron and Steel institute. but was unable to attend for the presentation in London. Martin died at Fourchambault, near Nevers, on May 23. 1915. (C.W. D.)

MARTIN, VIOLET FLORENCE (Martin Ross) (1862–1915), Irish writer, was born at Ross house, County Galway, from which she took her pen name, on June 11, 1862, of an old Irish family. From the time of her father's death in 1872 she spent her childhood in Dublin. and was educated privately and at Alexandra college. Dublin. The greater part of her life was spent in Ireland, but she often traveled abroad with her cousin Edith Oenone Somervilie. with whom she collaborated. Their books give vivid and sympathetic pictures of Irish life, and their love of hunting (Miss Somerville was for 12 years master of the West Carbery foxhounds) gave rise to the series of books of which *Some Experiences of an Irish R.M.* is perhaps the best known. Their novels include *The Real Charlotte* (1894), their first serious work; *Mount Music* (1919); and *The Enthusiast* (1921). The latter two were published under joint authorship. although after Miss Martin's death. since they were largely her work. Her qualities can best be seen in two volumes of essays, autobiographical in character, *Some Irish Yesterdays* (1906) and *Stray-Aways* (1920). She died at Cork on Dec. 21, 1915.

MARTIN, a name appiied to the well-known European and American birds. the house martin (*Delichon urbica*), sand martin (*Riparia riparia*) and purple martin (*Progne subis*). Others occur all over the world, except in New Zealand.

The house martin, like its ally, the swallow (*q.v.*), is a migrant, arriving in Europe and western Asia in spring from its winter quarters in South Africa and India. It is a smaller bird than the swallow, lacking the latter's forked tail; the plumage is black above and white beneath. The nest, a half hemisphere of mud and straw. lined with feathers, is built under the eaves of houses; occasionally nests are found on cliffs, which must have been the original site. Two broods are usual.

The sand niartin is smaller than the last and has a brownish tinge to the upper parts. It is the earliest of the British Hirundinidae to arrive. The nest is placed at the end of a horizontal burrow in a sandy bank or the face of a quarry. It ranges from Ireland to the Sea of Okhotsk and across North America, where it is called the bank swallow. In winter. it reaches the Transvaal. India and Caiçara in Brazil. The larger purple martin of Canada and the United States normally builds in hollow trees. It readily adapts itself to nesting boxes but leaves when house sparrows are abundant. It ranges from southern Mexico to within the Arctic circle. The rock martin (*Riparia rupestris*) of Europe builds a bottle-shaped nest of mud. All the martins feed on insects, which they capture as they fly. The eggs are usually white, The kingbird (*q.v.*) is known as bee martin.

MARTIN DU GARD, ROGER (1881–1958), French writer. won the Nobel prize for literature in 1937. He was born at Neuilly-sur-Seine on March 23, 1881, and educated to be an archivist and paleographer at the École des Chartes, Paris. His first book was an archaeological study, *L'Abbaye de Jumièges* (1909). His literary vocation was confirmed when he published *Jean Barois* (1913), a novel in dialogue demonstrating the effect of the Dreyfus case on the character and outlook of the younger generation in France and at the same time outlining some of the intellectual problenis of the period (*see* Dreyfus, Alfred). His masterpiece, however. is the story of two families, the Fontanins and the Thibaults, respectively Protestant and Catholic, told in the 11-volume series of eight novels collectively entitled *Les Thibault* (1922–40), of which the component parts are *Le Cahier gris* (1922); *Le Pénitencier* (1922); *La Belle saison,* 2 vol. (1923); *La Consultation* (1928); *La Sorelina* (1928); *La Mort du père* (1929); *L'Été 1914,* 3 vol. (1936); and *Épilogue* (1940). In these books he surveys French society before and during World War I by presenting the lives of the two families against the historical background and under the social and intellectual influences of the times.

Besides two other novels (*Confidence africaine*, 1931; *Vieille France*, 1933), his work includes three plays: *Le Testament du père Leleu* (1920), *La Gonfle* (1928) and *Un taciturne* (1931). He died at Bellême, Normandy, Aug. 23, 1958. (A. PE.)

MARTINEAU, HARRIET (1802–1876), English social and historical writer; a prominent public figure of her day, was born on June 12, 1802, in Norwich. Deaf from an early age, and later a victim of heart disease and other illnesses, she was nevertheless undeterred from an active career in which she mingled with the foremost intellectuals of the time. During a serious illness that she underwent from 1839–44, her friends raised an annuity enabling her to buy a small farm, "the Knoll," at Ambleside, which she cultivated until her death there on June 27, 1876.

A popularizer of economics and a propagandist for religious liberalism and for the abolition of slavery, Miss Martineau first gained a large reading public with an extensive series of stories and dialogues illustrating classical economics, chiefly the ideas of Malthus and Ricardo. After a visit to the United States (1834–36) she espoused the then unpopular abolitionist movement and abandoned her belief in a *laissez faire* economy for a more utopian system. A trip to the near east in 1846 led to a study of the evolution of religious beliefs and an increasing skepticism. Her chief historical work, *The History of the Thirty Years' Peace, 1816–1846* (1849), was a widely read popular volume. Her unorthodox views gained her a reputation for radicalism that alienated some of her friends but failed to impede her pursuit of ideas. She became an adherent of the positivist philosophy of Comte, whose *Positive Philosophy* she condensed and freely translated with the approval of the author. Probably this was Martineau's most scholarly work, but she is equally remembered for her candid autobiography, published posthumously in 1877.

In addition to the autobiography, Martineau's major works include *Illustrations of Political Economy*, 25 vol. (1832–34); *Poor Laws and Paupers Illustrated*, 10 vol. (1833–34); *Illustrations of Taxation*, 5 vol. (1834); *Society in America* (1837); *Retrospect of Western Travel* (1838); *Eastern Life, Past and Present* (1848); *Letters on the Laws of Man's Nature and Development* (1851); *The Positive Philosophy of Auguste Comte, Freely Translated and Condensed* (1853).

See also F. F. Miller, *Harriet Martineau* (1884); T. Bosanquet, *Harriet Martineau* (1927); F. S. Marvin, "Harriet Martineau: Triumph and Tragedy," in *Hibbert Journal*, vol. xxv (1928). (H. E. BAR.)

MARTINEAU, JAMES (1805–1900), English philosopher and divine, was born at Norwich, of Huguenot ancestry, on April 21, 1805, the seventh child of Thomas Martineau and Elizabeth Rankin, the sixth, h i senior by almost three yenrs, being his sister Harriet (*see* MARTINEAU, HARRIET). James was educated at Norwich Grammar school and at the private academy of Lant Carpenter at Bristol. On leaving, he was apprenticed to a civil engineer at Derby, but in 1822 entered Manchester college, then lodged at York n-ith a view to entering the Unitarian ministry.

On leaving the college in 1827 Martineau taught for a time in his old school at Bristol. From 1828 to 1832 he mas junior minister of a Presbyterian church in Dublin, but resigned on a matter of conscience. He was called to Liverpool, and there for a quarter of a century exercised extraordinary influence as a preacher. In 1840 he was appointed professor of mental and moral philosophy and political economy in Manchester New college, which had been moved to Manchester. This position he held for 4j years (until 188j). In 1853 the college moved to London, and four years later Martineau followed. In 1858 he became minister of Little Portland Street chapel in London. Martineau received many academic honours. He died in London on Jan. 11, 1900.

Martineau's most characteristic and stimulating works are his sermons, published as *Endeavours after a Christian Life* (1st series, 1843; 2nd series, 1847); *Hours of Thought on Sacred Things* (1st series, 1876; and series, 1879); the various hymnbooks he issued at Dublin in 1831, at Liverpool in 1840, in London in 1873; and the *Home Prayers* in 1891. Martineau just escaped the active period of the old Unitarian controversy. But its presence is felt in his *The Rationale of Religious Inquiry* (1836), and later in his *Types of Ethical Theory* (1885) and *A Study of Religion* (1888) and, in some measure, in *The Seat of Authority in Religion* (1890). Martineau's theory of the religious society or church was that of an idealist rather than of a statesman or practical politician. He stood equally remote from the old voluntary principle, that "the State had nothing to do with religion," and from the sacerdotal position that the clergy stood in an apostolic succession, and either constituted the church or were the persons into whose hands its guidance had been committed. He hated two things intensely, a sacrosanct priesthood and an enforced uniformity. He may be said to have believed in the sanity and sanctity of the state rather than of the church. Statesmen he could trust as he would not trust ecclesiastics. And so he even propounded a scheme, which fell stillborn, that would have repealed uniformity, taken the church out of the hands of a clerical order and allowed the co-ordination of sects or churches under the state. Not that he would have allowed the state to touch doctrine, to determine polity or discipline; but he would have had it to recognize historical achievement, religious character and capacity: and endow out of its ample resources those societies which had vindicated their right to be regarded as making for religion. His ideal may have been academic, but it was the dream of a mind that thought nobly both of religion and of the state.

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MARTINET, a military term (generally used in a disparaging sense) implying a strict disciplinarian or drillmaster. The term originated in the French army about the middle of Louis XIV's reign, and was derived from Jean Martinet, who as lieutenant colonel of the king's regiment of foot and inspector general of infantry, drilled and trained that arm in the model regular army created by Louis and the marquis de Louvois between 1660 and 1670. Martinet seems also to have introduced the copper pontoons with which Louis bridged the Rhine in 1672. He was killed; as a *maréchal de camp*, at the siege of Duisburg in the same year, being accidentally shot by his own artillery while leading the infantry assault. His death, and that of the Swiss captain Soury by the same discharge, gave rise to a bon mot, typical of the polite ingratitude of the age, that Duisburg had cost the king only a martin and a mouse.

The "martin" as a matter of fact shares with the marquis de Vauban and other professional soldiers of Louis XIV the glory of having made the French army the first and best regular army in Europe. Great nobles, such as the vicomte de Turenne, Prince de Condé and the duke of Luxembourg; led this army and inspired it, but their fame has obscured that of the men who made it manageable and efficient.

It was about this time that the soldier of fortune, who joined a regiment with his own arms and equipment and who had learned his trade by varied experience, began to give place to the suldier regularly enlisted as a recruit in permanent regiments and trained by his own officers. The consequence of this happening was the introduction of a uniform, or nearly uniform, system of drill and training.

Thus, Martinet was the forerunner of Leopold of Dessau and Frederick William, just as Jean Jacques de Fourilles, the organizer of the cavalry, who was forced into an untimely charge at Seneffe (1674) by a brutal taunt of Condé, and there met his death, was the forerunner of Hans von Zieten and Friedrich von Seydlitz. These men, while differing from the creators of the Prussian army in that they contributed nothing to the tactics of their arms, at least made tactics possible by the thorough drilling and organization they imparted to an army.

MARTÍNEZ DE LA ROSA, FRANCISCO DE PAULA (1787–1862), Spanish statesman and man of letters, whose distinguished career in politics and literature rings strangely hollow in a revolutionary epoch, was born in Granada, March 10, 1787. He was a member of the *Cortes* de Cádiz (1812) and his first prose comedy, *Lo que puede un empleo*, was played there. He was called from exile to be minister in the interregnum (1820–23) and again after further exile in France to be prime minister and creator of a constitution. the Estatuto Real (1834), which pleased nobody: but was happier in later years as ambassador (Paris. 1843. 1846 and Rome, 1847) and president of the Xteneo and academy. In literature: similarly, he progressed elegantly but without intimate conflict from Moratinian comedy. Xlfierian tragedy and an unexceptional *Arte poética* to the presentation of the first violently romantic drama. *La conjuración de Venecia* (April 23, 1834), a startling amalgam in prose of conflicts, passions. vengeance and cemeteries. His abundant neoclassical poetry reveals a lifelong interest in national history. He died at Madrid, Feb. 7, 1862.

See J. Sarrailh, *Un homme d'état espagnol* (19.30). (R. F. B.)

MARTÍNEZ RUIZ, JOSÉ: *see* Azorín.

MARTINEZ SIERRA, GREGORIO (1881–1948), one of the outstanding Spanish dramatists and producers of the 20th century, was born at Madrid on May 6, 1881. He published his first work, El *Poema del Trabajo,* at the age of 17, and although his true vocation was the theatre, he first won recognition as a poet and critic with *La Tristeza del Quijote* (1905) and *Tu eres la Paz* (1906). His best plays were *Cancidn de Cuna* (1911; *Cradle Song), Primavera en otoño* (1911; *The Romantic Young Lady). El Reino de Dios* (1916; *The Kingdom of God)* and *Los Pastores* (1913; *The Two Shepherds).* These owed much of their success in London and New York to the translations by Harley Granville-Barker. His *Un Teatro de arte en España* (1926) describes his work at the Teatro Eslava. Madrid, of which he was director from 1917 to 1928. He died at Madrid on Oct. 1, 1948. (W. F. Se.)

MARTÍNEZ ZUVIRÍA, GUSTAVO: *see* Wast, Hugo.

MARTINI, GIOVANNI BATTISTA (1706–1784), Italian musician. was born at Bologna on April 24, 1706. He was received as a Minorite on Sept. 11, 1722. In 1725 he became chapelmaster in the Franciscan church at Bologna, where he opened a school of composition at which several celebrated musicians were trained. He consistently declared his preference for the traditions of the old Roman school of composition. Padre Martini was a zealous collector of musical literature and possessed an extensive musical library which passed at his death to the Imperial library at Vienna and the city of Bologna; Burney estimated the collection at 17,000 volumes. He died at Bologna on Aug. 4, 1784 His *Elogio* was published by Pietro della Valle at Bologna in the same year.

Martini's father, Antonio Mario Martini, a violinist. had taught him the elements of music, and he had later learned singing and harpsichord playing from Padre Pradieri and counterpoint from Antonio Riccieri. His education in classics he received from the fathers of the oratory of San Filippo Neri. His canons were published about 1800. edited by Pio Cianchettini.

MARTINI, JOHANN PAUL AEGIDIUS (1741-1816) German musician, sometimes also known as Martini Il Tedesco, was born in Freistadt on Sept. 1. 1741. When he was only 10 he became organist at the Jesuit seminary at Neustadt and at 17 held the same position at the Franciscan convent at Freiburg. He soon determined to move to France, however, and first settled at Nancy. There he changed his family name, Schwartzendorf, to Martini, by which he was known thereafter. and entered the service of King Stanislaus I of Poland, then living in France. After the king's death, Martini went to Paris. where he remained for the rest of his life. He published his highly popular opera *L'Amoureux de quinze ans* in 1771. For a time, he served as conductor of the Théâtre Feydeau, and later became inspector of the Paris conservatory, following nhich he was made professor of composition there He was forced to retire in 1802 but when Louis XVIII came to power in 1814 he made Martini superintendent of court music Martini died in Paris. Feb. 10, 1816. Besides his considerable output of music both secular and religious, he wrote *Mélopée moderne,* a study of vocal music.

MARTINI (di Martino), **SIMONE** (*c* 1284–1344) Italian painter, incorrectly called Simone Memmi by Giorgio Vasari, was an early and important exponent of Gothic painting who did more than any other artist to spread the influence of Sienese painting He was very possibly a pupil of Duccio di Buoninsegna (*q.v*). from whom he inherited his love of harmonious, pure colours and most of his early figure types. To these he added a gracefulness of line and delicacy of interpretation which were inspired by French Gothic works, which the young artist studied in Italy. He carried to perfection the decorative line of the Gothic style. and he subordinated volume to the persuasive rhythm of this line, giving his figures a transcendental beauty and grace.

ALINARI

SAINT CLARA AND SAINT ELIZABETH BY SIMONE MARTINI. IN THE CHURCH OF S. FRANCESCO. ASSISI

Simone's earliest documented work is the large fresco in the Sala del Mappamondo of the Palazzo Pubblico, Siena. representing the "Madonna Enthroned with the Child. Angels. and Saints." This painting, signed and dated 1315, but retouched by Simone himself in 1321, is a free version of the main representation in Duccio's "Maestà" of 1308–11. However, the abstract character and lack of setting of the earlier work has given way to concrete concepts: Simone's Virgin, crowned and splendidly attired, is a Gothic queen who holds court under a Gothic canopy. About 1317 the artist painted in Naples the highly spiritual altarpiece "St. Louis of Toulouse Crowning His Brother, King Robert of Anjou," now in the Museo di Capodimonte in that city. Two or three years later he composed for Sta. Caterina. Pisa, a colouristically magnificent Madonna polyptych, which is now in the Museo Nazionale. Pisa. Perhaps in the middle of the 1320's he began the ten scenes, full of chivalrous ideals, from the life of St. Martin of Tours in this saint's chapel in the lower church of S. Francesco, Assisi. More down to earth is the equestrian portrait of 1328 in the Palazzo Pubblico. Siena, representing Guidoriccio da Foligno, general of the Sienese Republic. On the other hand, deliberately unreal is the "Annunciation" triptych, painted for the Cathedral of Siena. but now in the Uffizi gallery, Florence. Simone signed this work in 1333 with his brother-in-law, the Sienese painter Lippo Memmi, an associate for many years. The exquisite rhythm of the lines and dematerialized forms of Gabriel and Mary in the central part of the "Annunciation" led many artists to imitation, but none of them achieved as vibrant contours and as spirited forms as did Simone in this great masterpiece. In 1339 the painter settled at the papal court in Avignon, where he remained until his death in 1344, and where he made the acquaintance of Petrarch. He executed for the poet a portrait of his beloved Laura! as is known from two of Petrarch's sonnets, in which Simone is eulogized.

Simone was the most important Sienese painter after Duccio. His influence in Siena was great in the 14th century and considerable in the 15th. His art was imitated by local painters in Naples, Pisa. Orvieto, Assisi, and Avignon.

Bibliography.—Giovanni Paccagnini, *Simone Martini* (1955) with a comprehensive bibliography. Useful discussions of Simone's life and art in English are to be found in Raimond van Marle, *The Development of the Italian Schools of Painting,* vol. 2 (1924); and in Curt H. Weigelt, *Sienese Painting of the Treceiato* (1930). For Petrarch's references to Simone's portrait of Laura consult Francesco Petrarca, Le *Rime* (1929), sonnets LVIII and LIX, no. LXXVII and LXXVIII.

(G. M. Cr.)

MARTINIQUE, an island in the Lesser Antilles (West Indies) and a French overseas *département,* located 25 mi. S. of Dominica and 20 mi. N. of St. Lucia, about 14° 40' N. lat. and 61° W. long. Its area is 431 sq.mi. The island is 43.5 mi. long. with its greatest width 19 mi. A cluster of volcanic mountains in the north, a similar group in the south and a line of lower heights in between form the backbone of the island. Its deep ravines and precipitous escarpments are clothed in forest. Mt. Pelée in the north is the culminating point (4.554 ft.); that of Carbet reaches 3,911 ft.; the mountains in the south are much lower.

On the northwest and north the coast is elevated; on the south a lateral range, branching from the backbone of the island, forms a blunt peninsula hounding the low-shored bay of Fort-de-France. Another peninsula, Caravelle, projects from the middle part of the east coast, and south of this the coast is low and fretted, with many islets, cays and coral reefs. Plains, most numerous and extensive in the south, make up about one third of the total area.

History.—Martinique (Madinina), occupied originally by the Arawakan Indians, then conquered by the Cariban Indians, was probably discovered by Christopher Columbus on June 15, 1502. On June 25, 1635 possession was taken of the island in the name of the French Compagnie des fles d'Amérique. Actual settlement was carried out by Pierre Belain, sieur d'Esnambuc, captain general of the island of St. Christopher. In 1637 his nephew Dyel Duparquet became captain general of the colony, now numbering 700 men, and subsequently obtained the seigneury of the island by purchase from the company under the authority of the king of France.

In 1654 welcome was given to 300 Jews expelled from Brazil, and by 1658 there were at least 5,000 persons exclusive of the Caribs. The latter, pushed into the east; disappeared after many wars or were assimilated. Purchased by the French government from Duparquet's children for 120,000 livres, Martinique was assigned to the West India company, but in 1674 it became part of the royal domain.

The *habitants* (French landholders) at first cultivated cotton and tobacco, but in 1650 sugar planting began and in 1723 the coffee plant was introduced. Slave labour was an early feature (there were 60,000 Negroes in the island by 1736). In 1666 and 1667 the island was attacked by the British, but hostilities were terminated by the treaty of Bred?. The Dutch made similar attempts in 1674 and the British again in 1693 Life in Martinique during the 17th century is well described in the works of R. P. du Tertre and R. P. Labat. Captured by Adm. George Rodney in 1762, Martinique was restored to the French in 1763 but after the conquest by Sir John Jervis and Sir Charles Grey in 1793 it was retained by the British for eight years. Seized again in 1809, it was not surrendered till 1814. The island was the birthplace of the empress Josephine.

Slavery was abolished in 1848 through the initiative of the French reformer Victor Schoelcher and all the inhabitants became French citizens.

Martinique suffered from occasional hurricanes causing much damage to the sugar crops, as in 1767 when 1,600 persons perished, 1839, 1891, 1903 and 1928. But the most terrible natural disaster was the eruption of Mount Pelée in 1902, when St.-Pierre, formerly the chief commercial centre and the largest city of the island, was destroyed. Early in the year various manifestations of volcanic activity occurred; on April 25 there was a heavy fall of ashes and on May 2 and 3 a big eruption destroyed extensive sugar plantations north of St.-Pierre and caused a loss of some 150 lives, but on May 8 the final calamity came without warning when a mass of fire swept over St.-Pierre, destroying all but a single ship in the harbour. The total loss of life was estimated at 40,000. Besides St.-Pierre, one tenth of the island was devastated. Another series of eruptions took place in 1929.

From 1940 to 1945 Martinique was under the Vichy regime of France. It became a *département* in 1946.

Social and Economic Conditions.—The population (1954 census) was 239,130. The bulk of the population is Negro, ranging from the sacatras, who retain little trace of European blood, to the *sangmêlé*, with only a touch of Negro commixture.

The capital is Fort-de-France, on the bay of the same name, with a population in 1954 of 40,380. Other principal centres of population are Le Lamentin on the bay of Fort-de-France, and Le François and Robert on the east coast.

The dominant crop is sugar. Bananas are produced, also pineapples, cacao and coffee. Rum; sugar and bananas make up most of the exports. Imports embrace rice, flour and other foodstuffs, petroleum products and textiles. *See* also Index references under "Martinique" in the Index volume. (L. W. BE.; HU. DE.)

MARTINUZZI, GYÖRGY (properly JURAJ UTJEŠENOVIĆ) (1482–1551), Hungarian statesman, known in Hungarian history as FRATER GYÖRGY or simply THE FRATER, was born at Kamičic, Croatia. From 8 to 20 years of age he was attached to the court of John Corvinus: subsequently he saw something of warfare under John Zapolya but, tiring of a military life, he entered the Paulician Order when he was 28. His historical career began when his old patron Zapolya (who had become king of Hungary) forced to fly before his successful rival Ferdinand, afterward the emperor Ferdinand I, sent him on a diplomatic mission to Hungary. It was through his tact and ability that John recovered Buda (1529), and henceforth Frater Gyorgy became his treasurer and chief counselor.

In 1534 Martinuzzi became bishop of Nagyvarád (Grosswardein); in 1538 he concluded with Austria the peace of Grosswardein, which left Zapolya with the royal title and most of Hungary. On Zapolya's death (1540) Martinuzzi acted as guardian and regent for his infant son John Sigismund, for whom on Dec. 29, 1541, he concluded the treaty of Gyula with the sultan, which left an enlarged Transylvania as an independent principality under Turkish suzerainty. For a time Martinuzzi kept Transylvania neutral and on friendly terms with both Austria and the Porte. In 1550, however, the queen-mother Isabella, who hated him, contrived against him with the hospodars of Moldavia and Walachia and the Turks. Martinuzzi defeated all his enemies and concluded a composition confirmed by the diet of Kolozsvár (1551) whereby Isabella renounced her rights over Transylvania, in her son's name, to Ferdinand of Austria.

The Frater retained the governorship of Transylvania, and was subsequently consecrated cardinal and archbishop of Esztergom. Thus Hungary was once more reunited, but the inability of Ferdinand to defend it against the Turks, as promised: forced the Frater to resume payment of tribute to the Porte in Dec. 1551. Ferdinand, however, suspecting the cardinal's loyalty, had him assassinated at Alvinczy (Dec. 17, 1551). Ferdinand took the responsibility of the murder on himself. He sent to Julius III an accusation of treason against the Frater in 87 articles and the pope exonerated Ferdinand of blame.

MARTIUS, KARL FRIEDRICH PHILIPP VON (1794–1868), German botanist and traveler who studied the flora of Brazil, was born on April 17, 1794, at Erlangen, where he graduated M.D. in 1814. He afterward devoted himself to botanical study, and in 1817 was sent to Brazil by the king of Bavaria. In 1820 he was appointed conservator of the botanic garden at Munich, and in 1826 professor of botany in the university; he held both offices until 1864. His chief publications include: *Nova Genera et Species Plantarum Brasiliensium* (3 vol., 1823–32); *Icones selectae plantarum cryptogamicarum brasiliensium* (1827); *Historia palmarum* (3 vol., 1823–50); and an account of his travels in Brazil (3 vol., 1823–31). In 1840 he began the *Flora Brasiliensis*, with the assistance of other botanists.

Martius died at Munich on Dec. 13, 1868. The *Flora Brasiliensis* was not completed until 1906. It was edited after Martius' death, first by A. W. Eichler and then by I. Urban.

MARTYN, HENRY (1781–1812), English missionary to India, was born on Feb. 18, 1781, at Truro, Cornwall. He was educated at Truro grammar school and St. John's college, Cambridge, and was senior wrangler and first Smith's prizeman in 1801. In 1802 he became a fellow of his college. He obtained a chaplaincy under the East India company and left for India on July 5, 1805. He translated the whole of the New Testament into Hindi, and into Persian twice, and the Psalms into Persian, the Gospels into Judaeo-Persian, and the Prayer Book into Hindustani. Ordered by the doctors to take a sea voyage, he went to Persia to correct his Persian New Testament, whence he wished to go to Arabia and there compose an Arabic version. He set out from Bombay in Jan. 1811 for Bushire. After an exhausting journey from the coast he reached Shiraz and was soon plunged into discussion with the disputants of all classes. Having made an unsuccessful journey to Tabriz to present the shah with his translation of the New Testament, he fell ill with fever and had to seek a change of climate. On Sept. 12, 1812, he started with two Armenian servants. Although the plague was raging at Tokat (near Eski-Shehr in Asia Minor), he was compelled by prostration to stop there. On Oct. 6, he died.

MARTYN, JOHN (1699–1768), English botanist, author and translator of Virgil *(see* below), was born in London on Sept. 12, 1699. From 1733 to 1761 he was professor of botany at Cambridge and from 1730 to 1752 a physician at Chelsea; where he died on Jan. 29, 1768.

His reputation rests chiefly upon his translations, with critical notes. of the Georgics (1741) and Bucolics (1749) of Virgil and his *Historia plantarum rariorum* (1728–1737), describing and illustrating in colour noteworthy plants. The work was discontinued after five parts were published.

See G. C. Gorham, *Memoirs of John Martyn and Thomas Martyn* (1830). (J. W. Tr.)

MARTYROLOGY, a catalogue or list of martyrs or, more exactly, of saints, arranged in the order of their anniversaries. This is the accepted meaning in the Latin Church. In the Eastern Church the nearest equivalent to the martyrology is the Greek Synaxarium. As regards form, we should distinguish between simple martyrologies, which consist merely of an enumeration of names, and historical martyrologies, which also include stories or biographical details. As regards documents, the most important distinction is between local and general martyrologies. The former give a list of the festivals of some particular church; the latter are the result of a combination of several local martyrologies. The most important ancient martyrology that has been preserved is in the form (mainly) of an enumeration of names and was falsely attributed to St. Jerome. The preserved form goes back to the end of the 6th century. It is the result of the combination of a general martyrology of the Eastern Churches; a local martyrology of the Church of Rome, some general martyrologies of Italy and Africa and a series of local martyrologies of Gaul. The task of critics is to distinguish between its various constituent elements. Unfortunately, this document is in a lamentable condition. Of the best known historical martyrologies the most famous is that of Usuard (*c.* 875), on which the Roman martyrology was based. The first edition of the Roman martyrology appeared at Rome in 1583. The third edition, which appeared in 1584, was approved by Gregory XIII, who imposed this martyrology upon the whole church.

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MARTYRS, EARLY CHRISTIAN. The original meaning of the Greek word martys was "witness"; in this sense it is often used in the New Testament. Since the most striking witness which Christians could bear to their faith was to die rather than deny it, the word soon began to be used in reference to one who was not only a witness but specifically a martyr. This usage is present, at least implicitly, in Acts xxii, 20 and Rev. ii, 13. The first Christian martyrs were St. Stephen (Acts vi, 8–vii, 60) and St. James (Acts xii, 2). Of the Apostles the most important martyrs were SS. Peter and Paul, both put to death at Rome (I Clement v). Clement of Rome describes them as God's athletes, contending for the heavenly prize, and mentions a "great multitude" executed at the same time (probably under Nero; *cf.* Tacitus, *Ann.,* xv, 44). Early in the 2nd century Ignatius of Antioch described his own prospective martyrdom as a way of "attaining to God" and urged the Roman Christians not to make any effort to have him spared.' In the sporadic persecutions of the first two centuries martyrdoms were not especially frequent, but the martyrs mere highly regarded by Christians (the emperor Marcus Xurelius viewed their constancy as theatrical). The earliest authentic "Acts of Martyrs" surviving are those of Justin at Rome *c.* 165, of Polycarp at Smyrna c. 167, of about 50 Christians at Lyons and Vienne (Gaul) in 177 and of a few at Scillium in Africa in 180. In addition, from the Roman side there are letters exchanged by Pliny the Younger, legate in Bithynia-Pontus, and the emperor Trajan in the year 112 (Pliny, *Ep.,* x, 96–97). From all these accounts something of the procedure involved can be made out. The government's position was not entirely clear. Were Christians to be condemned as Christians because of specific criminal charges or because of crimes inherent in the profession of Christianity? In any event, they were ordered to prove their abandonment of Christianity by offering sacrifices to the Roman gods; when they refused to do so, they were executed. Veneration of a martyr's relics is first attested in the *Martyrdom of Polycarp.*

With the passage of time and with a fresh emphasis on martyrdom (often regarded as a substitute for baptism) in the persecutions under Decius (A.D. 250) and Diocletian (A.D. 303–311), the authentic acts of the early martyrs were often replaced by legendary accounts (for instance, none of the versions of the death of Ignatius is genuine). Though doubts about these new narratives had arisen earlier, it was not until the late 19th century that the study of martyr acts was placed on a secure foundation, above all by the writings of the Bollandist Hippolyte Delehaye, who applied literary and historical criticism to these acts with significant success. After his time the study was advanced by the work of Herbert Musurillo, who carefully examined the papyrus fragments that record the difficulties of Alexandrian "martyrs" before various Roman emperors. These accounts do not provide prototypes of the martyr acts (closer parallels are found in such Hellenistic Jewish writings as IV Maccabees), but they reflect the kind of situation out of which martyr acts arose.

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(R. McQ. G.)

MARUTS, the storm-gods of Hindu mythology, prominent in the Rig-Veda which makes them sons of Rudra but associates them with Indra, the goddesses Indrani and Saraswati and more closely with Rodasi, their beauteous bride. Yet they are sometimes hostile to Indra and rend Vritra, the "drought," in pieces. In the epic era they appear to be the Maruta, the winds, sons of the benevolent earth-goddess, Aditi.

MARVEL, IK: *see* MITCHELL, DONALD GRANT.

MARVELL, ANDREW (1621–1678), English poet, whose political reputation overshadowed appreciation of his unique gifts as a poet until the 20th century, was born on March 31, 1621, at Winestead, Yorkshire, where his father was rector. The latter moved in 1624 to become master of the Charterhouse, an almshouse (with a garden) just outside the city wall of Hull, and preacher (not incumbent) at the parish church. The boy attended Hull grammar school, and in his 13th year (like other boys from schools which did not carry education very far) proceeded to the university. He was a sizar at Trinity college, Cambridge: from 1633 to 1638, when he became a scholar, and took his B.A. in 1639. In Jan. 1641 his father was drowned when crossing the Humber, which may account for Marvell's departure from the university. Otherwise he would have proceeded M.A. and, being a first-rate scholar without great worldly ambition, would probably have enjoyed a distinguished academic career. One Greek and one Latin poem survive from his university days and also a well-authenticated story that he was temporarily led away by the Jesuits.

He had his living to earn. His brother-in-law Edmund Popple, a Hull merchant, probably took him into his office, but for four years, almost certainly 1642–46, he traveled on the continent, to Holland, France, Italy and Spain, thus missing the Civil War. He can only have done this as a tutor, almost certainly to one of the Skinner family of which Milton's friend Cyriack is the best known. At Rome he met Richard Flecknoe (*q.v.*), whom he satirized in a style reminiscent of both Horace and Donne. Back in England he may have contemplated a literary career in royalist circles, as the poems on Richard Lovelace. Lord Hastings and Lord Francis Villiers, younger brother of the 2nd duke of Buckingham, suggest; but Uorkshire drew him, and about 1651–52 he was tutor at Nun Appleton to Lord Fairfax's daughter Mary. Perhaps his political views were changing, but in neither religion nor politics was he ever a bigoted partisan. A moderate man, he was more influenced by persons than principles. His one firm persuasion was English patriotism. Now, though he admired Charles I's demeanour on the scaffold and though in 1651 he wrote scathingly about the Puritan historian Tom May, Oliver Cromwell's strength of character won him over ("An Horatian Ode upon Cromwell's

Return From Ireland" 1650). In 1653 Milton made an abortive attempt to get him appointed his assistant in the Latin secretaryship. Instead he became tutor to Cromwell's ward William Dutton from 1653 to 1657, at first at Windsor in the house of John Oxenbridge who had been to Bermuda (*cf.* "Bermudas"), later at Saumur, France, where there was a noted Protestant academy. In 1657 Marvell was himself appointed Latin secretary (*i.e.,* foreign secretary) under John Thurloe, the secretary of state, an office he held till the Restoration. Though poems on "The First Anniversary" (1655) and "On the Death of O.C." show his continued and growing admiration of Cromwell, his role was that of the civil servant, not the politician. His political career began with his election as M.P. for Hull in Richard Cromwell's parliament (1659). He was re-elected in 1660 and 1661 and was a house of commons man for the rest of his life. Dissatisfaction with Clarendon's government, especially the disastrous conduct of the Dutch War of 1664–67, appears in the long, witty and still most readable "Last Instructions to a Painter," written in 1667 but, like all but one of his political satires, not published till after the Revolution. In the next decade alarm about the king's intentions produced the anonymous *An Account of the Growth of Popery and Arbitrary Government in England* (1677), purporting to have been printed at Amsterdam. Traces survive of his close touch with the leaders of the Country party, but the long series of newsletters to the Hull corporation is concerned mostly with bare facts. The corporation paid him 6s. 8*d.* for each day's parliamentary attendance and also sent presents in kind. The only long break in attendance was in 1663–65 when he went as secretary on an embassy to Russia.

In 1678 Marvell, who seems to have been unmarried, had an attack of fever at his London lodgings and died on Aug. 18 through medical incompetence. He had in his charge 5500 belonging to two Hull friends who hoped thereby to save something from their bankruptcy. They arranged with his housekeeper-servant, Mary Palmer, to claim that she was his widow and entitled to his property. Marvell's Hull relations took out letters of administration for his property there, but Mary Palmer, finding his manuscript poems, had them published as "of my late dear Husband" (*Miscellaneous Poems by Andrew Marvell, Esq.,* 1681) : the object was probably not to make money by poems quite out of fashion but to bolster up the claim to widowhood. Otherwise most of the poems might have been lost for ever, or, like Thomas Traherne's, accidentally discovered two centuries later.

The 1681 volume was accurately described as miscellaneous. Its 58 items even include a letter and four prose epitaphs. Whatever poems, early or late, have not survived, the variety of Mary Palmer's haul suggests that it included what Marvell thought his best. There are, for example, a few dialogues, moral, pastoral or pastoral-moral; a few poems full of "metaphysical" conceits ("The Definition of Love" is as intellectual as anything of Donne's, and "To His Coy Mistress" sets playfulness against a sternly sublime background) ; two characteristically 17th-century "weeper" poems ("Eyes and Tears," "Mourning") ; one narrative ("The Nymph Complaining for the Death of Her Faun") in a unique way reminiscent of the Civil War; one meditative description of a portrait ("The Picture of little T.C.") ; two personal satires ("Flecknoe" and "Tom May's Death"), one without and one with venom. The group of Mower poems probably belongs to the Nun Appleton period, as the two local poems ("Upon the Hill and Grove at Bill-borow" and "Upon Appleton House") and "To Doctor Witty" certainly do. The moment of deepest experience in "Upon Appleton House" is similar to that in "The Garden" ("My Soul into the boughs does glide"), which on the evidence of its last stanza can also be ascribed to the two years of bliss with Fairfax: but a poet's maturest expression is based on repeated experiences, and it is not fanciful to trace to the Charterhouse garden the beginning of Marvell as the garden-loving poet.

Other poems of the 1650s can be dated by their subject-matter. "An Horatian Ode" (Horatian, *i e.,* not Pindaric), the two other Cromwell poems and "Bermudas" have been mentioned above. *The Character of Holland,* a satire of more than Hudibrastic wit, was occasioned by the Dutch War of 1652–54; "On a Victory Obtained by Blake" (1657) by the Spanish War; "Two Songs" by the marriage of Cromwell's daughter Mary (1657). Latin poems for diplomatic occasions indicate the aspirant to scholarly government service. Much later (1674) is the poem prefixed to the second edition of Milton's *Paradise Lost.* It occurs, oddly, near the middle of the volume. The arrangement of the contents cannot have been Marvell's but. with exceptions, it is intelligent and systematic, and is presumably the publisher's. He misplaced "Bermudas" through ignorance. and the pastoral "Dialogue Between Thyrsis and Dorinda" perhaps because it was a late find while the book was in the press. Though not a great poem, it is interesting: first, because in part at least it is known to have been in existence in 1643; secondly, because it was published (without the author's name) as words to music in 1659. At the last moment the publisher of the folio took fright about the three English Cromwell poems ("An Horatian Ode," "The First Anniversary," "Upon the Death of O.C.") and cut them out.

Though it cannot be proved that none of the *Miscellaneous Poems* (except that to Milton and Latin suggestions for an inscription on the Louvre) were written after the Restoration. it is improbable both for stylistic reasons and because it is known that Marvell became more and more absorbed by politics. He did from 1667 onward write anonymous verse satires, but, with exceptions, it is not easy to be sure which of those popularly (or conveniently) ascribed to him after his death in 1678 were really his. They circulated in manuscript and were printed after the Revolution in *Poems on Affairs of State* (1689–1716). His acknowledged success was in prose, *The Rehearsal Transpros'd* (1672–73). This was a witty best-seller and laughter-causer of the day, an attack on an ecclesiastico-political adversary, Samuel Parker, subsequently James II's bishop of Oxford and president of Magdalen college.

In the same vein as *The Rehearsal Transpros'd* was *Mr. Smirke: or the Divine in Mode* (1676; again a title taken from a current play). Marvell at this time developed an interest in the origins of the early church which produced *A Short Historical Essay Touching General Councils, Creeds, and Impositions in Matters of Religion* (1680), a pamphlet cutting the ground from the usual Protestant view of the first four centuries and well on the way to the deism of his nephew William Popple, author of *A Rational Catechism* (1687).

Achievement and Reputation.—While Marvell's controversial prose is now interesting only to specialists, and while his verse satire is far inferior to Dryden's and no better than that of dozens of his contemporaries, his small but exceptionally varied collection of miscellaneous poetry has continued to rise steadily in the estimation of general readers ever since Charles Lamb may be said to have discovered it. After Donne, perhaps even together with Donne. he is the finest of those many fine amateur poets of the earlier 17th century who wrote, not for publication, but for their own pleasure and that of their friends, and whose poetry reflects so much of what is most attractive in the culture and society in and out of which it was written. While no poetry could well be more original, could more unmistakeably reveal the hand of its author, than Marvell's, it is at the same time continuously dependent on the example and stimulation of predecessors and contemporaries. This is one of the great differences between Marvell and Donne; for, while Donne seems to have resolved to write in a manner in which no English poet had ever written before. Marvell, it might almost be said, was willing to accept, to exploit and to re-combine anything that had ever made poetry enjoyable. He is the only great metaphysical poet who did not break with the Elizabethan past, and who combines something of Donne's dialectic and ingenuity with a pastoral, pictorial and descriptive content which may be regarded as a development both of Elizabethan pastoralism and of those "catalogues of delights" (they seem to begin with Theocritus' description, imitated by Ovid, of Polyphemus' wooing of Galataea) of which Marlowe's *Passionate Shepherd* inspired so many imitations and of which even Milton's *L'Allegro* and *Il Penseroso* may be regarded as examples. Marvell, in fact, is the most eclectic of all 17th-century poets, and his originality consists very largely in the beauty and piquancy of his various combinations of old and new.

In spite of two 18th-century editions no one before Charles Lamb took any real interest in Marvell's poetry. He was revered as an incorruptible Whig, a republican of complete integrity. Wordsworth linked him with Algernon Sidney and James Harrington. In the 19th century he was republished and anthologized. but not till the 20th was he fully recognized as nature-mystic. meditative patriot, wit of great depth and superb master of the octosyllabic couplet. (H. M. MA.; J. B. LN.)

BIBLIOGRAPHY.—*The Works of Andrew Marvell* were ed. by T. Cooke, 2 vol. (1726) and E. Thompson, 3 vol. (1776). Their rediscovery in the late 19th century was marked by A. B. Grosart's *The Complete Works in Prose and Verse of Andrew Marvell*, 4 vol. (1872–75). *Poems and Letters* were ed. by H. M. Margoliouth, 2 vol. (1927; 2nd ed., 1953); *Poems: Printed from the Unique Copy in the British Museum, With Some Other Poems,* were ed. by H. Macdonald (1952); and *Selected Poetry and Prose* was ed. by D. Davison (1952). *See* also P. Legouis, *André Marvell, Poète, Puritain, Patriote* (1928); M. C. Bradbrook and M. G. Lloyd Thomas, *Andrew Marvell* (1940), with a summary of the evidence about Mary Palmer. (H. M. MA.)

MARX, JOSEPH (1882–), Austrian composer and critic known for his songs. Born at Graz, May 11, 1882, he was a pupil there of E. W. Degner. He became professor at the musical academy in Vienna in 1914, and was appointed director in 1922. In 1924 he helped to found the Vienna *Hochschule* for music. In 1931 he became music critic of the *Neues Wiener Journal* and in 1946 of the *Wiener Zeitung*. He wrote over 100 songs. the earliest of which date from about 1900. In them the style of Brahms and Hugo Wolf is blended with that of French and Kussian songs. "Tuch der Tranen" and "Kolumbine" show the influence of Debussy, and the realistic "Windräder" has an affinity with Moussorgsky. Marx's texts include poems by Joseph von Eichendorfi. Goethe, Ruiner Maria Rilke and Stefan Zweig, and he also set German translations of poems by Verlaine, Pierre Louys and André Giraud. In the *Italienisches Liederbuch* (1907–12) on poems by Paul Heyse, Marx developed further the style of Wolf. Many of his songs, such as "Und gestern hat er mir Rosen gebracht" and "Valse de Chopin," are remarkable for their accompaniments and sense of musical imagery. He also wrote *Castelli Romani* for piano and orchestra. chamber works and symphonic poems. His criticisms were published under the title *Betrachtungen einer romantischen Realisten* (1947).

See A. Liess, *Joseph Marx: Leben und Werk* (1943).

MARX, KARL HEINRICH (1818–1883), German philosopher of history and the most important figure in the history of socialist thinking. was born. May 5, 1818, of Jewish parents in the town of Trèves (Trier) in Rhenish Prussia. In 1824 his father. a lawyer with a keen interest in philosophy. embraced Christianity and all members of the family were baptized as Protestants. During his student days at the universities of Bonn and Berlin. Marx studied history and philosophy and was strongly influenced by the works of Georg Wilhelm Friedrich Hegel (*q.v.*), an influence that always remained one of the most important elements in his thinking. In 1841 he received a doctor's degree from the University of Jena. His liberal political views led him to consider journalism as a career and in 1842 he became an editor of the *Rheinische Zeitung* in Cologne. The following year he married Jenny von Westphalen, close friend of his boyhood and daughter of a high government official. It was a marriage of deep love that withstood the vicissitudes of all the subsequent years. Shortly after his marriage. Marx's newspaper was suppressed and he emigrated to Paris with his wife. There he became acquainted with French socialist writers and established his lifelong friendship with Friedrich Engels. Both these influences led Marx to become a socialist.

In 1847, at a new place of exile in Brussels, Marx wrote a reply to P. J. I'roudhon's book *Philosophie de la misère* ("Philosophy of Poverty") and entitled it *Misère de la philosophic* (Eng. trans., *Poverty of Philosophy*, 1935). In it he developed the fundamental propositions of his economic interpretation of history. Against I'roudhon's (and the utopian socialists') quest for the morally moat desirable social order he put his own search for the inevitable; *i.e.*, the system that would by necessity result from the operation of historical forces. Another even more important document originated from Marx's (and Engels') pen during the stay in Brussels—Dns *Kommunistische Manifest* (1848, many reprints; Eng. trans. by Samuel Moore, 1888), which contains a summary of his whole social philosophy. It was written to serve as the platform of the Communist league. *The Communist Manifesto* appeared at a moment most favourable to its effectiveness: on the eve of the February (1848) revolution in France during which socialism showed its power.

The revolutionary atmosphere in Germany in 1848 made it possible for Marx to return to Cologne and revive his newspaper, now under the title of *Neue Rheinische Zeitung*, but in 1849 he was expelled. This time he settled in London, where he spent the rest of his life—most of it in dire poverty. Journalistic activity for the *New York Tribune*, whose managing editor was Charles A. Dana. a Fourierist, at times alleviated the distress. but only the generosity of Engels. who worked in the Manchester affiliate of his father's textile firm. protected the Marx family from starvation. Several of Marx's children died. among them his only son. Edgar. Of his three daughters who reached adult life, two married French socialists (Paul Lafargue and Charles Longuet); the third, after Marx's death, established an unhappy association with the British Marxist Edn·ard Aveling and ended by suicide. Marx died on Mar. 14, 1883, fifteen months after the death of his wife. He was buried at Highgate cemetery.

In spite of poverty and persistent illness. Marx proved himself a prolific writer. Anxious to apply his philosophy of history to the events in France. where civil war had broken out between the workers and the middle class in the summer of 1848, Marx wrote his booklet Die *Klassenkämpfe in Frankreich 1848 bis 1850* (1850/1859; Eng. trans. 1942) and followed it up with *Drr Achtzehnte Brumaire tics Louis Napoleon Bonaparte* (1852–1885; Eng. trans. by Eden and Cedar Paul. 1940)—both of them masterpieces of historiography. He gave a critical history of econoinic literature in his hook *Zur Kritik der politischen Ökonomie* (1859, Eng. trans. by N. I. Stone. 1904). His most famous work was Das *Kapital.* (The first volume appeared in 1867; second and third volumes were published posthumously in 1885 and 1894 edited by Engels. An English translation of the first volume by Samuel Moore and Edward Aveling appeared in 1886; a translation of the second and third volumes by Ernest Cntermann. 1907 and 1909.) In this hook Marx developed a theory of the capitalist system and its dynamism. nith emphasis on its self-destructive tendencies.

The only important organizational activity Marx ever undertook was his leadership of the International Workingmen's association, (the First International) beginning in 1864. Most of the time his own followers were only a minority among the members, but he balanced the various factions against each other with great skill and infinite patience and held out to them their common goals, until the conflict with the anarchists put an end to the International. With the British labour movement Marx had little contact. although in the International some British trade-unionists were for a time among his strongest supporters. In France, his influence during his lifetime was overshadowed by that of Proudhon (*q.v.*) and in Germany—at least up to the late 1870s—by that of Ferdinand Lassalle (*q.v.*) but Lassalle and his successor, J. B. von Schweitzer. were interpreters rather than opponents of many of Marx's ideas. (See MARXISM.)

Marx regarded tsarism as the greatest enemy of freedom in all of Europe. and he wished for a strengthening of British imperial power as a counterweight to Russia. He also had a great hatred of Napoleon III. He was opposed to Prussian hegemony over Germany as established by Bismarck hut asserted the right of the German people to unity: some utterances to the contrary not withstanding. Marx respected and even shared national feelings. Marx took a passionate interest in the American Civil War as a partisan of the North. In spite of his merciless criticism of bourgeois liheralism. Marx treasured the liberal-humanitarian tradition from which the socialist movement had sprung. and in all probability would have abhorred the antihumanitarian practices of present-day Communism. Rlarx did not live long enough to co-ordinate the strands in his great fund of ideas, and the anreconciled contradictions became a source of dissension among his intellectual heirs.

With the exception of Engels. Marx had no close, lifelong friend. To many of his contemporaries, he appeared coldly arrogant. conceited and full of hate. Whether these traits were part of his nature or merely a response to his many frustrations, is a question which none of his many biographers has convincingly answered. *See* references under "Marx. Karl Heinrich" in the Index volume.

BIBLIOGRAPHY.—Franz Mehring, *Karl Marx* (1918; Eng. trans. by Edward Fitzgerald. 1935); Otto Rühle. *Karl Marx, His Life and Work* (1928; Eng. trans. by Eden and Cedar Paul, 1929); Gustav Mayer, *Friedrich Engels* (1934; Eng. trans. by G. and H. Highet, 1936); Moscow Institut Marxisma-Leninisma. *Karl Marx, Chronik seines Lebens* (1934); Dona Torr (trans. and ed.), *Correspondence, 1846–1895* (1934).

Writings.—An exhaustive bibliography of those of Marx's writings which have been translated into English is given in the second volume of Donald D. Egbert and Stow Persons (eds.), *Socialism and American Life* (1952). In an appendix to his biography. Mehring gives a fairly complete list of the originals. The collected edition of Marx's and Engels' writings planned by the Institut Marxisma-Leninisma has remained incomplete; the collection contains (in original German) the earliest works, the complete correspondence between Marx and Engels in four volumes (1929–31) and an annotated edition of the *Anti-Dühring* (1935), including all preparatory notes that could be iound, and also Marx's comments on the draft. (C. L.)

MARX, WILHELM (1863–1946), German politician, was born at Cologne Jan. 15, 1863. He entered the political branch of the civil service and became a judge. In 1899 he nas elected to the Prussian diet and in 1910 entered the German reichstag, where he soon became prominent among the leaders of the Centre. He was elected president of the Centre party in 1921. and on Sov. 30. 1923, succeeded Gustav Stresemann as chancellor of the reich. In Xug. 1924 he took part in the Conference of London which determined the acceptance of the Dawes plan. (*See* GERMANY.) In the autumn of 1924 Marx dissolved the reichstag in the hope of getting a government majority, and after the elections retired from the post of chancellor. In Feb. 1925 he became Prussian minister-president for a short period. After the death of Friedrich Ebert he stood as candidate for the post of president of the reich. but was defeated by Paul von Hindenburg. In Jan. 1926 he became minister for justice and occupied territories in the second Luther cabinet and later in the same year succeeded Hans Luther as chancellor. He remained chancellor through the reshuffle on the entry of the German National party representatives into the cabinet, but resigned on June 13, 1928, partly owing to ill health. He lived in retirement until he died at Bonn, on Aug. 5, 1946.

MARXISM, a body of social doctrine worked out by Karl Marx in cooperation with his friend Friedrich Engels and systematized later by some of Marx's followers. especially Karl Kautsky. Marxism is a philosophy of history, implemented by an elaborate economic theory. This philosophy purports to demonstrate the inevitability of socialism (*q.v.*) and eventually of full communism (*q.v.*), the latter to be understood as a classless, collectivist order in which the social product is distributed according to needs and in which the state, law, money and the concept of economic value have lost their functions and therefore have "withered an-ay." The following are the most important elements of Marxist doctrine:

Determinism.— Fundamentally. Marxists believe that history is governed by laws which the human mind can recognize and which offer man a possibility to foresee the future of society in its most important characteristics. Marxist determinism has been expressed with particular vigour by Rosa Luxemburg. one of the most original minds among the Marxists, n-ho spoke of the "granite foundation of objective historical necessity," on which Marxism has huilt the socialist creed. in contrast to the "fog of pre-Marxian systems and schools of thought which wanted to derive socialism merely from the injustice and wickedness of the present world and relied merely on the revolutionary determination of the workers" (from an appendix to the second German edition of her book *Die Akkumulation des Kapitals,* p. 37).

Marxist determinism promises victory to the working class and thus is apt to strengthen the latter's self-conhdence in the class struggle. .but at the same time the question arises as to why workers should make sacrifices in order to bring about developments which are inevitable in any event. This problem is related to, though not identical with, the issue of free will versus causal necessity as known to general philosophy. For Marxists, this fundamentally insoluble dilemma is particularly important because they regard themselves not only as scholars but also as active promoters of social change,

Economic Interpretation of History.——What are the laws that govern history and can be made the basis of social prognosis? The first of these laws is supposed to determine the direction of the historical process. In its general form. the law says that economic developments are basic to social evolution in other areas. Ideas and institutions. law and politics. even religious concepts and artistic expression are parts of the social "superstructure." inevitably changing with the gradual transformation of the economic foundation. Since technological development leads to production units of ever increasing size. bringing together ever greater masses of workers in one enterprise and requiring ever larger amounts of capital per unit of labor, only the community at large will finally be able to provide the organizational frame work of production. This conclusion is supported by the theorem that the rate of profit will inevitably decline (*see* below).

Marxism does not contend that ideas exercise no influence on history, but merely that they are not independent agents; as intermediary links between economic developments and outward event-, ideas may he very important from a Marxist point of view. Nor do Marxist believe that man is exclusively motivated by selfish or "material" interests; they do maintain that altruism, religious devotion. patriotism or other "idealistic" feelings are themselves the products of economic conditions and of their direct and indirect effects on the human mind.

The most problematic point in the economic interpretation of history is the ambiguity of the concept of *economic* change. If all the developments in the field of production. distribution and consumption were included. it would seem true enough that in this wide field some causes of practically all ideological and institutional developments can be found, but also that many economic facts in this broad sense are just as much effects as they are causes oi changes in the "superstructure"; for instance, changes in artistic tastes, in political institutions, in social traditions and even in religious doctrines influence consumption of commodities and thereby become determinants of production. and law is as much a determinant as it is a product of economic life. Thus a maze of mutual causal relationships results and, with cause and effect undistinguishable in many instances. no social prognosis could be built on this foundation. Marx himself nowhere gave an explicit and comprehensive presentation of his economic interpretation of history. although fragmentary expositions and allusions are dispersed over all his writings. Engels, with Marx's endorsement, supplied more extensive explanations. especially in his polemical book *Herr Eugen Dühring's Revolution in Science*, but even he did not quite clear up the meaning of the term "economic" as used in this context.

To read as much consistency as possible into the Marxist system, it must be assumed that those changes which are regarded as basic to all others are physical and for the most important part. technological. Technological progress. although its speed is influenced by political. legal and other developments in the "superstructure." is very nearly irreversible. Under all sorts of institutional arrangements and irrespective of prevailing religious creeds and philosophies. man has improved his control over nature. although with varying degrees of effectiveness. This gradual perfection of technology depends on physical experiment and its mathematico-philosophical interpretation. Since the results can be recortied— either in memory and tradition or in books and laboratory files—the stock of knowledge about nature is certain to grow. anti thus technology moves along a one-way road: toward greater human command over nature. To the extent that the social consequences of this movement can be foreseen. the Marxist claim to forecasts of social evolution has indeed a firm foundation.

The assumption that Marx meant physical change when he designated economic change as basic to all social evolution is supported by a number of examples through which Marx and Engels tried to elucidate their basic proposition. This version of the economic interpretation of history is accepted by some Marxist writers, especially George Plekhanov and Nicolai Rukharin, but rejected by others. for instance by Sidney Hook.

Whatever version is accepted, one weakness' remains in the economic interpretation of history. True as it is that we think in a particular may because we happen to live in an age with a particular state of technology, we also think as we do because the dominant ideas of the present age were preceded by other ideas which had exhausted their fruitfulness or were discovered to be nithout an adequate basis in facts. The Renaissance folloned the middle ages not merely because improved shipping and perfection of all sorts of tools had increased trade, improved the crafts, opened new sea lanes and led to new discoveries. and thereby created a new type of man, but also because men by mere intellectual and spiritual effort had found the limitations of medieval thinking and feeling. The economic interpretation of history overstates its case by denying that man's intellectual and spiritual development possesses any autonomy; but this part of Marxism has greatly enriched all social sciences by drnning attention to technological progress as a cause of some very important aspects of cultural and institutional development.

The economic interpretation of history, although called "historical materialism" by Marx himself and many Marxists, has no essential relationship to philosophical materialism, and only a vague analogy exists between the two concepts.

Dialectics.—Marx tended to believe that all important historical progress is achieved through an all-out conflict between an old and a new principle of social organization, and that consequently progress would be impeded if the tension between these two principles were "prematurely" reduced by limited reforms of the old system. This belief is based on dialectic philosophy, which Marx took over directly from the German philosopher Hegel and indirectly from ancient Greek philosophers. For the consistent Marxist dialectician. straight-line, gradual progress can never lead to worthwhile results; for him. reforms represent progress only if they operate as a foreign body within the existing system and thus accelerate its death, for instance, when taxation of profits within a capitalist system is raised so high as to destroy entrepreneurs' incentive. Since true reform, which does not destroy the present system but gradually transforms it, is ruled out, revolution becomes necessary. and to a consistent believer in dialectics the suffering and sacrifices of violent change constitute the price that mankind has to pay to have any essential progress at all.

This was the philosophy that Marx professed. but he failed to show complete consistency in dealing with its implications. Apparently he was not prepared to rule out peaceful progress unconditionally. and he may also have found it difficult to reconcile dialectic philosophy with the economic interpretation of history. since technological progress is the very model of "straight-line" gradual evolution.

Class **Struggle.**—Marx stressed the obvious truth that social groups have conflicts of interest that are often reflected in antagonistic political creeds. He tends to go beyond this truism by implying that the classes have no common interests at all, and that their struggle, in which he sees the great motive power of history. is essentially illimitable.

The basis of this more far-reaching belief is the connection Marxism established between the class struggle concept and dialectic philosophy. In the course of history, Marx saw each principle of social organization represented by a social class: feudalism by the nobility, capitalism by the entrepreneurs, socialism by the norkers. The struggle of the classes is identical with the dialectic conflict of organizational principles. Consequently, the class struggle is governed by the law of dialectics; it is necessarily an all-out conflict—it cannot be limited by the rules of democracy, which substitute "ballots for bullets" and require respect for the inalienable rights of the opponent. The victory of the new class must be followed by repression of the former ruling class until the last vestiges of the old order are extinguished. In the struggle of the workers against the capitalists, this repression will result in the "dictatorship of the proletariat," as the political form of society in the period of transition from capitalism to full communism.

As Marx was not a consistent dialectician, he wrote many passages that are incompatible with the belief in the illimitable class struggle. There exists, therefore. a cleavage in the Marxist system betneen the belief in democratic evolution and the contrary belief in the inevitability of revolution ending in dictatorship. This cleavage has transmitted itself to Marx's disciples and is reflected by the conflict betneen the supporters of democratic socialism. many of whom still treasure the Marxist tradition, and those of modern Communism. Intermediate positions between these two extremes were once held by writers like Kautsky, but this old Marxist "Centre" has in the main joined the democratic camp Some developments within the Communist camp. especially but not exclusively in Poland and Yugoslavia, indicate a possibility that a new Marxist centre may arise.

Labour Value **Theory.**—Marx accepted the explanation of value as given by the classical economists of his day, especially David Ricardo (q *v.*). According to the classical doctrine, the value of a commodity depends on the amount of labour time necessary for its production. Marx applied this theory with some refinements to human labour power. According to him a worker's labour power is sold like any other commodity, at a price determined by the labour time necessary to produce it (the time necessary to produce the means of subsistence and education). Labour power, however, is the only commodity that can produce a value greater than its own, because a worker can work more hours than are necessary to keep him alive and in a position to reproduce his kind The product of this "surplus labour" is called "surplus value" and is appropriated by the employer who has acquired the legal right to the full use of labour power by paying the worker the labour-time value of that power. This surplus value is the source of all nonwage income: profit, rent and interest. The purchase of labour power at a price corresponding to its labour-time value and therefore inevitably smaller than the labour-time value of the products is called "exploitation of labour" by Marx—a term which, according to hlarx's own allegation. was not intended as an ethical condemnation but which he nevertheless often used in a sense implying a moral judgment.

In elaborating the theory that "exploitation of labour" is the only source of profit, (in the third volume of Das *Kapital*), Marx ran into difficulties that caused him to deviate from the logical consequences of the labour value theory on which he had based his initial propositions. This widely discussed self-contradiction, however, merely adds one more argument to the body of proofs by which modern theory has refuted the explanation of value from labour time. Yet the labour theory of value. and its derivative, the surplus value theory, cannot be eliminated from the Marxist system as some recent Marxists and semi-Marxists have suggested, for these theories are indispensable for the support of the proposition that capitalism is doomed by objective economic necessity —a proposition that belongs to the very essence of Marxism.

Since all profit results from "exploitation of labour," the rate of profit—the amount per unit of total capital outlay—depends largely on the number of workers employed Machines cannot be "exploited": they can therefore not contribute to total profits, although they help labour produce more useful things. Only payroll capital—"variable capital"—is productive of surplus value and consequently of profit. The introduction of machines is profitable for the individual entrepreneur. to whom they give an advantage over his competitors, but as outlay for machinery grows in relation to outlay for wages, profit declines in relation to total capital outlay. The capitalist will receive less and less per hundred dollars of capital and can only try to postpone his bankruptcy by pressure upon the norkers; finally, the "capitalist class becomes unfit to rule, because it is incompetent to assure an existence to its slave nithin his slavery." Consequently the system collapses and the working class inherits the power.

Theory of Alienation.—One of the many subsidiary doctrines contained in Marx's writings has recently attracted much interest: the contention that, for the worker under industrial capitalism, work is merely a means to protect himself from starvation, whereas for the medieval craftsman, or even the peasant, work was also means of self-expression. To the extent that this "alienation" of man from his work really exists, it is obviously a result of the fragmentation of the work process through division of labour. Marx does not wish to return to medieval methods of production, but he believes that modern technology when freed from the fetters of capitalist profit calculation will liberate modern man from the tie to one particular occupation, will permit him to change his activities frequently enough to make him visualize every phase of his work as part of the social process of production and thus find new satisfaction. There is nothing in technological development, however, or in collectivist experience since Marx's days to support these particular expectations; on the other hand. the replacement of manual labour by machines in some of the most tedious jobs and the shortening of the working day have certainly alleviated the alienation problem.

Appraisal of Marxism. — In spite of its weaknesses, Marxism has played a role greater than any other recent system of social philosophy; its effects cannot be summarized by a simple formula. Marxism has strengthened the workers' movement which has been the greatest single force operating for social justice; it has reconciled the workers to modern technology, imbued them with a great respect for intellectual accomplishment and strengthened their desire for education; more effectively than any other school, it has called attention to the role of economic and especially of technological factors in history. On the other hand, it has supplied totalitarian enemies of freedom with important intellectual weapons. Marxism is the only admissible social doctrine in the Soviet Union and the "People's Democracies," although more recently the inadequacies of the labour value theory as a basis for rational planning have caused important, if tacit. modifications of Marxism.

Austro-Marxism.—In its orthodox form, Marxism denies the existence of any "super-class ethics": all moral rules are considered reflections of the social position of either the dominant class or of the oppressed class. In opposition to this view, an effort was made, mainly by Austrian socialists, to return to the pre-Marxian idea that the socialist postulates should be based on an ethical code binding on all humanity while most other elements of Marxist thought were retained. This open acknowledgment of the ethical basis of socialism was incompatible with the more extreme versions of the class struggle concept, since ethical rules which determine the ultimate ends of a movement also have a bearing on the legitimacy of means. Austro-Marxism might therefore have supplied the right-wing of the socialist movement with a badly needed theoretical basis, but most of the Austro-Marxists, as, for instance, their most prominent leader, Otto Bauer, kept politically close to the Marxist centre group.

Neo-Marxism. — In his analysis of capitalism, Marx had been concerned almost exclusively with a highly competitive kind of capitalist system in which the entrepreneurs were in the main opposed to state intervention. The decades after Marx's death produced a kind of capitalism that was permeated with monopoly and in which the majority of businessmen desired state intervention for the protection of monopolies, for protective tariffs and for the opening of foreign markets and promotion of foreign investments. A number of Marxists writers tried to modify Marxist theory in order to account for these new facts and to exploit them for the strengthening of Marxist policy arguments.

The first of these Neo-Marxists was Rudolf Hilferding (*q.v.*) who in his book *Das Finanzkapital* (1910) maintained that the increasing influence of the banks over industry was mainly responsible for cartelization — because the banks wanted to prevent their industrial customers from ruining each other through competition — and also for the search for foreign capital outlets. For the latter phenomenon, Rosa Luxemburg (*q.v.*) offered a new explanation in her book *Die Akkumulation des Kapitals* (1913). From Marx's discussion of the interdependence of consumer and producer goods industries she drew the conclusion that capitalism was threatened with a glut of consumer goods and maintained that this threat was the motive power behind the imperialist ventures of capitalist states—ventures which she regarded as temporarily successful but necessarily futile in the end. Fritz Sternberg, in his book *Der Imperialismus* (1926), tried to clear up the many obscurities in Luxemburg's reasoning and supplemented it with an argument which, from a Marxist point of view, seemed more convincing: since the colonial areas use more manual labour and less machinery. the decline of the rate of profit has not advanced as far there as in the old industrial countries; therefore. investment in colonies and semicolonies offers the western capitalists a temporarily higher profit rate. This latter argument was further expounded by the Polish writer Henryk Grossmann in his book *Das Akkumulations-und Zusammenbruchsgesetz des kapitalischen Systems* (1929). Finally, Evelyn John St. Loe Strachey gave a comprehensive presentation of the Neo-Marxist theory of imperialism and capitalist doom in his book The *Nature of Capitalist Crisis* (1935), using mainly the argument of the higher profit rate in the noncapitalistic areas.

The historic significance of Neo-Marxism rests upon its utilization by Lenin in his book *Imperialism, the Highest State of Capitalism* (1916). Lenin did not commit himself to the details of Rosa Luxemburg's analysis but took from it the general idea that western capitalism had prolonged its life by expanding into colonial areas; he drew the conclusion that capitalism would perish if deprived of its colonial domains. Under the spell of this thought, Bolshevism staged its anti-imperialist campaign in which it achieved major successes but also encountered conflicts with the rising nationalism of the ex-colonials — conflicts which seem to increase as "capitalist" imperialism becomes a thing of the past.

See also CAPITALISM; LENIN; MARX, KARL HEINRICH; STALIN, JOSEPH VISSARIONOVICH.

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MARY, the mother of Jesus. Out of the sparse details of her life as portrayed in the Gospels, Christian piety and theology have constructed a picture that fulfills the prediction ascribed to her in the Magnificat (Luke i, 48): "Henceforth all generations will call me blessed."

It would be impossible to write a biography of Mary based upon biblical accounts., in spite of the fact that the span of time covered by those accounts is longer than the life of Jesus. The first mention of her is the story of the annunciation, which reports that she was living in Nazareth (Luke i, 26 ff.); the last mention of her (Acts i, 14) includes her in the company of those who devoted themselves to prayer after the ascension. Between these two references are several scenes of a rather occasional character. the visit with Elizabeth. her cousin and the mother of John the Baptist (Luke i, 39 ff.); the birth of Jesus and the presentation (Luke ii, 1 ff.); the coming of the Magi and the flight to Egypt (Matt. ii, 1 ff.); the Passover visit to Jerusalem (Luke ii, 41 ff.); the marriage at Cana in Galilee (John ii, 1 ff.); the attempt to see Jesus while he was teaching (Mark iii, 31 ff.); the station at the cross, where. apparently widowed, she mas entrusted to John (John xix, 26 ff.). Even those interpreters for whom these scenes have represented a series of literal historical accounts have found it difficult to draw a portrait of Mary on the basis of them.

But since the early days of Christianity. the themes which these scenes symbolize have been the basis for thought and contemplation about Mary, developing and expanding through the centuries. Christian communions and theologians differ from one another in their interpretation of Mary principally on the basis of where they set the terminal point for such development and expansion. To a considerable degree, therefore. a historical survey of that development is also an introduction to the state of contemporary Christian thought about Mary.

Guarantee of the Incarnation.— Probably the earliest allusion to Mary in Christian literature is the phrase "born of a woman" in Gal. iv, 4. As parallels like Job xiv, 1 and Matt. xi, 11 suggest. the phrase is a Hebraic way of speaking about the essential humanity of a person. When applied to Jesus. therefore. it was intended to assert that he was truly a man, in opposition to the attempt, later seen in the Docetae (*q.v.*), to deny that he had a completely human life. It seems unwarranted to read anything further into the phrase, as though "born of a woman" necessarily implied "but not of a man and a woman." Thus the phrase made of Mary the guarantee of the reality of the incarnation. For the ancient world, one human parent was necessary to assure that a person was genuinely human, and one of the roles assigned to Mary from the beginning has been that of providing this assurance. Some historians have even maintained that the primary connotation of the phrase "born of the Virgin Mary" in the Apostles' Creed was this same insistence by the church upon the reality of the incarnation. That insistence has been the irreducible minimum in all the theories about Mary that have appeared in Christian history. Those who deny the virgin birth usually claim to do so in the name of this insistence upon true humanity. Those who defend the virgin birth usually maintain that the true humanity was made possible when the Virgin accepted her role as the guarantee of the incarnation (Luke i, 38): "Let it be done to me according to thy word." This is the original source of the title "coredemptress" assigned to Mary in Roman Catholic theology, though the term has come to connote a more active participation by the Virgin in the redemption of mankind; the precise nature of this participation is still a matter of controversy among Catholic theologians.

Virgin Mother.— By far the most voluminous narratives about Mary in the New Testament are the infancy stories in Matthew and Luke. In their present form, both accounts make a point of asserting that Jesus was conceived in the womb of Mary without any human father (Matt. i. 18 ff.; Luke i, 34 ff.); the many textual variants in Matt. i, 16, some of them with the words "Joseph begat Jesus," have caused some scholars to question whether such an assertion was part of Matthew's original account. The most voluminous discussions of Mary in postbiblical Christian literature have also been those dealing with her virginity. The narratives in Matthew and Luke seem to be the only references to the matter in the New Testament, unless John i. 13 is taken to read ". . . who was born" rather than ". . . who were born." On the basis of these narratives, it was the unanimous teaching of all the orthodox fathers oi the church that Mary conceived her Son with her virginity unimpaired, a teaching enshrined in the Apostles' Creed and concurred in by the classical Reformers as well as by most Protestant believers since the Reiormation. Only with the rise of Protestant theological liberalism did this teaching begin to lose the universal support it had enjoyed. One of the major points in the attack by iundamentalism (*q.v.*) upon this liberalism was its insistence upon the literal accuracy of all the miracle stories in the Bible, including and especially those dealing with the miraculous conception of Jesus.

Mother of God.—The first major theological controversy over Mary had to do with the propriety of applying to her the title of *Theotokos*, ',God-bearer" or "mother of God." The title itself was a logical deduction from the dogma of the full deity of Christ as this was established during the 4th century, and those who defended that dogma were also the ones to draw the deduction. By the end of the 4th century, therefore, it had successfully established itself in various sections of the church. Because it seemed to him that the supporters of the title were confounding the divine and the human in Christ, Nestorius objected to its use. preferring the less explicit title *Christotokos*. Along with other aspects of his teaching. Nestorius' objections were condemned at Ephesus in 431, and *Theotokos* was unconditionally approved. In the devotion of Eastern Christendom the *Theotokos* (Russian *Bogoroditsa*) has played a major role, also becoming one of the favourite subjects for icon painters. Through its incorporation in the Ave Maria, the title "mother of God" has been circulated throughout western Catholicism. By the approval it received in both Lutheran and Reformed confessions during the period of the Reiormation. the title assured itself a place in the theology. if not in the piety. of orthodox Protestantism. It is as mother of God that the Virgin is also termed mediatress. The official teaching of the Roman communion has sought to make clear that this latter term is not intended to detract from the glory of Christ as sole Mediator, but that Mary mediates between Christ and mankind as she did at Cana in Galilee (John ii. 3).

Ever Virgin.— One corollary that could be deduced from the New Testament assertion of Mary's virginity in the conception of Jesus was the doctrine of her perpetual virginity. not only "before birth" but "in birth and after birth." to use the usual phrases. The Apostles' Creed appears to teach at least her virginity "in birth" when it says "born of the Virgin Mary." Although the earliest mention of the doctrine occurs in the apocryphal Protevangelium Jacobi. its origins and extent are not easy to trace, Roman Catholic historians and Protestant historians coming to contradictory conclusions. The doctrine had no explicit warrant in the Sew Testament. and Old Testament passages such as Ezek. xliv. 2 and Song of Sol. iv, 12 were probably convincing only to those who already believed the doctrine. In addition, the doctrine posed two problems of biblical interpretation. both of which were discussed in detail by defenders of the doctrine from Jerome to Luther. To the argument from words such as "until" (Matt. i. 25), "before" (Matt. i. 18) and "first-born" (Luke ii, 7) that Mary must have borne further children, the defenders of the perpetual virginity have replied that none of these words speaks at all about what followed: an only child is a first-born child, and a man who "died before repenting of his sins" did not necessarily repent thereafter. The other biblical problem was that oi the "brothers" of Jesus referred to in I Cor. ix, 5, Gal. i, 19, and several times in the Gospels and in Acts. Defenders of the perpetual virginity have explained these either as "kinsmen" or as children of Joseph by a previous marriage or as children of another Mary and of Cleophas. Partly because of these problems, the doctrine of the perpetual virginity of Mary has not been supported as unanimously as has the doctrine of the virginal conception or the title "mother of God." It achieved dogmatic status at the Council of Chalcedon in 451, and is therefore binding upon Eastern Orthodox and Roman Catholic believers; in addition, it is maintained by many Anglican, some Lutheran and a few Protestant theologians.

Immaculate.—As the doctrine of her perpetual virginity implied an integral purity of body and soul, so, in the opinion of many early theologians, she was also free of other sins. In a discussion aimed at proving the universality of sin, Augustine spoke for the western church when he wrote: "We must except the holy Virgin Mary. Out of respect for the Lord, I do not intend to raise a single question on the subject of sin. After all, how do we know what abundance of grace was granted to her who had the merit to conceive and bring forth Him who was unquestionably without sin?" (*Nature and Grace*, ch. 36). But it was the distinction between original sin and actual sin, firmly established in western theology by the same Augustine, that eventually compelled a further clarification of what the sinlessness of Mary meant. Certain eastern theologians in the 4th and 5th centuries were willing to attribute actual sins to her, but most theologians in both east and west came to accept the view that she never did anything sinful, a view that found expression even among the Reformers. But was she free from original sin as well? And if so, how? Thomas Aquinas took a representative position when he taught that her conception was tarnished, as was that of all men, but that God suppressed and ultimately extinguished original sin in her, apparently before she was born. But this position was opposed by the doctrine of the immaculate conception (*q.v.*), systematized by Duns Scotus and finally defined as Roman Catholic dogma in 1854. According to this dogma, Mary was not only pure in her life and in her birth, but "at the first instant of her conception was preserved immaculate from all stain of original sin, by the singular grace and privilege granted her by Almighty God, through the merits oi Christ Jesus, Savior of mankind."

Assumed Into Heaven.--When the immaculate conception was promulgated, petitions began coming to the Vatican for a definition regarding the assumption oi the Virgin into heaven, as this was believed by most Roman Catholics and celebrated in the feast of the assumption (*q.v.*). During the century that folloned, more than 8,000,000 persons signed such petitions; yet Rome hesitated, the doctrine being difficult to define on the basis of Scripture and early witnesses to Christian faith. No account of the place and circumstances of Mary's death was generally accepted in the early church, no burial place acknowledged, and no miracles credited to relics of her body. But such arguments from silence did not suffice to establish a dogma, and on the positive side even the earliest doctrinal and liturgical tradition appeared relatively late in history. Pope Pius XII made the dogma official in 1950, declaring "that the immaculate mother of God, the ever Virgin Mary, when the course of her earthly life was run! was assumed in body and in soul to heavenly glory." As it was formulated, the dogma left open to speculation the question of Mary's death.

In addition to these official titles and roles assigned to her by Catholic Christianity, the Virgin has served to symbolize the redemption of the life of nature and to provide a bridge between Christianity and those religions of nature that have spoken of this redemption. In the secular life and literature of the west since the day of the *Minnesänger,* she has symbolized the nobility of woman. Even those non-Roman churches which have most vigorously criticized the "Mariolatry" they claimed to find in the dogmas of the immaculate conception and the assumption have frequently addressed praises to her in their hymnody that they would have hesitated to express in the prose of their dogmatic theology. Thus, in ways she could never have anticipated, all generations have called her blessed.

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(J. J. Px.)

MARY I (*1 j16–I*j58), queen of England. unpleasantly remembered as "Bloody Mary" because of the religious persecutions which occurred during her reign. was the daughter of Henry VIII and Catherine of Aragon. . Mary was born at Greenwich, on Monday, Feb. 18, 1516. and she was baptized on the following Wednesday, Thomas Cardinal Wolsey standing as her godfather. She seems to have been a precocious child and is reported in July 1520, when scarcely 4½ years old, as entertaining some visitors by a performance on the virginals. When she was little over nine, she was addressed in a complimentary Latin oration by commissioners sent over from Flanders on commercial matters and replied to them in the same language "with as much assurance and facility as if she had been twelve years old." Her father was proud of her achievements. About the same time that she replied to the commissioners in Latin. he was arranging that she should learn Spanish. Italian and French. A great part, however, of the credit of her early education was undoubtedly due to her mother, who not only consulted the Spanish scholar Juan Luis Vives upon the subject but was herself Mary's first teacher in Latin.

When Mary was two years old. she was proposed in marriage to the dauphin, son of Francis I. Three years later the French alliance was broken off and in 1522 she was affianced to her cousin, the young emperor Charles V, by the treaty of Windsor. In 1525, however. after his great victory over Francis at Pavia, Charles released himself from this engagement and made a more convenient match.

Later in the same year Mary was given an establishment of her own and was sent to Ludlow with a council which was designed to secure the better government of the Marches of Wales. For several years she accordingly kept her court at Ludlow, while new arrangements were made for the disposal of her hand. She was now proposed as a wife. not for the dauphin as before, but for his father Francis I, who had just been redeemed from captivity at Madrid, and who was only too glad of an alliance with England to mitigate the severe conditions imposed on him by the emperor.

When the Anglo-French alliance was finally concluded, however, by a treaty dated Westminster. April *30,* 1527, it was provided that Princess Mary should be married either to Francis himself or to his second son Henry, duke of Orléans.

It was immediately after this treaty that Henry VIII began the proceedings for his "divorce" from Catherine that were to make the next nine years perhaps the most miserable period of Mary's life. From the end of *1 j31* mother and daughter were kept apart. Possibly Queen Catherine had the harder trial; but Mary's was scarcely less severe. On the birth of Anne Boleyn's daughter Elizabeth (Sept. *1533).* Mary was required to give up the dignity of princess and acknowledge the illegitimacy of her own birth. On her refusal her household was broken up, and she was sent to Hatfield to act as lady-in-waiting to her own infant half-sister. Nor was even this the worst of her trials; she feared that her very life was in danger from the hatred of Anne Boleyn.

Mary's health, moreover, was indifferent, and even when she was seriously ill. although Henry sent his own physician. Dr. Buttes. to attend her, he declined to let her mother visit her. At her mother's death, in Jan. *1*536, she was forbidden to take a last farewell of her.

But in May following another change occurred. Anne Boleyn, her bitterest enemy, fell under the king's displeasure and was put to death. Mary was then urged to make a humble submission to her father as the means of recovering his favour and after a good deal of correspondence with the king's secretary. Thomas Cromwell. she eventually did so. The terms exacted of her were bitter in the extreme. but Mary, alone and at the mercy of her imperious father, at length subscribed an act of submission, acknowledging the king as "Supreme Head of the Church of England under Christ." repudiating the pope's authority, and confessing that the marriage between her father and mother "was by God's law and man's law incestuous and unlawful."

Henry was now reconciled to her and gave her a household in some degree suitable to her rank. During the rest of the reign her position was less difficult. She appeared at the court and a number of new marriage projects for her were made; though all of them came to nothing. Her privy purse expenses for nearly the whole of this period have been published and show that Hatfield, Beaulieu or Newhall in Essex. Richmond and Hunsdon were among her principal places of residence. Although she was still treated as of illegitimate birth. in 1j44 she was restored by statute to a position in the succession next after Edward and any other legitimate children who might be born to the king, but under conditions to be regulated by Henry's will.

During the reign of her brother. Edward VI, Mary was again subjected to severe trials. which at one time made her seriously meditate escaping abroad. Edward himself indeed seems to have been personally kind to her, but the religious innovations of his reign soon brought her into conflict with the government. She had done sufficient violence to her own convictions in submitting to a despotic father and was not disposed to yield an equally tame obedience to authority exercised by a factious council in the name of a younger brother not yet come to years of discretion. Besides, the cause of the pope was naturally her own. In spite of the declaration formerly wrung from herself. most people did not regard her as a bastard although the full recognition of her rights implied the recognition of the pope as head of the church. Hence, when in 1549 Edward's parliament passed an Act of Uniformity enjoining services in English and communion in both kinds, she insisted on having mass in her own private chapel under the old form. When ordered to desist, she appealed for protection to her cousin, the emperor Charles V, who intervened for some time not ineffectually. threatening war with England if her religious liberty was interfered with.

But Edward's court was composed of factions of which the most violent eventually carried the day. Lord Seymour, the admiral, was attainted of treason and beheaded in 1549. His brother. the protector Somerset, met with the same fate in 1552. John Dudley, duke of Northumberland, then became paramount in the privy council and easily obtained the sanction of the young king to those schemes for altering the succession which led immediately after Edward's death (July 6. 1jj3) to the usurpation of Lady Jane Grey. Dudley had, in fact, overawed the rest of the privy council, and when Edward died, he took such energetic measures to give effect to his scheme that Lady Jane was actually recognized as queen for some days, and Mary had to flee from Hunsdon into Norfolk. But the country was devoted to her cause, as indeed her right in law was unquestionable, and before many days she was royally received in London and took up her abode within the Tower.

Her first acts as queen displayed a character very different from that which she still holds in popular estimation. Her clemency toward those who had taken up arms against her was remarkable. She released from prison Lady Jane's father, the duke of Suffolk. and had difficulty even in signing the warrant for the execution of Northumberland. Lady Jane herself she fully meant to spare. and did spare till after Sir 'Thomas Wyatt's formidable insurrection in 1554. Her conduct. indeed, was in most respects conciliatory and pacific, and so far as they depended on her personal character the prospects of the new reign might have appeared altogether favourable.

But her position was one of peculiar difficulty, and the policy on which she determined was far from judicious. Inexperienced in the art of governing. she had no trusty councillor but Stephen Gardiner, bishop of Winchester; and she was naturally led to rely even more on the advice of her cousin, the emperor, who had been her mother's friend in adversity and had done such material service to herself in the preceding reign. Following the emperor's guidance she determined almost from the first to make his son Philip her husband. though she was 11 years his senior. She was also strongly desirous of restoring the old religion and wiping out the stigma of illegitimacy upon her birth.

Of all these objects her marriage mas the most unpopular. Restoration of the old religion might deprive the new owners of abbey lands of their comfortable acquisitions; and it was only with an express reservation of their interests that the thing was actually accomplished. A declaration of her own legitimacy necessarily cast a slur on that of her sister Elizabeth and cut her off from the succession. But the marriage promised to throw England into the arms of Spain and place the resources of the kingdom at the command of the emperor's son.

The commons sent her a deputation to entreat that she would marry an Englishman, and when her resolution became known early in 1554, insurrections broke out in different parts of the country. Suffolk, whose first rebellion had been pardoned. proclaimed Lady Jane Grey again in Leicestershire, while Wyatt raised the county of Kent and, though denied access by London bridge, led his men around by Kingston to the very gates of London before he was repulsed. In the midst of the danger Mary showed great intrepidity, and the rebellion was presently quelled. Thereupon she married Philip (July 25, 1554), restored the old religion and admitted Cardinal Pole to absolve the kingdom from its past disobedience to the Holy See (Nov. 30, 1j54).

It was a more than questionable policy thus to ally England with Spain—a power then actually at war with France. By the treaty, indeed, England was to remain neutral; but in the end it was drawn into the quarrel. Meanwhile the country was full of faction, and seditious pamphlets of Protestant origin inflamed the people with hatred against the Spaniards. Philip's Spanish followers met with ill-usage everywhere, and violent outbreaks occurred. A year after his marriage Philip went over to Brussels to receive from his father the government of the Low Countries and afterward the kingdom of Spain. To Mary's distress, his absence was prolonged for a year and a half, and when he returned in March 1jj7 it was for the purpose of getting England to declare war on France. As soon as this purpose was achieved he went back to Brussels (in July) to return no more to England.

In spite of the encouragement that France had given to disaffection among Mary's subjects, there had been strong opposition to Philip's demands among Mary's advisers. But an attempt by Thomas Stafford and other English refugees in France to seize Scarborough played into her hands, and she was able to declare war against the French on June 7, 1j57. In this war Mary found herself opposed by the pope, who took part with France against Spain; Scotland. too, soon declared war upon her: and on Jan. 5, 1558, she suffered the final calamity of the loss of Calais.

The persecution of the Protestants, which has cast so much infamy upon her reign. did not begin until Mary had been more than a year and a half on the throne. When the kingdom was reconciled to Rome and absolved by Cardinal Pole. it n-as natural and logical that the old heresy laws should be revived. as they were then by act of parliament. But Mary must bear the final responsibility for the severity of their enforcement, which was unprecedented in England.

Merciful and kindly by nature, she yet seems to have felt that the Protestants' stern fanaticism and ill-will to the old religion made them dangerous, even to the public peace; and that the persecution was necessary if the old faith were to be preserved in England. John Rogers, the first of the martyrs. was burned on Feb. 4, 1555. John Hooper, bishop of Gloucester, had been condemned six days before and suffered the same fate upon the 9th. From this time the persecution went on uninterrupted for three years and three-quarters. numbering among its victims Nicholas Ridley, Hugh Latimer and Thomas Cranmer. It came to an end at last on the death of Mary. Nearly 300 victims are known to have perished at the stake; and their fate created a revulsion against Rome that nothing else was likely to have effected.

Mary was of weak constitution and subject to frequent illnesses, both before and after her accession. One special infirmity caused her to believe a few months after her marriage that she was with child, and thanksgiving services were ordered throughout the diocese of London in Nov. 1554. The same delusion recurred in April 1558, when though she did not make her expectation public, she drew up a will in anticipation of the dangers of childbirth. constituting her husband regent during the minority of her prospective heir. To this she added a codicil on Oct. 28 following, when the illness th t was to be her last had set in. showing that she had ceased to have much expectation of maternity. and earnestly entreating her "next heir and successor by the laws" (whom she did not name) to allow execution of the instrument. She died on Nov. 17. 1j58.

Her name perhaps deserved better treatment than it has generally met with; for she was not by nature cruel. Her kindness to the poor is undoubted. and the severe execution of her laws seemed to her a necessity. Moreover. she was alive to the injustice with which the law was usually strained in behalf of the prerogative; and in appointing Sir Richard Morgan chief justice of the common pleas she charged him "not to sit in judgment otherwise for her highness than for her subjects." and to avoid the old error of refusing to admit witnesses against the crown.

Mary's conduct as queen was governed by the best possible intentions; and it is evident that her religious zeal caused most of the trouble she brought upon herself. Her subjects were entirely released, even by papal authority. from any obligation to restore the confiscated lands of the church. But she herself made it an object, at her own expense, to restore several of the monasteries; and courtiers who did not like to follow her example encouraged the fanatics to spread an alarm that it would even yet be made compulsory. So the worldly minded joined hands with godly heretics in stirring up enmity against her. Her unpopular foreign marriage and the national humiliations which followed upon it made their task all too easy.

See Sir Frederic Madden, Introduction to *The Privy Purse Expenses of the Princess Mary* (London, *1831*); J. M. Stone, *History of Mary I, Queen of England* (London, 1901); H F. M Prescott, *Mary Tudor* (rev. ed. of *Spanish Tudor*) (London, 1952). (J. GAI.; R. B WM.)

MARY II (1662–1694), queen of England. wife of king William III, elder daughter of James, duke of York, afterward King James II, by his first wife, Anne, daughter of Ednard Hyde, 1st earl of Clarendon. was born in London on April 30, 1662. She was educated as a Protestant, and as it was probable that she would succeed to the English throne after the deaths of her uncle, Charles II. and her father, the choice of a husband for her was an important political event. About 1672 the name of William, prince of Orange. was mentioned in this connection; and after some hesitation on both sides caused by the condition of European politics. the betrothal of William and Mary took place in Oct. 1677 and was quickly followed by their marriage in London on Kov. 4.

Mary's married life in the Netherlands does not appear to have been a happy one. She soon became very popular among the Dutch, but she remained childless. Her troubles were not diminished after her father became king of England in 1685. James had treated his daughter very shabbily in money matters; and it was increasingly difficult for her to remain loyal to both father and husband when they were so divergent in character and policy. Mary shared heartily in the events which immediately preceded William's expedition to England in 1688.

After the success of the undertaking she arrived in London in Feh. 1689; and by her faithful adherence to her promise that William should always bear rule made a satisfactory settlement of the English crown possible.

William and Mary were together proclaimed king and queen of England, and afterward of Scotland. and were crowned on April 11, 1689. During the king's absence from England the queen. assisted by a committee of the privy council, was entrusted with the duties of government. duties which she performed faithfully: but which she gladly laid down on William's return. In these times of danger, however, she acted when necessary with courage and promptitude, as when in 1690 she directed the arrest of her uncle Henry Hyde. 2nd earl of Clarendon; but she was constantly anxious for William's safety, and unable to trust many of her advisers.

Mary was distressed by a quarrel with her sister Anne that in 1692 resulted in the dismissal of Marlborough. This somewhat diminished her popularity, which had hitherto been one of the mainstays of the throne.

Weak in body and troubled in mind, the queen died at Kensington palace from smallpox on Dec. 28, 1694, and was buried in Westminster abbey.

Mary was a woman of a remarkably modest and retiring disposition, whose outstanding virtue was perhaps her unswerving loyalty to William. Burnet has passed a remarkable panegyric upon her character. She was extremely pious and charitable; her blameless private life was in marked contrast with her surroundings, both in England and the Ketherlands; without bigotry she was greatly attached to the Protestant faith and to the Church of England. Greenwich Hospital for Seamen was founded in her honour.

For the political events of Mary's life *see* WILLIAM III. For her private life *see* N. M. Waterson, *Mary II, Queen of England* (Durham, N.C., and Cambridge, 1928) ; G. M. V. Campbell Long (M. Bowen, pseudonym). *The Third Mary Stuart* (London. 1929) ; Hester Chapman, *Mary II, Queen of England* (London. Toronto, 1953).

MARY (VICTORIA MARY AUGUSTA LOUISA OLGA PAULINE CLAUDINE AGNES) (1867–1953), consort of George V (*q.v.*), was born on May 26. 186;. at London. She was the eldest child of Francis, prince (later duke) of Teck. of the royal house of Württemberg, and of Princess Mary of Great Britain, a granddaughter of George III. Born in Kensington palace, she spent her childhood and girlhood in London.

From the age of 16 to 18 she lived in Florence and there acquired that taste for the arts which was to distinguish her throughout life. In 1891 she became engaged to the elder son of the prince of Wales, the duke of Clarence. who died a few weeks before the marriage was to have taken place. A year later her engagement was announced to the duke's younger brother, afterward George V. They were married on July 6, 1893. As duchess of York (during Queen Victoria's reign) and princess of Wales (during Edward VII's reign) she was active with her husband in a variety of public duties, including a journey to Australia in 1901, for the opening of the federal parliament, and a long tour in India during 1905.

With the accession of King George in 1910 she became queen, and brought to her high position gifts of taste and intellect which quickly made their mark on court life. Her bearing showed how accurate Queen Victoria had been when she wrote that May (the name by which Queen Mary was known in the family circle) was so sensible and distinguée. Her good taste showed itself in the mastery of the royal collections and her anxiety that they should be displayed to the best advantage. In the 1920s she encouraged the publication of an account of the inside of Buckingham palace.

During World War I the queen was especially concerned with the welfare of servicemen and with nursing and after the war appeared increasingly in public, particularly after the decline of the king's health in 1928. His gratitude to her was expressed in his speech in Westminster during his silver jubilee in 1935, and the king asked that that passage be placed last in the speech because he was afraid that he might be overcome "when I think of all that I owe her."

In widowhood the queen moved to Marlborough house. To her eldest son. King Edward VIII, she mas singularly devoted, and his abdication was a severe test of her courage. During World War II she retired to Badminton, the home of her niece. the duchess of Beaufort. She became a familiar figure in the nest country, visiting bombed towns and service centres and delighting in giving lifts to soldiers and airmen in her car. In 1945 she resumed her life in London. Her health began to fail after the shock of the death of King George VI in 1952 and although she attended his lying in state in Westminster hall she was thereafter seldom seen in public.

She died at Marlborough house on March 24, 1953.

Although Queen Mary in her dress and manner retained something of the habit of the Victorians—she never made a speech in public and never spoke on the telephone—her spirit moved with the times, and this helps to explain her popularity with all classes.

Queen Mary had five sons—King George VI. the duke of Kent and Prince John; who predeceased her, and the dukes of Windsor and Gloucester, who survived her—and one daughter, the princess royal. (R. T. B. F.)

MARY (1496–1533), queen of France, daughter of Henry VII of England and Elizabeth of York. The treaty of Calais (Dec. 21, 1507) arranged for her marriage with Charles of Austria (Charles V) when the prince reached the age of 14, and the wedding was celebrated by proxy in 1508. The contract was renewed (1513) by Henry VIII, but the emperor Maximilian I was now in treaty for a marriage with Renee of France for his son, and evinced an intention to withdraw from the contract. He was forestalled by Cardinal A'olsey. who arranged, by the peace of 1514, the marriage of Mary with Louis XII of France.

The marriage was celebrated at Xbbeville on Oct. 9. The bridegroom was a broken man of 52; the bride a beautiful. well-educated and charming girl of 18, whose heart was already engaged to Charles Brandon, duke of Suffolk, her future husband. The political marriage was, however. no long one.

Mary was crowned queen of France on Nov. 5, 1514; on Jan. 1, 1515, King Louis died. Mary had only been induced to consent to the marriage with Louis by the promise that, on his death, she should be allowed to marry the man of her choice. But the dukes of Lorraine and Savoy were mentioned as possible suitors. and meanwhile the new king, Francis I, was making advances to her.

Suffolk himself was at the head of the embassy which came from England to congratulate the new king, and he used the opportunity to win the hand of the queen. Mary feared opposition, and, in spite of Suffolk's promise to the king to delay any action until after his return, she persuaded him to marry her secretly before he left Paris. Suffolk was ultimately pardoned through Wolsey's intercession, on payment of a heavy fine and the surrender of all the queen's jewels and plate. The marriage was openly solemnized at Greenwich on May 13, 1515. Mary died on June 24, 1533.

By the duke of Suffolk she had three children: Henry, born on March 11, 1516, created earl of Lincoln (1525), who died young; Frances, born on July 16, 1517, the wife of Henry Grey, marquess of Northampton, and mother of Lady Jane Grey (*q.v.*); and Eleanor.

MARY (QUEEN OF SCOTS)[1] (1542–1587), daughter of King James V. and his wife Mary of Lorraine, was born at Linlithgow in Dec. 1542, a few days before the death of her father. In July 1543 a treaty for the betrothal of the infant to Edward, heir of Henry VIII. of England, was made by the regent Arran, but Henry's obvious ambition to annex the crown of Scotland at once to that of England aroused instantly the general suspicion and indignation of Scottish patriotism. The marriage treaty was denounced by the Scots at the end of the same year, Henry retaliated by invasions of Scotland, and the Scots renewed their ancient alliance with France. In 1548 the queen of five years old was betrothed to the dauphin Francis, and set sail for France, where she arrived on Aug. 15. For the next ten years, the child was under the care of her mother's relatives, the Guises. In April 1558 she was married to the dauphin, and in November of the same year Elizabeth became queen of England. In the eyes of Roman Catholic Europe, Elizabeth's birth mas illegitimate, and Mary was de *jure* queen of England. Henry II. of France ordered his son and daughter-in-law to challenge Elizabeth's claim by assuming the royal arms of England. Civil strife broke out in Scotland between John Knox and the queen-dowager—between the self-styled "congregation of the Lord" and the adherents of the regent—and Elizabeth retaliated by helping the insurgent Protestants against the queen-dowager and her French troops. The war ended with the death of Mary of Lorraine in June 1560. Francis and Mary, who had become king and queen of France, had no efficient representative in Scotland. and the Protestant leaders were in control of the situation. On Aug. 25 Protestantism was proclaimed and Catholicism suppressed in Scotland by a parliament which mas assembled without the assent of the absent queen.

On Dec. 5 Francis II. died; in Aug. 1561 his widow left France for Scotland. The queen arrived in safety at Leith. On Aug. 21 she first met the only man able to withstand her; and their first passage of arms left, as he has recorded, upon the mind of John Knox an ineffaceable impression of her "proud mind, crafty wit and indurate heart against God and His truth." And yet her acts of concession and conciliation were such as no fanatic on the opposite side could have approved. She assented, not only to the undisturbed maintenance of the new creed, but even to a scheme for the endowment of the Protestant ministry out of the confiscated lands of the Church. Her half-brother, Lord James Stuart, shared the duties of her chief counsellor with William Maitland of Lethington, the keenest and most liberal thinker in the country. By the influence of Lord James, in spite of the earnest opposition of Knox, permission was obtained for her to hear mass celebrated in her private chapel—a licence to which, said the reformer, he would have preferred the invasion of ten thousand Frenchmen. Through all the first troubles of her reign the young queen steered her skilful and dauntless way with the tact of a woman and the courage of a man. An insurrection in the north, headed by the earl of Huntly, gave Lord James, whom she created earl of Murray, the opportunity of destroying the influence of the most powerful Catholic nobleman in Scotland (1562).

The question of the queen's second marriage was, meanwhile, occupying the attention of both English and Scottish statesmen. The chief aim of the diplomacy of Mary and Maitland of Lethington was a recognition by Elizabeth of the Scottish queen's claim to succeed her, in default of heirs of Elizabeth's own body. A marriage between Mary and a Habsburg prince was rendered impossible by Elizabeth's threat that, if Mary married a foreign prince, she would be debarred from the English succession. Elizabeth proposed as a suitor to the queen of Scots her own favourite Lord Robert Dudley, the widower if not the murderer of Amy Robsart; but she permitted Mary's cousin, Henry, Lord Darnley, to make a visit to Scotland Darnley's mother, the countess of Lennox, was the daughter of Margaret Tudor, widow of James IV, by her second husband, the earl of Angus, and therefore the next heir to the English throne after Mary herself. She had been born and brought up in England, and had married the earl of Lennox, an exiled Scottish traitor of Mary's minority. Elizabeth knew that a marriage which would unite the two claims to the succession was a probable result of Darnley's visit, but she protested against the marriage. Mary, who had already married her kinsman, in secret, at Stirling Castle, with Catholic rites celebrated in the apartment of David Rizzio, her secretary for correspondence with France, assured the English ambassador, in reply to the protest of his mistress, that the marriage would not take place for three months, when a dispensation from the pope would allow the cousins to be publicly united without offence to the Church On July 29, 1565, they were accordingly remarried at Holyrood. Protestant feeling was aroused, and Murray raised a rebellion. He entered Edinburgh with his forces, but failed to hold the town against the guns of the castle, and fell back upon Dumfries before the advance of the royal army, which was joined by James Hepburn, earl of Bothwell, on his return from a three years' outlawed exile in France. Another new adherent was the son of the late earl of Huntly, to whom the forfeited honours of his house were restored a few months before the marriage of his sister to Bothwell. In Oct. 1565 the queen marched an army of 18 000 men against the malcontents; their forces dispersed in face of superior numbers, and Murray, on seeking shelter in England, was received with contumely by Elizabeth, whose half-hearted help had failed to support his enterprise, and whose intercession for his return found at first no favour with the queen of Scots But the conduct of the besotted boy on whom, at their marriage, she had bestowed the title of king, began at once to justify the enterprise and to play into the hands of all his enemies alike. His father set him on to demand the crown matrimonial, which would at least have assured to him the rank and station of independent royalty for life Rizzio, hitherto his friend and advocate, induced the queen to reply by a reasonable refusal to this hazardous and audacious request. Darnley who professed to be jealous of Rizzio's intimacy with his wife, at once threw himself into the arms of the party opposed to the policy of the queen and her secretary, and the destruction of Rizzio was planned

On March 9 the palace of Holyrood was invested by a troop under the command of Morton, while Rizzio was dragged by force out of the queen's presence and slain without trial in the heat of the moment. A parliament which had been summoned for the attainder of Murray and his fellow-conspirators was discharged by proclamation issued in the name of Darnley as king; and in the evening of the next day the banished lords returned to Edinburgh On the day following they were graciously received by the queen, who undertook to sign a bond for their security, but delayed the subscription till next morning under plea of sickness During the night she escaped with Darnley, whom she had already seduced from the party of his accomplices, and arrived at Dunbar on the third morning after the slaughter of her favourite. From thence they returned to Edinburgh on March 28 guarded by 2,000 horsemen under the command of Bothwell, who had escaped from Holyrood on the night of the murder, to raise a force on the queen's behalf with his usual soldierly promptitude. The slayers of Rizzio fled to England, and were outlawed; Darnley was permitted to protest his innocence and denounce his accomplices.

A reconciliation between husband and wife followed the birth of their son, James, on June 19, 1566, but it was only temporary. Darnley refused to be present at the baptism of the prince in October, and soon afterwards, while suffering from a serious ill-

[1] In a letter dated April 4, 1882, referring to the publication of his drama *Mary Stuart*, Swinburne wrote to Edmund Clarence Stedman: "*Mary Stuart* has procured me two satisfactions which I prefer infinitely to six columns of adulation in The *Times* and any profit thence resulting. (1) A letter irom Sir Henry Taylor . . . (2) An application from the editor of the *Encyclopædia Britannica*—who might, *I* suppose, as in Macaulay's time, almost command the services of the most eminent scholars and historians of the country—to me, a mere poet, proposing that I should contribute to that great repository of erudition the biography of Mary Queen of Scots. I doubt if the like compliment was ever paid before to one of our 'idle trade.' " The present article is based on the biography consequently written by the poet ior the 9th edition, after revision by Prof. R. S. Rait.

ness, he went to stay with his father in Glasgow. He had earned his doom at all hands alike. and if his wife and Bothwell were by this time plotting against him, his death was not to be the result of a mere domestic conspiracy, for Bothwell had other accomplices than the queen On Jan. 22, 1567, Mary visited her husband at Glasgow and proposed to remove him to Craigmillar Castle, where he would have the benefit of medicinal baths; but instead of this resort he was conveyed, on the last day of the month, to the lonely and squalid shelter of the residence known as Kirk-of-Field. On the evening of Sunday, Feb. 9, Mary took her last leave of the miserable boy who had so often and so mortally outraged her as consort and as queen. That night the whole city was shaken out of sleep by an explosion of gunpowder which shattered to fragments the building in which he should have slept and perished; and the next morning the bodies of Darnley and a page were found strangled in a garden adjoining it, whither they had apparently escaped over a wall, to be despatched by the hands of Bothwell's confederates.

Three months and six days after the murder of her husband Mary became the wife of her husband's murderer. On Feh. 11 she had written to the bishop of Glasgow, her ambassador in France. announcing her providential escape from a design upon her own as well as her hushand's life. A reward of £2.000 was offered by proclamation for discovery of the murderer. Bothwell and others, his satellites or the queen's. were instantly placarded by name as the criminals. Gracefully and respectfully, with statesmanlike, yet feminine dexterity, the demands of Darnley's father for justice on the murderers of his son were accepted and eluded by his daughter-in-law. On March 28 the Privy Council. in which Bothwell himself sat, appointed April 12 as the day of his trial. Bothwell was acquitted in default of witnesses against him, and his wealth and power were enlarged by gift of the parliament which met on the 14th and rose on April 19—a date made notable by the subsequent supper at Ainslie's tavern. where Bothwell obtained the signatures of its leading members to a document affirming his innocence, and pledging the subscribers to promote the marriage by which they recommended the queen to reward his services and benefit the country. On the second day following Mary went to visit her child at Stirling, where his guardian, the earl of Mar, refused to admit more than two women in her train. It was well known in Edinburgh that Bothwell had a body of men ready to intercept her on the way bark, and carry her to Dunbar—not, as was naturally inferred. without good assurance of her consent. On April 24, as she approached Edinburgh. Bothwell accordingly met her at the head of 800 spearmen. assured her (as she afterwards averred) that she was in the utmost peril, and escorted her, together with Huntly, Lethington and Melville. who were then in attendance, to Dunbar Castle. On May 3 Lady Jane Gordon, who had become countess of Bothwell on Feb 22 of the year preceding, obtained a separation on the ground of her husband's infidelities. Mary and Bothwell returned to Edinburgh with every prepared appearance of a peaceful triumph. Lest her captivity should have been held to invalidate the late legal proceedings in her name, proclamation was made of forgiveness accorded by the queen to her captor in consideration of his past and future services. Bothwell. as a conscientious Protestant, reiused to marry his mistress according to the rites of her Church. and she, the chosen champion of its cause, agreed to be married to him by a Protestant,

On May 12 Bothwell was created duke of Orkney and Shetland and the marriage was solemnized three days later. The confederate lords almost immediately took up arms and seized the town and the castle of Edinburgh. Proclamations were issued in which the crime of Bothwell was denounced, and the disgrace of the country, the thraldom of the queen and the mortal peril of her infant son: were set forth as reasons for summoning all the lieges of the chief cities of Scotland to rise in arms on three hours' notice and join the forces assembled against the one common enemy. On June 1j, one month from their marriage day. the queen and Bothwell, at the head of a force of fairly equal numbers. but visibly inferior discipline, met the army of the confederates at Carberry hill, some 6m. from Edinburgh. Du Croc, the French ambassador, obtained permission, through the influence of Maitland, to convey to the queen the terms proposed by their leaders—that she and Bothwell should part, or that he should meet in single combat a champion chosen from among them. At last it was agreed that the queen should yield herself prisoner, and Bothwell be allowed to retire in safety to Dunbar, with the few followers who remained to him.

In the evening she was taken to Holyrood, and thence to the port of Leith, where she embarked under guard, with her attendants, for the island castle of Lochleven. On the 20th a silver casket containing letters and French aerses, miscalled sonnets, in the handuriting of the queen, was taken from the person of a servant who had been sent by Bothwell to bring it from Edinburgh to Dunbar. (See CASKET LETTERS) Three days after this discovery Lord Lindsay, Lord Ruthven and Sir Robert Melville were despatched to Lochleven, there to obtain the queen's signature to an act of abdication in favour of her son, and another appointing Murray regent during his minority. She submitted, and a commission of regency was established After an imprisonment of 11 months, in the course of which Elizabeth intervened on her behalf, and sent Mary a letrer and a ring in token of her protection, a young member of the household at Lochleven, Willie Douglas, aged 18, succeeded on May 2 in assisting her to escape by a postern gate to the lake-side, and thence in a boat to the msinland, where George Douglas, Lord Seton and others were awaiting her Thence they rode to Seton's castle of Niddry, and next day to Hamilton Palace, round nhich an army of 6,000 men was soon assembled The queen's forces made for the castle of Dumbarton, marching 2m. south of Glasgow, by the village of Langside. Here hlurray, with 4,500 men, met and defeated his sister's army on May 13. Mary fled 60m. from rhe field of her last battle before she halted at Sanquhar, and for three days of flight, according to her own account, had to sleep on the hard ground, live on oatmeal and sour milk, and fare at night like the owls, in hunger, cold and fear On the third day from the rout of Langside she crossed the Solway and landed at Workington in Cumberland, May 16. 1j68. On the 20th Lord Scrope and Sir Francis Knollys uere sent from court to carry messages and letters of comfort from Elizabeth to Mary at Carlisle. Her fateful choice of England instead of France was determined by her thirst for victory. She believed that Elizabeth's horror of rebellion would lead the English queen to assist her to regain her crown, and she knew no such help could be expected from France, embroiled in the wars of religion. On July 1j, after various delays interposed by her reluctance to leave the neighbourhood of the border, where on her arrival she had received the welcome and the homage of the leading Catholic houses of Northumberland and Cumberland, she was removed to Bolton Castle in north Yorkshire. During her residence here a conference was held at York between her onn and Elizabeth's commissioners and those appointed to represent her son as a king of Scots. These latter, of whom Murray himself was the chief, privately laid before the English commissioners the contents of the famous casket. On Oct. 24 the place of the conference was shifted from York to London. where the enquiry was to be held before Queen Elizabeth in council. Mary was already aware that the chief of the English commissioners, the duke of Norfolk, was secretly an aspirant to the peril of her hand: and on Oct 21 she gave the first sign of assent to the suggestion of a divorce from Bothwell On Oct. 26 the charge of complicity in the murder of Darnley was distinctly brought forward against her, in spite of Norfolk's reluctance and Murray's previous hesitation. On Jan. 10, 1569, the judgment given at the conference acquitted Murray and his adherents of rebellion, while affirming that nothing had been proved against Mary—a verdict accepted by Murray as equivalent to a practical recognition of his office as regent for the infant king. This position he was not long to hold; and the fierce exultation of Mary at the news of his murder gave reason to fear, if her liberty of correspondence and intrigue were not restrained, the likelihood of a similar fate for Elizabeth. On Jan. 26, 1569 she had been removed from Bolton Castle to Tutbury in Staffordshire, where proposals were conveyed to her, at the instigation of Leicester, for a marriage with the duke of Norfolk, to which she gave a graciously conditional assent; but the discovery of these proposals consigned Norfolk to the Tower, and on the outbreak of an insurrection in the north Mary, by Lord Hunsdon's advice, was again removed to Coventry, when a body of her intending deliverers was within a day's ride of Tutbury. In October Cecil had an interview with Mary at Chatsworth, when the conditions of her possible restoration to the throne in compliance with French demands were debated at length. The queen of Scots, with dauntless dignity, refused to yield the castles of Edinburgh and Dumbarton into English keeping, or to deliver up her fugitive English partisans then in Scotland; upon other points they came to terms, and the articles were signed Oct. 16. On the same day Mary wrote to Elizabeth. requesting the favour of an interview which might reassure her against the suggestion that this treaty was a mere pretence. On Nov 28 she was removed to Sheffield Castle, where she remained for the next 14 years in charge of the earl of Shrewsbury. The detection of a plot, in which Norfolk was implicated, for the invasion of England by Spain on behalf of Mary, who was then to take him as the fourth and most contemptible of her husbands, made necessary the reduction of her household and the stricter confinement of her person On May 28, 1j72, a demand from both houses of parliament for her execution as well as Norfolk's was rejected by Elizabeth, who, however, entered into negotiations with successive Scottish regents for Mary's delivery into their hands and her immediate execution.

In 1581 Mary accepted the advice of Catherine de' Medici and Henry III that she should allow her son's title to reign as king of Scotland conjointly with herself when released and restored to a share of the throne. This plan was but part of a scheme including the invasion of England by her kinsman, the duke of Guise, who was to land in the north and raise a Scottish army to place the released prisoner of Sheffield beside her son on the throne of Elizabeth After the overthrow of the Scottish accomplices in this notable project, Mary poured forth upon Elizabeth a torrent of pathetic and eloquent reproach for the many wrongs she had suffered at the hands of her hostess, and pledged her honour to the assurance that she now aspired to no kingdom but that of heaven. In the spring of 1583 she retained enough of this saintly resignation to ask for nothing but liberty. without a share in the government of Scotland; but Lord Burghley not unreasonably preferred, if feasible, to reconcile the alliance of her son with the detention of his mother. In the autumn of 1584 she was removed to Wingfield Manor under charge of Sir Ralph Sadler and John Somers, who accompanied her also on her next removal to Tutbury in Jan. 1585. On Christmas Eve, 1585, she was removed from the hateful shelter of Tutbury to the castle of Chartley in the same county. Her correspondence in cipher from thence with her English agents abroad, intercepted by Walsingham and deciphered by his secretary, gave eager encouragement to the design for a Spanish invasion of England under the prince of Parma. In 1j3j Anthony Babington was induced to undertake the deliverance of the queen of Scots by the murder of the queen oi England. In the conduct and detection of her correspondence with Babington, traitor was played off against traitor, and spies were utilized against assassins, with as little scruple as could be required or expected in the diplomacy of the time. In August the conspirators were netted, and Mary was arrested at the gate of Tixall park. At Tixall Mary was detained till her papers at Chartley had undergone thorough research. Her secretaries were examined in London, and one of them gave evidence that she had first heard of the conspiracy by letter from Babington, of whose design against the life of Elizabeth she thought it best to take no notice in her reply, though she did not hold herself bound to reveal it. On Sept. 2j she was removed to the castle of Fotheringhay in Northamptonshire. On Oct. 6 she was desired to answer the charges brought against her before certain of the chief English nobles.

On Oct. 14 and 1j, 1586. the trial was held in the hall of Fotheringhay castle. Mary conducted the whole of her own defense with courage incomparable and unsurpassable ability, insisting on the production of proof in her own handwriting as to her complicity with the project of the assassins. who had expiated their crime on the 20th and 21st of the month preceding. Elizabeth determined to adjourn the judgment and transfer the place of it to the star-chamber. Here, on Oct. 2j. the commissioners again met: and one of them alone. Lord Zouch, dissented from the verdict by which Mary was found guilty of having, since June 1 preceding, compassed and imagined divers matters tending to the destruction of Elizabeth. This verdict was conveyed to her, about three weeks later, by Lord Buckhurst and Robert Beale. She wrote to Elizabeth and the duke of Guise two letters of almost matchless eloquence and pathos. admirable especially for their loyal and grateful remembrance of all her faithful servants.

Elizabeth was uncertain how James VI., then 20 years of age, might take the execution of his mother. When Elizabeth discovered that James was much more interested in the succession to the English throne than in his mother's life. and that. if he was assured that her trial and condemnation would not prejudice his claim to the succession. he would (in his own words) "digest" his resentment. she rejected the intercessions made by France and Scotland, and on Feb. 1. 1587, she signed the death-warrant. On Feb. 7 the earls of Shrewsbury and Kent arrived at Fotheringhay with the commission of the council for execution of the sentence. Mary received the announcement with majestic tranquillity, expressing in dignified terms her readiness to die, her consciousness that she was a martyr for her religion, and her total ignorance of any conspiracy against the life of Elizabeth At eight next morning she entered the hall of execution, having taken leave of the weeping envoy from Scotland, to whom she gave a brief message for her son; took her seat on the scaffold, listened with an air of even cheerful unconcern to the reading of her sentence, solemnly declared her innocence of the charge conveyed in it and her consolation in the prospect of ultimate justice. rejected the professional services of Richard Fletcher, dean of Peterborough, lifted up her voice in Latin against his in English prayer, and when he and his fellom-worshippers had fallen duly silent prayed aloud for the prosperity of her own Church, for Elizabeth, for her son, and for all her enemies; then, with no less courage than had marked every hour and every action of her life, received the stroke of death from the wavering hand of the headsman.

Five months after Mary's death her body was buried at Peterborough, whence in 1612 it was removed to King Henry VII.'s chapel in Westminster Abbey. It still lies there in a sumptuous tomb erected by her son, James VI.

Mary Stuart was in many respects the creature of her age, of her creed, and of her station; but the noblest and most noteworthy qualities of her nature were independent of rank. opinion or time. Even the detractors who defend her conduct on the plea that she was a dastard and a dupe are compelled in the same breath to retract this implied reproach, and to admit. with illogical acclamation and incongruous applause. that the world never saw more splendid courage at the service of more brilliant intelligence, that a braver if not "a rarer spirit never did steer humanity." A kinder or more faithful friend, a deadlier or more dangerous enemy, it would be impossible to dread or to desire. Passion alone could shake the double fortress of her impregnable heart and ever-active brain. The passion of love. after very sufficient experience, she apparently and naturally outlived; the passion of hatred and revenge was as inextinguishable in her inmost nature as the emotion of loyalty and gratitude. Of repentance it would seem that she knew as little as of fear.

Adept as she was in the most exquisite delicacy of dissimulation, the most salient note of her original disposition mas daring rather than subtlety. Beside or behind the voluptuous or intellectual attractions of beauty and culture. she had about her the fresher charm of a fearless and frank simplicity. a genuine and enduring pleasure in small and harmless things no less than in such as were neither.

In 1562 she amused herself for some days by living "with her little troop" in the house of a burgess of St. Andrews "like a burgess's wife," assuring the English ambassador that he should not find the queen there.—"nor I know not myself where she is become." From Sheffield lodge. 12 years later, she applied to the archbishop of Glasgow and the cardinal of Guise for some pretty little dogs, to be sent her in baskets very warmly packed,—"for besides reading and working, I take pleasure only in all the little animals that I can get." For her own freedom of will and of way, she cared much; for her creed she cared something; for her country she cared nothing. (A. C. S.; R. S. R.)

BIBLIOGRAPHY.—The biography of Mary Stuart being virtually the history of Scotland during the period covered by her life, with which the history of England at the same period is also largely concerned, the chief events in which she figured are related in all the general *Histories* of both countries. The most important original authorities are the voluminous *State Papers* of the period, with other manuscript documents preserved at the British Museum, the Cambridge University Library, Hatfield and elsewhere. *See* especially the *Reports* of the Historical Manuscripts Commission; *Calendar of State Papers Relating to Scotland and Mary Queen of Scots* (Scottish Record Publ., 1898); *Calendar of Letters and State Papers Relating to English Affairs, Principally in the Archives at Simancas,* vol. i–iv (1892–99); and the *Calendars of State Papers: Domestic Series, Edw. VI.–James I.; Foreign Series, Elizabeth; Venice Series.* Important unofficial works: *Histories* of John Knox, Bishop John Lesley, George Buchanan and Robert Lindsay of Pitscottie; the *Diurnal of Remarkable Occurrents from the Death of James IV. till 1575* (Bannatyne club, 1833); Robert Birrell's "Diary," in Sir. J. G. Dalzell's *Fragments of Scottish History* (Edinburgh, 1798); etc. Much of Mary's own correspondence will be found in Prince A. Labanoff's *Lettres inédites, 1558–87* (1839), and *Lettres, instructions, et mémoires de Marie Stuart,* 7 vol. (London, 1844), selections from which have been translated into English by W. Turnbull in *Letters of Mary Queen of Scots* (1845), and by Agnes Strickland in *Letters of Mary Queen of Scots and Documents Connected with Her Personal History,* 3 vol. (1842). Recently the following three publications have added to our knowledge of original sources: Conycrs Read, *Bardon Papers;* J. Pollen, *The Babington Conspiracy;* and M. Wood, *Balcarres Papers.*

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MARY OF LORRAINE (1515–1560)! generally known as MARY OF GUISE, queen of James V and afterward regent of Scotland, was born at Bar-le-Duc, France, on Nov. 22, 1515. She was the eldest child of Claude of Guise and Antoinette de Bourbon, and married in 1534 Louis II of Orleans, duke of Longueville, to whom in 1535 she bore a son. Francis (d. 1551). The duke died in 1537, and Mary was sought in marriage by James V, and by Henry VIII (after the death of Jane Seymour). James's suit was successful, and he married Mary at Paris, by proxy, early in 1538, and, in a second ceremony at St. Andrews, in June of that year. Her two sons. James (b. May 1540) and Robert or Arthur (b. April 1541), died within a few days of one another in April 1541, and her husband died in Dec. 1542, within a week of the birth of his heiress, Mary Queen of Scots. The regency fell to the heir presumptive, James. earl of Arran, who favoured England and the Protestant party, and who hoped to secure the infant princess for his son, Mary of Lorraine was approached by the English commissioner, Sir Ralph Sadler. to induce her to further her daughter's marriage contract with Henry's son, Edward. The marriage treaty between Mary, not then one year old, and Edward was signed in July at Greenwich, and guaranteed that Mary should be placed in Henry's keeping when she was ten. (See MARY QUEEN OF SCOTS.)

In 1550 Mary of Lorraine visited France and obtained from Henry II the confirmation of the dukedom of Châtelherault, already granted to the earl of Arran, in the hope of inducing him to resign the regency. Arran refused to comply until April 1554, when Mary of Lorraine took his place as regent for the absent queen. She had now to deal with an empty exchequer and with a strong opposition to her daughter's marriage with the dauphin Francis. The first revolt against her authority arose from an attempt to establish a standing army. When she provoked a war with England in 1557, the nobles refused to cross the border. In matters of religion she tried to hold the balance between the Catholics and Protestants and allowed the reformers the practice of their religion as long as they refrained from public preachings in Edinburgh and Leith, but the marriage of Francis and her daughter, Mary, in 1558 strengthened her position, and in 1559 she adopted the religious policy of her relatives, the Guises. She was reconciled with Archbishop John Hamilton, and took up arms against the Protestants of Perth, who, incited by John Knox, had destroyed the Charterhouse with the royal tombs. They submitted on condition that no foreign garrison be imposed on Perth and that the religious settlement be referred to the Scottish parliament. Mary of Lorraine broke the spirit of this agreement by garrisoning Perth with Scottish troops in the pay of France. The Lords of the Congregation soon assembled in considerable force on Cupar muir. Mary retreated to Edinburgh and thence to Dunbar, while Edinburgh opened its gates to the reformers, who issued a proclamation (Oct. 21, 1559) claiming that the regent was deposed. The lords sought help from Elizabeth I, while the regent had recourse to France. The strength of her opponents was increased by the defection of Châtelherault and his son Arran, and by the betrayal of her plans by her secretary, William Maitland, to the Lords of the Congregation. In Oct. 1559 they made an unsuccessful attack on Leith. Mary entered Edinburgh and conducted a campaign in Fife.

When an English army under Lord Grey entered Scotland in March 1560, the ailing regent received an asylum in Edinburgh castle, which was held strictly neutral by Lord Erskine (later earl of Mar). Before her death (June 11, 1560) Mary sent for the Lords of the Congregation, with whom she pleaded for the maintenance of the French alliance. (G. S. P.; S.)

MARY OF MODENA (MARIA BEATRICE ANNE MARGARET ISABEL D'ESTE) (1658–1718), queen of the English king James II, and daughter of Alphonso IV, duke of Modena, and the duchess Laura, of the Roman family Martinozzi, was born at Modena, Italy, on Oct. 5, 1658. She was married by proxy to James, then duke of York, on Sept. 30, 1673, and in November reached England, where she was regarded as an agent of the pope. During the "popish" plot. she went abroad with her husband. Between 1675 and 1682 she bore five children, of whom only one daughter survived infancy. When her second son, James Francis Edward, was born on June 10 (old style), 1688, it was said that the child was not really hers, and that a fraud had been perpetrated to secure a Roman Catholic heir. At the outbreak of the revolution she made the disastrous mistake of consenting to escape to France (Dec. 10, 1685) with her son. She urged James to follow when it was his manifest interest to stay in England. and when he went to Ireland, she pressed for his return. Another daughter, Louisa Maria, was born at St. Germain, France, on June 28. 1692. When her husband died on Sept. 6, 1701, she induced Louis XIV to recognize her son as king of England, an act which precipitated the War of the Spanish Succession (*q.v.*). Surviving James by 17 years. Mary lived at St. Germain and at Chaillot, in a house of the Visitation, where she died on May 7, 1718.

MARY (1457–1482), duchess of Burgundy, only child of Charles the Bold, duke of Burgundy, and his wife Isabella of Bourbon, was born on Feb. 13, 1457. As heiress of the rich Burgundian domains her hand was eagerly sought by a number of princes. When her father fell upon the field of Nancy, on Jan. 5, 1477, Louis XI of France took possession of the duchy of Burgundy, as a fief lapsed to the French crown, and also of Franche-Comté, Picardy and Artois (to which France was to renounce her claims in 1493). He was anxious that Mary should marry the dauphin Charles and thus confer the inheritance of the Netherlands on his descendants. Mary declined the French alliance and married the archduke Maximilian of Austria, afterward the emperor Maximilian I, at Ghent on Aug. 18, 1477. She died on March 27, 1482. Her son, Philip, married Joan the Mad of Castile and Aragon and was the father of Charles V; her daughter: Margaret of Austria, proved a great governess of the Netherlands and the Franche-Comté (*q.v.*).

See L. Hommel, *Marie de Bourgogne et le grand héritage,* 2nd ed. (Brussels, Paris, 1945); G. Dumont, *Marie de Bourgogne, impératrice d'Allemagne,* 4th ed. (Brussels, 1945).

END OF VOLUME FOURTEEN

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